Oklahoma Panhandle Safe Bridges Project

Beaver, Cimarron, and Texas Counties, Oklahoma

Benefit Cost Analysis Technical Memo

November 1, 2024

CED8

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Benefit-Cost Analysis

Executive Summary

The Benefit-Cost Analysis (BCA) for the Oklahoma Panhandle Safe Bridges Project application compares the costs and benefits of the proposed Project. The analysis utilized the Bridge Investment Program Benefit-Cost Analysis Tool v.1.0.4 (BCA Tool) and associated User Manual released by USDOT in December 2023. To the extent possible, expected benefits were monetized. A qualitative discussion is presented for benefits that are more difficult to quantify.

Oklahoma Circuit Engineering District (CED) 8 proposes to replace four bridges in Oklahoma's Panhandle that are in poor condition or at risk of falling into poor condition, have substandard clearances, and can no longer accommodate the needs of the regional transportation network. Specific improvements planned as part of the project include:

- Replacement of four bridges in a bundled project, three with new pre-stressed concrete beam bridges, and one bridge may be constructed using the innovative Valmont-U Beam Bridge System.
- Providing lane and shoulder widths to meet today's design standards, as well as new safety guardrails.

Table 1 below summarizes the changes expected from the project, and the associated quantified benefits. The period of analysis used in the estimation of benefits and costs is 35 years, including five years of project development and construction, and 30 years of operations. The project will construct four new bridges each with a 75-year design life and so a longer analysis period was selected. Total project development and construction costs are estimated at $27.7 million. Costs were entered into the BCA Tool in today's dollars and automatically de-escalated to 2022 and discounted for a total discounted capital cost of $22.8 million.

All relevant data and calculations used to derive the benefits and costs of the project are shown in the BCA Tool that accompanies this grant application. Based on the analysis presented in the rest of this document, the Project is expected to generate $262.6 million in discounted benefits and $22.8 million in discounted capital costs (**Table 1**). Therefore, the Project is expected to generate a Net Present Value of $239.8 million and a Benefit/Cost Ratio (BCR) of 11.51 as shown below in **Table 2**. Each individual bridge has a BCR of at least 1.0.

Table 1: Summary of Monetized Benefits

Baseline Status and Problems to be Addressed	Change to Baseline	Types of Impacts & Benefits	Population Affected by Impacts	Benefit Value (2022 $ millions)
The four existing bridges are in fair or poor condition with deficient horizontal clearances and no shoulders. With no improvement the bridges would require load posting and eventual closure, requiring long detours. These detours increase travel time and collision risk. The existing narrow bridges do not allow pedestrians or bicyclists to safely cross.	CED 8 proposes to construct four new bridges with standard lane and shoulder widths. The new bridges would safely accommodate both vehicles and bicycles/pedestrians. Improving the condition of the bridges would avoid future load postings and closures, avoiding costly detours.	***Impact*** - Enhanced roadway design ***Benefit*** - Improved vehicle safety	Vehicle Owners and Truck Operators	$ 29.2
		Impact - Reduced vehicular delays and avoided detours due to structure condition ***Benefit*** - Reduction in travel times	Vehicle Owners, and Truck Operators	$ 65.0
		Impact - Reduced vehicular delays and avoided detours due to structure condition ***Benefit*** - Reduced vehicle operating costs (fuel reduction)	Vehicle Owners and Truck Operators	$ 119.6
		Impact - Reduced time spent idling during delays ***Benefit*** - Emissions reduction	Vehicle Owners, Truck Operators, and Residents of adjacent communities	$ 44.4
		Impact – Avoided impacts to communities on the detour route ***Benefit*** – Noise reduction	Residents of adjacent communities	$ 0.3
		Impact – New structure with less frequent maintenance requirements ***Benefit*** – Maintenance cost savings.	Beaver, Cimarron, and Texas Counties	$ 0.1
		Impact - New bridge ***Benefit*** – Extended residual life of bridge	CED 8, ODOT	$ 3.9
Total Benefit				**$ 262.6**

Table 2: Summary of BCA Outcomes, Millions of 2022 Dollars

Category	Benefit	Percent of Total Benefits
Safety	$ 29,154,716	**11%**
Travel Time	$ 64,958,945	**25%**
VOC	$ 119,630,261	**46%**
Resilience	$ -	**0%**
Health and Amenity	$ -	**0%**
CO2 Emissions	$ 37,125,979	**14%**
Non-CO2 Emissions	$ 7,306,593	**3%**
Other Environmental	$ 333,442	**<1%**
Maintenance	$ 120,683	**<1%**
Residual Value	$ 3,938,600	**2%**
Other Benefits	$ -	**0%**
Total Benefits	$ 262,569,219	**100%**
Total Discounted Costs	$ 22,809,461	**N/A**
BCR	11.51	**N/A**
Net Present Value (NPV)	$ 239,759,758	**N/A**

In addition to the monetized benefits, the project is expected to generate benefits that are more difficult to quantify. A brief description of those benefits is provided below. More detail is presented in the **Merit Criteria** section of the application narrative.

- **Economic Impacts, Freight Movement, and Job Creation**: The existing bridges carry a high percentage of truck traffic related to surrounding agricultural and energy production activities. The economy of this area is dependent upon these vehicles having safe and reliable transportation to and from production sites. Three of the four bridges are currently load posted and without improvement, additional postings and/or closure would be required. The resulting detours range from 3 to almost 38 miles, resulting in significant increases in travel time and operating costs.
- **Climate Change, Sustainability, Resiliency, and the Environment**: While not all of the bridges have a documented history of flooding, NBI 18599 has overtopped in the recent past. All of the bridges will be reconstructed with a raise in profile grade to allow passage of the 100-year storm. This will protect against future flooding events as rainfall events become more severe.
- **Equity, Multimodal Options, and Quality of Life:** The Project will improve the quality of life for local and regional users. The existing bridges are critical links in the limited roadway network of this rural area. Improving the bridges to provide safe crossings with sufficient capacity to meet current and future demand will improve mobility for all users for future generations. Reliability will be improved providing improved traffic flow, as well as additional bridge width to provide a safer facility, allow collisions to be cleared more quickly, and provide

emergency responders better access. The Project will provide increased transportation security and access in areas that are disadvantaged for both of these factors.

- **Innovation Areas: Technology, Project Delivery, and Financing:** CED 8 intends to bundle these four bridges into a single project, resulting in time and cost savings. In addition, Valmont U-beams are being considered for one of the bridges which would shorten construction time and reduce future maintenance.

Introduction and Methodology

This document provides detailed technical information on the benefit-cost analysis (BCA) conducted in support of the grant application for the Project. The BCA includes the monetized benefits and costs measured using the USDOT BCA Tool, as well as the quantitative and qualitative 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. While a BCA is just one of many tools that can be used in making decisions about infrastructure investments, it provides a useful benchmark from which to evaluate and compare potential transportation investments. This memo documents the assumptions used to produce the analysis, a description of the baseline, the sources of data used to project the outcome of the project, and the values of key input parameters. The methodology and calculations are derived from the USDOT BCA Tool.

Project Overview

The proposed Oklahoma Panhandle Safe Bridges Project will construct four new bridges in Oklahoma's Panhandle. The existing bridges are in fair to poor condition, have deficient clearances, and do not meet the transportation needs of the region. Three of the bridges are rated "fair" and one is rated "poor." The purpose of the Project is to eliminate these deficient bridges and restore safe crossings that are up to today's design standards and meet the transportation needs of the current and future regional network. CED 8 intends to construct the Project as a bundle, letting all four bridges as a single project to a single contractor. The scope of the Project is a regional project that includes the rural counties of Cimarron, Texas, and Beaver. The bridges are all surrounded by productive land uses, either agricultural or the energy sector, and serve as direct connections to Hwy 412, a major cross-state, east-west connection for freight and other travel. Net detour lengths range from 3 miles to 27.7 miles, and any possible future closure of any one of these bridges would pose a hardship for the local economy and the regional residents' connections to daily activities such as school, work, medical facilities, and the grocery store.

The Project will provide four new structures designed with a 75-year life to today's standards, with sufficient capacity to accommodate future traffic demand. The Project will improve safety, improve the efficiency and reliability of the movement of people and freight, increase resiliency to severe weather events, and provide safe and secure transportation options to nearby Historically Disadvantaged Communities and Areas of Persistent Poverty. More detail about the Project's

safety, state of good repair, economic, resiliency, and equity/quality of life outcomes are presented in the application narrative.

Specific improvements planned as part of the Project include:

- Construction of new two-lane bridges on a new alignment with 11' driving lanes with new prestressed concrete beam bridges in a bundled project.
- Providing lane and shoulder widths to meet today's design standards, as well as new safety guardrail.

Base Case and Alternative

The Base Case for the Project is defined as the "No Build" scenario. This scenario reflects no capital improvements within the project limits but would require certain maintenance and rehabilitation costs over the analysis period.

The Alternative Case is defined as the Build scenario as described in the Project Description section above.

Types of Impacts

The proposed Project is expected to have the following impacts:

- Reduction in expected number of crashes due to wider bridges with standard shoulders and guardrail,
- Reduction in travel times and vehicle operating costs due to avoidance of detours that would be required if the bridges are not improved,
- Improved resiliency to flooding events,
- Improved pedestrian and bicycle access,
- Reduction in noise and emissions due to avoided detours, and
- Decreased maintenance costs and increased useful life of the four bridges.

Project Cost and Schedule – Alternative Case

Total project capital development and construction costs are estimated at $27.7 million in today's dollars. The BCA Tool adjusted these costs to 2022 dollars and discounted them by 3.1%[1]. The adjusted project development and construction cost amounts to $22.8 million in discounted dollars. Project construction is anticipated to start in 2028 and take two years with completion by mid-2030. For simplicity, 2030 is assumed as the Project opening year and first year of Project-related benefits.

The Project will require maintenance during the 30-year operating period that is estimated at $210,000 for all four bridges. This assumes inspections every two years and minor repairs.

Project Cost – Base Case

The Base Case (No Build) assumes no capital development or construction. However, the Base Case would require additional maintenance over the next 30 years[2]. Maintenance costs of the No Build include annual inspections and minor repairs. The total major maintenance rehabilitation

[1] Except carbon dioxide emissions which are discounted at 2%.
[2] Maintenance costs for NBI 18599 were calculated through 2042 when the bridge is anticipated to be closed.

costs required are estimated at about $504,000. While the Alternative Case has maintenance costs associated with the project lifecycle planning, it is less than what would be incurred under the Base Case when discounted over time. Thus, the Alternative case creates a net savings in maintenance costs of approximately $294,000 ($120,683 discounted), or a 42% savings.

Alignment with Selection Criteria

The main benefit categories associated with the Project are mapped into the merit criteria set forth by U.S. DOT in **Table 3** below.

Table 3: Benefit Categories of the Project

Criteria	Benefit(s)	Description	Monetized	Qualitative
Safety	Increased vehicle safety	Widened bridge and addition of shoulders and guardrail are expected to reduce collisions and fatalities. Also, savings from avoidance of detours as associated crashes.	Yes	Yes
	Added pedestrian and bicycle comfort and safety	Wider lanes and in some cases, shoulders will provide a separated space for pedestrian and bicyclists	No	Yes
State of Good Repair	Reduced O&M Cost	Bridge replacement will reduce O&M	Yes	Yes
	Residual Value	Useful life of bridge will be extended	Yes	Yes
	Detour avoidance	Bridge replacement will avoid costly detours when the bridge is load posted and eventually closed	Yes	Yes
	Contribution to local economic development and growth	Economic impact of construction project.	No	Yes
Economic Impacts, Freight Movement, and Job Creation	Travel time savings	Travel time reliability will increase the efficiency and movement of the goods and people surrounding the project.	Yes	Yes
	Support good paying jobs and strong labor standards	Construction will provide good paying jobs and will provide equal employment opportunities.	No	Yes
Climate Change, Resiliency, and the Environment	Emissions reduction	Detour avoidance will reduce emissions.	Yes	Yes
	Noise reduction	Detour avoidance will reduce noise impacts along the detour route.	Yes	Yes
	Flood Resiliency	The raise in elevation of the bridge will reduce the	No	Yes

Criteria	Benefit(s)	Description	Monetized	Qualitative
		potential for future bridge damage and/or closures due to flooding.		
Equity, Multimodal Options, and Quality of Life	Pedestrian and bicycle accommodation	Wider lanes and in some cases, shoulders will provide a separated space for pedestrian and bicyclists	No	Yes
	Transportation access and security	Provide safe and secure transportation options for a disadvantaged area.	No	Yes
Innovation Areas: Technology, Project Delivery, and Financing	Project bundling	Bundling of the four bridges is anticipated to save approximately 10% in construction costs.	Yes	Yes
	Innovative technology	The use of Valmont U-beams would save time in construction and overall cost.	No	Yes

General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of construction and including 30 years of operations. The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. These assumptions are documented in the USDOT BCA Tool. Specifically:

- Input prices, costs, and benefits are expressed in 2022 dollars.
- The period of analysis begins in 2030 and ends in 2059. The project includes five years of project development and two years of construction in 2028 - 2029 prior to the 30-year analysis period.
- A constant 3.1 percent real discount rate is assumed throughout the period of analysis, except for benefits related to CO_2 greenhouse (GHG) emissions which are discounted at a 2.0 percent real discount rate.
- Opening year demand and benefits are inputs to the BCA and are assumed to be fully realized after construction is finished and project starts operations in 2030 (no ramp-up).

Traffic Volumes

The BCA Tool provides traffic volumes for each structure based on the latest inspection reports. The Tool includes a forecasted annual average daily traffic (AADT) volume for the opening year and last year of the analysis period, based on an NBI-calculated growth rate. This data was used to project traffic for one bridge: NBI 18599. Traffic counts were completed by CED 8 in 2024 at the other three bridges. Counts were collected over a one-week period in May 2024. Results from the three bridges counted indicate that volumes are higher (in some cases much higher) than what is shown in NBI, and the truck percentages are also much higher. This is likely due to the agricultural and energy-related activities in the area, both of which depend on heavy trucks to transport products and equipment. These counts were used instead of the NBI data at the three bridges where they were collected. Growth rates for these three locations were calculated based

on historical count data from ODOT's nearby count sites. Between five and eleven count sites were used for each bridge location dating back to 2013. Based on the average growth rate for each site, projected volumes were derived for the years 2023-2059. These values were entered into Table 53 for each bridge in the BCA Tool. Traffic count data, count site data, and projected traffic volumes are available at CED 8 Project.

Benefits

This section describes the measurement approach used for each quantifiable benefit or impact category identified in **Table 1** and provides an overview of the methodologies and assumptions. A summary of all benefits is presented in **Table 2**.

Safety Benefits

Data from the ODOT SAFE-T collision database were reviewed for all four bridges between the years 2012-2022[3]. There were three total collisions documented during this time period, one on NBI 17589 and two on NBI 17606 including one fatality. While the improvements are anticipated to improve safety on all four bridges, quantified safety benefits were calculated only on the bridges with documented collisions. Safety benefits of the new bridges include reduction in expected number of crashes through addition of shoulders and new guardrail. Crash Modification Factors (CMF) were investigated and identified for these improvements. A summary of the CMFs applied is summarized in **Table 4**.

Table 4: Crash Modification Factors Applicable to the Project

			Applicability to Project Bridges/Collision Types		
CMF ID	Description	Factor	17606 PDO	17606 Fatal	17589
5402	Add shoulder (from <5' unpaved to 5' paved)	0.71	0.71	0.71	
8410	Add guardrail (fatal collisions only)	0.80		0.80	
	TOTAL		**0.71**	**0.568**	**N/A**

CMFs were applied to each bridge depending on the improvement proposed, the condition of the existing safety features, and the collision type. For NBI 17606, CMF 8410 was applied to the fatal collision only. This CMF was multiplied by CMF 5402 since the project will also add a 5-foot shoulder to the bridge. Monetization of crashes is calculated by the BCA Tool according to values provided in the BCA Guidance document (Table 39 in the BCA Tool). In addition, the Project will realize safety benefits from avoided detouring. According to NBI data, under the Base Case, two bridges would be required to be load posted for 50% of buses and trucks by 2028. One bridge would require closure in 2042. In total, safety benefits of the Project are estimated at $29.2 million.

[3] Collision data can be found at CED 8 Project

By 2059, the project is anticipated to impact 100,654 person-miles traveled (PMT) assuming the average daily traffic volumes shown in the BCA Tool, 1.67 persons/vehicle (per BCA guidance), and a one-mile distance per bridge.

Travel Time Savings

The Project will provide travel time and mobility related benefits due to the avoidance of detours. Posting and closure dates for each bridge were derived from the NBI data in the BCA Tool. Travel time savings are reduced somewhat by delays during construction of NBI 18599, which will be closed during construction. It is assumed the bridge would take 120 days to construct. With the bundled project the contractor would determine the construction sequencing and phasing, so the year of construction of this particular bridge is not known. Therefore, it was assumed half the construction would occur in 2028 and half in 2029. Disbenefits of work zone delays are estimated at $29,813. The remaining three bridges will be reconstructed on offset alignments and will not require the existing bridges to be closed during construction. Total travel time savings for the Project is $65.0 million.

Reduced Vehicle Operating Costs

Vehicle operating costs are captured in the benefits of detour avoidance. Estimated vehicle operating cost savings of the Project are $119.6 million.

Emissions Reduction

Emissions reduction benefits are captured in the detour avoidance benefits. Emissions reduction benefits for the Project are estimated at $37.1 million for CO2 and $7.3 million for non-CO2 emissions.

Other Environmental

The BCA Tool calculates noise reduction benefits as a result of detour avoidance. The benefit is calculated at $333,442.

Maintenance Savings

As described above, the total major maintenance and rehabilitation costs required under the Base Case are estimated at about $504,000, compared to the Alternative Case at approximately $210,000. While the Alternative Case has maintenance costs associated with the project lifecycle planning, it is less than what would be incurred under the Base Case when discounted over time. Thus, the Alternative case creates a net savings in maintenance costs of approximately $120,683 in discounted costs.

Residual Value

Under the No Build scenario, the existing bridges would not have any remaining useful life in 2059. The new bridges are assumed to have a design life of 75 years and represent between approximately 54-80% of the project cost. Associated approach roadway improvements make up the remainder of the Project costs and are estimated to have a 20-year design life. The residual value translates to a benefit of $3.9 million in discounted savings.

BCA Sensitivity Analysis

The BCA outcomes presented in the 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 "critical variables"—the variables and model parameters whose variations have the greatest impact on the BCA outcomes.

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables—how much the final results would vary with reasonable departures from the "preferred" or most likely value for the variable, and
- Assess the robustness of the BCA and evaluate whether the conclusions reached under the "preferred" set of input values are significantly altered by reasonable departures from those values.

The sensitivity analysis was conducted with respect to traffic volumes and capital costs. The outcomes of the analysis are summarized in **Table 5** below. The table provides the percentage changes in project NPV associated with variations in variables or parameters.

Table 5: BCA Sensitivity Analysis

Parameters	Change in Parameter Value	New NPV (millions of discounted $)	% Change in NPV	New B/C Ratio
Project Analysis		**$239.8**		**11.51**
Traffic Volumes	Use of NBI traffic volumes vs. count data[4]	$10.8	-95%	1.47
Capital Cost	20% Increase	$236.0	-.02%	9.62

The table demonstrates that under the alternative parameter values that may depress Project NPV, the Project maintains NPV above zero and BC Ratio of 1.47 or higher. Using the NBI traffic data instead of the count data collected by CED 8 in 2024, Project NPV decreases 95% to $10.8 million but the BC ratio remains positive at 1.47. An increase in capital costs of 20% has very little effect on NPV and the BC ratio remains high at 9.62. However, the individual BCR of NBI 18599 drops to below 1.0.

[4] Note NBI 18599 did not have count data so NBI data was used in both the Project and sensitivity analysis.