

APPENDIX E: BENEFIT-COST ANALYSIS

RECONNECTING KNOXVILLE

RECONNECTING COMMUNITIES PILOT (RCP)

BENEFITS COST ANALYSIS NARRATIVE

EXECUTIVE SUMMARY

The Benefit-Cost Analysis (BCA) for the proposed 9.0 mile RECONNECTING COMMUNITIES PILOT (RCP) Reconnecting Knoxville multimodal connections project adheres to the National Cooperative Highway Research Program Report 552: Guidelines for Analysis of Investments in Bicycle Facilities (NCHRP 552) and the U.S. Department of Transportation's (USDOT's) Benefit-Cost Analysis Guidance for Discretionary Grant Programs (March 2022).

This BCA assumed that design and engineering costs will be expended in 2024 (3 years before projects being open), that right-of-way costs will be expended in 2025 (2 years before projects being open), and that construction and inspection costs will be expended in 2026 (1 year before projects being open). It is also assumed that annual operations and maintenance costs will be 0.5% of total project construction expenditures or \$4,758,180 for 20 years (YOE\$) in accordance with the National Cooperative Highway Research Program and 2020 US DOT BCA Guidance which translates to \$237,909 (YOE\$) per year of the trail's operation for the entire 9.0-mile project.

The proposed \$61.7 million (2020\$) Reconnecting Knoxville multimodal connections projects will conservatively provide up to \$219.3 million (2020\$) in economic benefits (Exhibit 1). This results in a benefit-cost ratio of 3.55:1 when a 7 percent discount rate is applied to the costs for their estimated year of expenditures. The project is also expected to accumulate hard to estimate benefits in tourism and increased property values.

	7% Discount Rate
Costs (2020 M\$)	
Capital Cost	\$61.7
<i>Total Costs</i>	<i>\$61.7</i>
Benefits (2020 M\$)	
Equity Benefits	
Access to Pedestrian & Bike Recreation	\$9.7
Access to Bike Commuting	\$7.0
Sub-Total	\$16.6
Mobility Benefits	
Bike Commuter General	\$48.7
Bike Commuter Stadium	\$2.8
Ped & Bike Recreation	\$34.8
Ped & Bike Recreation - Urban Wilderness	\$10.7
Ped & Bike Recreation - Stadium	\$13.7
Sub-Total	\$110.7
Health Benefits	
Ped & Bike Activity - Mortality Reduction	\$83.4
Sub-Total	\$83.4
Safety Benefits	
Reduced Crashes	\$1.4
Sub-Total	\$1.4
Operational Benefits	
Residual Savings	\$7.1
Sub-Total	\$7.1
<i>Total Benefits</i>	<i>\$219.2</i>
Outcome	
Net Present Value (2020 M\$)	\$157.5
Benefit-Cost Ratio	3.55

BCA Workbook – "BCA" Worksheet

BCA SUPPORT DOCUMENTS

The development of this BCA Narrative included the preparation of workbooks in Microsoft Excel format that are referenced within this document. These workbooks are unlocked and will allow full evaluation of formulas and input used in this BCA. Below is a brief description of these workbooks that are available on the webpage for use of US DOT in the evaluation of the Reconnecting Knoxville grant application.

1. KCDC_RCP_BCA_2022.xlsx
 - a. BCA Worksheet –
 - i. BCA Calculations with Capital Cost Total, BCR and NPV Total
 - b. BCA_CapitalCosts –
 - i. Summary of Capital Cost valuations
 - c. PROJECT SUMMARY –
 - i. Tables for Project Budget, Funding Sources, Schedule, Project Status
 - d. PROJECT SPENDING –
 - i. Tables for Year to Year Project Spending and Spending Categories
 - e. CAPITAL Inflation –
 - i. Inflation Factors Used in the BCA NPV
 - f. TRIP GENERATION –
 - i. Population Density and Bike and Pedestrian Daily Trip Calculations
 - g. CRASH SUMMARY –
 - i. Crash Rate Calculations using Crash Data from ETRIMS and Screening
 - h. EQUITY Ped & Bike –
 - i. EQUITY Benefit Calculation for Induced Ped & Bike Recreation
 - ii. Induced Ped & Bike – Households wo Vehicle
 - i. EQUITY Bike Commuter –
 - i. EQUITY Benefit Calculation for Induced Bike Commuting
 - ii. Induced Bike Commuting – Households wo Vehicle
 - j. MOBILITY Bike Commuter – STADIUM
 - i. MOBILITY Benefit Calculation for Induced Bike Commuting – Stadium
 - ii. Induced Bike Commuting – Stadium Residential Development
 - k. MOBILITY Ped & Bike –
 - i. MOBILITY Benefit Calculation for Induced Ped & Bike Recreation
 - ii. Induced Ped & Bike Trips from living near Reconnecting Knoxville Project
 - l. MOBILITY Ped & Bike UW -
 - i. MOBILITY Benefit Calculation for Induced Ped & Bike Recreation
 - ii. Induced Ped & Bike Trips from those visiting the Urban Wilderness
 - m. MOBILITY Ped & Bike – STADIUM
 - i. MOBILITY Benefit Calculation for Induced Ped & Bike Recreation
 - ii. Induced Ped & Bike Trips from those visiting the Stadium
 1. Access Parking, Community Events, and Festivals
 - n. SAFETY NOBUILD Crash
 - i. Existing Crash Rates within the 400 m buffer area
 - ii. NO BUILD Crash Cost Calculations on a year-by-year bases for 20 Years
 - o. SAFETY BUILD Crash Reduction
 - i. SAFETY Benefit Calculation based on Build vs No Build Comparison
 - ii. Predicted Crash Rates with the 400 m buffer area
 - iii. BUILD Crash Cost Calculations on a year-by-year bases for 20 Years
 - p. HEALTH Mortality Reduction

- i. HEALTH Benefit Calculation for Reduced Mortality for Induced Active Transportation Values
 - q. OPERATIONAL Residual
 - i. OPERATION Benefit Calculation for Reconnecting Knoxville Project Value after 20 Year Operations
 - ii. Asset Life Assumptions based on BEA Rate of Depreciation & Linear decline in value based on service life
- 2. RCP PROJECT CRASH ANALYSIS.XLSX
 - a. Crash Type and Severity
 - i. TABLE used for Crash Safety Benefit of the BCA
 - b. CRASH DATA – BASE
 - i. Screened Data from TDOT ETRIMS Crash Database
 - c. KNOXVILLE CRASH DATA
 - i. Spreadsheet from Knoxville Regional Transportation Planning Organization
 - ii. Bike Crash Rates based on population for the City of Knoxville
- 3. CENSUS DATA BASE ANALYSIS.XLSX
 - a. CENSUS_DATA
 - i. Data from US Census and American Community Survey
 - ii. Tables with General Census Data from Census Tracts around Reconnecting Knoxville
 - iii. Data from Census Tracts 1, 8, 19, 20, 21, 22, 23, 67, 68
 - b. NS INCOME
 - i. Data from US Census and American Community Survey SO802 Dataset
 - ii. Data from Census Tracts 1, 8, 19, 20, 21, 22, 23, 67, 68
 - iii. Table – Data used in Grant Narratives
 - c. NS AGE
 - i. Data from US Census and American Community Survey SO101 Dataset
 - ii. Data from Census Tracts 1, 8, 19, 20, 21, 22, 23, 67, 68
 - iii. Table – Data used in Grant Narratives
 - d. NS RACE
 - i. Data from US Census and American Community Survey PO1 Dataset
 - ii. Data from Census Tracts 1, 8, 19, 20, 21, 22, 23, 67, 68
 - iii. Table – Data used in Grant Narratives
 - e. PD01DATA
 - i. Base Data from US Census and American Community Survey PO1 Dataset
 - f. SO101 AGE DATA
 - i. Base Data from US Census and American Community Survey SO101 Dataset
 - g. DPO3DATA
 - i. Base Data from US Census and American Community Survey DPO3 Dataset
 - h. SO802DATA
 - i. Base Data from US Census and American Community Survey SO802 Dataset
 - i. BASE
 - i. DATA TABLE Used in BCA to Sort Commuter Data from SO802 Dataset

PROJECT BUDGET

Total project costs were compiled from engineering budgets of projects in design phase, actual cost data of similar bike, pedestrian, and multimodal roadway facility projects in the area currently under construction or completed within the last three years. The breakdown of the project budgeted costs are included in the Reconnecting Knoxville RCP application narrative and Exhibit 2 of project costs and funding on the next page.

The Reconnecting Knoxville project includes 14 project elements and are described in the Grant Narrative in detail. The summary table below summarizes and includes the budgeted costs, funding amounts and categories, and schedule (YOE\$).

		EAST KNOXVILLE GREENWAY	CULTURE CORRIDOR	STADIUM CONNECTOR	OLD CITY CONNECTOR	MORNINGSIDE CONNECTOR	SUMMIT HILL CONNECTOR	AUSTIN HOMES GREENWAY CONNECTOR	AUSTIN HOMES CONNECTOR	JAMES WHITE BRIDGE CONNECTOR	JAMES WHITE PARKWAY LINEAR PARK	URBAN WILDERNESS GATEWAY PARK	DANDRIDGE CONNECTOR	HILL AVENUE CONNECTOR	SCIENCE MUSEUM CONNECTOR
PROJECT LENGTH	9 TRACT AREAS	20, 21, 67, 68	68	67, 68	67, 68	68	68	68	67, 68	8, 68	8, 22, 23	23	20, 21, 68	68	68
LENGTH (miles)	9.00	2.4		0.5		2.0	0.2	0.8	0.5	0.9	1.0		0.1	0.4	0.2
LENGTH (feet)	47,520	12,672		2,640	0	10,560	1,056	4,224	2,640	4,752	5,280	0	528	2,112	1,056
TOTAL		PROJECT COSTS & FUNDING													
PROJECT COST	83,558,090	4,940,270	1,350,000	19,000,000	10,000,000	6,100,000	500,000	5,009,820	4,670,000	2,738,000	19,500,000	6,000,000	250,000	1,500,000	2,000,000
NEPA & DESIGN	8,318,440	490,270	600,000	1,900,000	800,000	300,000	75,000	722,470	120,000	410,700	1,900,000	600,000	50,000	150,000	200,000
ROW & UTILITY	1,095,000	450,000			50,000						595,000		0		0
CONSTRUCTION & CEI	74,144,650	4,000,000	750,000	17,100,000	9,150,000	5,800,000	425,000	4,287,350	4,550,000	2,327,300	17,005,000	5,400,000	200,000	1,350,000	1,800,000
TOTAL FUNDING	43,207,770	4,940,270	0	19,000,000	0	4,600,000	0	0	4,670,000	1,997,500	0	6,000,000	0	0	2,000,000
FEDERAL FUNDING	4,750,216	3,952,216								798,000					
STATE FUNDING	950,000									950,000					
NON GOVERNMENT LOCAL FUNDING	7,720,000					4,600,000			1,120,000						2,000,000
LOCAL FUNDING	29,787,554	988,054		19,000,000					3,550,000	249,500		6,000,000			
PREVIOUSLY INCURRED AMOUNT	410,810	190,810							120,000	100,000					
UNFUNDED AMOUNT	40,350,320	0	1,350,000	0	10,000,000	1,500,000	500,000	5,009,820	0	740,500	19,500,000	0	250,000	1,500,000	0
PROJECT PHASE - FUNDING STATUS															
FUNDING STATUS	CURRENT PHASE TIP / FUNDING STATUS	NEPA PARTIALLY FUNDED	PROGRAMMING NOT FUNDED	NEPA - DESIGN FUNDED	PROGRAMMING NOT FUNDED	PROGRAMMING NOT FUNDED	PROGRAMMING NOT FUNDED	DESIGN PARTIALLY FUNDED	CONSTRUCTION FUNDED	NEPA PARTIALLY FUNDED	PROGRAMMING NOT FUNDED	DESIGN FUNDED	PROGRAMMING NOT FUNDED	PROGRAMMING NOT FUNDED	DESIGN FUNDED
PROJECT SCHEDULE															
YR PROJECT FUNDED	2019 & 2022 RCP GRANT	2019 & FY22 - RCP GRANT	2022	2022 - RCP GRANT	2022 - RCP GRANT	2022 - RCP GRANT	2022 - RCP GRANT	2022 - RCP GRANT	2021	2022 - RCP GRANT	2022 - RCP GRANT	2021	FY22 - RCP GRANT	FY22 - RCP GRANT	2021
NEPA	2022	2023	2023	2023	2023	2023	2023	2023	2021	2022	2023	2021	2023	2023	2023
DESIGN	2023	2023	2023	2023	2023	2023	2023	2023	2022	2023	2023	2021	2023	2023	2023
ROW	2024	2024	2023	2023	2023	2023	2023	2023	2022	2023	2024	2024	2024	2024	2024
CONSTRUCTION BID	2025	2025	2024	2024	2024	2024	2024	2025	2023	2024	2025	2025	2025	2025	2025
CONSTRUCTION COMPLETE	2026	2026	2026	2026	2026	2026	2025	2026	2023	2025	2026	2026	2026	2026	2026

TOTAL FUNDING	\$83,558,090	100%	EQUALS PROJECT COST
LOCAL MATCH	\$38,457,554	46%	STATE & NON GOVERNMENT & GOVERNMENT MATCH
FEDERAL	\$4,750,216	6%	
FEDERAL - RCP GRANT	\$40,350,320	48%	

BCA Workbook – “PROJECT SUMMARY” Worksheet

RECONNECTING KNOXVILLE PROJECT ELEMENTS (YOE\$)

PROJECT DESCRIPTION	TOTAL COST	NEPA & DESIGN	ROW & UTILITY	CONSTRUCTION ONLY	CONSTRUCTION CONTINGENCY	CONSTRUCTION ENGINEERING
EAST KNOXVILLE GREENWAY	4,940,270	490,270	450,000	3,200,000	400,000	400,000
CULTURE CORRIDOR	1,350,000	600,000		600,000	75,000	75,000
STADIUM CONNECTOR	19,000,000	1,900,000		13,680,000	1,710,000	1,710,000
OLD CITY CONNECTOR	10,000,000	800,000	50,000	7,320,000	915,000	915,000
MORNINGSIDE CONNECTOR	6,100,000	300,000		4,640,000	580,000	580,000
SUMMIT HILL CONNECTOR	500,000	75,000		340,000	42,500	42,500
AUSTIN HOMES GREENWAY CONNECTOR	5,009,820	722,470		3,429,880	428,735	428,735
AUSTIN HOMES CONNECTOR	4,670,000	120,000		3,640,000	455,000	455,000
JAMES WHITE BRIDGE CONNECTOR	2,738,000	410,700		1,861,840	232,730	232,730
JAMES WHITE PARKWAY LINEAR PARK	19,500,000	1,900,000	595,000	13,604,000	1,700,500	1,700,500
URBAN WILDERNESS	6,000,000	600,000		4,320,000	540,000	540,000
DANDRIDGE CONNECTOR	250,000	50,000		160,000	20,000	20,000
HILL AVENUE CONNECTOR	1,500,000	150,000		1,080,000	135,000	135,000
SCIENCE MUSEUM CONNECTOR	2,000,000	200,000		1,440,000	180,000	180,000
	83,558,090	8,318,440	1,095,000	59,315,720	7,414,465	7,414,465

BCA Workbook – “PROJECT SPENDING” Worksheet

PROJECT SPENDING SUMMARY BY YEAR (YOE\$)

		YEAR OF EXPENDITURE					
PROJECT DESCRIPTION	TOTAL COST	2021	2022	2023	2024	2025	2026
EAST KNOXVILLE GREENWAY	4,940,270		190,810	200,000	549,460	2,000,000	2,000,000
CULTURE CORRIDOR	1,350,000			600,000		750,000	
STADIUM CONNECTOR	19,000,000			1,900,000	5,700,000	5,700,000	5,700,000
OLD CITY CONNECTOR	10,000,000			400,000	450,000	4,575,000	4,575,000
MORNINGSIDE CONNECTOR	6,100,000			300,000	1,933,333	1,933,333	1,933,333
SUMMIT HILL CONNECTOR	500,000			75,000		425,000	
AUSTIN HOMES GREENWAY CONNECTOR	5,009,820			361,235	361,235	2,143,675	2,143,675
AUSTIN HOMES CONNECTOR	4,670,000		120,000	4,550,000			
JAMES WHITE BRIDGE CONNECTOR	2,738,000		100,000	310,700	1,163,650	1,163,650	
JAMES WHITE PARKWAY LINEAR PARK	19,500,000			950,000	1,545,000	8,502,500	8,502,500
URBAN WILDERNESS	6,000,000			300,000	300,000	2,700,000	2,700,000
DANDRIDGE CONNECTOR	250,000			50,000	200,000		
HILL AVENUE CONNECTOR	1,500,000			150,000		1,350,000	
SCIENCE MUSEUM CONNECTOR	2,000,000			200,000		900,000	900,000
	83,558,090	-	410,810	10,346,935	12,202,678	32,143,158	28,454,508

BCA Workbook – “PROJECT SPENDING” Worksheet

INFLATION 2021 FACTOR		0.9809		INFLATION FACTOR - USDOT BCA 2022 Guidance - Table A-7													
INFLATION 2022 FACTOR		0.9621															
DISCOUNT		7%		DISCOUNT YEAR		2020											
CAPITAL COST SUMMARY DETAIL				PREVIOUS INCURRED COSTS (2020\$)							PREVIOUS INCURRED COSTS (YOE\$)						
OPERATION	CAPITAL SPENDING	PROJECT COSTS		NEPA	DESIGN	ROW	UTILITY	CONST	CEI	CONTINGENCY	NEPA	DESIGN	ROW	UTILITY	CONST	CEI	CONTINGENCY
YEAR #	YEAR	UNDISCOUNTED	DISCOUNTED														
	2021	\$0	\$0					\$0							\$0		
	2022	\$410,810	\$395,245	\$296,434	\$98,811						\$308,108	\$102,703					
	2022	\$0	\$0					\$0							\$0		
FUTURE PROJECT				FUTURE PROJECT (2020\$)							FUTURE PROJECT (YOE\$)						
	2023	\$5,796,935	\$4,732,026	\$236,601	\$4,495,424						\$289,847	\$5,507,088					
	2023	\$4,550,000	\$3,714,155					\$2,971,324	\$371,416	\$371,416					\$3,640,000	\$455,000	\$455,000
	2024	\$2,110,695	\$1,610,239	\$80,512	\$1,529,727						\$105,535	\$2,005,160			\$7,197,587	\$899,698	\$899,698
	2024	\$8,996,983	\$6,863,756					\$5,491,004	\$686,376	\$686,376							
	2024	\$1,095,000	\$835,370			\$835,370							\$1,095,000				
	2025	\$32,143,158	\$22,917,628					\$18,334,102	\$2,291,763	\$2,291,763					\$25,714,527	\$3,214,316	\$3,214,316
	2026	\$28,454,508	\$18,960,440					\$15,168,352	\$1,896,044	\$1,896,044					\$22,763,607	\$2,845,451	\$2,845,451

BCA Workbook – “BCA_CapitalCosts” Worksheet

PROJECT SPENDING SUMMARY

SPENDING SUMMARY		
PREVIOUSLY INCURRED SPENDING	YOES	2020\$
CONSTRUCTION	\$0	\$0
ROW	\$0	\$0
UTILITIES	\$0	\$0
DESIGN	\$102,703	\$98,811
NEPA	\$308,108	\$296,434
TOTAL INCURRED	\$410,810	\$395,245
FUTURE PROJECT SPENDING	YOES	2020\$
CONSTRUCTION	\$59,315,720	\$41,964,783
ROW	\$1,095,000	\$835,370
UTILITIES	\$0	\$0
NEPA & DESIGN	\$7,907,630	\$6,342,265
CONST ENGINEERING (10%)	\$7,414,465	\$5,245,598
CONST CONTINGENCIES (10%)	\$7,414,465	\$5,245,598
20 YR MAINTENANCE	\$4,721,038	\$1,666,347
TOTAL FUTURE	\$87,868,318	\$61,299,961

BCA Workbook – “BCA_CapitalCosts” Worksheet

PROJECT BUDGET (YOES):

- Project Costs: \$83,558,090
- Local Funding (includes State Only Funding) \$38,457,554
- Total Funding: \$43,207,770
- Unfunded Project: \$40,350,320

PROJECT SPENDING:

It is assumed that future design and engineering costs will be expended in 2024 (3 years before projects being open), that right-of-way & utility costs will be expended in 2025 (2 years before projects being open), and that construction and inspection costs will be expended in 2026 (1 year before projects being open).

It is also assumed that annual operations and maintenance costs will be 0.5% of total project construction expenditures or \$4,721,038 for 20 years (YOES) in accordance with the National Cooperative Highway Research Program and 2020 US DOT BCA Guidance which translates to \$236,052 (YOES) per year of the trail’s operation for the entire 9.0-mile project.

Project Element Year by Year (YOES) expenditures are detailed in the table titled “PROJECT SPENDING SUMMARY BY YEAR (YOES)” on the previous page and in the BCA Workbook on the “BCA_CapitalCosts” and “PROJECT SPENDING” worksheets. Previous vs Future Spending Summary is included in the table above titled “SPENDING SUMMARY” and is included in the BCA Workbook on the “BCA_CapitalCosts” worksheet.

PROJECT BENEFITS

This BCA uses trip generation methods found in the National Cooperative Highway Research Program Report 552 (NCHRP 552) - Measuring and Forecasting Demand - "Guidelines for Analysis of Investments in Bicycle Facilities." This methodology assumes that the project will induce trips based on the distance Reconnecting Knoxville project is from potential users or households. This BCA used population density using census tracts where the project is located and established areas around the project at 200 M, 400 M, 600 M, 800 M, and 1,600 M (M = meters) as provided by the NCHRP 552. These buffer areas established influence zones where differential factors can be applied in establishing the number of induced Walk and Bike Trips. This methodology uses the "Base Commute Rate" C as a base rate for calculating the proximal effect of the project on trip generation. Below are input tables found in the BCA workbook on worksheet "TRIP GENERATION."

CENSUS TRACT POPULATION SUMMARY AND OVERALL PROJECT POPULATION DENSITY

CENSUS TRACTS AFFECTED BY PROJECT					
CENSUS TRACT #	TOTAL CENSUS TRACT POPULATION	TRACT AREA (SQ MILES)	TRACT AREA (SQ KM)	POPULATION DENSITY (POP / SQ MILE)	POPULATION DENSITY (POP / SQ KM)
1	2,907	0.59	1.53	4,927	1,902
8	3,502	1.13	2.93	3,099	1,197
19	1,555	0.85	2.20	1,829	706
20	3,114	0.93	2.41	3,348	1,293
21	2,857	3.51	9.09	814	314
22	3,658	2.76	7.15	1,325	512
23	3,261	1.93	5.00	1,690	652
67	2,922	1.10	2.85	2,656	1,026
68	4,483	1.40	3.63	3,202	1,236
	28,259		36.78		768.37
					PROJECT AREA POPULATION DENSITY

BCA Workbook – "TRIP GENERATION" Worksheet

BUFFER AREA SUMMARY WITH CALCULATED DAILY PEDESTRIAN AND BIKE TRIPS

TOTAL BUFFER AREA	BUFFER WIDTH (M)	200 M	400 M	600 M	800 M	1,600 M
22.51	AREA OF EACH BUFFER (KM ²)	4.570	3.700	4.100	4.715	5.422
	Number of Pedestrians	779	336	327	259	298
	Number of Bicyclists	209	122	135	102	85
	Population within Buffer Area	3,511	2,843	3,150	3,623	4,166
	Cumulative Population within Buffer Zone	3,511	6,354	9,505	13,128	17,294

BCA Workbook – "TRIP GENERATION" Worksheet

BUFFER AREA INDUCED USAGE FACTOR TABLE

DISTANCE FROM FACILITY		TOTAL		
ONE SIDE	BOTH SIDES	WALK %	BIKE %	
200 M	400 M	22.18%	5.95%	Adult %
400 M	800 M	11.84%	4.28%	82%
600 M	1,200 M	10.37%	4.28%	Bike Commuter %
800 M	1,600 M	7.16%	2.82%	2.03%
1,600 M	3,200 M	7.16%	2.03%	Walk Commuter %
BASE DAILY TRIPS		1,999	652	7.16%

NCHRP 552 - Measuring and Forecasting Demand - "Guidelines for Analysis of Investments in Bicycle Facilities" 2006

BCA Workbook – "TRIP GENERATION" Worksheet

Total pedestrian (walk) trips 1,999 and bike trips are 652 are calculated using the base bike commuter rate of 2.03% (C) as detailed in the NCHRP 552 multiplied by a distance factor. The factors are summarized in the "Buffer Area Induced Usage Factor Table." The total trips for pedestrians and bikes for each buffer zone is calculated and listed in the "Buffer Area Summary with Calculated Daily Pedestrian and Bike Trips" table above.

Many of the benefit valuations are based on these base trip measurements. The benefit sections that follow detail the number of trips used and the benefit valuation in 2020\$ for each benefit used in this BCA.

EQUITY BENEFITS

Access to Recreation Opportunities - Pedestrian & Bike Facility Benefit – Induced Households without vehicle

Knoxville has 92,471 working households. The 2021 American Community Survey SO802 that focuses on “Transportation to Work by Selected Characteristics.” This data indicates that 3.3% or 3,051 households within the City of Knoxville do not have access to a vehicle for transportation. These households significantly benefit from active transportation investments to improve access to employment as well as recreation. Inside an area within 1.0 mile (1,600 meters) of the Reconnecting Knoxville multimodal connection projects, 6.8% of households do not have access to a vehicle. This project is generally located in an area that has twice the City of Knoxville rate for working households without a vehicle. Over half of our projects length is within Census Tract 68 which has a rate of 24.2% or over 7 times the rate across the City of Knoxville.

This means that based on the population density found within 1.0 mile (1,600 meters) of the Reconnecting Knoxville project that 1,176 working households without a vehicle will gain readily available access to the recreation opportunities created by walking, and biking. It is assumed that 100% of these households will use the project on average 1 walking trip a day. It is also assumed that the Bike Commuter rate of 2.03% of these households will ride a bike. Reconnecting Knoxville will be providing safe connectivity to critical destinations such as downtown, shopping, restaurants, Stadium, the Urban Wilderness, Community Events, and Festivals.

Based on data from Knoxville Regional Planning Organization, 2.03% bike commuter rate in Knoxville, there will be 24 households that will begin or be induced to use a bicycle to commute or for utilitarian uses of that household. The mobility aspect being a Bike Commuter is reflected in a separate benefit analysis for this population. However, the utilization of a Bike for commuting purposes will provide a means to enjoy the Reconnecting Knoxville project for recreation.

The trips calculated for this recreation benefit is in addition to the trips calculated in the Mobility Benefit for other population segments included in this BCA. This Equity benefit in year 1 is \$398,584 (2020\$) using the National Cooperative Highway Research Program methodology. This benefit totals a Net Present Value of \$9,684,535 (2020\$) over 20-years using a 7 percent discount rate. See the “EQUITY Ped & Bike” worksheet of the BCA spreadsheet.

Access to Bike Commuting - Bike Commuter Mobility Benefit – Induced Working Households without a Vehicle

Households without a vehicle uniquely benefit from having safe connections to work because they currently utilize existing infrastructure without the benefit of separated, safe, and well-connected multimodal paths. Reconnecting Knoxville project will provide working households within 1.0 mile (1,600 meters) a unique and new connection to abundant work, recreation, shopping, and leisure activities.

Bicyclists are willing to travel additional distances to avoid biking in traffic. The National Cooperative Highway Research Program finds that bicyclists are willing to travel up to 20.38 additional minutes (valued at \$12) to use an off-street bike path if one is available instead of the shortest path in mixed traffic.

The BCA assumes that 2.03% (Commuting Bike Rate in Knoxville) of working households without a vehicle will be induced to ride to work. This corresponds to 24 new bike commuters in the 1.0-mile (1,600 meter) area around project.

The trips calculated for this bike commuting benefit is in addition to the trips calculated in the Mobility Benefit for other population segments included in this BCA.

This Equity benefit in year 1 is \$286,466 (2020\$) using the National Cooperative Highway Research Program methodology. This benefit totals a Net Present Value of \$6,960,361 (2020\$) over 20-years using a 7 percent discount rate. See the “EQUITY Bike Commuter” worksheet of the BCA spreadsheet.

MOBILITY BENEFITS

Bike Commuter Mobility Benefit – Reconnecting Knoxville Project

Bicyclists are willing to travel additional distances to avoid biking in traffic. The National Cooperative Highway Research Program finds that bicyclists are willing to travel up to 20.38 additional minutes (valued at \$12) to use an off-street bike path if one is available instead of the shortest path in mixed traffic. Currently, 2.03% percent of commuters in the 1.0 mile radii of the Reconnecting Knoxville projects bike to work. This corresponds to about 167 existing bike commuters in the 1.0-mile radii of projects are expected to be added as a result of these projects being built.

This Mobility benefit for bike commuters totals a Net Present Value of \$48,703,386 (2020\$) over 20-years using a 7 percent discount rate. See the “MOBILITY Bike Commuter” worksheet of the BCA spreadsheet.

Bike Commuter Mobility Benefit – Stadium Residential Development

The Stadium project includes the private construction of 466 residential units. These residential units are likely to attract people that want to live and work in the Downtown area and will have a higher likelihood of using active transportation.

STADIUM - BIKE COMMUTER TRIPS			
TRIP DESCRIPTION	# of Households	USER %	TRIPS
RESIDENTIAL BIKE COMMUTERS - STADIUM DEVELOPMENT	466	2.03%	9.5

Commuter % Based on 2020 Census Ridership

BCA Workbook – “TRIP GENERATION” Worksheet

Using the Bike Commuter rate of 2.03% these residential units will generate 9.5 Bike Commuter Trips.

The National Cooperative Highway Research Program methods provide that a benefit for every commuter trip of \$12 can be applied.

This Mobility benefit for bike commuters totals a Net Present Value of \$2,758,179 (2020\$) over 20-years using a 7 percent discount rate. See the “MOBILITY Bike Commuter STADIUM” worksheet of the BCA spreadsheet.

Pedestrian & Bike Facility Benefit – Reconnecting Knoxville Project

This BCA assumes that the Reconnecting Knoxville projects provide new and improved connectivity to the existing transportation network. These improvements improve the quality or comfort of the journeys made by active transportation users (pedestrians, public transport, and cyclists). The 2022 US DOT BCA Guidance for Discretionary Grant Programs provides methodology for assessing the monetary value of each trip for pedestrian and bike facility “amenity” benefits.

US DOT Methods for evaluation of a new or improved pedestrian and bike facility includes projects that increase safety, level of service, and comfort primary through widening an existing sidewalk or creation of a new active transportation corridor. The US DOT BCA Guidance provides Table A-8 and A-9 that this BCA used in calculating the value of pedestrian and bicycle preference values. This BCA used the total induced trips for both pedestrians and bikes as this facility provides connectivity and levels of service not provided for by any nearby facilities. The value of \$0.10 / person mile walked (up to 0.86 miles) and \$1.42 / cycling mile (up to 2.38 miles) are used in the valuation calculations as required the US DOT BCA Guidance in tables A-8 and A-9.

The Mobility benefit for the bike users who live nearby the Reconnecting Knoxville projects is \$804,847 (2020\$) per year or \$19,555,671 (2020\$) for the 20-year life of the project.

The Mobility benefit for the pedestrian users who live nearby the Reconnecting Knoxville projects is \$627,486 (2020\$) for the first year or \$15,246,262 (2020\$) for the 20-year life of the project.

See the “MOBILITY Ped & Bike” worksheet of the BCA spreadsheet.

Pedestrian & Bike Facility Benefit – Urban Wilderness Connection

South Knoxville's 1,000 Acre Urban Wilderness is home to 42 miles of trail and is located just 2.2 miles from Downtown Knoxville. The Howard Baker Jr. Center for Public Policy prepared a whitepaper on the "Economic Potential of South Knoxville's Urban Wilderness" in June 2015. This report noted that "Few cities outside the Rocky Mountain region have trail systems or bike parks within 10 miles of downtown with as many trail miles as the Urban Wilderness." The Reconnecting Knoxville project will provide a vital link from the Urban Wilderness to downtown Knoxville, shopping, restaurants, and the Smokies Stadium venue. It also will allow those that live near the Reconnecting Knoxville project access to the benefits of the Urban Wilderness.

The Howard Baker Economic Report estimates that the Urban Wilderness will generate 260,070 bike users days per annually or 713 bike trips per day as a local amenity trail system. The report estimates that the average user will spend \$32.03 per day. "The proximity of the Urban Wilderness to the downtown commercial district suggests trail use expenditures will be larger than other areas..." The report also indicates that "moving the Urban Wilderness from a local amenity to a regional and perhaps national destination will also require the city, county, and state level government investments to improve facilities, expand trail opportunities, and promote the area."

URBAN WILDERNESS - MODE SPLIT		
15.2%	6.57	Pedestrian - Walk, Hike, Running
84.8%	713	Bikes
100.0%	720	Total

American Trails - Webinar - UT Professor Gene Fitzhugh- Presentation about the Urban Wilderness Trail 2020 Trail Count - Survey

BCA Workbook – "Trip Generation" Worksheet

Using data collected by UT Professor Gene Fitzhugh this BCA applied a 15.2%/84.8% modal split for pedestrians and bikes to the 713 bike trips generated in accordance with the Howard Baker report.

The BCA assumes 50% of the visitors who use the Urban Wilderness trail using a bike will also use the Reconnect Knoxville project to access recreation and shopping opportunities referenced in the report that will equate to (713 x 50%) 356 bike trips per day.

The BCA assumes that 15.2 % of the visitors using the Urban Wilderness based on the 2020 UT Urban Wilderness visitor counts at Baker Creek adjacent to the proposed Reconnecting Knoxville project. This equates to 6.57 daily pedestrian trips using both the Urban Wilderness trail and the Reconnect Knoxville project to access recreation and shopping opportunities referenced in the Howard Baker Report.

The Mobility benefit for the bike users is \$439,466 (2020\$) for the first year of operations and \$10,677,875 for the 20-year life of the project.

The Mobility benefit for the pedestrian users is \$2,062 (2020\$) for the first year of operations and \$50,094 for the 20-year life of the project.

See the "MOBILITY Ped & Bike UW" worksheet of the BCA spreadsheet.

Pedestrian & Bike Facility Benefit – Smokies Stadium Connection

The Stadium project will include the building of parking to support the residents and tenants who live and work in the privately financed apartments, townhouses and offices that would be built near the stadium. There are nearly 7,700 public parking spaces within a 10-minute walk to the Stadium with 15,000 parking spaces in garages and surface lots within a 20-minute walk. Reconnecting Knoxville project will provide walkable, greenway-connected and transit-friendly infrastructure that will support the economic success of the Stadium.

The Stadium project includes the private construction of 466 residential units. These residential units are likely to attract people that want to live and work in the Downtown area and will have a higher likelihood of using active transportation.

STADIUM - BIKE AND RECREATION TRIPS			
TRIP DESCRIPTION	# of Households	USER %	TRIPS
RESIDENTAL WALKING COMMUTER	466	7.16%	33.4
RESIDENTAL WALKING	466	22.18%	103.4
Commuter % Based on 2020 Census Ridership Induced Walking % from NCHRP 552 200M Buffer			
TRIP DESCRIPTION	DAILY PARKING	%	TRIPS
VENUE - WALKING	958	50.00%	479.0
PARKING GARAGE AT 50% OCCUPANCY- KNOX COUNTY MULTI USE STADIUM TAX REVENUE AND ECONOMIC IMPACT ANALYSIS - TO USE PROJECT CONNECTION			
TRIP DESCRIPTION	VISITOR / YR	USER %	TRIPS
VENUE - BIKE	13,000	2.03%	263.9
New Bike Trips - Community Events and Festivals			
TRIP DESCRIPTION	# of Households	USER %	TRIPS
RESIDENTAL BIKE	466	5.95%	27.7
RESIDENTAL BIKE COMMUTERS - STADIUM DEVELOPMENT	466	2.03%	9.5
Induced Biking % from NCHRP 552 200M Buffer Commuter % Based on 2020 Census Ridership			

BCA Workbook – “TRIP GENERATION” Worksheet

This BCA uses the average bike and walk commuter rates from the 2020 US Census American Community Survey Data for the Reconnecting Knoxville project of 7.16% and 2.03% respectively. This residential housing development will generate 9.5 bike trips and 33.4 walk trips per day. See the BCA worksheet “TRIP GENERATION” for these calculations.

The NCHRP 552 provides a methodology for predicting bike and walk trip generation that provides higher rates of use for active transportation the closer a household is to a multimodal facility. The Stadium residences are closer than 200 meters from the Reconnecting Knoxville project and will generate 103.4 daily walkers (22.18% of households) and 27.7 bike users (5.95% of households).

The Mobility benefit for the bike users who live in the Stadium housing that is nearby the Reconnecting Knoxville projects is \$371,430 (2020\$) per year or \$9,024,766 (2020\$) for the 20-year life of the project.

The Mobility benefit for the pedestrian users who live in the Stadium housing that is nearby the Reconnecting Knoxville projects is \$193,278 (2020\$) for the first year or \$4,696,155 (2020\$) for the 20-year life of the project.

See the “MOBILITY Ped & Bike STADIUM” worksheet of the BCA spreadsheet for benefit calculations.

HEALTH BENEFITS

A study referenced in NCHRP 552 demonstrates a more physically active population will enjoy lower health care costs or “reduced mortality.” NCHRP 552 and US DOT provide methods for monetizing the annual per-capita cost savings from increased physical activity specifically created by the increased bicyclists and walkers expected to use the Reconnecting Knoxville projects.

This BCA uses a method detailed in the 2022 US Department of Transportation’s BCA Guidance for Discretionary Grant Programs for valuation of the health benefit of active transportation modes for this project. The method allows for all induced active transportation modes be included. We used NCHRP 552 methods to determine the induced trip demands using buffer areas at 200, 400, 600, 800, and 1,600 meters from our projects for bicyclists and walkers.

DISTANCE FROM FACILITY		TOTAL			
		TRIP GENERATION TABLE INPUTS			
ONE SIDE	BOTH SIDES	WALK %	BIKE %	Adult %	Based on 2020 Census
200 M	400 M	22.18%	5.95%	82%	
400 M	800 M	11.84%	4.28%	Bike Commuter %	Base Commute Rate (C)
600 M	1,200 M	10.37%	4.28%	2.03%	
800 M	1,600 M	7.16%	2.82%	Walk Commuter %	Base Commute Rate (C)
1,600 M	3,200 M	7.16%	2.03%	7.16%	
BASE DAILY TRIPS		1,999	652		

NCHRP 552 - Measuring and Forecasting Demand - "Guidelines for Analysis of Investments in Bicycle Facilities" 2006

BCA Workbook – “TRIP GENERATION” Worksheet

The age range for this benefit calculation varies due to a statistical decline in bike use for users between 64 and 74. This benefit methodology allows for benefits due from walking for the age range of 20 to 64 and biking age range from 20 to 74.

AGE DISTRIBUTION SUMMARY		
CENSUS TRACTS 1, 8, 19, 20, 21, 22, 23, 67, 68		
AGE	POPULATION	%
Under 5 years	1,275	5.0%
5 to 9 years	1,519	6.0%
10 to 14 years	1,358	5.4%
15 to 19 years	1,183	4.7%
20 to 24 years	4,056	16.1%
25 to 29 years	2,618	10.4%
30 to 34 years	1,714	6.8%
35 to 39 years	1,311	5.2%
40 to 44 years	1,450	5.7%
45 to 49 years	1,090	4.3%
50 to 54 years	1,771	7.0%
55 to 59 years	1,595	6.3%
60 to 64 years	1,294	5.1%
65 to 69 years	1,090	4.3%
70 to 74 years	737	2.9%
75 to 79 years	428	1.7%
80 to 84 years	496	2.0%
85 years and over	273	1.1%

American Community Survey ACS 2020 SO101 - 5 YEAR

The trips used to calculate this benefit are found by using the base number of induced trips (all age ranges) for the Reconnecting Knoxville projects and applying various factors to account for trips induced within a certain age distribution. This BCA used guidance found in 2020 USDOT BCA Guidance Table A-12 to perform these calculations.

The Mobility benefit for the pedestrian and bike users in reducing mortality corresponds to a Net Present Value of the of \$82,776,373 (2020\$) for walkers and \$584,395 (2020\$) for bikes over the 20-year evaluation of the projects.

See the “HEALTH Mortality Reduction” worksheet of the BCA spreadsheet for benefit calculations.

SAFETY BENEFITS

Injury and fatality numbers involving bicyclists and pedestrians used for this benefit calculation were pulled from the Enhanced Tennessee Roadway Information Management System (ETRIMS) hosted by the Tennessee Department of Transportation and the Knoxville Regional Transportation Planning Organization (Knoxville TPO). FHWA Highway Safety Crash Screening Methods were used to determine the average annual bike and pedestrian-involved crash rates in Knoxville and crashes within 1.0 mile of the Reconnecting Knoxville projects.

BUFFER WIDTH (M)	200 M	400 M
AREA OF EACH BUFFER (KM^2)	4.570	3.700
Number of Pedestrians	779	336
Number of Bicyclists	209	122
Population within Buffer Area	3,511	2,843
Cumulative Population within Buffer Zone	3,511	6,354

BCA Workbook – “TRIP GENERATION” Worksheet

	CRASH REDUCTION SUMMARY		
	NO BUILD CRASH STATISTICS (2017 TO 2021)		
BUFFER AREA AROUND PROJECT	200 M	400 M	200 M + 400 M AREAS
TOTAL POPULATION WITHIN EACH AREA	3,511	2,843	6354
NO BUILD CRASH DATA			
TOTAL BIKE CRASHES 5YR - 400 M BUFFER AREA	2	2	4
TOTAL PED CRASHES 5 YR - 400M BUFFER AREA	10	15	25
TOTAL BIKE & PED CRASHES - 5 YEAR PERIOD	12	17	29
BUFFER / CRASHES / YEAR	2.40	3.40	5.80
NO BUILD CRASH RATES			
BUFFER CRASH RATE PER 1000 POP	0.68	1.20	0.91
KNOXVILLE CRASH RATE (CRASHES / 1000 POP)	0.63	0.63	0.63
BUFFER CRASH RATE / KNOXVILLE CRASH RATE	1.08	1.90	1.45
BUILD CRASH RATES			
BUFFER CRASH RATE - after 0.92 CMF APPLIED	0.629	1.100	0.840
PREDICTED CRASHES AFTER PROJECT	2.208	3.128	5.336
PREDICTED BIKE & PED CRASHES AFTER PROJECT	2.21	3.13	5.34
CRASH REDUCTION NO BUILD VS BUILD			
ANNUAL BIKE AND PED CRASH REDUCTION	0.192	0.272	0.464

BCA Workbook – “CRASH SUMMARY” Worksheet

This BCA used methods detailed in the 2022 US DOT BCA Guidance and NCHRP 552 to determine crash reduction and crash valuation. A 5-year time period from 2017 to 2021 was used to query georeferenced crash data from ETRIMS. This data established the existing crash rates per 1000 population within the 200 meter and 400 meter buffer areas for the existing conditions or No Build. The BCA applied a crash modification factor (CMF) to the existing crash rate calculated to determine the crash rate of the built project. The difference in the No Build vs Build crash rates were used to calculate the number of crashes reduced for bicyclists and pedestrians. This reduction was then applied to valuation methods detailed in the 2020 USDOT BCA Guidance. This BCA used KABCO Scale to MAIS conversion table to distribution crash severity and valuations as provided in the 2022 US DOT BCA Guidance in Table A-1.

The findings for the BCA evaluation were that existing bike and pedestrian crash rates would be reduced 0.464 crashes per year for a physically separated bike and pedestrian facility.

The Safety benefit for pedestrian and bike users corresponds crash rate reduction of the Build vs the No Build crashes. The Total Safety benefit was calculated as the Net Present Value of \$1,413,491 (2020\$) over the 20-year project life using a 7 percent discount rate.

See the “SAFETY BUILD Crash” & “SAFETY NOBUILD Crash” worksheets of the BCA spreadsheet.

OPERATIONAL BENEFITS

OPERATIONAL - RESIDUAL BENEFIT

Project components will have a useful life longer than the analysis period

TYPE OF ASSET	SERVICE LIFE (YEARS)
Industrial buildings	31
Mobile offices/17/	16
Office buildings/17/	36
Commercial warehouses/17/	40
Other commercial buildings/17/	34
Religious buildings	48
Educational buildings	48
Hospital and institutional buildings	48
Hotels and motels/18/	32
Amusement and recreational buildings/18/	30
All other nonfarm buildings/18/,/19/	38
Railroad replacement track/19//20/	38
Other railroad structures/19//20/	54
Telecommunications/20/	40
Railroad equipment*	50
Highways and streets	60
Conservation and development	60
Sewer systems	60
Water systems	60
Military facilities	50
Other	60

Source: BEA Rate of Depreciation, Service Lives, Declining-Balance Rates, and Hulten-Wyckoff Categories

http://www.bea.gov/scb/account_articles/national/wlth2594/tableC.htm

FTA Circulator 5010.1D Grant Management Requirements 2008,
<https://cms.fta.dot.gov/funding/grant-programs/capital-investments/fta-circular-50101d-november-2008>

RESIDUAL BENEFITS SUMMARY	
DISCOUNT YEAR	2020
UNITS FOR RESIDUAL BENEFITS	2020 \$
VALUE OF ROW (DOES NOT DEPRECIATE)	\$ -
END OF LIFE YEAR FOR REMAINING VALUE	2046
Asset after 20 years of service	\$ 41,130,137
Total Value Remaining in 2046\$	\$ 41,130,137
Linear decline in value of service life	\$ 41,130,137
RESIDUAL BENEFIT w/ 7% (2020\$)	\$ 7,082,424
RESIDUAL BENEFIT SUMMARY	
Total Year 2046\$	\$ 41,130,137.30
Discounted at 7% to 2020\$	\$ 7,082,424.27

BCA Workbook – “OPERATIONAL Residual” Worksheet

The residual capital benefit for this project after the calculated 20 years operation (remaining 40 years) is \$7,082,424 (2020\$).

TOTAL BENEFITS

The total benefits for the Reconnecting Knoxville projects is \$219.2 (2020\$) including equity, mobility, health, safety, and operational benefits.

	7% Discount Rate
Costs (2020 M\$)	
Capital Cost	\$61.7
<i>Total Costs</i>	\$61.7
Benefits (2020 M\$)	
Equity Benefits	
Access to Pedestrian & Bike Recreation	\$9.7
Access to Bike Commuting	\$7.0
Sub-Total	\$16.6
Mobility Benefits	
Bike Commuter General	\$48.7
Bike Commuter Stadium	\$2.8
Ped & Bike Recreation	\$34.8
Ped & Bike Recreation - Urban Wilderness	\$10.7
Ped & Bike Recreation - Stadium	\$13.7
Sub-Total	\$110.7
Health Benefits	
Ped & Bike Activity - Mortality Reduction	\$83.4
Sub-Total	\$83.4
Safety Benefits	
Reduced Crashes	\$1.4
Sub-Total	\$1.4
Operational Benefits	
Residual Savings	\$7.1
Sub-Total	\$7.1
<i>Total Benefits</i>	\$219.2
Outcome	
Net Present Value (2020 M\$)	\$157.5
Benefit-Cost Ratio	3.55

Furthermore, there are expected to be additional benefits to tourism, the environment, and property value increases, but these are difficult to quantify and excluded in this case since the other benefits are already estimated to significantly outweigh the costs.

After quantifying the expected net benefits expected under the Build case and taking into account the residual cost benefits of the project for years beyond the analysis period, the BCR for the project was calculated to be 3.55, suggesting that the project benefits over the analysis period would exceed the expected costs associated with project implementation.