

# **Puyallup River Bridge Replacement TIGER III Benefit-Cost Analysis**

## **I. Project Summary**

### **Base Case (Baseline Scenario)**

The Puyallup River Bridge is comprised of six connecting segments totaling 2,453 feet in length. Originally constructed in 1928, two of the six segments (F 16A and F16B) are of particular concern because they are experiencing major structural deficiencies. Segment F 16A is a 200-foot steel truss with a bridge sufficiency rating of 20.6. Segment F 16A extends over 6 railroad tracks that provide primary freight access to the Port of Tacoma and industrial areas including the new Innovative Partnership Zone (IPZ). Segment F 16B is a 600-foot concrete girder bridge with a bridge sufficiency rating of 7.0. The existing bridge accommodates three lanes of vehicular traffic—two eastbound lanes and one westbound lane. Heavy trucks [AASHTO type 3 (25 tons), AASHTO #S2 (36 tons), and AASHTO type 3-3 (40 tons)] all are currently prohibited from utilizing the bridge due to load restrictions. There are limited pedestrian and no bicycle facilities on the existing bridge.

The Benefit-Cost Analysis for the Base Case utilizes a 20-year analysis period beginning in the year 2012 and ending in the year 2031. The Base Case assumes that the existing bridge remains open yet restricted to heavy trucks from 2012 through 2019. Structural mitigation and ongoing maintenance is required to keep the bridge open to vehicular traffic during this period. The concrete portions of the bridge will require additional shoring and the rehabilitation of existing shoring in the year 2014. However, continued use of temporary shoring cannot be justified in the long-term. The temporary repairs have already been in place for nearly 10 years and not considered a long term solution. By the year 2019, all temporary repairs will be considered inadequate and the City of Tacoma will be forced to close the bridge as a liability and safety risk. As a result, the City is forced to close the bridge to all vehicular traffic in the year 2020. The City has a history of closing significant bridges (i.e., Hylebos and Murray Morgan Bridges) due to lack of funding. Public outcry over closure of the bridge eventually spurs alternative funding in the year 2028. Construction of the replaced bridge begins in the year 2030 and construction is completed in the year 2031.

### **Proposed Project (Build Scenario)**

The proposed project will replace two of the six connecting segments of the Puyallup River Bridge (Segments F 16A and F16B); a cable stay bridge with a bridge sufficiency rating of 100. The design of the replaced segments will accommodate four lanes of vehicle traffic (two in each direction) and an 8-foot bicycle and pedestrian pathway in each direction. The new bridge will also provide adequate clearance for a new BNSF rail line underneath the bridge.

The Benefit-Cost Analysis for the proposed project utilizes a 20-year analysis period beginning in the year 2012 and ending in the year 2031. Construction of the new cable stay bridge will begin in May 2012 and will be completed in November 2013. The City of Tacoma will conduct routine maintenance of the bridge through the year 2031. Special inspection of the bridge cables are scheduled to occur in two five-year intervals, followed by ten-year intervals thereafter. The new bridge will utilize a 9-inch deck to satisfy WSDOT rebar clearance requirements. The deck will be composed of high-strength concrete, which has high durability and wear characteristics. Therefore, a 2-inch overlay system is not required. The new bridge will also utilize high-performance, weathering steel that will not require future painting.

## Long-Term Outcomes

The replacement of the Puyallup River Bridge will maintain an essential link over the Puyallup River and preserve the movement of freight and goods in to and out of the Port of Tacoma, the seventh largest container port in North America. The existing bridge will be closed in the year 2020 in the Base Case. Bridge closure under the Base Case would require all vehicles to choose a longer, alternate route, increasing congestion and vehicle delay. Reduced access to the Port and Innovative Partnership Zone may also discourage and reduce new business development. Closure of the bridge would also damage the existing businesses in the immediate and more widespread areas along the bridge (Puyallup Avenue) corridor. Bridge replacement will avoid the pending bridge closure and detour routes, resulting in fuel savings, reduced greenhouse gas emissions, reduced vehicle delay, and several other long-term economic and livability benefits:

- The long-term *livability* benefits of the proposed project include improved pedestrian, bicycle, and transit access. These benefits are not captured in the benefit-cost analysis.
- The long-term *economic* benefits of the proposed project as reflected in the benefit-cost analysis include improved mobility (resulting in improved ability to access the Port of Tacoma and local/regional businesses), reduced congestion and vehicle delay (providing travel time savings for drivers and local and regional businesses), and fuel savings (passed on to all bridge users). The proposed project will reduce vehicle delay by 1,352,816 hours, vehicle miles traveled by 125,706,078 miles, travel time by 2,787,815 hours, and fuel consumption by 10,191,722 gallons. Economic benefits not reflected in the benefit-cost analysis include increased BNSF train capacity (saving approximately 90 minutes per train going out of the Port of Tacoma to locations across the United States, primarily to the north and east) and improved labor productivity (vehicle delay into the Port of Tacoma in the Base Case may cause cargo ships to relocate to Canada, resulting in a shift from high-productivity Longshoreman jobs to low-productivity jobs).
- The long-term *state of good repair* benefit of the proposed project includes reduced operations and maintenance costs over the 20-year planning horizon, resulting in an undiscounted cost savings of \$4,279,000.
- The long-term *sustainability* benefits of the proposed project include reduced greenhouse gas emissions as a result of eliminating passenger and heavy vehicle delay. The proposed project will reduce CO<sub>2</sub> emissions by 75,055 metric tons over a 20-year period.
- The long-term *safety* benefits of the proposed project include accident reductions as a result of improved level of service along the Puyallup Avenue/Pacific Highway corridor. The proposed project will avoid 7 property damage only accidents and 5 injury accidents for every 3 years that the new bridge is in operation. Safety benefits that are not captured in the benefit-cost analysis include improved emergency response times. The new bridge would also reduce possible increases in truck/passenger accident rates as a result of detours when the existing bridge closes.

## Affected Population

The bridge is located in an area designated as an impoverished “Community Empowerment Zone” by the State of Washington and is an economically distressed area. The designation as a Community Empowerment Zone means that the local business tax structure has been simplified to encourage rehabilitation and redevelopment projects. The Neighborhood Element of the City of Tacoma Comprehensive Plan designates the area served by the Puyallup River Bridge as the “New Tacoma Neighborhood.” The neighborhood is characterized as a “...diverse mixture of housing, businesses, and industries...” The vision for this neighborhood is based upon economic vitality, housing, and mixed use development supported by transportation and infrastructure improvements. The project is located in a

transition area, but still includes many low-income residents living in older motels and multi-family residences who rely upon the Puyallup River Bridge to access the Tacoma Dome (multi-modal) Station one mile west in Tacoma. According to 2000 Census Data, the project is located in an area where nearly one-quarter of the population is living below the poverty level.

The existing Puyallup River Bridge is utilized by a total of 16,200 vehicles per day (15,115 passenger vehicles and 1,085 heavy vehicles per day). Projected growth rates in traffic volumes for the benefit-cost analysis are assumed at 2 percent annually from 2012 to 2021 and 1 percent annually from 2022 to 2031. The Puyallup River Bridge is part of a vital truck route providing access to the seventh largest container Port in the nation, the Port of Tacoma, and other industrial and warehousing properties within the cities of Fife and Tacoma. The bridge provides access to commercial business and industry within the Port of Tacoma Industrial Center, the City of Tacoma Downtown Regional Center, and the City of Fife. Puyallup Ave, across the bridge also provides access to the recently designated IPZ zone future development such as proposed commercial, retail, warehousing, and renewable energy projects (such as a Biodiesel development). Heavy vehicles are currently restricted from using the bridge, forcing at least 1,085 heavy trucks per day to use one of three alternate truck routes.

The closure of the bridge under the Base Case would force all users of the bridge (heavy trucks, commuters, buses, and local residents to use an alternate detour route, resulting in increased congestion, increased travel times, increased air pollution, reduced safety etc. The preservation and improvement of the bridge will provide economic revitalization of the Puyallup/Pacific Highway corridor, benefiting two regional commercial centers and the Port of Tacoma shipping industry. The livability benefits of the project will primarily be felt by low-income residents living in the project area. The economic, sustainability, and safety benefits will be felt by all users of the bridge, including low-income residents, commuters, and local and regional businesses.

## **II. Benefit-Cost Summary**

As shown in **Table 1**, results from the benefit-cost analysis produced a net present value of nearly \$22.7 million at a 7 percent discount rate. The high net present value is driven by the substantial benefit realized from reduced vehicle day, fuel savings, travel time, and reduced greenhouse gas emissions.

It is important to note that many of the project benefits discussed in the TIGER III narrative, particularly in areas such as livability and economic competitiveness, were not measured or monetized as part of this analysis. Other non-quantifiable impacts that can occur to close the existing bridge sooner include natural disasters (e.g. earthquake), “Acts of God,” and/or increased degradation of the bridge. Such benefits/costs would be additive to the total project benefits/costs, increasing the net present value identified in **Table 1**.

As discussed under Section I, Project Summary, the Puyallup River Bridge would be replaced under both the Baseline and Build Scenarios at a cost of \$30 million. As shown in **Appendix Table A-1**, the marginal cost of replacing the bridge sooner (in 2012 rather than 2030) is approximately \$17.6 million at a 7 percent discount rate. With net benefits totaling approximately \$44.2 million (**Appendix Table A-2**), the proposed Project results in a benefit/cost ratio of 2.5 at a 7 percent discount rate. The net present value and benefit/cost ratio of the proposed Project at a 3 percent discount rate are nearly \$75.4 million and 6.6, respectively. Supporting documentation for all cost and benefit calculations is provided in **Appendix A**.

**Table 1: Summary of Benefit-Cost Analysis**

INPUT VALUES		Monetized Value	
		Discount Rate 7%	Discount Rate 3%
<b>NET BENEFITS</b>			
State of Good Repair	Reduced operating and maintenance costs	\$3,601,304	\$3,965,006
Economic Competitiveness	Reduced vehicle delay, travel time, and fuel savings	\$38,094,291	\$67,465,661
Livability	Not included in BCA	-	-
Sustainability	Vehicle emission savings	\$819,292	\$1,421,284
Safety	Value of life and injuries savings from reduced accidents	\$1,715,391	\$2,525,907
Total Benefits	Table A-2	\$44,230,277	\$75,377,858
<b>COSTS</b>			
Construction	Marginal design and construction costs (Table A-1)	\$17,645,893	\$11,441,049
<b>NET PRESENT VALUE</b>		<b>\$22,773,820</b>	<b>\$59,706,898</b>
<b>BENEFIT-COST RATIO</b>		<b>2.5</b>	<b>6.6</b>

### III. Methodology

#### Cost: Construction and Maintenance

Costs for years 2012-2031 for the Baseline and Build Scenarios were based on the assumptions laid out in Section I above. Costs under the Baseline Scenario include annual maintenance while the bridge is open, structural mitigation and painting in 2012, shoring in 2014, the cost to close the bridge in 2020, and the costs of installing and maintaining barricades until the new bridge is constructed in years 2030-2031. Costs under the Build Scenario include the cost of construction in 2012-2013 and an annual maintenance cost for the remaining years of the analysis. The analysis period ends in 2031 because that is the year in which both scenarios have a reconstructed bridge and the costs and benefits in future years are the same. The construction period and pre-discounted cost of construction of the replaced bridge is identical under the Baseline and Build Scenarios. The construction period is assumed to be 18 months. The cost of constructing the replaced bridge is \$30 million. The supporting documentation regarding costs associated with the baseline and build scenario can be found in **Appendix A**.

#### Safety Benefit: Accident Avoidance

The proposed project will improve the intersection of Puyallup Avenue and Portland Avenue, where there were 24 accidents in a three-year reporting period (2007-2009). Of these 24 accidents, six accidents produced eight injuries. The Department of Transportation (DOT) has developed estimates of the costs of property damage and injury accidents, as shown in **Table 2**.

**Table 2. Estimated Cost of Accidents**

Type of Accident	2011 dollars
Property Damage Only (PDO) <sup>1</sup>	\$ 3,393
Injury – Severity Unknown <sup>2</sup>	\$ 112,394

Sources: The Economic Impact of Motor Vehicle Crashes 2000, <http://www.nhtsa.gov/DOT/NHTSA/Communication%20&%20Consumer%20Information/Articles/Associated%20Files/EconomicImpact2000.pdf>, and Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses – 2011

Revision (2011). <http://ostpxweb.dot.gov/policy>; Values from accident report converted to AIS scale using KABCO-AIS Conversion Table from NHTSA, July 2011 and published in the Federal Register, August 12, 2011 (Vol 76, No 156, page 50308).

<sup>1</sup> PDO accident cost estimate provided in 2010 dollars. Cost escalation for PDO accidents from 2010 to 2011 values based on Federal Reserve data here: [http://www.minneapolisfed.org/community\\_education/teacher/calc/hist1800.cfm](http://www.minneapolisfed.org/community_education/teacher/calc/hist1800.cfm)

<sup>2</sup> Estimate developed using KABCO-AIS Conversion Table (NHTSA, July 2011).

Based upon analysis of historic accidents, it is estimated that the proposed project would reduce almost half of the accidents occurring at the intersection of Puyallup and Portland Avenues. Thus, the calculation below assumes that seven of the property damage only accidents and three of the injury accidents (producing five injuries) could be avoided with the project. Thus, the potential annual benefit associated with accident reduction for the project is \$195,241, as shown in **Table 3**.

**Table 3. Estimated Annual Costs of Accidents at Intersection of Puyallup and Portland Avenues (2011\$)**

	Cost (2011\$)	Accidents / Injuries	Total cost (2011\$)
Property Damage Only Accident	\$ 3,393	7	\$ 23,754
Injury Accident (Number of injuries)	\$ 112,394	5 <sup>1</sup>	\$ 561,970
Total Cost of Avoidable Accidents			\$ 585,724
Average annual cost of accidents <sup>2</sup>	\$ <b>195,241</b>		

Source: Accident Report, the City of Tacoma, 2007-2009 Data

<sup>1</sup> Number of injuries (three accidents)

<sup>2</sup> Total divided by three (for the three-year accident-reporting period.)

The calculations for the cost of accidents and estimate of reductions are provided in the “Accident Avoidance” spreadsheet in Appendix A.

### **Economic Competitiveness Benefit: Reduced Delay, Travel Time, and VMT**

The economic competitiveness portion of the Puyallup River Bridge BCA was conducted using data collected from City of Tacoma and Federal publications. The three major factors influencing the benefit to cost analysis provided for the Puyallup River Bridge are the net change in delay, travel time, and vehicle miles traveled (VMT). This analysis identifies the difference (net change) between the Baseline and Build Scenarios.

The delay, travel time, and VMT results are determined by finding the net change between the Baseline and Build Scenarios. Final outputs in the form of miles, dollars, and hours of delay or travel time represent the negative impact cause by not building the new Puyallup River Bridge spans. The baseline condition currently does not allow heavy vehicles on the bridge, but does allow passenger vehicles to utilize the bridge until 2020. In 2020, no vehicles will be able to use the bridge. During the periods of closure, passenger vehicles and heavy vehicles detour around the bridge via alternate routes within the project vicinity. The Build Scenario would allow for no long-term detours, no increased delay, and no additional travel time. The Build Scenario also saves money from reduced fuel costs associated with detours and delay.

### ***Data***

The data required to determine cost, miles traveled, and hours of delay and travel time related to the project consist of 24-Hour (ADT) counts conducted by the City of Tacoma, and detour routing (lengths and intersection delay) during the bridge closure. The socio-economic data includes values for travel time (\$24.64/hour), fuel mileage for passenger and heavy vehicles (mpg), price per gallon of fuel (\$3.754), and delayed vehicle fuel consumption (gallons/hour). Fuel cost (per gallon) data was obtained from the US Energy Information Administration, Gasoline & Diesel Fuel Prices, West Coast Region, October 10, 2011. The mean global value for monetizing pounds of CO<sub>2</sub> (\$/lb of CO<sub>2</sub>) and the value of travel time saved per vehicle (in \$/hour) were determined from *Chapter VIII of the Final Regulatory Impact Analysis of the National Highway Traffic Safety Administration's Rulemaking on Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks*. The *Status of the Nation's Highways, Bridges and Transit: 2004 Conditions and Performance* was referenced from the Federal Highway Administration for idling delay costs per hour. Exhibit 4-11 lists gallons of fuel consumed as compared to annual travel delay (this exhibit references the Texas Transportation Institute 2004 Urban Mobility Study). The Seattle-Everett urban area experienced 65,276,000 hours of annual travel delay which resulted in 110,000,000 gallons of annual excess fuel consumed. The average is 1.69 gallons of fuel consumed for every hour of travel delay.

### ***Detours***

The Puyallup River Bridge is the major connector between the Port of Tacoma and the City Center/ Interstate-5 (I-5) corridor for distribution of shipping product. Upon closure of the Puyallup River Bridge in the Baseline Scenario, three other routes have been identified as primary detours to redistribute trips throughout the project vicinity. The three detours identified for the project are:

1. **Interstate 5:** Vehicles will reroute to and from Milwaukee Way and Portland Avenue by E 28th Street, Port of Tacoma Road, and I-5 to arrive at the desired destination. The I-5 detour distance is 1.79 net additional miles. 10 percent of heavy vehicle users will utilize the I-5 detour.
2. **State Route 509:** Detouring will route vehicles to SR-509 via the Port of Tacoma road and Pacific Avenue. The SR-509 detour distance is 2.1 net additional miles. 10 percent of heavy vehicle users will utilize the SR-509 detour.
3. **Lincoln Avenue:** The Lincoln Avenue detour reroutes trips to the north via Milwaukee Way, Portland Avenue, and Puyallup Avenue. 80 percent of heavy vehicle users will utilize the Lincoln Avenue detour. The Lincoln Avenue detour is 1.59 net additional miles.

### ***Calculations***

To determine the net impacts created by closing the Puyallup River Bridge under the Baseline Scenario, the data gathered was compiled in a series of worksheets to determine how much additional delay, travel time, and VMT were generated on an annual basis. Delay, travel time, and VMT were based on the additional time and distance created between utilizing the bridge and having to detour around the bridge if closed. The ADT was multiplied by the delay, travel time, and detour VMT to achieve a daily rate, and then converted to an annual value in hours or miles per year. All analyses were computed based on 312 days per year (determined by eliminating Sundays 364-52). This value is conservative and was assumed to represent reduced hours across a cumulative weekend period, although trucking activities will continue throughout the weekend.

The delay, travel time, and VMT per year values were increased for each year to represent local vehicle growth. The City of Tacoma identified a 2 percent growth rate for the first 10 years and then 1 percent

growth for the remaining 10 years. Utilizing the data values for fuel consumption and fuel efficiency, total delay saved, travel time reduced, and VMT, the following 20-year net reduction is achieved by constructing the new Puyallup River Bridge:

- 1,352,816 hour reduction of delay
- 125,706,078 mile reduction in total VMT
- 2,787,815 hour reduction in travel time

The above values are then related to the cost and benefits analysis via a monetary comparison and are shown with discounted rates of 7 percent and 3 percent in accordance with Appendix A of the Federal Register.

### **Sustainability Benefit: Reduced Greenhouse Gas Emissions**

The sustainability portion of the Puyallup River Bridge BCA was conducted by utilizing the data associated with reduced vehicle delay, travel time, and VMT, as summarized above. Although delay, travel time, VMT reductions are benefits to constructing the new bridge, these transportation outputs can also generate environmental costs in the form of emissions (“Criteria Pollutants”).

Due to delay, additional travel time, and greater VMT, fuel consumption increases resulting in additional greenhouse gas emissions released. The primary greenhouse gas emission is Carbon Dioxide, or CO<sub>2</sub>. Each of the variables outlined in the Economic Competitiveness section (delay, travel time, and VMT) all relate to additional fuel consumption as a result of closing the bridge.

### **Data**

The data required to identify the net increase in CO<sub>2</sub> emissions include: fuel mileage (mpg), price per gallon of fuel (\$3.75), vehicle fuel consumption (gallons/hour), the cost per metric ton of Carbon Dioxide (\$ Varies/metric ton), and pounds of CO<sub>2</sub> generated per hour (CO<sub>2</sub>/hour).

### **Calculations**

To determine the net impacts created by closing the Puyallup River Bridge, the delay, travel time, and VMT were calculated in the Economic Competitiveness section. These yearly basis values are multiplied by fuel mileage to determine the total amount of fuel used. Fuel costs are correlated by an average price per gallon (\$3.75 per gallon). The total number of gallons is then multiplied by pounds of CO<sub>2</sub> per hour. The resultant emissions value is then converted to metric tons, as identified in the Federal Register. Each metric ton of CO<sub>2</sub> is equivalent to a varied, 3% average cost per metric ton for the years 2012 and 2031 as identified in the Annual Social Cost of Carbon (SCC) Values: 2010-2050 Appendix Table A1 in the Federal Register. The total fuel consumption and CO<sub>2</sub> emissions reduced by constructing the bridge are:

- 10,191,722 gallon reduction in fuel
- 75,055 metric ton reduction of CO<sub>2</sub>

### **Discounting**

To calculate the total costs of each scenario over time, discount rates of 7 percent and 3 percent were applied. A 3 percent discount rate was included based upon the guidance in the Federal Register, which suggests using 3 percent if “the alternative use of funds currently dedicated to the project would be other public expenditures, rather than private investment.” As this project would be supported by a TIGER Grant, we have assumed that the money, if not spent on the Puyallup River Bridge, would be spent on

some other public infrastructure project. The formula used to discount the estimates of costs (all in 2011 dollars) is:  $PV = [1/(1+r)^t] FV_t$ , where  $r$  = the discount rate,  $t$  = years from 2011, and  $FV$  = the future cost in nominal dollars (2011).

# **Appendix A**

## **Supporting Calculations**