



LINK NC Benefit Cost Analysis (BCA)

Executive Summary

The LINK NC Benefit Cost Analysis (BCA) describes the advantages of the project, given an award and construction completion. NCDOT used USDOT’s Benefit Cost Analysis Guidance (2024) to execute the BCA analysis and incorporated the recommended parameter values where suitable. The BCA employed an analysis period spanning 20 years (2032-2051), anticipating construction commencement in 2030. All costs and benefits are presented in 2023 base year dollars.

The BCA considered five distinct benefit categories:

- **Safety:** Reduction in crashes and associated costs.
- **Emission Reduction:** Reduction in vehicle miles traveled (VMT), thereby improving air quality by reducing carbon dioxide (CO₂) emissions.
 - **Reduction in Non-CO₂ Emissions:** Impact provided by improved air quality for better environmental and personal health.
 - **Reduction in CO₂ Emissions:** Impact provided by improved air quality for better environmental and personal health
- **Amenity Benefits:** Enhanced pedestrian and bicyclist journey quality and experience due to new facilities.
- **Health:** Increased life expectancy through enhanced opportunities for personal health improvements.
- **Residual Value:** The value of infrastructure enhancements post the 20-year evaluation period.

Summary of the BCA Results

Table 1 shows the BCA summary and the total benefits. The capital costs incorporated in the BCA amount to \$7,555,000. With a 20-year evaluation (2032-2051) and a real discount rate of 3.1 percent¹, the analysis illustrates a net present value (NPV) of **\$43,612,083** and a benefit-cost ratio (BCR) of **10.41**.

Table 1. BCA Summary

Category	Discounted Value (in 2023 Dollars)
Net Discounted Benefits	\$48,247,575
Net Discounted Capital + O&M Costs	\$4,635,492
Net Present Value	\$43,612,083
Benefit-Cost Ratio	10.41

¹ CO₂ emissions uses a discount rate of 2%.

Table 2 outlines the undiscounted benefits over the evaluation period for each category.

Table 2. Undiscounted Benefits over Evaluation Period

Category	Monetary Value (in 2023 Dollars)
Safety Benefits	\$78,624,140
Non-CO2 Emission Reduction	\$2,207
CO2 Emissions Reduction	\$19,566
Amenity Benefits	\$199,185
Health Benefits	\$2,994,360
Residual Value	\$3,124,633

NCDOT did not calculate the following items based on low quantitative values relative to the inputs for:

- **Travel Time Savings:** Not used for cost or benefit due to lack of current corridor congestion. This project will not meaningfully improve capacity, congestion, or travel time.
- **Vehicle Operating Cost Savings:** With no anticipated travel time savings for the corridor, there are no calculations performed for improved operational costs for vehicles.
- **Resiliency:** While the project does include new closed drainage improvements that may reduce pooling on the roadway during precipitation events and contribute to overall improved drainage, its specific contribution cannot be determined.

Detailed calculations and supporting data for this analysis can be found in the [referenced LINK NC BUILD BCA Workbook](#).

Calculation Methodology for Benefits

LINK NC provides substantial benefits for the community, with primary advantages for those residing within the census tracts directly adjacent to the corridor. The LINK NC projects are designed to improve walking accessibility and connectivity for the residents and users of the corridor. These two census tracts were thus used as the analyzed walkshed for commute and utilitarian trips impacted on the corridor.

Benefits were calculated using population and mode share estimates from the 2019-2023 American Community Survey (ACS). The assumed annual population growth rate was 1.3%, based on the North Carolina Office of State Budget and Management 2050 population projection for New Hanover County, annualized to an annual growth rate from 2020.

NCDOT calculated benefits by contrasting walking in the no-build scenario with the projected changes following project implementation (build scenario). NPV and BCR calculations distinguish the differences between the two scenarios.

Baseline (No Build) and Build Scenario Assumptions

- **Baseline Conditions:** Assume no change in walking mode share from the 2019 – 2023 ACS. To determine the annualized commute walk trips, NCDOT assumed that the daily commuting population takes 2 walking trips (one to work and one back) 5 days a week for 52 weeks. Utilitarian walking trips were calculated based on the local walk share for non-commute trips for all eligible adults (assumed 68 percent of the population based on USDOT’s BCA Guidance), multiplied by the utilitarian walk share, multiplied by 365 days of the year. Based on the ACS, commute walk share for LINK NC is 1.98% and utilitarian trips is 2.26%.

- Build Conditions:** Assume induced trips from improved walking conditions aimed at achieving a 3% walking mode share for commuting and utilitarian trips by 2050, based on the [NCDOT Long-Range Economic Impact Analysis goal](#). Most build scenario vehicle trips were assumed as short commuting and utilitarian trips accomplished by a passenger vehicle; trucks, SUVs, and commercial vehicles were not included in the analysis. The anticipated emission benefits are likely under-represented and would result in increased emissions benefits.

Population and Modal Use in LINK NC

NCDOT used ACS data from ACS to determine walking for the project area. Walking was selected since the project improvements are focused primarily on pedestrians, and reported mode share for bicycling in the project area is 0%. The LINK NC projects, specifically the Multi-Use Path (MUP) segment, is part of a larger regional greenways network planned in New Hanover County. Ultimately, NCDOT expects the LINK NC projects to play an important role in increasing bicycle use and safety in the project area, but due to the nature of this long-range plan and the limited quantifiable data associated with it, there may be some long-term benefits that are not accounted for in this BCA. Table 3 summarizes the baseline mode share for the project area. Table 4 displays the trip multiplier used in the BCA analysis, derived from the 2017 National Household Travel Survey (NHTS), the most recent survey with complete data. The trip multiplier is used to project demand and activity for future utilitarian trips from census commute data and is used in the BCA as a function for projecting future VMT reduction.

Table 3. Baseline Mode Share (Transportation to Work)

	Total	Commuter	Drove Alone	Carpool (Any)	Transit	Bicycle	Walked	Other means	WFH
Population	11,769	6,317	4,838	502	0	0	125	72	780
Mode Share			77%	8%	0%	0%	1.98%	1%	12%

Table 4. Demand/Activity Multipliers (NHTS, 2017)

Demand/Activity Multipliers	Factor
Utilitarian Walk Trip Multiplier	3.27
Vehicle Miles Traveled Reduced	
Commuter – Walk (miles)	0.72
Utilitarian – Walk (miles)	0.83

Costs

The capital costs for LINK NC are \$7,555,000. The main application provides more detailed information on the project costs. The LINK NC budget used a 30% contingency, which is incorporated into the capital costs to responsibly account for unanticipated costs associated with final design, right-of-way, and environmental documentation.

Operations and Maintenance

Estimated maintenance costs were based on NCDOT values for anticipated pavement maintenance cycles, average annual signal and lighting maintenance, and annual sidewalk maintenance. NCDOT estimated that the multimodal improvements in the Build scenario will cost \$5,820 more on a yearly basis to maintain over the 20-year period analyzed within the BCA than maintaining the baseline conditions.

Useful Life

The expected useful life of the improvements ranges from 20 to 50 years. NCDOT used an analysis period of 20 years post-construction. NCDOT claimed a residual value benefit of **\$3,124,633**. More information on the calculations may be found in the “Residual Value” tab in the [LINK NC BUILD BCA Workbook](#).

Benefits

Safety Benefits

NCDOT calculated historical crash costs for the LINK NC corridor and estimated the reduction from implementing safety improvements. Historical ten-year (2014-2023) pedestrian and bicyclist crash data was used to compute baseline conditions. The LINK NC improvements are not anticipated to have a significant impact on vehicle crash severity, so NCDOT did not analyze vehicular crash data for the BCA. Bicyclist/pedestrian crashes were selected within 300 feet of the corridor (300 feet was selected as a buffer to capture pedestrians and bicyclist crashes that will be averted in Build Year with the inclusion of the median fence in the LINK NC improvements). Bicyclists were included in the crash reporting due to the lack of formal bicycle facilities and local knowledge and observation that bicyclists commonly operate on pedestrian facilities, including crossing at the intersections improved by LINK NC.

Future reductions used Crash Modification Factors (CMFs) from NCDOT’s Crash Reduction Factor Project Development document and the CMF Clearinghouse. The primary safety countermeasures selected for this project are summarized in Table 5. Bicycle/pedestrian crash history is summarized in Table 6. The ten-year crash data are assigned to one of the two countermeasures identified in Table 5 based on whether the crash type involved a pedestrian or bicyclist moving along the roadway or crossing. In the ten year analysis, 14 total crashes were reported as crossing related, including four fatal and 4 serious injury crashes. Two crashes were reported as walking/bicycling along the roadway, including one fatal crash. Annual crash costs in Table 6 are calculated by applying a severity cost to each crash type, as identified in the BCA Guidance, and annualizing.

Table 5. Selected Countermeasures

Countermeasure Type	Applicable Crashes	CMF	Source
Sidewalk	Pedestrian - Along Roadway	0.26	NCDOT CRF Sheet
Crosswalk with Multiple Improvements	Pedestrian - Crossing	0.5	NCDOT CRF Sheet

Table 6. Crash Data and Annual Costs

Non-Motorized Crashes by Improvement	Total Crashes (10-Year)	K	A	B	C	O	U	PDO	Search Distance	Annual Crash Cost
New Sidewalk and Multi-Use Path	2	1			1				Along Corridor	\$1,331,800
Install Crosswalk with Multiple Improvements	14	4	4	3	3				Along Corridor	\$5,891,350

NCDOT also calculated the Build anticipated crashes, shown in Table 7. See Table 5 for source information for CMFs.

Table 7. Anticipated Build Condition Crash Reductions

Vehicle Crashes	CMF	K	A	B	C	O	U	PDO
New Sidewalk and Multi-Use Path	0.26	0.26			0.26			
Install Crosswalk with Multiple Improvements*	0.5	2	2	1.5	1.5			

*Additional improvements include median pedestrian fencing. Future crashes are assumed to be focalized to the crosswalks in Build scenario.

Table 8 describes an annual crash cost – calculated from the Build year reductions outlined in Table 7 – and safety benefit – the difference in No Build crash costs and Build crash costs. These results are calculated in the “Safety” tab of the [LINK NC BUILD BCA Workbook](#).

Table 8. Anticipated Annual Crash Cost and Safety Benefit

Mode	Improvement Type	Anticipated Annual Crash Cost	Safety Benefit
Pedestrian	Sidewalk	\$346,268	\$985,532
Pedestrian	Crosswalk with Multiple Improvements	\$2,945,675	\$2,945,675

Emissions Reduction

NCDOT calculated the emissions reduction impact of LINK NC by determining baseline VMT and calculating the annual difference in VMT based on the anticipated increased opportunity for safe multimodal transportation in the Build scenario. This VMT analysis uses passenger vehicle. Trucks, SUVs, and commercial vehicles were not included in the analysis; those emissions values are higher and would result in increased emissions benefits. NCDOT calculated annual emissions savings by using USDOT’s BCA Guidance values (Table 9). Emission Cost Reductions are displayed for non-CO₂ emissions in Table 10 and for CO₂ emissions in Table 11.

Table 9. Emissions Costs Per VMT

Vehicle Type and Location	Recommended Value per Mile (2023\$)	
	Non-CO ₂ Emissions	CO ₂ Emissions
All Vehicles – All Locations	\$0.015	\$0.133

Table 10. Emissions For Non-CO₂ No Build and Build

Year	No Build Non-CO ₂ Emission Costs (\$)	Build Non-CO ₂ Emission Costs (\$)	Non-CO ₂ Emission Reduction
2032	\$53,995	\$53,966	\$29
2033	\$53,996	\$53,966	\$30
2034	\$53,997	\$53,965	\$32
2035	\$53,998	\$53,964	\$35
2036	\$54,000	\$53,963	\$37
2037	\$54,001	\$53,961	\$40
2038	\$54,002	\$53,959	\$43
2039	\$54,003	\$53,957	\$46
2040	\$54,005	\$53,954	\$51

2041	\$54,006	\$53,950	\$55
2042	\$54,007	\$53,946	\$61
2043	\$54,008	\$53,940	\$68
2044	\$54,010	\$53,933	\$77
2045	\$54,011	\$53,923	\$88
2046	\$54,012	\$53,909	\$103
2047	\$54,013	\$53,889	\$124
2048	\$54,015	\$53,860	\$155
2049	\$54,016	\$53,809	\$206
2050	\$54,017	\$53,708	\$309
2051	\$54,018	\$53,401	\$617

Table 11. Emissions For CO₂ No Build and Build

Year	No Build CO ₂ Emission Costs (\$)	Build CO ₂ Emission Costs (\$)	CO ₂ Emission Reduction
2032	\$478,753	\$478,500	\$253
2033	\$478,764	\$478,495	\$269
2034	\$478,775	\$478,488	\$287
2035	\$478,786	\$478,480	\$306
2036	\$478,797	\$478,469	\$328
2037	\$478,808	\$478,456	\$352
2038	\$478,819	\$478,439	\$380
2039	\$478,830	\$478,419	\$411
2040	\$478,841	\$478,393	\$448
2041	\$478,852	\$478,361	\$491
2042	\$478,863	\$478,320	\$543
2043	\$478,874	\$478,269	\$605
2044	\$478,885	\$478,202	\$683
2045	\$478,896	\$478,114	\$782
2046	\$478,907	\$477,993	\$914
2047	\$478,918	\$477,820	\$1,098
2048	\$478,929	\$477,556	\$1,373
2049	\$478,940	\$477,110	\$1,830
2050	\$478,951	\$476,210	\$2,741
2051	\$478,962	\$473,492	\$5,470

Amenity Benefits

NCDOT calculated amenity benefits for the new sidewalk and MUP facilities added in LINK NC. These values were calculated by using USDOT’s 2024 BCA Guidance values. NCDOT used facility length of 0.51 miles, the total length of new pedestrian facilities added in LINK NC, an average width of 6.48, accounting for a 10-foot MUP and a 5-foot sidewalk, and an amenity value detailed in Table 12. Table 13 displays the annual amenity benefits for the 20-year period.

Table 12. Amenity Parameters for Pedestrian and Bicyclist Improvements

Improvement Type	Recommended Value per Person-Mile Walked (2023)
Expand Sidewalk (per foot of added width)	\$0.11

Table 13. Anticipated Amenity Benefits from Build Scenario

Year	Amenity Benefits
2032	\$2,618
2033	\$2,781
2034	\$2,960
2035	\$3,159
2036	\$3,381
2037	\$3,630
2038	\$3,912
2039	\$4,235
2040	\$4,609
2041	\$5,047
2042	\$5,569
2043	\$6,203
2044	\$6,990
2045	\$7,996
2046	\$9,330
2047	\$11,188
2048	\$13,963
2049	\$18,571
2050	\$27,762
2051	\$55,280

Health Benefits

The health benefits are derived from the anticipated increased opportunity for walking in the Build scenario. Health benefits were calculated from the expected activity of applicable persons in the recommended age ranges (20-74). NCDOT assumed 68% of the induced trips fall into in the applicable age range. USDOT’s BCA Guidance values is displayed in Table 14 and the annual health benefits are displayed in Table 15.

Table 14. Recommended Monetization Values for Walking and Cycling

Mode	Applicable Age Range	Recommended Value per Induced Trip (2023)
Walking	Ages 20-74	\$8.06

Table 15. Anticipated Health Benefits from Build Scenario

Year	Health Benefits
2032	\$39,361
2033	\$41,808
2034	\$44,503

2035	\$47,489
2036	\$50,820
2037	\$54,563
2038	\$58,806
2039	\$63,662
2040	\$69,282
2041	\$75,873
2042	\$83,725
2043	\$93,254
2044	\$105,088
2045	\$120,210
2046	\$140,260
2047	\$168,191
2048	\$209,906
2049	\$279,182
2050	\$417,345
2051	\$831,031

Residual Value

The expected useful life of the improvements range from 20 years to 50 years, with a residual value benefit calculated post the 20-year analysis. Project improvements with an expected 50-year useful life include total costs associated with sidewalk, multi-use path, signals, fencing construction and acquisition. NCDOT assumed that 12% of the project budget would be spent on the construction of shorter life project components (e.g. pavement markings, crosswalks), and 88% of the project budget would be spent on the construction of longer life project components (sidewalks, MUPs, signals and mast arms). Residual value for the useful life of the project components is displayed in Table 16.

Table 16. Residual Value

Project Component	Capital Cost (2023 \$)	Useful Life (Years)	Residual Value
Long Life Project Components	\$5,207,722	50	\$3,124,633
Shorter Life Project Components	\$710,144	20	\$0

Results

Table 17 through Table 20 on the next pages summarize the benefit-cost analysis for the 20-year period (2031-2051). Employing a 2% discount rate for CO₂ and a 3.1% real discount rate for other entities, LINK NC has a net present value of **\$43,612,083** and a benefit-cost ratio of **10.41**. The LINK NC corridor is 0.29 miles long and had 16 bicycle and pedestrian crashes over ten years, including five fatalities and one serious injury. NCDOT has worked to value engineer LINK NC so the cost is feasible and the scope narrowed in order to have maximum benefit to the local community and efficient use of public funds. LINK NC has a high BCR because this is a condensed high-severity pedestrian and bicyclist crash corridor and the improvements laid out in the grant and analyzed in this BCR are designed to improve the safety outcomes in Monkey Junction.

Estimated Benefits, Costs, Net Present Value, and BCR

Table 17. Estimated Annual Benefits (Undiscounted and Discounted)

Year	Operations and Maintenance	Safety	Non-CO ₂ Emission Reduction	CO ₂ Emission Reduction	Amenity Benefits	Health Benefits	Residual Value	Total Benefits	Total Discounted Benefits
2032	\$5,820	\$3,931,207	\$29	\$253	\$2,618	\$39,361	\$0	\$3,967,649	\$3,014,450
2033	\$5,820	\$3,931,207	\$30	\$269	\$2,781	\$41,808	\$0	\$3,970,275	\$2,925,751
2034	\$5,820	\$3,931,207	\$32	\$287	\$2,960	\$44,503	\$0	\$3,973,169	\$2,839,852
2035	\$5,820	\$3,931,207	\$35	\$306	\$3,159	\$47,489	\$0	\$3,976,376	\$2,756,690
2036	\$5,820	\$3,931,207	\$37	\$328	\$3,381	\$50,820	\$0	\$3,979,952	\$2,676,212
2037	\$5,820	\$3,931,207	\$40	\$352	\$3,630	\$54,563	\$0	\$3,983,972	\$2,598,371
2038	\$5,820	\$3,931,207	\$43	\$380	\$3,912	\$58,806	\$0	\$3,988,527	\$2,523,131
2039	\$5,820	\$3,931,207	\$46	\$411	\$4,235	\$63,662	\$0	\$3,993,741	\$2,450,472
2040	\$5,820	\$3,931,207	\$51	\$448	\$4,609	\$69,282	\$0	\$3,999,776	\$2,380,390
2041	\$5,820	\$3,931,207	\$55	\$491	\$5,047	\$75,873	\$0	\$4,006,854	\$2,312,911
2042	\$5,820	\$3,931,207	\$61	\$543	\$5,569	\$83,725	\$0	\$4,015,285	\$2,248,097
2043	\$5,820	\$3,931,207	\$68	\$605	\$6,203	\$93,254	\$0	\$4,025,518	\$2,186,070
2044	\$5,820	\$3,931,207	\$77	\$683	\$6,990	\$105,088	\$0	\$4,038,225	\$2,127,047
2045	\$5,820	\$3,931,207	\$88	\$782	\$7,996	\$120,210	\$0	\$4,054,464	\$2,071,405
2046	\$5,820	\$3,931,207	\$103	\$914	\$9,330	\$140,260	\$0	\$4,075,995	\$2,019,815
2047	\$5,820	\$3,931,207	\$124	\$1,098	\$11,188	\$168,191	\$0	\$4,105,988	\$1,973,530
2048	\$5,820	\$3,931,207	\$155	\$1,373	\$13,963	\$209,906	\$0	\$4,150,784	\$1,935,119
2049	\$5,820	\$3,931,207	\$206	\$1,830	\$18,571	\$279,182	\$0	\$4,225,176	\$1,910,645
2050	\$5,820	\$3,931,207	\$309	\$2,741	\$27,762	\$417,345	\$0	\$4,373,544	\$1,918,408
2051	\$5,820	\$3,931,207	\$617	\$5,470	\$55,280	\$831,031	\$3,124,633	\$7,942,419	\$3,379,208
Undiscounted Total	\$116,400	\$78,624,140	\$2,207	\$19,566	\$199,185	\$2,994,360	\$3,124,633		
Discounted Total	\$67,201	\$45,391,985	\$1,091	\$12,348	\$98,562	\$1,481,693	\$1,329,096		\$48,247,575

Table 18. Capital Cost and Discounted Capital Cost Summary

Year	Capital Cost	Discounted Capital Cost
2030	\$0	\$0
2031	\$5,917,866	\$4,635,492
2032	\$0	\$0
2033	\$0	\$0
2034	\$0	\$0
2035	\$0	\$0
2036	\$0	\$0
2037	\$0	\$0
2038	\$0	\$0
2039	\$0	\$0
2040	\$0	\$0
2041	\$0	\$0
2042	\$0	\$0
2043	\$0	\$0
2044	\$0	\$0
2045	\$0	
2046	\$0	
2047	\$0	
2048	\$0	
2049	\$0	
2050	\$0	
2051	\$0	
	\$5,917,866	\$4,635,492

Table 19. Estimated Total Costs and Benefits

Category	Value
Total Discounted Benefits	\$48,247,575
Total Discounted Costs	\$4,635,492
Net Present Value	\$43,612,083
Benefit Cost Ratio	10.41

