



**OKLAHOMA**  
Transportation



November 2024

**FY2025 BRIDGE INVESTMENT PROGRAM (BIP)**

## **Over and Through Waterloo:**

Solutions for Freight and Community Mobility on I-35  
Benefit/Cost Analysis

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## 1. INTRODUCTION

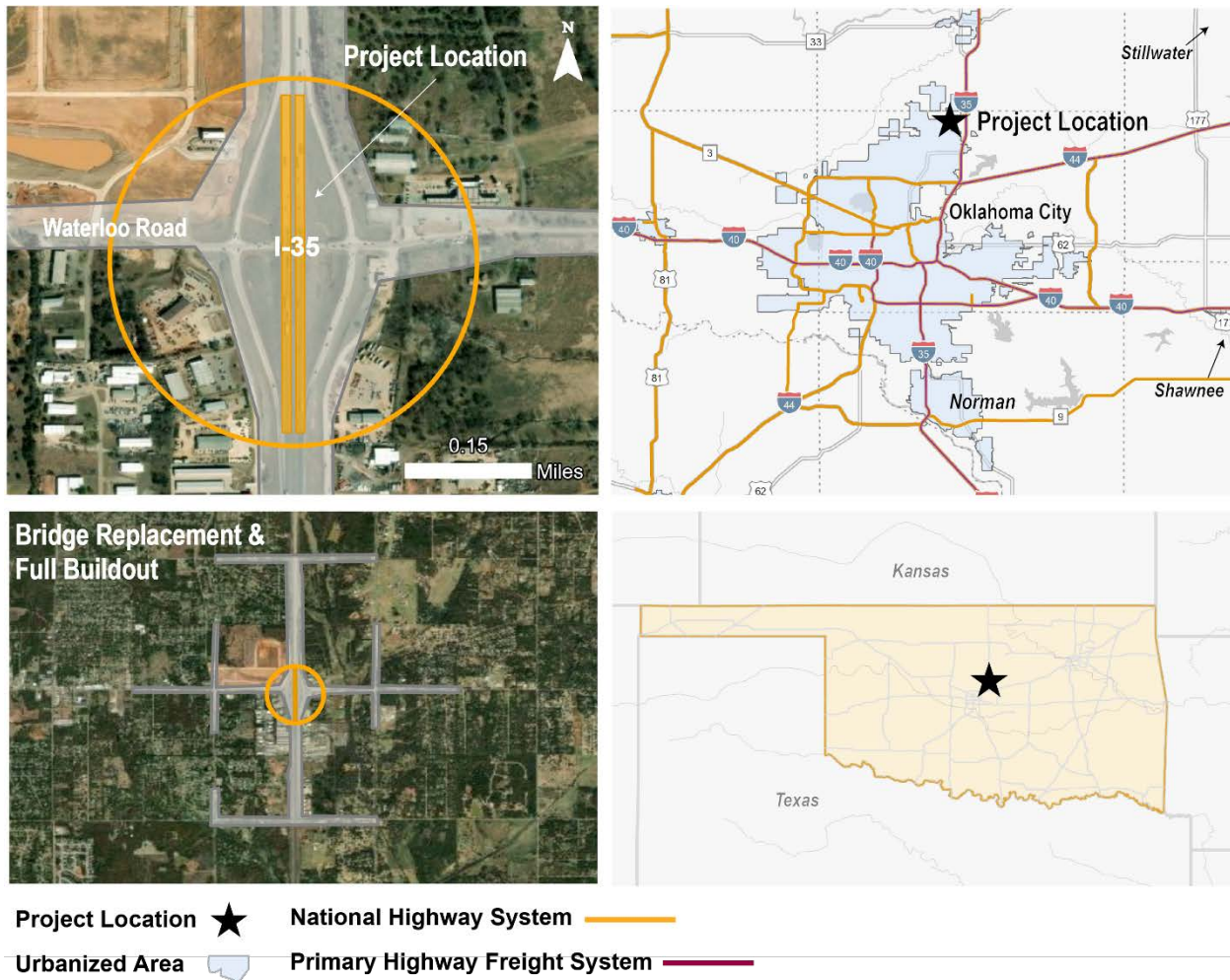
This technical memorandum presents the Benefit/Cost Analysis (BCA) for the development of the ***Over and Through Waterloo: Solutions for Freight and Community Mobility on I-35*** (the Project) in Oklahoma. The BCA supports the submission of a discretionary grant application for the Bridge Investment Program (BIP) Grant from the U.S. Department of Transportation (U.S. DOT). The Project involves replacing two bridges on Interstate 35 (I-35) in Edmond, Oklahoma. The bridges, I-35 south and I-35 north bound (Figure 1), are in fair condition. If no intervention occurs, the condition of these bridges will deteriorate to the point of **closure by 2052**, leading to significant detours for interstate traffic. The Project will replace the bridges, resulting in state-of-good repair benefits, avoided detours and delays associated with closures, and increased safety.

The rest of this memorandum is organized as follows:

- ▶ **Benefit/Cost Analysis Framework** describes the method and process followed to conduct the BCA.
- ▶ **Project Benefits** includes a detailed explanation and calculation of the Project benefits.
- ▶ **Project Cost** documents the project capital and operation and maintenance costs.
- ▶ **Summary of Results** provides the BCA's overall results and impacts.



Figure 1 | Project Area Map



## 2. BENEFIT/COST ANALYSIS FRAMEWORK

The BCA adheres to the BIP’s NOFO for Fiscal Year (FY) 2023 through FY 2026, the U.S. DOT’s Benefit-Cost Analysis Guidance for Discretionary Grant Programs<sup>1</sup> (December 2023), and the BIP BCA Tool.<sup>2</sup> As per U.S. DOT’s Guidance, a BCA should define the baseline or “No-Build” scenario and the alternative or “Build” scenario. The benefits and costs are calculated by comparing the “Build” scenario against the “No-Build” scenario. Since the BCA calculates the expected benefits expected to accrue from the “Build” scenario over a specified period and compares them to the expected costs of the project, both calculations are discounted into the present to calculate their present value.

<sup>1</sup> <https://www.transportation.gov/sites/dot.gov/files/2023-12/Benefit%20Cost%20Analysis%20Guidance%202024%20Update.pdf>.

<sup>2</sup> <https://www.fhwa.dot.gov/bridge/bip/bca/>.

## 2.1 Key Methodological Components

Key methodological elements of this analysis include:

- **Scenarios:** The analysis examines existing and future conditions under both the “No-Build” scenario and under the “Build” scenario.
- **Built Bridges:** The project will remove the two bridges (I-35 SB and I-35 NB) and replace the structures with up-to-date bridges carrying the southbound and northbound I-35 traffic. This BCA analyzes the Project's impact by modeling the two bridges as a single, integrated project.
- **Discounting:** All costs and benefits are expressed in 2022 dollars and discounted at a rate of 3.1% per year, except for CO<sub>2</sub> emissions, which are discounted at 2%.
- **Project Lifespan:** The analysis covers the Project's construction phase and 30 years of operation. The reconstructed bridge will have a service life of 75 years<sup>3</sup>, with a residual value of 60% by 2056.

## 2.2 Key Assumptions

- **Analysis Period:** Includes both the design and construction phases, followed by 30 years of operation.
- **Construction Period:** Construction is assumed to begin in 2026 (assumed for the BCA calculations) and end in early 2027, at which point the project will be completed.
- **Operating Period:** The Project will run for 30 years starting in 2027 and ending in 2056 per U.S. DOT guidance. During this period, benefits will accrue.
- **Average Annual Daily Traffic (AADT):** The Project uses the BIP Tool to estimate the AADT for the analysis years. In 2027 the combined AADT for the I-35 NB and I-35 SB bridges is 53,164 vehicles, 6,380 (12%) of which are commercial vehicles. In 2052, the combined AADT for the I-35 NB and I-35 SB bridges is 105,197 vehicles, 12,611 (12%) of which are commercial vehicles. The NBI's Calculated AADT Growth Rate is 2.38%.

## 2.3 “Build” and “No Build” Scenarios

Following the U.S. DOT BCA Guidance, the “Build” and “No Build” scenarios were used to evaluate the impacts of the Project. Under the “No Build” scenario, no capital investments are made; the bridges are not replaced and, as per the National Bridge Inventory (NBI) forecast, they will be closed to traffic in 2052. This scenario assumes only regular maintenance will be conducted, but the bridges will continue to deteriorate and be decommissioned. Since Oklahoma is primarily rural, the closure will create a **detour of**

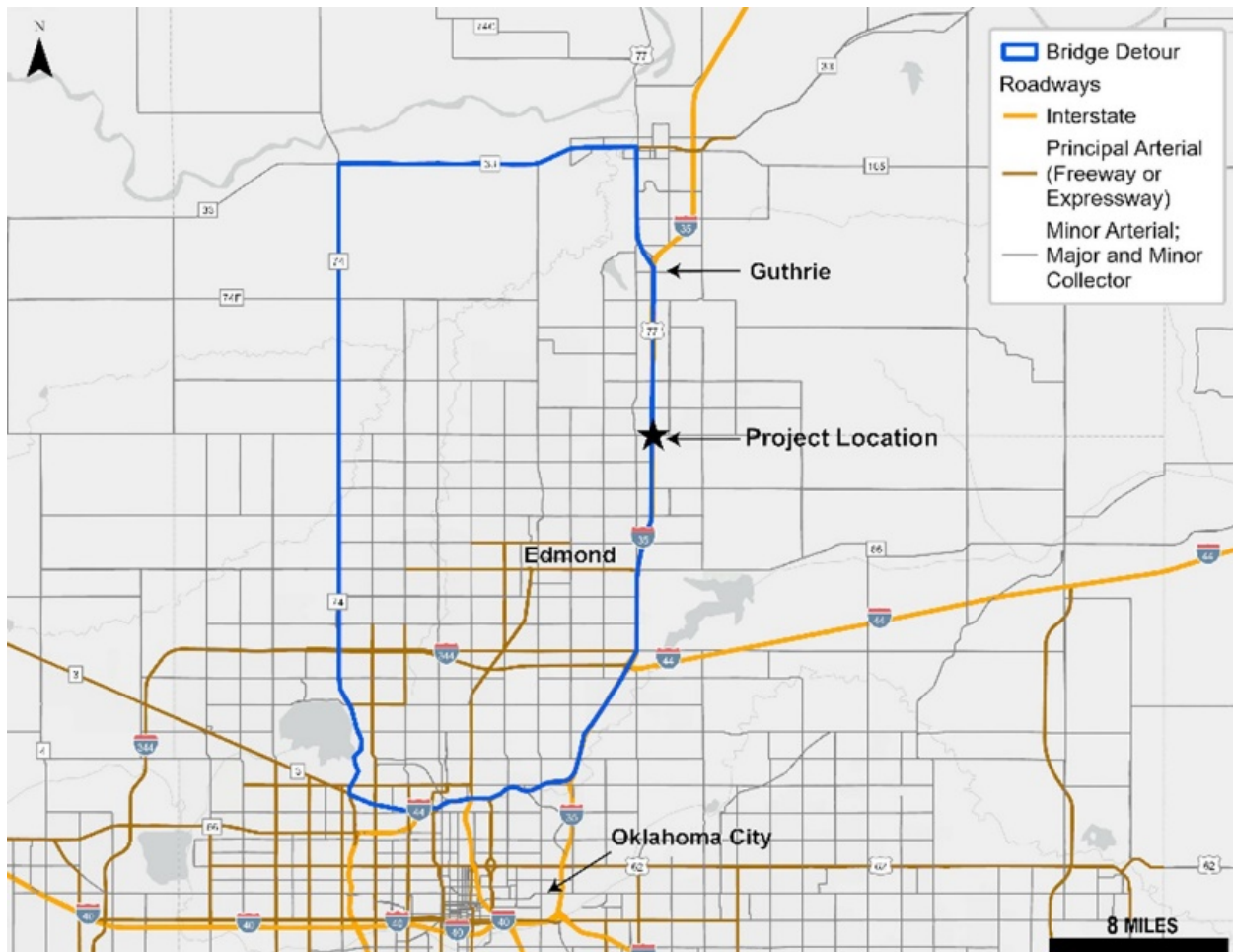
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<sup>3</sup> <https://www.fhwa.dot.gov/bridge/preservation/docs/hif22052.pdf>.

**net 17 miles (additional over existing traffic flows) as the traffic will be routed on the closest state highways.**

Under the “Build” scenario, the bridges are replaced in both the north- and south-bound directions and the bridges’ closures and detours are avoided. The Oklahoma Department of Transportation (ODOT) will conduct regular maintenance and, as per FHWA’s Service Life Design Reference Guide, the new bridge would have a service life of 75 years. The primary benefits under the “Build” scenario are associated with the detour avoidance after the bridges’ closure in 2052. The detour route is shown in Figure 2 as the blue line.

**Figure 2 | Project Detour Map**



Source: ODOT

Most benefits of the Project derive from avoiding bridge closures and the resultant detouring of traffic. Table 1 shows the avoided vehicle miles traveled by avoiding the detouring of traffic when the bridges close in 2052. The project will avoid 8.6 million vehicle miles of traffic.

**Table 1 | Avoided Vehicle Miles of Travel due to the Project**

Year	VMT Saved		
	Passenger Vehicles	Commercial Vehicles (Trucks)	Total
2052	1,465,099	199,776	1,664,875
2053	1,491,890	203,429	1,695,319
2054	1,518,680	207,082	1,725,762
2055	1,545,471	210,734	1,756,206
2056	1,572,262	214,387	1,786,649
<b>Total</b>	<b>7,593,402</b>	<b>1,035,408</b>	<b>8,628,810</b>

### 3. PROJECT BENEFITS

Most of the **Project’s** benefits occur between 2052 and 2056 based on avoiding the long detour associated with the closure of the bridges in 2052, under the No-Build scenario. This BCA found the following four areas of benefits associated to the Project:

1. Safety Benefits which include crash avoidance by avoiding detours and providing a safer facility.
2. Economic Competitiveness Benefits including travel time savings and vehicle operating cost savings.
3. Environmental Sustainability Benefits of avoiding CO<sub>2</sub> and non-CO<sub>2</sub> emissions from detouring around closed bridges.
4. State of Good Repair Benefits consist of the residual value after the period of analysis and reduction in operation and maintenance costs for the new bridges.

#### 3.1 Safety Benefits

The Project’s safety benefits stem from the potential reduction in crashes linked to avoided detour Vehicle Miles Traveled (VMT) under the “Build” scenario, plus crashes reduced in the bridge project area because of the bridge safety improvements.

#### Bridge Improvements

The primary safety improvements come from an additional travel lane in each direction, wider shoulders, and improved vertical and horizontal clearances for Waterloo Road. This analysis chooses to focus on the on-bridge crash reductions associated with the additional travel lanes. The project will increase capacity from 4 lanes to 6 lanes total, although the additional lane capacity will be utilized at a later time. The analysis examines the historic and annual average crashes on the bridges by severity and applies a Crash



Modification Factor of 0.85 (CMF ID: 7924)<sup>4</sup>, to estimate the reduction in crashes and their monetary value. Table 2 presents the safety benefits from adding a travel lane in each direction. Over the 30-year analysis period for the project, the potential safety benefit of the additional travel lanes is estimated at \$374,895 per year undiscounted, or \$6.4 million discounted to 2022 dollars in total.

### Avoided Detour Crash Exposure

This BCA uses Oklahoma County traffic total crash data over 5 years (2021, 2020, 2019, 2018, 2017) to estimate 5-year average crash rates by crash type. This is used as a proxy for the potential impact of rerouting the significant volumes of I-35 traffic onto existing roadways as a result of bridge closures in 2052. Table 2 summarizes the crashes by type and the resulting crash rates for Oklahoma County.

**Table 2 | Oklahoma County Crash Data and Rates (2017–2021)**

Oklahoma County Crash Data	Fatal Crashes	Injury Crashes	Property Damage Only Crashes
2017–2021 Average Annual Crashes	82	5,871	15,185
5-Year Average Crashes per 100 million VMT	0.988	69.71	180.415

Source: Cambridge Systematics Analysis based on Oklahoma Highway Safety Office Crash Data

The Avoided Detour Crashes are estimated as:

#### “No Build” AADT X Detour Length (17 miles) X Crash Rates

The avoided crashes by severity type are then multiplied by the default crash costs in the BIP-BCA tool which are based on the U.S. DOT BCA Guidance (December 2023).

Under the “Build” scenario, the Project is expected to reduce potential detour-related crash costs by **\$442.4 million** (discounted to 2022 dollars) over the years 2052 through 2056. Table 3 shows the safety (crash reduction) benefit by year.

**Table 3 | Safety Benefits (Avoided Detour Crashes)**

Year	Discounted Safety (Discounted 2022\$)
2052	\$90,742,893
2053	\$89,623,855
2054	\$88,490,073

<sup>4</sup> <https://cmfclearinghouse.fhwa.dot.gov/results.php?qst=>

Year	Discounted Safety (Discounted 2022\$)
2055	\$87,343,444
2056	\$86,185,767
<b>Total</b>	<b>\$442,386,032</b>

### 3.2 Economic Competitiveness Benefits

The Project’s economic competitiveness benefits are associated to the savings in Travel Time (TT) and Vehicle Operating Costs (VOC) under the “Build” scenario which eliminates the potential bridge closure and 17 net detour miles.

**Travel Time Savings** are benefits that accrue when the “Build” scenario closure of I-35 is prevented and there is no need for vehicle traffic detouring. Travel time savings in this BCA are computed using the BIP-BCA Tool. Thus, the “No Build” AADT is multiplied by the minutes of avoided detour TT (17 minutes per detour trip), times the average vehicle occupancy (1.67 for passenger vehicles and 1.0 for trucks), multiplied by the value of time by mode, i.e., for trucks (\$33.50 per hour) and passenger vehicles (\$19.60 per hours for All Purposes).

**Vehicle Operating Costs (VOC) savings** are based on the avoided detour VMT under the “Build” scenario (zero miles detour) compared to the “No Build” (17 net miles detour). To calculate VOC savings under the “Build” scenario, the “No Build” AADT is multiplied by the detour VMT, times VOC per vehicle type. The VOC are prepopulated on the Defaults Tab’s BIP Tool and given by the U.S. DOT BCA Guidance as \$0.52 and \$1.32 per mile for light duty vehicles and commercial trucks, respectively.

The travel time savings and VOC savings from the avoided detour (2052-2056) for the Project sum to **\$841.6 million and \$730.3 million, respectively**, discounted to 2022 dollars. Table 4 presents the annual monetized values for each of the detour avoidance benefits, travel time and VOC savings.

**Table 4 | Economic Competitiveness Benefits of the "Build" Scenario**

Year	Travel Time Cost Savings (Discounted 2022\$)	Vehicle Operating Cost Savings (Discounted 2022\$)	Total Detour TT & VOC Cost Savings (Discounted 2022\$)
2052	\$172,630,189	\$149,793,285	\$322,423,473
2053	\$170,501,307	\$147,945,994	\$318,447,301
2054	\$168,344,376	\$146,074,366	\$314,418,742
2055	\$166,163,007	\$144,181,535	\$310,344,543
2056	\$163,960,620	\$142,270,469	\$306,231,089

Year	Travel Time Cost Savings (Discounted 2022\$)	Vehicle Operating Cost Savings (Discounted 2022\$)	Total Detour TT & VOC Cost Savings (Discounted 2022\$)
<b>Total</b>	<b>\$841,599,499</b>	<b>\$730,265,649</b>	<b>\$1,571,865,148</b>

### 3.3 Environmental Sustainability Benefits

#### Emissions Savings

The Project will reduce emissions by avoiding the 17-mile net detour under the No-Build scenario. Like the safety benefits, U.S. DOT provides monetized values per VMT for CO<sub>2</sub> and non-CO<sub>2</sub> emissions. These are provided as defaults in the BIP-BCA tool. Multiplying these values by the avoided detour-related VMT provides the emissions reduction benefits of the Project. The total emissions savings over the 30-year analysis period amount to **\$190.4 million** in discounted 2022 dollars, approximately **9% of total project benefits**. These benefits break down to **\$182.3 million** for CO<sub>2</sub> emissions and **\$8.2 million** for non-CO<sub>2</sub> emissions (Table 5).

**Table 5 | Annual Emissions Savings**

Year	Discounted CO <sub>2</sub> Emissions Cost Reductions (Discounted 2022\$)	Discounted Non-CO <sub>2</sub> Emissions Cost Reductions (Discounted 2022\$)	Total Emissions Cost Reductions (Discounted 2022\$)
2052	\$36,268,769	\$1,681,025	\$37,949,794
2053	\$36,618,082	\$1,660,292	\$38,278,374
2054	\$36,544,733	\$1,639,287	\$38,184,020
2055	\$36,460,182	\$1,618,044	\$38,078,226
2056	\$36,364,897	\$1,596,596	\$37,961,493
<b>Total</b>	<b>\$182,256,664</b>	<b>\$8,195,245</b>	<b>\$190,451,909</b>

#### Other Environmental Benefits

In addition, the Project is expected to generate **\$8.2 million** in noise reduction benefits, categorized as "Other Environmental Benefits" by the BIP Tool, also discounted to 2022 dollars.

### 3.4 State of Good Repair Benefits

The Project will reduce ongoing maintenance and operation costs by replacing the aging bridges with new structures. While no significant capital investments are expected in the No-Build scenario, operations and maintenance will be conducted as needed for the aging bridge structures. The Build scenario also assumes that routine maintenance will occur but given the relative newness of the structure, at a lesser average annual cost. The discounted maintenance cost savings for the new structures is estimated at \$1.5 million.

Furthermore, since the new bridges will have a useful service life of 75 years, there will be residual asset value (60%) beyond the 30-year analysis period. This residual value is estimated at **\$1.9 million** in discounted 2022 dollars.

### 3.5 Benefits Summary

In total, the ***Over and Through Waterloo: Solutions for Freight and Community Mobility on I-35*** will deliver an estimated **\$2.2 billion in benefits**, discounted to 2022 dollars. These benefits come from avoided crashes, travel time savings, vehicle operating cost savings, emissions reductions, noise reductions, reduced maintenance costs, and the residual value of the infrastructure. The breakdown of the total benefits is shown in Table 6.

**Table 6 | Long Term Benefits**

Benefits and Costs	Discounted Value (2022\$)
Safety Crash Cost Savings	\$442,386,032
Travel Time Savings (Avoided Detours)	\$841,599,499
Vehicle Operating Cost Savings (Avoided Detours)	\$730,265,649
CO <sub>2</sub> Emissions Cost Reduction	\$182,256,664
Non-CO <sub>2</sub> Emissions Cost Reduction	\$8,195,245
Other Environmental	\$8,198,672
Residual Asset Value	\$1,859,094
O&M Cost Savings	\$1,454,193
<b>Total Benefits</b>	<b>\$2,216,215,048</b>

## 4. PROJECT COSTS

The capital costs of the Project are primarily related to construction and have been derived from ODOT’s construction cost estimates. As shown in Table 7, the construction will occur from 2026 to 2027, with the Project expected to open in 2027. The total cost of the Project, including any previous expenditures (assigned to 2024), discounted to 2022 dollars, is estimated at **\$14.0 million**.



**Table 7 | Project Schedule and Capital Costs**

Project Schedule	Value	Unit
First Year of Construction	2026	year
Last Year of Construction	2027	year
Project Opening	2027	year
	Value	Unit\$
<b>Total Project Cost</b>	\$14,021,857	Discounted 2022\$

## 5. SUMMARY OF RESULTS

Table 8 presents the evaluation results for **Over and Through Waterloo: Solutions for Freight and Community Mobility on I-35**. The Project will generate \$2.2 billion in net benefits over the 30-year analysis period, yielding a **BCR of 158.1** and a NPV of **\$2.2 billion**. This extremely high BCR reflects the significant safety, economic, and environmental benefits of avoiding the **detour** with high AADT, which strongly justifies the investment.

**Table 8 | Project Evaluation Measures**

Evaluation Measures	Value (discounted 2022\$)
Project Benefits = PB	\$2,216,215,048
Total Project Costs = PC	\$14,021,857
Net Present Value = PB—PC = NPV	\$2,202,353,025
<b>Benefit/Cost Ratio = BCR = PB / PC</b>	<b>158.1</b>

## 6. SENSITIVITY TESTING

As previously mentioned, the key driver of most benefits is the avoidance of a 17-mile net detour for all north- and south-bound I-35 traffic around the closed bridges starting in 2052 through 2056 (the end of the 30-year analysis period). The sensitivity analysis assumes that only the heaviest vehicles (commercial trucks) would be detoured and that the bridges would be able to carry the personal vehicle (car) traffic for those years. In essence, the sensitivity analysis calculates the Project’s benefits if the bridges would be load posted rather than closed altogether.

From 2052 through 2056, commercial vehicle traffic is forecast to be 12% of all traffic to cross the bridges. If only commercial vehicle traffic detours, then the project measures are estimated as a Benefit/Cost ratio of **32.0:1** and a Net Present Value of **\$434.7** million in discounted 2022 dollars.