Benefit-Cost Analysis of the Champ Clark Bridge

Prepared for:

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EXECUTIVE SUMMARY

Modeling Approach

Table 1 summarizes the types of outcomes that have been identified for the project and the assessment approach adopted within the benefit-cost and economic impact assessments. These outcomes are organized according to TIGER selection criteria. As detailed in Section 1 of this report, the quantification of benefits involves both spreadsheet evaluations and calculations performed by the TREDIS transportation economics tool (See Appendix 3).

The time horizon of the benefit-cost analysis covers the construction period from 2016-2018, and an operational period from 2019-2038. All benefits are expressed in constant 2015 dollars, and discounted to 2015. In addition to the benefit-cost analysis, a separate analysis was run to quantify economic impacts related to short-term job creation from construction and long-term job creation from transportation efficiency gains that affect business operations.

Table 1 Project Outcomes

Long-Term Outcome	Type of Societal Benefits	Assessment Approach and Document Section Reference
State of Good Repair	Maintenance & repair savings	Quantitative assessment (TREDIS) ***Refer to Section 1.1***
	Reduced VMT from not closing bridge	Quantitative assessment (TREDIS) ***Refer to Section 1.2***
	Avoided bridge closures from flooding	Quantitative assessment (TREDIS) ***Refer to Section 1.2***
Economic Competitiveness	Travel time savings from avoided bridge closure & resulting diversion	Quantitative assessment (TREDIS) ***Refer to Section 1.3***
	Operating cost savings from avoided bridge closure & resulting diversion	Quantitative assessment (TREDIS) ***Refer to Section 1.4***
	Short-term job creation from construction & long-term job creation from transportation efficiency gains	Quantitative assessment (TREDIS) ***Refer to Section 2***
Safety	Prevented accidents both from avoiding increased exposure from diversion and from improved bridge design	Quantitative assessment (Spreadsheet) ***Refer to Section 1.5***
Environmental Sustainability	Emission benefits from avoided extra mileage associated with bridge closure and diversion	Quantitative assessment (Spreadsheet) ***Refer to Section 1.6***
Quality of Life	Maintaining accessibility for residents and businesses located on either side of the Mississippi River	Qualitative Assessment ***Refer to Section 1.7***

Summary of Benefits and Costs

Completion of the Champ Clark Bridge replacement will result in a variety of benefits, the sum of which more than offset the costs of construction. The benefits realized by this project can be categorized into the cost savings associated with lower travel times and vehicle-operating costs, improvements in safety, reduced vehicular emissions, and quality of life impacts (see the Project Matrix tab of Appendix 1). Quality of life impacts are described qualitatively, while all other impacts are monetized and then compared in present value terms to project costs. Using a discount rate of 7%, the ratio between monetized benefits and costs (in 2015 dollars) is 8.70. A sensitivity analysis using a 3% discount rate results in a benefit-cost ratio of 13.93. Details of benefits and costs by year are presented in Tab A1-4 of the Appendix 1 spreadsheet. Section 1 of this report enumerates in detail the various elements included in benefit-cost analysis.

Table 2 Summary of Undiscounted Benefits

Benefit Type	Cumulative Benefits ($ mil.)
Travel Time Savings	505.1
Vehicle Operating Cost Savings	507.7
Safety Benefits	67.4
Environmental Sustainability	39.4
- CO2 Savings	26.7
- Non CO2 Emissions Savings	12.7

Table 3 Summary of Benefits and Costs

	Undiscounted	Discounted at 7%	Discounted at 3%
Project Costs*	50.9	50.7	52.3
Total Benefits	1,119.6	441.0	729.0
- Total Non C02 Benefits	1,092.9	423.9	711.9
- C02 Benefits	26.7	17.2**	17.2
Benefit-Cost Ratio		***8.70***	***13.93***

* Project costs include $63.2 Million in capital outlays, along with adjustments for O&M costs, and a residual value calculated to account for the fact that the bridge’s useful life extends beyond the analysis period.

** In accordance with Federal interagency Social Cost of Carbon (SCC) guidance, the value of carbon dioxide emissions changes over time and is discounted at a lower discount rate of 3%, even in the 7% discount rate analysis.

Summary of Economic Impacts

In addition to a valuation of project benefits, economic impacts of the proposed Champ Clark Bridge replacement were estimated using the TREDIS transportation economics suite. The project is expected to support 332 jobs from construction of the facility at the height of the construction period and an average of 203 jobs annually in the 20 year operations period from 2019-2038. Detail on estimated economic impacts is included in Section 2 of this report.

Table 4 Summary of Economic Impacts

Source of Impact	Cumulative Impacts			Jobs
	Business Output ($ mil.)	GRP ($ mil.)	Wage Income ($ mil.)	
Construction (2016-2018)	81.1	35.0	29.7	332 in 2018
Improved Transportation Efficiency (2019-2038)	523.2	235.5	169.9	average of 203 jobs annually

1 RESULTS OF BENEFIT-COST ANALYSIS

1.1 Project Costs

Design and construction of the Champ Clark Bridge replacement are scheduled to occur in the three-year period from 2016-2018. During construction, the current bridge will remain in place. In undiscounted terms, the Champ Clark Bridge replacement is expected to cost $63.2 Million in capital outlays. Replacement of the Bridge will yield savings in operating and maintenance cost, relative to the base-case scenario in which the bridge is kept open until 2023. The annual operating cost for the current aged bridge is $234,492. After the bridge is closed, $20,120 will be required annually to cover the cost of navigation lighting, detour signage, checks of the road closure, and yearly bridge inspections to ensure the closed bridge is not in danger of collapsing. In the build case, the replaced Champ Clark Bridge will require fewer resources for its annual maintenance, with annual cost $20,500. Because the life of the bridge extends beyond the analysis period, a residual value of $11.5 million is included in the last year of analysis. The total undiscounted net cost of the project is $50.9 Million. Discounted at 7%, the present value of costs is $50.7 Million, and at 3%, the present value of costs is $52.3 Million. Tab A1-1 in the Appendix 1 spreadsheet presents all cost assumptions in detail, by year of analysis.

1.2 State of Good Repair

The Champ Clark Bride is inspected every year. Currently the substructure and deck condition are rated five (fair) and the superstructure is rated four (poor). The top and bottom flanges of the floor beams at the gusset plate connections of the Champ Clark Bridge have section loss averaging 30%, and the floor beam bottom flanges under joints have section losses up to 50%. Several areas of the lower chord have holes rusted through. The structure continues to exhibit rapid deterioration of the truss members leading to additional weight restrictions in the future and eventual closure. Baseline assumptions for the project assume closure to trucks by the year 2017 and closure to all traffic by 2023. In addition, an average of 2.6 days per year of bridge closure were modeled in the base case for flooding of the Route 54 approach on the Illinois side, based on the fact that the bridge has been closed for 13 days during flooding events in the last five years.

The expected closure dates are based on an evaluation by the Missouri Department of Transportation (MoDOT) founded on sound management practices and realistic budget limitations. Because the current bridge design is functionally obsolete and does not meet MoDOT or Illinois Department of Transportation (IDOT) standards for lane width, shoulders, or vertical clearance—and because the current bridge approach is subject to periodic flooding on the Illinois side—it was judged that a rehabilitation-only alternative would not meet the project's definition of need and would not be a responsible or suitable build alternative.

Benefits of the new bridge are derived using assumptions about detour mileage and time resulting from bridge closure first to truck traffic, and then to all vehicles. In a scenario in which the Champ Clark Bridge is closed, the closest available alternative for crossing the Mississippi River into Illinois is the crossing at Hannibal, to the north. The distance between the Champ Clark Bridge and the Mark Twain Memorial Bridge in Hannibal is 47 miles along U.S. 54 and U.S. 61. Information is not available about the origin and destination of all users of the Champ Clark Bridge. Therefore, 47 miles was used as a conservative diversion mileage assumption, based on the understanding that some travelers may experience a shorter diversion, while others may be faced with longer trips to arrive at their ultimate destination (the total distance between one side of the Champ Clark Bridge and the other, is 77 miles via the Hannibal detour and 183 miles via St. Louis/Alton to the south).

The costs of diversion are estimated by calculating vehicle-miles and vehicle-hours associated with the diversion route and then applying per-mile and per-hour cost factors. In addition to the 47-mile diversion length specific above, the following key assumptions govern the analysis:

1. Baseline daily bridge volumes from 2014: 3,475 cars and 589 trucks
2. An average annual trip growth rate of 0.36%
3. Average diversion speeds of 60 mph on the section from Louisiana to U.S. 61 and 66 mph on U.S. 61 from Bowling Green to Hannibal.
4. Adoption of TIGER suggested trip purpose splits and values of time for *intercity* travel by conventional surface modes (see Appendix 2). The bridge connects two states, with Louisiana representing the closest community on the Missouri side and Pittsfield being the nearest city in Illinois. Intercity values are therefore chosen as the most appropriate to longer-distance trips facilitated by the bridge.

Tab A1-2 in Appendix 1 presents the development of TREDIS inputs, based on the above key assumptions. Three separate sets of inputs were run through TREDIS and then aggregated to produce the total effects of the Champ Clark bridge replacement. The first model run addresses the period from 2023 to 2038, during which diversion of all vehicles would occur in the base case scenario. The second model run addresses the period from 2017 until 2038 when the bridge is closed to trucks only. The third model run addresses the additional diversion effect from flooding. In all cases, travel characteristics input into TREDIS represent the total additional mileage and hours imposed on the transportation system in the base case, but not the build case. Phasing assumptions are used to capture the effect of the travel growth rate over time.

Tab A1-3 in Appendix 1 presents changes in travel characteristics (Trips, Vehicle Miles Traveled (VMT), Vehicle Hours Traveled (VHT), etc.) between base and build scenarios, as calculated by TREDIS.

1.3 Travel Time Savings

Travel time savings are calculated within the TREDIS benefit-cost module based on changes in vehicle-hours traveled between base and build (as presented in Tab A1-3 of Appendix 1) and per-hour cost factors and vehicle occupancies for each mode-purpose combination. These factors are summarized in Appendix 2.

Travel time savings as calculated by TREDIS are presented in Tab A1-4 of Appendix 1, by year, under the headings *Business Time Cost*, *Personal Time Cost,* and *Freight Time Cost*. *Business Time Cost* includes driver time costs for the truck mode and time costs for business trips by car. *Freight Time Cost* includes the cost born by shippers and receivers of freight, associated with having freight tied up in transit.

In the period from 2019-2038, the project is expected to result in a total cumulative travel time savings of $505.1 Million (undiscounted), of which $157.5 Million is realized through savings for business purposes, $240.6 Million derives from personal time savings, and $107.0 Million is associated with savings in freight delivery times.

1.4 Vehicle Operating Cost Savings

Vehicle operating cost savings are calculated within the TREDIS benefit-cost module based on changes in vehicle-miles traveled between the base and build cases (as presented in Tab A1-3 of Appendix 1), along with per-mile operating cost factors for cars and trucks. The cost-factors and their underlying assumptions are summarized in Appendix 2.

Vehicle operating cost savings as calculated by TREDIS are presented in Tab A1-4 of Appendix 1, by year.

In the period from 2019-2038, the project is expected to generate total cumulative operating cost savings of $507.7 Million (undiscounted).

1.5 Safety Benefits

Safety benefits include monetized savings associated with reductions in the number of crashes occurring per year. The reductions in numbers of crashes can be traced to two effects: (1) reduced accident rates on the new bridge, relative to the current bridge with its deficient design, and (2) reduced accident exposure from avoiding increases in vehicle-miles on the detour route.

MoDOT calculated average fatality, personal injury, and property damage crash rates per 100 million vehicle-miles traveled based on data from 2009-2013. These rates are reported at an aggregate level (i.e. for all vehicles, with no breakout of car versus truck rates) for the following (see Tab A1-5 in Appendix 1):

1. The Champ Clark Bridge;
2. Samples of six rural two-lane arterial major river bridges that are representative of the expected safety characteristics of the replacement bridge; and
3. The US 54 diversion route section from Louisiana to Bowling Green and the US 61 section between Bowling Green and Hannibal. As no data is available for crash rates on the Illinois side for diversion, a distance-weighted average of these rates was assumed to be the best approximation of safety exposure for diverted vehicles.

Aggregate crash rates for vehicles were converted into separate crash rates for cars and trucks, based on vehicle involvement data from Missouri (details on Tab A1-5 in Appendix 1). Safety benefits are then calculated within Tab A1-6 of Appendix 1. Additional details related to crash valuations can be found in Appendix 2. In the period from 2019-2038, the project is expected to generate total cumulative safety savings of $67.4 Million (undiscounted). The majority of these savings derive from the effect of avoiding crashes on the diversion route.

1.6 Environmental Sustainability

Environmental sustainability benefits are derived from reductions in a variety of emission types released into the air as a result of vehicle operations. Avoidance of long diversion routes results in fewer tons of damaging emissions being released, and thus less cost imposed on society. Tons of emissions saved are estimated based on savings in vehicle-miles traveled and then monetized. Appendix 2 summarizes assumptions about emissions rates per vehicle-miles traveled, based on a variety of federal sources. Also included are the per-ton valuations for each emissions factor, as established in TIGER guidance.

Environmental sustainability benefits are calculated in Tab A1-7 of Appendix 1. In the period 2019-2038, the project is expected to generate total cumulative savings to society of $39.4 Million (undiscounted), $26.7 Million of which is associated with reductions in carbon dioxide emissions, while the remaining $12.7 Million derives from reductions in volatile organic compounds, nitrogen oxides, sulfur dioxide, and particulate matter.

In accordance with Federal interagency Social Cost of Carbon (SCC) guidance, the value of carbon dioxide emissions changes over time and is discounted at a lower discount rate of 3%, even in the 7% discount rate analysis.

1.7 Quality of Life

Prior sections of this benefit cost analysis have focused on quantifying the costs imposed on travelers and on the surrounding community in a scenario in which the Champ Clark Bridge is not replaced and is therefore closed, forcing diversions. While these quantitative assessments demonstrate clearly the value of the Champ Clamp Bridge replacement relative to the cost of replacement, there is an additional qualitative story to be told about the benefits of the project in supporting quality of life within northeast Missouri. A recent March 2015 presentation by Louisiana Mayor Bart Niedner to the Missouri Highway Commission clearly demonstrates the role played by the bridge in supporting workforce and employment access, as well as connections up and down the supply chain within the region.[1] Mayor Niedner provided details regarding community dependence on the bridge:

- **Stark Brothers Nurseries**, a major employer with upwards of 200 employees, draws workforce from both sides of the bridge. Their main facility is located in Missouri, but 50% of their fruit trees are grown in Illinois. Transportation back to Missouri shipping facilities as key to their business model.
- **Able Oil** has stores in Louisiana, Bowling Green, and Elsberry, Missouri. Business depends on customers from Illinois. Prior bridge closures resulted in sales at the pump decreasing by 44%.
- **Fifth Gear Acquisitions**, a fulfillment, distribution, and customer service company recently acquired by Speed Commerce, reports that 72 of its employees commute daily from Illinois across the bridge. When the bridge is closed, the company pays workers a daily stipend, amounting to $5,000 dollars per day. Long-term closure of the bridge would result in permanent loss of employees – with large training costs incurred to replace the lost workforce.
- **West End Financial Services** reports that 1/3 of its loan business involves customers on the Illinois side of the bridge.
- The **Louisiana Visitors and Convention Bureau** reports that US 54 across the Champ Clark Bridge is used by tourists traveling from central Illinois to major tourist destinations in Missouri such as Branson and the Lake of the Ozarks in Missouri. Similarly, the **Eagle's Nest** bed and breakfast identifies 45% of its overnight guests as having arrived via the Champ Clark Bridge.
- Illinois farmers rely on the Champ Clark Bridge to access the **Bunge Grain Elevator** in Louisiana.

Moreover, Mayor Niedner reports that access to skilled labor already poses a challenge for manufacturing business in the region. Bridge closure would exacerbate this problem.

Beyond business interests, the bridge also supports community access to recreation. For example, the Twin Pike YMCA serves Pike County, Missouri and Pike County, Illinois. The business model of this facility would be severely compromised by bridge closures. The Two Rivers Marina is located just across the bridge in Illinois, offering residents of Louisiana, Missouri access to boating, camping, and other recreational activities.

[1] Presentation by Mayor Bart Niedner to the Missouri Highways and Transportation Commission on March 10, 2015. Video available at: https://youtu.be/T4s9Jb4vFMY

2 ECONOMIC IMPACTS

In addition to the benefit-cost analysis described in previous sections, an economic impact analysis was also performed for the Champ Clark Bridge replacement project. The benefit-cost analysis describes the efficiency of proposed investment in the bridge replacement, by comparing (in present-value terms) the monetized value of net welfare gains from the project to the costs of the project. Economic impact assessments, on the other hand, describe project impacts in terms of the flow of money in the economy. Economic impacts are measured in terms of jobs, income, gross-regional product (GRP), and business output.

The economic impact analysis considers a) short-term stimulus from construction outlays, and b) enhanced economic activity from reduced transportation costs. The impact analysis includes both the direct effects (jobs, income, GRP, and business output directly resulting from construction outlays or transportation savings) as well as induced and indirect effects (multiplier effects as these dollars are spent in the economy and stimulate demand in other sectors).

Economic impacts are estimated using the TREDIS transportation economics suite—the most widely used system for economic impacts of transportation projects in the US and Canada. Appendix 3 provides information about TREDIS methodology and underlying economic data. Tab A1-8 in Appendix 1 provides detailed economic impact results from the TREDIS module, summarized by year. As described in Section 1.2, three separate sets of inputs were run through TREDIS and then aggregated to produce the total effects of the Champ Clark bridge replacement.

The Champ Clark Bridge replacement is expected to support 332 jobs from construction of the facility at the height of the construction period and an average of 203 jobs annually in the 20 year operations period from 2019-2038. During construction, project expenditures are expected to support $29.7 Million in wage income, $35.0 Million in GRP, and $81.1 Million in business output cumulatively from 2016-2018. In addition, transportation efficiency gains are expected to generate an additional $169.9 Million in wage income, $235.5 Million in GRP, and $523.2 Million in business output cumulatively from 2019-2038.

APPENDIX 2: VALUATION FACTOR ASSUMPTIONS

Below are the key input assumptions and valuation factors used within the TREDIS benefit-cost analysis and spreadsheet modeling of emissions and safety benefits. All data sources are documented in footnotes. Conversions to 2015 dollars are made using the Bureau of Labor Statistics CPI Inflation Calculator.[2]

Value of Time

Because the Champ Clark Bridge connects Missouri and Illinois, the per-person-hour values of time used for the analysis are those defined by the TIGER BCA Resource Guide for intercity travel. Benefit estimation also adopts the TIGER suggested car trip purpose splits for intercity travel by conventional surface modes. Freight time costs are calculated within the TREDIS model, using per ton-hour cost factors and a customized regional commodity profile based on the FHWA Freight Analysis Framework.

Table 5 Value of Time by Mode and Purpose

Mode/Purpose	Value (2013 $ per person-hour)[3]	Value (2015 $ per person-hour)
Truck – All	$25.80	$26.00
Car – Business	$24.40	$24.58
Car – Personal	$17.50	$17.63

Table 6 Car Trip Purpose Split

Trip Purpose	Percentage[4]
Car – Business	21.4%
Car – Personal	78.6%

[2] Accessible at: http://www.bls.gov/data/inflation_calculator.htm

[3] TIGER Benefit-Cost Analysis (BCA) Resource Guide. Intercity travel by surface modes Page 5. http://www.dot.gov/sites/dot.gov/files/docs/Tiger_Benefit-Cost_Analysis_%28BCA%29_Resource_Guide_1.pdf

[4] TIGER Benefit-Cost Analysis (BCA) Resource Guide. Distribution for intercity travel by conventional surface modes. Page 5.

Vehicle Occupancy

Table 7 Crew, Passenger, and Freight Vehicle Loading Factors

Mode/Purpose	Crew Per Vehicle	Passenger per Vehicle[5]	US Freight Tons Per Vehicle[6]
Truck – All	1.08[7]	0	36
Car – Business	0	1.55	0
Car – Personal	0	1.55	0

Vehicle Operating Costs

Table 8 Per-Mile Vehicle Operating Costs

Mode/Purpose	Value (2015 $ per mile)[8]
Truck – All	$1.06
Car – Business	$0.48
Car – Personal	$0.48

[5] Based on average vehicle occupancy for car trips from the 2009 NHTS. http://nhts.ornl.gov/tables09/fatcat/2009/avo_TRPTRANS_WHYTRP1S.html

[6] 2002 Vehicle Travel Information System (VTRIS) average estimates of truck share and mean gross vehicle weight for straight trucks and tractor + single trailer trucks nationally, as summarized in FAF2 Freight Traffic Analysis. Chapter 3: Development of Truck Payload Equivalency Factors. Table 3.1: Results of Vehicle Weight Validation. http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/faf2_reports/reports7/c3_payload.htm

[7] Based on vehicle occupancy rates for single-unit and combined trucks defined in HERS-ST Highway Economic Requirements System - State Version: Technical Report (http://www.fhwa.dot.gov/asset/hersst/pubs/tech/tech05.cfm#sect552) and the split of 2010 vehicle miles traveled between single-unit trucks and combination trucks on other arterial rural highways, from the 2010 Highway Statistics Series, Annual Vehicle Distance Traveled in Miles and Related Data - 2010 1/ By Highway Category and Vehicle Type (http://www.fhwa.dot.gov/policyinformation/statistics/2010/vm1.cfm).

[8] Values derived by the TREDIS software group, using multiple sources: Vehicle operating cost per mile is defined for cars as an average of small, medium and large cars and SUV; source AAA (2011). Vehicle operating costs per mile for trucks were calculated by multiplying estimated gallons per mile (FHWA Highway Statistics Series 2010 Data) by applicable gasoline or diesel prices, and then adding in American Trucking Research Institute (ATRI) 2011 data on costs per mile for truck/trailer lease or purchase payments, repair and maintenance, truck insurance premiums, permits and licenses, tires, and tolls. ATRI supplementary data were held constant for all truck types. Diesel prices were drawn from 2011 figures from the U.S. Energy Information Administration "Weekly Retail Gasoline and Diesel Prices" (see http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_a.htm). The default value for all trucks is a weighted average based on an estimated mix of truck types.

Safety Costs

MoDOT collects crash data on fatalities, injuries, and property damage. TIGER Guidance recommends monetizing the value of injuries according to the maximum Abbreviated Injury Scale (AIS). Therefore, assumptions must be made to convert aggregate injury crash statistics into the AIS scale. The conversion is made based on the mapping presented in Table 9. Personal injuries are then valued based on the calculations presented in Table 10. Final valuation factors are presented in Table 11.

Table 9 Mapping of MoDOT Accident Classification to TIGER Guidance Classification

MoDOT Crash Classification	TIGER Guidance Classification
Fatality	AIS 6 Unsurvivable
Personal Injury	KABCO Injured (Severity Unknown)
Property Damage	Property Damage Only (PDO) Crashes

Table 10 Calculation of weighted average AIS-based cost for MoDOT personal injury accidents[9]

AIS	U - Injured Severity Unknown	AIS Cost (2013$)
0	0.21538	$0
1	0.62728	$28,200
2	0.10400	$441,800
3	0.03858	$987,000
4	0.00442	$2,500,400
5	0.01034	$5,574,200
	Weighted average (2013 $s)	$170,404

Table 11 Crash Valuation Factors

Value	$ per Fatalities Accident[10]	$ Per Personal Injury Accident	$ Per Property Damage Accident[11]
2013 $	$9,400,000	$170,404[12]	$3,927
2015 $	$9,471,219.15	$171,695.07	$3,956.75

9 TIGER Benefit-Cost Analysis (BCA) Resource Guide. Table 4. KABCO/Unknown – AIS Data Conversion Matrix.

10 TIGER Benefit-Cost Analysis (BCA) Resource Guide. Page 2.

11 TIGER Benefit-Cost Analysis (BCA) Resource Guide. Page 4.

12 Derived in Table 7.

Environmental Costs

Emissions generated on a per mile basis were calculated, using information from the U.S. EPA Office of Transportation and Air Quality. Emissions are then valued according to TIGER Guidance, with a conversion factor from long tons to metric tons of: (2,240 lbs./2,205 lbs) = 1.01587 metric tons per long ton.

Table 12 Emissions Generated on a Per Mile Basis[13]

	Long tons per VMT				
Mode	**VOCs**	**NOx**	**SOx**	**PM**	**CO2**
Passenger Car	1.05E-06	7.04E-07	0.00E+00	4.32E-09	3.74E-04
All Trucks	1.18E-06	2.47E-06	1.79E-09	4.37E-08	9.63E-04

Table 13 Value per Metric Ton of Non-Carbon Emissions

Value per metric ton[14]	VOCs	NOx	SOx	PM
2013 $	$1,999	$7,877	$46,561	$360,383
2015 $	$2,014.15	$7,936.68	$46,913.77	$363,113.44

Table 14 Value per Metric Ton of Carbon Emissions

Year	CO3 values (2013 $)[15]	CO3 values (2015 $)
2016	46	46.35
2017	47	47.36
2018	49	49.37
2019	51	51.39
2020	52	52.39
2021	52	52.39
2022	54	54.41
2023	55	55.42

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[13] Values derived by the TREDIS software group, using multiple sources: EPA. Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks, October 2008, http://www.epa.gov/otaq/consumer/420f08024.pdf; Average In-Use Emissions from Heavy-Duty Trucks, October 2008, http://www.epa.gov/otaq/consumer/420f08027.pdf; Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2008, http://epa.gov/climatechange/emissions/usinventoryreport.html; MOVES2010 model, March 2010 Build, Database MOVES20091221, in Hours of Service (HOS) Environmental Assessment, 2011, Appendix A, Exhibit A-4, "Long-haul and Drayage Truck Travel Emission Factors," http://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/2011_HOS_Final_Rule_EA_Appendices.pdf; "Policy Discussion – Heavy-Duty Truck Fuel Economy," Presentation by Drew Kodjak, National Commission on Energy Policy, 10th Diesel Engine Emissions Reduction (DEER) Conference, August 29 – September 2, 2004, http://www1.eere.energy.gov/vehiclesandfuels/pdfs/deer_2004/session6/2004_deer_kodjak.pdf.

[14] TIGER Benefit-Cost Analysis (BCA) Resource Guide. Page 6.

[15] TIGER Benefit-Cost Analysis (BCA) Resource Guide. Page 7.

2024	56	56.42
2025	57	57.43
2026	58	58.44
2027	60	60.45
2028	61	61.46
2029	62	62.47
2030	63	63.48
2031	63	63.48
2032	65	65.49
2033	66	66.50
2034	67	67.51
2035	68	68.52
2036	69	69.52
2037	71	71.54
2038	72	72.55

APPENDIX 3: TREDIS METHODOLOGY

Inside the TREDIS Model

Project benefits, costs, and economic impacts are estimated using the TREDIS transportation economics suite—the most widely used system for economic impacts of transportation projects in the US and Canada.[16] Embedded within TREDIS is baseline economic data from IMPLAN[17], along with future projections of industry growth by sector from Moody's Analytics. Also included within the TREDIS model is region-specific data on freight flows by commodity, which enables region-specific valuation of freight time savings.

When conducting a TREDIS analysis, users enter information on transportation performance changes (e.g. travel time and distance) and project timing. Within the benefit-cost module, TREDIS values and discounts these changes according to selected cost factors (detailed in Appendix 2).

In calculating economic impacts of a transportation project, TREDIS first translates transportation performance changes and cost savings into resulting shifts in household spending and changes in production costs for businesses. An IMPLAN input-output model is then used to calculate how direct project impacts trigger additional macroeconomic changes, including inter-industry (indirect) supply-chain impacts and wage spending (induced) impacts.

Study Region Definition for Economic Analysis

The Clark Bridge is located in the city of Louisiana in Pike County, Missouri. In order to conduct an economic impact evaluation of this project's short and long-term economic effects, the TREDIS model was applied using an IMPLAN-based input-output structure for the five-county region of Pike County, Ralls County, Marion County, Lincoln County, and St. Charles County, Missouri. This 5-county region encompasses both the Clark Bridge, and its nearest alternative crossings to the north and south at Hannibal, MO and Alton, IL respectively.

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[16] For more information, visit www.tredis.com

[17] IMPLAN is the most widely used input-output economic modeling system in the US. This system uses industry- and region-specific economic data to translate direct effects into indirect and induced impacts. More information is available at www.implan.com