OKLAHOMA
Transportation

FY 2023-2024 MPDG

I-35 CAPACITY IMPROVEMENTS

Benefit-Cost Analysis

Benefit-Cost Analysis

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Executive Summary

The benefit-cost analysis (BCA) for this grant application systematically evaluates the costs associated with the proposed investment relative to the benefits of the project. Whenever feasible, benefits are quantified in monetary terms. In instances where quantification is challenging, a qualitative assessment is provided. The primary focus of the project seeking the Multimodal Project Discretionary Grant (MPDG) centers on enhancing the capacity and safety along I-35 and upgrading the interchange at SH-74 through the replacement of existing bridge (SH-74) over I-35.

Approximately 6.2 miles of this corridor are designated for capacity expansion, including the addition of lanes in each travel direction, with the reconstruction of the SH-74 interchange. This vital transportation link plays a crucial role in facilitating the movement of people and goods, thus enhancing regional connectivity and economic vitality.

This BCA conducted for the Oklahoma Department of Transportation's (ODOT) I-35 Capacity Improvements in McClain County, for submission to the U.S. Department of Transportation (USDOT) as a requirement of a discretionary grant application for the 2023/2024 Multimodal Projects Discretionary Grant (MPDG) Rural Grant Program is conducted in accordance with the benefit-cost methodology as outlined by USDOT in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs, released in January 2023.

The analysis is conducted over a 26-year horizon, incorporating six years for development plans and construction, followed by 20 years of operational evaluation. Construction costs are estimated at $78,100,000 in 2023 dollars and $70,290,000 in 2021 dollars. The detailed data and calculations integral to assessing the project's benefits and costs are outlined within the accompanying BCA model.

Based on the comprehensive analysis presented in this document, the project is projected to generate $181,886,514 in discounted benefits against $60,324,974 in discounted capital costs, utilizing a 7 percent real discount rate. This forecast translates into an anticipated Net Present Value of $157,554,864, resulting in a commendable Benefit/Cost Ratio of 3.02.

The project entails enhancing capacity in McClain County, OK and improving the I-35 interchange at SH-74 through bridge replacement. ODOT seeks $30,000,000 in MPDG Rural funding to support this endeavor, totaling $84,694,165 including $6,594,165 in previously incurred costs. Refer to **Table 1** below for further details.

Table 1 Project Cost Summary (2023$)

Project	Mileage	Construction Costs			Previously Incurred Costs	
		Construction	E&C	Contingency	Design	Right of Way & Utilities
SH-74 Interchange/ Bridge	Interchange	$11,596,000	$695,760	$1,739,400	$1,043,640	$1,906,300
I-35 South Section Widening	2	$18,560,619	$1,113,637	$2,784,093	$1,670,456	$200,000
I-35 North Section Widening	4.2	$34,388,836	$2,063,330	$5,158,325	$1,273,769	$500,000
Sub-Total		$64,545,455	$3,872,727	$9,681,818	$3,987,865	$2,606,300
Total		**$78,100,000**			**$6,594,165**	
		$84,694,165				

The initiative will lead to fewer accidents. Under the “Build” scenario, the estimated avoided crash cost amounts to $45,884,777 undiscounted and $16,743,178 in 2021 discounted dollars.

The project will involve operations and maintenance expenses. In comparison to the "No Build" scenario, the operational and maintenance cost savings will be $303,077 undiscounted and $244,233 for the "Build" scenarios, respectively. With a seven percent discount rate, the O&M cost savings will be $840,345 for the "Build" condition.

At the end of the 26-year operating period, the assets will retain a residual value of $38,443,624 in undiscounted dollars for the “Build” scenario. The residual value will be $7,083,206 in discounted dollars. The residual value is included in the total benefits of the project.

The project will reduce crash incidents, travel time, and operations and maintenance costs. Using a seven percent discount rate, this leads to the projects having a Net Present Value of $157,554,864. The “Build” scenario carries a Benefit Cost Ratio of 3.0. The overall project benefit matrix is in the table below. Baselines and issues to be addressed are shown in detail in **Table 2**.

Table 2 Baseline and Issues to be Addressed

Benefit	Benefit Description	Monetized Benefit (At 7% Discount Rate)
Travel Time	Anticipated reductions in travel times and improved interchange efficiency	$155.5M
Safety	Reduction in Crashes	$16.75M
Residual Value	Anticipated present value of the sum of the expected annual avoided damages over the project useful life.	$8.08M
Operations & Maintenance	New and better designed infrastructure equates to lower O&M costs	$0.84M
Environmental (Emissions)	Lower miles traveled equates to lower emissions	-$0.91M

In addition to the quantifiable benefits outlined in **Table 1** and further detailed in the project evaluation metrics found in **Table 2**, the Project stands to deliver qualitative benefits that, while challenging to quantify and monetize, significantly enhance the project's impact. These include enhanced travel reliability. Anticipated reductions in travel times and improved interchange efficiency are expected to yield smoother vehicle flow, thereby benefiting personal and commercial travel along the corridor.

In addition, synergy with priority planning initiatives. The proposed enhancements align with broader planning efforts, fostering improved connections and overall efficiency. Further, supporting sustainable sector growth. The Project's enhancements will facilitate the growth of renewable energy sectors, thereby contributing to sustainable economic development.

These qualitative advantages, combined with the quantifiable benefits, underscore the substantial potential and comprehensive value of the Project, focused on augmenting capacity along I-35 and elevating the SH-74 interchange through the replacement of the existing bridge.

A benefit-cost analysis (BCA) was conducted for the I-35 Capacity Improvements in McClain County, for submission to the U.S. Department of Transportation (USDOT) as a requirement of a discretionary grant application for the 2023/2024 MPDG Rural Grant Program. This appendix is organized as follows:

- Section 2 contains the project description.
- Section 3 documents the BCA methodology, including key methodological components, assumptions, and the study scenarios.
- Section 4 contains a detailed explanation and calculation of the project benefits.
- Section 5 contains a detailed explanation and calculation of the project costs.
- Section 6 contains the detailed results of the BCA.

1. Project Description

The Oklahoma Department of Transportation (ODOT) is actively pursuing $30,000,000 funding from the 2023/2024 Multimodal Project Discretionary Grant Program (MPDG) Rural grant to advance the I-35 Widening and reconstruct the intersection at SH-74 in McClain County, Oklahoma. This endeavor encompasses widening 6.2 miles of I-35 and executing crucial interchange enhancements at SH-74. The primary goal is to enhance a vital corridor facilitating connectivity between Kansas, Oklahoma City, and Texas, while supporting essential freight connections that underpin the economic vitality of both Oklahoma and the broader United States.

The primary initiative behind this Multimodal Project Discretionary Grant (MPDG) application, known as the I-35 Corridor Improvements in McClain County (the Project), targets a strategic span along Interstate 35 (I-35). This endeavor concentrates on elevating a crucial corridor's capacity by widening approximately 6.2 miles (one lane in each direction) and enhancing interchange of SH-74 bridge.

This application includes the overhaul of the bridge spanning I-35 and the introduction of interchange enhancements at SH-74 in Goldsby, OK. The I-35 segment intends to expand the mainline from 4 lanes to 6 lanes.

The Project carries a projected total cost of $84,694,165 (measured in 2023 dollars), and the MPDG's $30 million investment is integral to achieving full construction funding. As per the findings of the Benefit-Cost Analysis, the I-35 Widening and Bridge initiative is poised to achieve an impressive benefit-cost ratio (BCR) of 3.0, accompanied by a substantial net present value (NPV) of $157,554,864.

This endeavor holds immense significance, serving as a pivotal step toward fortifying transportation infrastructure and stimulating economic growth within the region.

The I-35 Capacity Improvements in McClain County endeavors to invigorate and expand critical infrastructure, enhancing transportation efficiency and safety. As a principal artery for both national and international freight movement, the I-35 corridor witnesses approximately 20% of its traffic comprised of trucks, simultaneously fulfilling a crucial commuter role within major metropolitan zones. Encompassing a span of 6.2 miles, the project encompasses the comprehensive interchange enhancements at SH-74.

The I-35 corridor functions as a dynamic economic catalyst for Oklahoma, the Chickasaw Nation, Texas, and the United States at large, facilitating trade and connectivity between the Oklahoma City vicinity and the Dallas/Fort Worth region. Furthermore, this strategic conduit stands as a vital freight artery connecting the United States and Mexico, culminating at the Port of Laredo in Texas. The Project's scope aligns with rural classifications, adhering to both the USDOT Notice of Funding Opportunities (NOFO) and the ODOT 2045 Long Range Transportation Plan criteria, targeting counties with populations below 200,000 and devoid of urban clusters.

By introducing additional capacity to the congested I-35 corridor, the initiative will mitigate traffic congestion, leading to reduced travel durations and heightened overall reliability for all users. The corresponding decrease in halted and idling vehicles will also contribute to a reduction in vehicle emissions, thereby fostering environmental sustainability. Moreover, the expanded inner shoulder is anticipated to play a pivotal role in curbing collisions, bolstering overall motorist safety.

The anticipated success of the Project extends beyond localized communities and businesses, permeating the efficient flow of commodities and services across both state and national borders. This grant application endeavors to secure funding that will propel this pivotal infrastructure enhancement, thereby enriching regional economies and promoting a safer, more efficient transportation network accessible to all.

2. Benefit Cost Analysis Framework

The Benefit-Cost Analysis (BCA) framework offers an evaluative structure to gauge the economic pros (benefits) and cons (costs) of a potential infrastructure project. These project benefits and costs are broadly defined and, to the extent feasible, quantified in monetary terms. The overarching objective of the Project's BCA is to assess whether the anticipated benefits of the Project sufficiently outweigh the costs from a national perspective. This BCA framework endeavors to encapsulate the net change in societal welfare resulting from the Project, encompassing cost savings and increases in welfare (benefits), along with potential disbenefits represented by identifiable costs (e.g., project capital expenses), and welfare reductions where specific groups might experience adverse impacts due to the proposed project.

This BCA framework involves defining a Base or "No Build" scenario, which is compared to the "Full Build" scenario. The BCA assesses the incremental difference between these scenarios, which represents the net change in welfare. BCAs seek to assess the incremental change in welfare over a project life cycle. The importance of future changes is determined through discounting, which is meant to reflect the time value of money.

The BCA conducted for this grant application assesses the costs linked to the proposed investment against the potential benefits of the project. To the best extent possible, these benefits have been quantified monetarily. Furthermore, a qualitative exploration is provided when a benefit is anticipated but challenging to quantify or express in monetary terms.

The importance of I-35 cannot be overstated—it serves as a vital conduit connecting Kansas, Texas, and Oklahoma City, playing a pivotal role in freight connections essential for economic vitality. The current I-35 corridor falls short in accommodating the 53,000 vehicles (with 20 percent representing trucks) navigating the project area daily. Projections anticipate over 80,000 daily vehicles by 2050, potentially resulting in Level of Service (LOS F) conditions by 2030 and escalating delays through 2050. Such congestion contributes to increased travel times, compromised reliability, emissions, and secondary accidents. The proposed lane additions and upgraded SH-74 interchange aim to alleviate these challenges, catering to present and future traffic needs.

This project's evaluation period spans 26 years, encompassing development, construction, and 20 years of operation. Total construction expenses are projected at $84.70 million in 2023 dollars and $76.22 million in 2021 dollars. Detailed computations and data used for deriving project benefits and costs are presented in the accompanying BCA model.

Based on this analysis, the Project is expected to yield $181.9 million in discounted benefits and $60.3 million in discounted capital costs, applying a 7 percent real discount rate. As a result, the Project is anticipated to generate a Net Present Value of $157.6 million, along with a commendable Benefit/Cost Ratio of 3.0.

Beyond the quantified benefits outlined in **Table 1** and **Table 2**, the Project also offers challenging-to-quantify qualitative advantages. These include enhancing travel reliability, supporting priority planning efforts for improved connections on I-35, and fostering the development of Oklahoma's renewable energy sector. The project serves as a pivotal conduit for supporting manufacturing, construction, servicing, and transportation of turbine components—an essential aspect of the state's growing wind energy sector.

Key Assumptions

General BCA assumptions and inputs include the following:

- All dollars assume 2021 as the base year.
- All benefits and costs beyond the base year are discounted at 7%, except for carbon dioxide emissions that are discounted at 3%.
- The time period begins in 2022, the first year of the project expenditures. For future years, the analysis period is capped at 20 years from anticipated completion. Since the project is anticipated to be complete and open to traffic at the beginning of the year 2028, the study time period ends at the end of the year 2047.

Additional BCA assumptions and inputs used in this analysis's development are provided below.

Travel Time Assumptions

Travel time savings are computed by contrasting person-hours of travel time between the "No-Build" and "Build" scenarios. For lane expansions, person-hours of travel time are calculated by multiplying the average vehicle occupancy with the Vehicle Miles Traveled (VMT) projections, then dividing by the speeds outlined in **Table 3**.

Table 3 Volume and Travel Calculations

Scenario	AADT* (vehicles/day)		Length* (miles)	Peak Period Speed		Non-Peak Period Speed	
	2022	2052		2022	2047	2022	2047
No-Build	52,600	84,043	6.20	72.0	72.0	72.0	72.0
Build	52,600	84,043	6.20	75.0	75.0	75.0	75.0

To accommodate speed variations throughout the day, these calculations are segmented into peak and non-peak periods. In the case of the interchange enhancement, the reduction in person-hours of travel time is approximated by multiplying vehicle delay durations with peak period traffic volumes. **Table 4** shows the demand traffic volume projection assumptions.

Table 4 Demand projection assumptions

Variable	I-35	Source/Comment
AADT (vehicles/day)		
2022	52,600	ODOT. Values for I-35 represent averages of multiple traffic counts along the segments.
2052	84,043	
Speed (mph)		
Free-Flow Speed	75.0	Assumed based on characteristics and classes of the roads; values are in line with posted speed limits.
2022 Average Observed Speed	72.0	Average of speed data provided by ODOT.
Capacity Adjustment Factors		
Heavy Vehicle Adjustment Factor (Fhv)	0.910	Values from ODOT. Variables defined in Equation 8-7b of Dowling et al. (1997).
Peak-Hour Factor (PHF)	0.900	
Delays (minutes/vehicle)		
2022 AM, No Build	0.24	Assumed.
2022 AM, Build	0.19	
2048 AM, No Build	2.19	
2048 AM, Build	1.67	
2022 PM, No Build	0.72	
2022 PM, Build	0.19	
2048 PM, No Build	4.82	
2048 PM, Build	1.86	

Person-hours are translated into monetary terms based on the distribution of automobile drivers versus truck drivers and the associated value of travel time savings for each category of driver. It was assumed that 80 percent of vehicles type were automobiles, and the remaining 20 percent for trucks. Average vehicle occupancy, the value of time, vehicle distribution by location, and peak period attributes are detailed in **Table 7**.

Table 5 Assumptions used in the estimation of travel time savings

Variable	Units	Value	Source
Value of Travel Time Savings – Automobiles	2021$/hour	18.8	Obtained from: U.S. DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023.
Value of Travel Time Savings – Trucks	2021$/hour	32.4	
Vehicle Occupancy – Automobiles	persons/vehicle	1.67	2017 National Household Travel Survey. Obtained from: U.S. DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2023.
Vehicle Occupancy – Trucks	persons/vehicle	1	Assumption
Number of Peak Period Hours – AM	hours	2	Assumption

Variable	Units	Value	Source
Number of Peak Period Hours – PM	hours	2	
Number of Non-Peak Period Hours	hours	14	Assumed that volume is negligible for 6 hours each day (e.g., 12 AM to 6 AM); remaining 18 hours minus the peak period hours is the number of non-peak period hours.
Percent of Daily Travel during Peak Hours	%	32.80%	California DOT, Cal-B/C v8.1 Table: Demand for Travel during Peak Period. (2021)
Percent of Daily Travel during Non-Peak Hours	%	67.20%	Calculated

Safety Assumptions

The methodology employed for crash predictions involved analyzing historical accident data and considering the projected growth rate of Average Annual Daily Traffic (AADT).

Accident data was categorized into three levels of severity: fatality, injury, and property damage only (PDO). These projected values were representative of the "No-Build" scenario. To estimate accident rates under the "Build" scenario, these rates were multiplied by a crash modification factor, which was derived from the increase in the number of lanes from four to six. The analysis was based on costs and crash rates categorized by accident severity, as outlined in **Table 6**.

Table 6 Assumptions used in the estimation of safety benefits

Variable	Units	Value	Source
Value of a Statistical Life	2021$/accident	$11,800,000	U.S. DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs, Table A-1, "Value of Reduced Fatalities and Injuries" (January 2023)
Cost of Injury	2021$/accident	$213,900	
Cost of PDO	2021$/accident	$4,000	
Crash Modification Factor	factor	0.85	CMF Clearinghouse. CMF ID: 7924; CMF Name: Increase from 4 lanes to 6 lanes.
Accident Distribution – Fatality	%	0.79%	2016 to 2020 accident data from ODOT.
Accident Distribution – Injury	%	28.68%	
Accident Distribution – PDO	%	70.53%	
Average Number of Accidents per Year	accidents/year	76	

Operation Cost and Residual Value Assumptions

To assess the advantages linked with upholding the existing transportation infrastructure in a well-maintained state, we consider the incremental expenses for operations and maintenance (O&M) as well as the residual value of assets.

The calculation of O&M cost savings involves contrasting the costs between the "No-Build" and "Build" scenarios. By subtracting the Build estimates from the No-Build estimates, we determine the incremental O&M costs. Positive values signify savings in operations and maintenance costs, resulting in a net benefit, whereas negative values indicate heightened operations and maintenance expenses, implying a net incremental cost of the project. Despite the increase in lane-miles and annual routine maintenance costs in the "No-Build" scenario due to frequent asphalt resurfacing, incremental O&M cost savings are observed.

The residual value is established through a linear depreciation approach, which considers construction costs over a useful life of 50 years, including total right-of-way costs. Specific assumptions for this benefit are outlined in **Table 7**. A full schedule of O&M cost schedule is shown in **Table 8**.

Table 7 Assumptions used in the estimation of state of good repair benefits

Variable	Units	Value	Comment
Annual Routine Maintenance, No-Build	2023$	$254,823	
Annual Routine Maintenance, Build	2023$	$271,370	
Pavement Maintenance, No-Build	2023$	$13,449,230	$2,241,538 every 7 years to resurface 28 lane-miles of asphalt; $11,923 every 5 years for center-line striping; $8,930,385 after 20 years to replace 20 lane-miles of concrete.
Pavement Maintenance, Build	2023$	$13,592,307	$3,398,077 every 10 years to resurface 42 lane-miles of asphalt; $59,615 every 5 years for center-line striping; $6,676,923 after 20 years to replace 20 lane-miles of concrete.
Bridge Maintenance, No-Build	2023$	$143,077	Silane treatment for the new bridge.
Bridge Maintenance, Build	2023$	$953,846	$1,000,000 for bridge rehabilitation in 2030; $1,000,000 for bridge rehabilitation in 2035.
Useful Life of Project	years	50	Assumption

Table 8 O&M Cost Schedule

Year	No Build			Build		
	Pavement	Bridge	Annual Routine Costs	Pavement	Bridge	Annual Routine Costs
2025			$254,823			$271,370
2026			$254,823			$271,370
2027			$254,823			$271,370

Year	No Build			Build		
	Pavement	Bridge	Annual Routine Costs	Pavement	Bridge	Annual Routine Costs
2028			$254,823		$143,077	$271,370
2029	$11,923		$254,823			$271,370
2030	$2,241,538		$254,823			$271,370
2031			$254,823			$271,370
2032		$476,923	$254,823	$59,615		$271,370
2033			$254,823			$271,370
2034	$11,923		$254,823			$271,370
2035			$254,823			$271,370
2036			$254,823			$271,370
2037	$2,241,538	$476,923	$254,823	$3,398,077		$271,370
2038			$254,823			$271,370
2039	$11,923		$254,823			$271,370
2040			$254,823			$271,370
2041			$254,823			$271,370
2042			$254,823	$59,615		$271,370
2043			$254,823			$271,370
2044	$8,930,385		$254,823	$6,676,923		$271,370
2045			$254,823			$271,370
2046			$254,823			$271,370
2047			$254,823	$3,398,077		$271,370
2048			$254,823			$271,370
Total	**13,449,230**	**953,846**	**6,115,752**	**13,592,307**	**143,077**	**6,512,880**
Grand Total		**20,518,828**			**20,248,264**	

Emission Assumptions

To effectively reduce emissions, the annual amount of pollutant emissions (NOX, PM2.5, SO2 and CO2) in tons per vehicles miles travelled along the segment length needs to be calculated. This will help us get an accurate estimate of the emission costs in dollars. Then, a comparison of the costs between the "No-Build" and "Build" scenarios. By subtracting the amount in dollars that the “Build” estimates from the “No-Build” estimates, we can determine the actual cost savings of the “Build” scenario. **Table 9** shows the assumptions used in the estimation of environmental sustainability benefits.

Table 9 Assumptions used in the estimation of environmental sustainability benefits

	Unit	Value	Source
Nitrogen Oxides (NOx)	$/metric ton	Varies by year	US DOT, Benefit-Cost Analysis Guidance for Discretionary Grants Program, January 2023 Revised; Table A-6.
Sulfur Oxides (SOx)	$/metric ton	Varies by year	
Fine Particulate Matter (PM2.5)	$/metric ton	Varies by year	
Carbon Dioxide (CO2)	$/metric ton	Varies by year	
NOx Emission Rate	grams/mile	Varies by year, speed, and vehicle	Estimates from MOVES run based on McClain County, Oklahoma. Speed bins of 2.5 mph were used to represent idling vehicles. Truck data is based on combination short-haul trucks using diesel fuel.
SOx Emission Rate	grams/mile	Varies by year, speed, and vehicle	
PM2.5 Emission Rate	grams/mile	Varies by year, speed, and vehicle	
CO2 Emission Rate	grams/mile	Varies by year, speed, and vehicle	

3. Project Benefits

Travel Time Benefits

For travel time benefits, **Table 10** outlines the travel time savings over the project life cycle. At a 7 percent discount rate, these savings are estimated to be $155.3 million in discounted (2021$) over the study period. These travel time savings include the travel time savings from lane increase and delay savings.

Table 10 Estimated travel time savings

	Over the Study Period	
	Undiscounted	Discounted
Travel Time Savings from Lane Increase	$61,189,072	$21,917,472
Delay Savings	$436,712,869	$133,379,526
Total Travel Time Savings	**$497,901,940**	**$155,296,998**

Safety Benefits

Table 11 shows a comprehensive calculation of accident cost savings throughout the project's lifecycle, categorized by the type of accident. The enhanced safety and the resulting reduction in accident costs yield social cost savings amounting to $16.4 million (in 2021$), discounted at a rate of 7 percent. Over the 20-year study period, it is projected that this initiative will prevent 2 fatality accidents, 84 injury accidents, and 206 PDO accidents.

Table 11 Estimated safety benefits

	Over the Study Period	
	Undiscounted	Discounted
Avoided Fatality Costs	$27,168,421	$9,913,652
Avoided Injury Costs	$17,893,629	$6,529,316
Avoided PDO Costs	$822,727	$300,210
Total Safety Benefits	**$45,062,050**	**$16,442,968**

Operation Cost & Residual Value Benefits

Table *12* provides a breakdown of the benefits associated with keeping the infrastructure in good condition throughout the project's duration. The discounted value of these advantages totals $7.9 million (2021$). As a result of the timing of O&M costs in the No-Build scenario, the incremental O&M savings, when discounted, surpass the undiscounted savings.

Table 12 Estimated O&M benefits

	Over the Study Period	
	Undiscounted	Discounted
Incremental O&M Savings	$303,077	$840,345
Residual Value of Assets	$38,443,624	$7,083,206
Total State of Good Repair Benefits	**$38,746,701**	**$7,923,551**

Emission Benefits

The aim of the project is to minimize the negative impact of transportation on the environment by reducing the emission of air pollutants. A significant reduction in overall fuel consumption is anticipated, which will lead to substantial cost savings in emissions.

The analysis suggests that this initiative will result in a reduction of greenhouse gases, specifically carbon dioxide (CO2), at a 3 percent discount rate, and other emission gases at a 7 percent rate. Based on calculations, a discounted savings of $1.9 million is predicted over the project's life cycle.

Table 13 Estimated environmental sustainability benefits

	Over the Study Period	
	Undiscounted	Discounted
Avoided Cost of Green House Gases (GHG) Emissions	$2,817,078	$1,460,340
Avoided Cost of Common Air Contaminants (CAC) Emissions	$1,947,473	$462,447
Total Environmental Sustainability Benefits	**$4,764,551**	**$1,922,787**

4. Project Costs

Capital Expenditures

The project's financial allocation encompasses construction, construction management, design, securing of right of way, and relocations of utilities. The estimation is that design, construction management, and utility relocations correspond to nine, six, and five percent of the construction cost, respectively. Capital expenses are projected to cover the period from 2022 to end of 2027, which encompasses previously accrued costs. Refer to **Table 14** provided below for a comprehensive breakdown of expenditure distribution.

Table 14 Project Costs Breakdown (2023$)

Category\Location	SH-74 Interchange/Bridge	I-35 South Section Widening	I-35 North Section Widening	Total
Construction	$11,596,000	$18,560,619	$34,,388,836	**$64,545,455**
Eng. & Construction Management	$695,760	$1,113,637	$2,063,330	**$3,872,727**
Design	$1,739,400	$1,670,456	$1,273,769	**$3,987,865**
ROW & Utilities Relocation	$1,906,300	$200,000	$500,000	**$2,606,300**
Contingency	$1,043,640	$2,784,093	$5,158,325	**$9,681,818**
Total Anticipated Costs	$14,031,160	$22,458,349	$41,610,491	**$78,100,000**
Total Previously Incurred Costs	$2,949,940	$1,870,456	$1,773,769	**$6,594,165**
Total Costs	**$16,981,100**	**$24,328,805**	**$43,384,260**	**$84,694,165**

Source: ODOT. Note: Design, Right of Way, and Utilities are previously incurred costs and are assumed to be split in between 2022 and 2024.

Residual Value

Construction cost and ROW purchases are considered when calculating residual value. In the "Build" scenario an estimated residual value of $38,443,624 is estimated. For the estimated net present value of the "Build" scenario using the 7% discount factor, $7,083,206 was estimated in residual value.

5. Summary of Results

Table 15 offers a condensed overview of the BCA outcomes. Calculations for annual costs and benefits extend across the project's lifecycle, factoring in a 7 percent discount rate. Under the 7 percent discount rate, the 20-year investigation period demonstrates that the $60.3 million investment yields a cumulative $181.9 million in overall benefits, an influential net present value of $157.5 million, an advantageous benefit-cost ratio of 3.0, and an internal rate of return standing at 18.3 percent.

Table 15 Overall results of the benefit-cost analysis (millions of 2021$)

Evaluation Metrics	Undiscounted	Discounted
Total Benefits	$89.4	$181.9
Total Costs	$76.2	$60.3
Net Present Value (NPV)	$65.1	$157.6
Benefit-Cost Ratio (BCR)	1.2	3.0
Payback Period (years)	9.8 years	6.8 years
Return on Investment (ROI)	85.4%	261%
Internal Rate of Return (IRR)	18.3%	

6. Sensitivity Analysis

The conclusions drawn from the BCA outcomes in previous sections rely on numerous assumptions and long-term projections, which are subject to considerable uncertainty. The main purpose of the sensitivity analysis is to identify critical variables that have the most significant influence on BCA outcomes. This sensitivity analysis serves two main functions:

- It assesses how changes in individual critical variables would impact the results, allowing for reasonable deviations from the preferred or most likely values.
- It evaluates the robustness of the BCA by determining whether conclusions drawn from the preferred input values remain consistent even with reasonable deviations.

The sensitivity analysis focused on variations in the discount rate, capital costs, annual growth of AADT, peak period hours, and estimated delays in 2050.

Table 16 presents the percentage changes in project NPV due to changes in these variables or parameters.

The quantitative assessment of sensitivity indicates that altering the number of peak period hours has the most significant impact among the studied sensitivities. Extending daily peak hours from four (two AM and two PM hours) to six results in a 101% increase in project NPV.

While capital costs introduce uncertainty, a 15% increase in these costs only reduces the BCR to 2.6. Despite this, the project remains favorable as its benefits far outweigh the costs, consistently yielding a benefit-cost ratio greater than 2. This conclusion holds across varying inputs that affect major benefit categories such as travel time savings, highlighting the project's robustness.

Table 16 Sensitivity Analysis Results

Parameters	Change in Parameters	NPV ($M)	Change in NPV	BCR
Baseline	**No change**	**$155.5**		**3.0**
Discount Rate	Change discount rates to 3%	$294.5	189%	5.0
Capital Costs	Increase capital costs by 15%	$69.4	15%	2.6
	Decrease capital costs by 15%	$513.0	-18%	3.6
Volume	Increase annual rate of growth by 0.5%	$155.7	0.1%	3.0
	Decrease annual rate of growth by 0.5%	$155.3	-0.1%	3.0
Number of Peak Hours	Increase total number of peak hours to 6	$312.5	101%	5.6
	Decrease total number of peak hours to 3	$97.7	-37%	2.1
Delays	Increase 2050 delays by 25%	$188.9	21%	3.6
	Decrease 2050 delays by 25%	$122.2	-21%	2.5