OKLAHOMA Transportation

Hochatown Community Access and Pedestrian Safety Project

Benefit-Cost Analysis

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FY23 RAISE Grant Application

RAISE Grant Request: $20 million

Introduction

A Benefit Cost Analysis (BCA) is an evaluation framework to assess the economic and social benefits and costs of an investment proposal. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The goal of a BCA is to assess whether the expected benefits of a project justify the costs from a national perspective. It attempts to capture the net welfare change including cost such as project capital costs, cost savings and increases in welfare (benefits), and welfare reductions where some groups are expected to be made worse off.

The BCA assesses the incremental difference between the No Build Case and the Build Case, which represents the net change in welfare. The importance of future impacts is determined through discounting, to reflect both the opportunity cost of capital as well as the societal preference for the present.

The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. DOT in the *BCA Guidance for Discretionary Grant Programs* released in January 2023.[1] This methodology includes the following analytical assumptions:

- Defining existing and future conditions under a No Build base case and a Build Case;
- Estimating benefits and costs during project construction and operation, including 20 years of operations beyond the Project completion when benefits accrue;
- Presenting dollar values in real 2021 dollars. In instances where cost estimates and benefits valuations are expressed in historical or future dollar years, using an appropriate inflation rate to adjust the values;
- Discounting future benefits and costs with a real discount rate of 7 percent, Co2 emissions benefits are discounted at 3.5 percent.

Project Overview

Description

The Project area is located along US-259, approximately 6.25 miles north of SH-3 Junction and extending north 6 miles into Hochatown. US-259 is a vital transportation link that provides access for recreational opportunities, commercial traffic, logging trucks, tourists, and local and regional commuters. The area has experienced a substantial increase in growth due to land investment opportunities for cabin rentals and popular tourist destinations including the Beaver Bend State Park.

The existing US-259 within the Project area is a two-lane, undivided roadway with limited shoulder widths and stormwater conveyed through roadside ditches. There are only limited left or right turning lanes, but no existing bicycle or pedestrian facilities. The highway also provides access to over 100 residential and commercial driveways.

The Project includes the construction of a new, multi-use pedestrian trail and the reconstruction of US-259 to improve vehicular movements, enhance safety, and provide a reliable infrastructure investment in a rural community that is often overlooked.

Change to Baseline/ Alternatives	Benefit	Population Affected	RAISE Merit Criteria	Present Value (discounted @ 7%)
Capacity improvements will reduce delay and increase throughput speeds for vehicles.	Travel Time Savings	Auto Users	Economic Competitiveness and Opportunity	$34.83m
	CO2 Emissions Reduction	All	Environmental Sustainability	$0.71m
Safety improvements including signalization at intersections, increased sight distance, and a continuous center turn lane.	Reduced Roadway Crashes	Auto Users	Safety	$33.04m
The addition of sidewalk space and a multiuse path encourages pedestrian and bicycle travel.	Pedestrian and Bicycle Journey Quality	Pedestrians and Bicyclists	Mobility and Community Connectivity	$2.73m
	Health Benefits		Quality of life	$8.14m
	Vehicle Operating Cost Savings	Auto Users	Economic Competitiveness	$0.34m

Change to Baseline/ Alternatives	Benefit	Population Affected	RAISE Merit Criteria	Present Value (discounted @ 7%)
	Reduced road maintenance	Oklahoma DOT	State of Good Repair	$0.099m
	External Highway Use Costs	All	Quality of life	$0.077m

General Assumptions

The table below presents some of the general assumptions of the BCA.

Assumption	Value
Construction Start Date	2024
Construction End Date	2026
Project Opening	2027
End of Analysis Period	2046
Operations Period*	20 years (post construction)
Base Year Dollars	2021
Discount rate (all impacts except Co2 emissions)	7.0 percent
Co2 emissions discount rate	3.0 percent

*US DOT BCA guidance states that projects aimed primarily at capacity expansion should use a 20-year analysis period, even if the useful physical life of the underlying infrastructure is greater than this.

Project Costs

Capital Costs

The project's costs include construction costs and contingency are estimated at $39,607,068 in 2022 prices. ODOT expects the construction to be completed within two years, between 2024 and 2026. For the purposes of this analysis the project costs are split equally for year 1 and year 2 of construction.

Table 1 - Construction Costs

Construction	33,005,893
Roadway	26,394,651.00
Multiuse Trail	808,350.00
Sidewalk	186,881.00
Signing/Striping	156,400.00
Signalization	900,000.00
Lighting	1,248,000.00
Mobilization/MOT	1,331,260.00
Construction Management	1,980,350.00
Contingency (20%)	6,601,178
Project Total	39,607,068.00

Operations and Maintenance Costs

ODOT have provided a cost estimate for future Operations and Maintenance activities for the existing roadway under a No Build scenario and for the new roadway and trail under a Build scenario. It is expected that the costs to operate and maintain an expanded roadway and trail compared to the current facility would be greater in the long term to its expanded size and function. In the near term the costs would be lower as there should not be any significant maintenance or rehabilitation costs in the first few years of operations of a new asset. Some maintenance activities which might have taken place between 2024 and 2026 would be deferred in anticipation of construction.

Table 2 - Maintenance & Rehab Costs for US-259

Year	NO-BUILD	BUILD
2023	$0	$0
2024	$15,000	$0
2025	$0	$0
2026	$100,000	$0
2027	$0	$0
2028	$2,000,000	$0
2029	$0	$0
2030	$0	$0
2032	$50,000	$0
2034	$0	$55,000
2036	$50,000	$0
2038	$15,000	$20,000
2040	$100,000	$50,000
2042	$0	$50,000
2044	$2,250,000	$0
2046	$0	$3,000,000

Project Benefits

Travel Time Impacts

The existing US-259 within the Project area is a two-lane, undivided roadway. The highway provides access to over 100 residential and commercial driveways, but there is limited left or right turning lanes. The roadway is already prone to congestion and this is expected to worsen with the expected growth of traffic and tourism in the area. The Project will increase capacity, facilitate turning movements and reduce delay by adding a continuous center turn lane and up to two travel lanes (one in each direction). The benefit of these Travel Time Savings has been quantified for the BCA.

Temporary traffic signals were recently installed with turn bays located at SH-259A North and South, and Stevens Gap Road. The Project will further develop these temporary measures into a permanent solution as well as additional intersection improvements. This increases intersection capacity and will generate further travel time savings beyond those quantified for this analysis, including reducing delay for traffic turning onto US-259.

The baseline traffic volume assumption is 12,000 vehicles per day (vpd) in both directions in 2022[1]. For the purpose of this analysis traffic volumes were assumed to grow at a rate of 2% per year throughout the analysis period, reaching 17,831 by 2042. Historical traffic growth has been significantly greater – between 5% and 15% per year on different sections of the 6-mile corridor between 2015 and 2019 (before the impacts of the pandemic). There is expected to be continued growth in local tourism. The Choctaw Nation Hochatown Resort is currently under construction on the south side of Hochatown and is due to open in 2023/24. A 2021 Lee Engineering traffic study estimated that the resort will generate over 5,000 additional daily trips on weekends. Therefore the 2% annual traffic growth assumption is very conservative for the near term, but was selected in recognition of the uncertainty of longer-term growth rates

Average travel times were estimated along the 6-mile corridor by estimating average travel speeds using the following speed-flow formula from the Highway Capacity Manual (HCM). Average speeds were estimated for each future year with or without capacity improvements.

$$Actual\ Speed = sf/(1 + a\left(\frac{v}{c}\right)^{b}$$

Where:

$sf = free - flow\ speed$

$v = traffic\ volume\ (measured\ by\ average\ vechiles\ per\ day)$

$c = road\ capacity\ as\ defined\ by\ HCM$

$a = 0.15\ and\ b = 4$

[1] 2022 two-way traffic counts, Freese and Nichols

The free-flow speed (sf) along the corridor was assumed to be 50 mph based on an average of the speed limit[2] of 55 mph south of Hochatown and 45 mph between Hochatown and Carson Creek Road.

The resulting time savings in terms of vehicle-hours were multiplied by an assumed average vehicle occupancy of 1.67[3] and multiplied by the Value of Time of $18.80[4] to estimate the total value of time saved.

Table 3 - Travel Time Savings – 2027 and 2042

	2 lanes	3 lanes	5 lanes
Road capacity (two-way)*	13,680	17,100	36,000
2022 Traffic Volume (two-way AADT)	12,000	12,000	12,000
2027 Traffic Volume (two-way AADT)	13,251	13,251	13,251
V / C Ratio	0.97	0.77	0.37
Average Speed	44.2	47.4	50.0
Hours saved relative to 2-lane	-	75,508	125,227
2042 Traffic Volume (two-way AADT)	17,831	17,831	17,831
V / C Ratio	1.30	1.04	0.50
Average Speed	34.9	42.5	49.6
Hours saved relative to 2-lane	-	333,432	552,980

* Service volume for Principal Arterial roadways = 17,100, with a 20% reduction (13,680) if no center-turn-lane, and 36,000 for a 5-lane arterial highway, according to the Association of Central Oklahoma Governments (ACOG)

The improved capacity and travel time savings may induce additional travel demand. This has not been included in the BCA as a conservative approach as it is difficult to quantify and would increase the size of the travel time savings benefit.

During construction of the new roadway there may be disruption to traffic flows causing travel time disbenefits. This was quantified using an assumption that in the Build scenario the posted speed limit during the two-year construction period will be 35 mph.

The total value of travel time savings, including the net effect of travel time disbenefit during construction, is $17.8m for a 3-lane roadway or $34.8m for a 5-lane roadway over the 20-year appraisal period (discounted, 2021 prices).

[2] See Matthew D. Deardoffa, Brady N. Wiesnerb, Joseph Fazioc: Estimating Free-flow Speed from Posted Speed Limit Sign (2011)

[3] USDOT BCA Guidance 2023 Table A-4

[4] USDOT BCA Guidance 2023 Table A-3, recommended value for “all purpose” trips

Safety Benefits

There are expected to be significant safety benefits associated with the project. The following project elements will reduce the risk of vehicular crashes:

- Left-turning vehicles will have a dedicated space away from through-traffic lanes, reducing rear-end collisions.
- The minor streets will have improved sight distance due to removing skewed approaches and improved turning radii.
- The addition of street lighting will improve nighttime visibility for drivers.
- Temporary traffic signals recently installed at three key intersections will be made permanent

Historical crash data for the last 10 years were analyzed to estimate the average annual number of collisions and injuries, disaggregated by severity, type and cause, and to identify the crashes which may be mitigated by the safety improvements in this project.

It was assumed that without any intervention (No Build scenario) the frequency and severity of crashes would continue at a similar rate to that seen in the last 10 years with an additional growth factor of 2% per year in line with the traffic growth assumption.

Crash Reduction Factors (CRF) from the Clearinghouse database were identified for the elements of the project which would improve safety. These were applied to different types of accidents depending on the safety intervention to estimate the reduction in crashes and injuries that could be expected in each year. This was multiplied by the dollar value associated with each type of injury based on the "KABCO" injury scale, which was developed by the National Safety Council1.

The table below shows the CRFs used, in terms of the percentage decrease in accidents.

Table 4 – Crash Reduction Factors

CRF ID	Intervention	CRF	Crashes this CRF is applied to (annual average number of crashes)
2338	Install Two Way Left Turn Lane on two lane road	-31.4%	All crashes on the corridor
7983	Install a traffic signal	-36.1%	Crashes within 250-foot buffer of a newly signalized intersection
11027	Install lighting	-41.9%	Crashes within 100-foot buffer of where new lighting will be installed
307	Increase triangle sight distance	-48%	Crashes within 250-foot buffer of where sight distance will be improved

Table 5 - Monetized crash values

Crash Type	Monetized Value per incident (2021 $)	Accidents avoided
No Injury - O	$4,000	-47% (6.2 per year)
Possible Injury - C	$78,500	-51% (2.6 per year)
Non-Incapacitating - B	$153,700	-44% (0.8 per year)
Incapacitating - A	$564,300	-60% (0.4 per year)
Killed - K	$11,800,000	-52% (0.2 per year)
Total		**-49% (10.3 per year)**

The total value is $33m over the 20-year appraisal period (discounted, 2021 prices).

The analysis only includes a reduction in vehicular crashes, because the historical crash data involved vehicles only. The project is also expected to generate significant improvements for pedestrians with the pedestrian crossings at intersections and installation of sidewalks and a trail. This represents an additional safety benefit beyond the value quantified for this analysis.

Active Travel Benefits

The Project includes the construction of a multi-use trail and building sidewalks alongside US-259. This will benefit existing pedestrians and cyclists and also to generate additional pedestrian trips and cycling trips.

Demand

The number of daily walking and cycling trips was estimated based on the assumptions shown in the table below for the number of residents and visitors, daily trip rate and mode shares. This was assumed to represent the level of active travel demand in the Build scenario following installation of the multi-use trail and sidewalks. This was estimated at 604 daily pedestrian trips and 135 daily bike trips, compared against only 200 pedestrian trips and 50 cycling trips in the base scenario.

These numbers were assumed to grow at 2% per year, in line with local traffic and tourism growth.

Active Travel Journey Quality

This impact is generated as a result of the new multi-modal infrastructure in comparison to the current lack of walking or cycling infrastructure. This benefit accrues to both new and existing cyclists/pedestrians.

The pedestrian journey quality benefit is $1.10 per person-mile walked ($0.55 for induced pedestrian trips due to the 'rule of a half' for New Users) assuming the sidewalk and trail will be 10 feet wide. This is multiplied by the average pedestrian trip

distance of 0.86 miles and the number of existing pedestrian trips in each forecast year.

The bicycle journey quality benefit is $1.77 for dedicated cycling land

multiplied by the average bicycle trip distance of 2.38 miles and the number of cyclists in each forecast year.

The projects total active travel journey quality benefits are $2.7m over the 20-year appraisal period (discounted, 2021 prices).

Active Travel Health Benefits

This benefit is due to an increase in physical activity from an increase in walking and cycling leading to improved cardiovascular health and a reduction in mortality risks. We apply $7.20 per induced pedestrian trip and $6.42 per induced bike trip.

The total value is $8.1m over the 20-year appraisal period (discounted, 2021 prices).

Table 6 - Assumptions for estimating active travel demand

Parameter	Value	Source
Resident population	250	ODOT
Daily visitors	6,500	Beaver Bend State Park visitor numbers – 2,283,600 in 2021
Daily trips per resident and visitor in the project area	3.2	2017 NHTS – Table 13 – Trips per day in rural areas
% Walk	2.9%	2017 NHTS – Table 26
% Cycle	1.1%	2017 NHTS – Table 26
Number of daily pedestrians:		
No Build	200	Streetlight BigData Analytics
Build	604	Calculation
Number of daily bicyclists:		
No Build	50	Streetlight BigData Analytics
Build	135	Calculation
Pedestrian journey quality benefit, per mile per 1 foot width of sidewalk	$0.11	US DOT BCA Guidance 2023 Table A-8
Bicycle journey quality benefit, per mile	$1.77	US DOT BCA Guidance 2023 Table A-9
Average walk trip distance (miles)	0.86	US DOT BCA Guidance 2023 Table A-8
Average cycle trip distance (miles)	2.38	US DOT BCA Guidance 2023 Table A-9

Benefits of a reduction in Vehicle Miles Traveled

In addition to journey quality and health benefits due to walking and cycling improvements, there will also be a reduction in vehicle trips, and Vehicles Miles Traveled (VMT), as some drivers switch to walking or cycling for some short distance trips. The estimated increase in pedestrian trips is 163,000 in 2027, with a corresponding reduction in vehicle miles of 83,800 in 2027, assuming an average pedestrian trip distance of 0.86 miles and an average vehicle occupancy of 1.67.

This represents a benefit of the project in terms of a reduction in user and external costs associated with driving.

Vehicle Operating

Cost Savings

For every vehicle mile reduced, users benefit from $0.46 reduced vehicle operating costs, including gasoline, maintenance, tire wear, and depreciation[5]. The total estimated value is $338,600 over the 20-year appraisal period (discounted, 2021 prices).

External Highways Use Costs Reduction

The reduction in VMT also leads to a reduction in external highway use costs including congestion, noise and safety. Note that the reduction in *external* safety costs is additional to the safety improvement described and quantified above. The total estimated value is $76,500 over the 20-year appraisal period (discounted, 2021 prices).

State of Good Repair

Every 1 mile of VMT reduced is assumed to generate a saving of $0.14 for reduced cost of maintenance, with a total estimated value of $99,000 PV over the analysis period.

Table 7 – Assumptions for VMT Reduction Benefits

Parameter	Value	Source
Average Vehicle Occupancy	1.67	US DOT BCA Guidance - Table A-4
Average walk trip distance (miles)	0.86	US DOT BCA Guidance 2023 Table A-8
Average cycle trip distance (miles)	2.38	US DOT BCA Guidance 2023 Table A-9
Vehicle Operating Cost per VMT	$0.46	US DOT BCA Guidance 2023 Table A-5
External Highway Use Cost per VMT (2021 $)		US DOT BCA Guidance 2023 Table A-14,
Congestion	$0.028	Light-Duty Vehicles - Rural
Noise	$0.0002	
Safety	$0.080	

Emissions Reduction

Emissions will be reduced as a result of the capacity improvements which reduce delay and increase average speeds along the corridor. The fuel consumption for the No Build vs Build (i.e., with and without congestion) was estimated for each year using fuel consumption values from US EIA Annual Energy Outlook 2022, which increase over time between 25 to 30 miles per gallon. These were adjusted using Fuel Efficiency Factors sourced from USEIA 2013 which reflect the reductions in fuel efficiency when average speeds decrease between 50 mph and 30 mph. The average speeds with and without capacity improvements were used for this calculation, calculated as described in the Travel Time Impacts section above.

The resulting values for CO2 emissions range between 345 grams per mile in 2022, to 280 or 341 grams per mile in 2046, with or without capacity improvements.

Emissions will also reduce as a result of the reduction in VMT due to the increase in walking and cycling. This has been calculated for carbon dioxide (Co2) as well as the most common local air pollutants generated by transportation activities include sulfur oxides (SOX), nitrogen oxides (NOX), and fine particulate matter (PM2.5).

Auto emissions factors for each of these pollutants is based on California Air Resources Board's EMFAC2017 Mobile Emissions Inventory for 2024 and 2044, with other years calculated based on the CAGR between those years. This was applied to the damage costs of each pollutant per metric ton[6]

Benefits from reductions in CO2 emissions are discounted at a 3 percent rate. The total estimated value is $705,700 over the 20-year appraisal period (discounted, 2021 prices).

[6] US DOT BCA Guidance - Table A-6

Residual Value

A residual value has been included because the project assets are expected to have several years of useful service life remaining at the end of the 22-year analysis period. The estimated service life of the expanded road is 30 years meaning the assets have a residual life span of 8 years. We assume a linear reduction in the value of the asset every year. The value of each year is $39.6m / 30 = $1.32m. Therefore, the residual value in 2046 (non-discounted) is $10.6m

Table 8 - Residual Values Assumptions

Item	Value
Assets Life Span	30 years
Analysis Period	22 years
Residual Value (non-discounted)	$10.6m
Residual values (2021 PV $)	$1.3m

Summary of Results

The results presented below show the highest cost option of expanding the roadway to five lanes - two lanes in each direction and a center turn lane. The Benefit Cost Ratio is over 2, indicating that the benefits of the project are more than double that of the costs. Alternative design solutions are still under consideration including a three lane or four lane design, which could still deliver most of the safety and active travel benefits and some capacity improvements at a lower cost. These alternatives were found to have a comparable Benefit Cost Ratio.

Table 9 – Benefit Cost Analysis Results

Discounted $2021 values

Benefit Cost Ratio	2.92
Net Present Value	$53,857,000
TOTAL BENEFITS (Discounted)	$81,903,200
Safety Benefits	$33,042,000
Time Savings	$34,829,400
Active Travel Journey Quality Benefits	$2,726,100
Active Travel Health Benefits	$8,139,700
Vehicle Operating Cost Saving	$338,600
Emissions Reduction	$705,700
State of good repair	$99,100
External Highway Use Costs	$76,600
Residual Value	$1,946,000
TOTAL COSTS (discounted)	$28,046,300
Capital Costs	$29,233,600
Maintenance	($1,187,300)