



APPENDIX A

BENEFIT COST ANALYSIS

RAISE Grant Application
SUBMITTED BY:



CITY OF
WINOOSKI
VERMONT

Benefit Cost Analysis

Executive (Project) Summary

This Benefit Cost Analysis (BCA) is being prepared for the Vermont Agency of Transportation (VTrans) for the removal and replacement of the bridge on US Route 2 and US Route 7 connecting the cities of Winooski, VT and Burlington, VT. This BCA was completed in accordance with the U.S. Department of Transportation's (USDOT) *Benefit-Cost Analysis Guidance for Discretionary Grant Programs (2022)*. This BCA uses a 30-year evaluation period from the completion of the project. This analysis results in a Benefit to Cost Ratio of 8.16.

Methodology/Assumptions

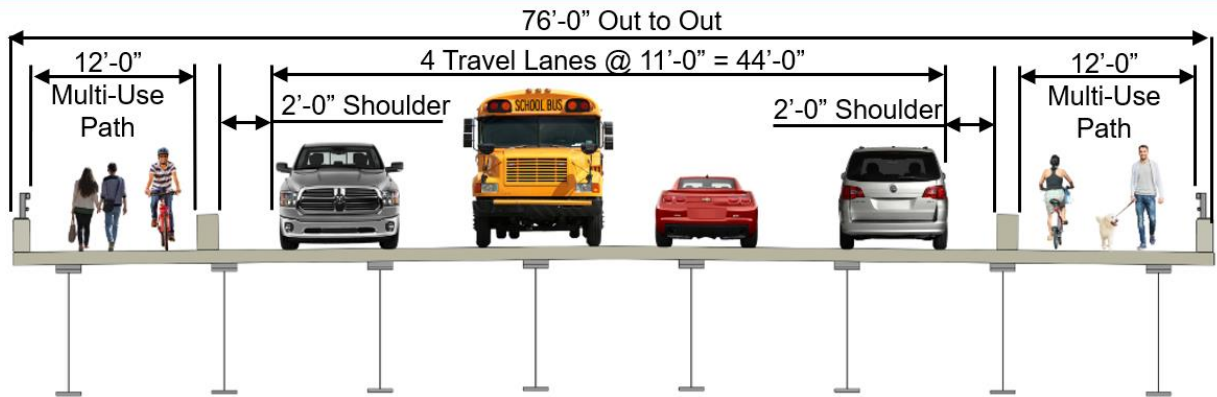
The evaluation period for benefits and costs of this project includes the development stages with design anticipated to begin in 2023 and continue until 2026 and construction is anticipated to be completed over a four-year span from 2027 to 2030. This puts the project opening year in 2031 and extends through 30-years of operations until 2060.

USDOT-recommended monetized values for crash cost reductions, travel time savings and vehicle operations costs were used to calculate project benefits. All costs in the BCA are stated in 2020 dollars to be consistent with the latest USDOT BCA guidance. Future benefits and costs are discounted at 7% per USDOT guidance.

Two alternatives are compared as part of this BCA: a No Build Alternative and a Build Alternative. The No Build Alternative explores a scenario that assumes that the bridge replacement project will not be performed during the evaluation period and no additional repairs or rehabilitation will be performed on the bridge. Based on the results of the most recent bridge inspection, it is assumed that within 5-10 years the sidewalks will no longer be safe for pedestrians to use due to the deterioration of the sidewalk at the bridge joints and the deterioration of the historic bridge railing. To maintain pedestrian accommodations across the bridge, one lane in each direction would be closed to vehicular traffic to accommodate pedestrians and cyclists, effectively restricting the roadway capacity by 50%. The bridge inspection also indicates that within 10-15 years the bridge will need to be closed to vehicular traffic due to deterioration of the decking. For this BCA, it is assumed that the sidewalks will need to be closed and the roadway capacity reduced to 50% at the 10-year horizon, in 2032, and the bridge will be fully closed to vehicles at the 15-year horizon, in 2037.

The Build Alternative is to replace the Winooski River Bridge with a two-span bridge that will widen the roadway and add shared use paths on both sides to a new out-to-out width of 76'. The new bridge will widen the lanes from a sub-standard 10' 6" width to a standard 11' width and will add 2' wide shoulders where there are currently none. Both widening the lanes and adding shoulders will add safety benefits to all roadway users. The new bridge will also have sidewalk barriers to increase pedestrian comfort and safety and will widen the sidewalks to become 12' wide shared used paths. This additional width will provide a safe place for cyclists who, in the existing condition, must either ride with traffic or ride on the sidewalk. The additional space for both bicyclists and pedestrians will establish a safe connection between the existing bike/ped network in Burlington to the south and the sidewalks and bike lanes in Winooski to the north.

Proposed Bridge Section



Benefits

In \$2020 discounted at 7 percent, the proposed bridge replacement project will provide approximately \$124 million in economic benefits from reduced vehicle hours traveled (VHT), reduced vehicle miles traveled (VMT), crash cost reductions, and the residual value of the new structure as compared to the No-Build Alternative and are described below. Additional qualitative benefits include quality of life improvements, increased community connectivity, improved multi-modal access, and the health benefits which are known to accompany an increase in active transportation. The following sections provide a detailed explanation of the quantifiable benefits associated with the proposed project.

Travel Time Savings

US Route 2 & US Route 7 carry approximately 25,000 vehicles per day. To account for the changes in vehicle hours traveled (VHT) and vehicle miles traveled (VMT) as a result of the capacity reductions stated above, a holistic approach was taken. In lieu of assuming that all traffic would follow a specific detour route, traffic was modeled to find various alternative routes throughout Winooski and Burlington based on origin-destination relationships in response to the increase in overall congestion from the decreased capacity across the bridge. This was done using a sophisticated regional model of Chittenden County which can output VHT and VMT. The travel time and travel distance outputs are representative of traffic across the entire model and not exclusive to the area of the bridge closure. This allows the model to tabulate the increased delay and miles traveled experienced by all drivers across the roadway network as the detoured traffic volumes use other roadways to complete their journeys. Therefore, not only does the model report the additional time spent for the drivers needing to use the detour, but also the drivers along the detour route that experience more delay due to the added traffic and congestion resulting from the detour. The additional congestion experienced by the entire network is reflected in the VHT output.

Chittenden County Daily Metrics	No Build	1 Lane in Each Direction (50% Capacity)	Full Bridge Closure
Vehicle Miles Traveled (VMT)	5,145,024	5,143,967	5,194,485
Vehicle Hours Traveled (VHT)	179,865	179,977	182,033
Change in Delay vs No Build	0	112	2,168
Change in VMT vs No Build (miles)	0	(1,057)	49,461

Comparing VHT outputs from the reduced capacity models against the No Build Alternative yields the following results: a 50% reduction in vehicle capacity across the existing bridge will result in a net increase in VHT of 112 hours spent traveling per day. However, when the bridge is fully closed and all traffic must find alternative routes, VHT increases by 2,168 hours per day. To monetize these values, average occupancy and vehicle operating costs were taken from Table A-3, Table A-4, and Table A-5 from the USDOT BCA Guidance. The net benefit of VHT across the 30-year evaluation in \$2020 is \$90,441,585. The benefit of time travel savings would begin in 2032 when the assumed date the No-Build alternative would require reducing the bridge’s capacity to 50% and would change to the full bridge closure value in 2037 when the bridge would be expected to be closed under the No-Build alternative.

Travel Distance Savings

Comparing VMT outputs from the reduced capacity models shown above against the No Build Alternative yields the following results: a 50% reduction in vehicle capacity across the existing bridge will result in a net reduction in VMT of 1,057 miles traveled. This reduction in VMT is due to leisure trips, such as shopping or dining, being deterred by the increased congestion created across the two city’s roadway networks as a result of the lane closures on the bridge. It is worth noting that although the distance traveled decreases by over 1,000 hours, the amount of time it takes to travel that reduced distance is 112 hours longer. When the bridge is fully closed, and all traffic must find alternative routes, VMT increases by 49,461 miles per day. The resulting net benefit of VMT across the 30-year evaluation is \$32,314,958 in \$2020. The benefit of travel distance savings would begin in 2032 when the assumed date the No-Build alternative would require reducing the bridge’s capacity to 50% and would change to the full bridge closure value in 2037 when the bridge would be expected to be closed under the No-Build alternative.

Crash Reduction Savings

The proposed bridge increases the outside shoulder widths from 0' to 2' which is anticipated to reduce the rate of crashes. The Crash Modification Factor (CMF) Clearinghouse cites a study which estimates crashes will be reduced by approximately 7%, with a CMF of 0.93, following the shoulder widening. This CMF is applicable to all crash types along a roadway with similar characteristics to US 2 & US 7.

The new bridge will also widen traffic lanes from a substandard width of 10' 6" to a standard width of 11'. This increased lane width is anticipated to reduce the rate of crashes by approximately 28%, based on a CMF of 0.72. This CMF is applicable to all crash types along a roadway with similar characteristics to US 2 & US 7.

USDOT recommends combining the effects of CMFs for similar crash types with one of four methods with the Dominant Effect Method and the Dominant Common Residuals Method, the two most applicable methods. In this case, the Dominant Effect Method proves most applicable and the CMF with the greatest impact is related to the lane widening. Therefore, the combined effect of the two countermeasures is a reduction of approximately 28% in the anticipated crash rates. Increasing the lane and shoulder widths is expected to help reduce all crash types, and specifically the "same direction sideswipe crashes" and "rear end crashes", which are the two most common crashes in the project area, by allowing vehicles more space to avoid each other. This results in a crash savings of \$471,831 in \$2020. The benefit of crash reduction savings would begin in 2031 after the new bridge is fully constructed.

CMF ID Number & Description	CMF	Crash Types (Severity)	Area Type
CMF 8712: Roadway with Narrow Shoulders	0.93	All (KABCO)	Urban
CMF 3936: Increase Lane Width	0.72	All (KABCO)	Urban

KABCO - BCA Guidance Table A-1

Residual Value

The useful life of the proposed bridge is expected to be 100 years which adds 70 years of useful life to the structure beyond the BCA evaluation period. This results in a residual value of \$18,200,000 in \$2060 or \$1,215,403 in \$2020.

Some of the qualitative benefits and quality of life improvement such as increased multi-modal access and health benefits from a modal shift to active forms of transportation are difficult to quantify and were therefore not considered in this BCA. These benefits can be assumed to make the current BCA ratio somewhat conservative.

Capital Costs/Build Alternative

The total project cost to remove and replace the Winooski River Bridge is estimated to be \$26,000,000 (\$2020). This amount includes new bridge construction, existing bridge removal, preliminary engineering, right-of-way, mitigation, and public participation costs. The estimate was developed by reviewing representative projects which were recently bid/constructed which have similar levels of complexity and mitigation. Costs were estimated based on the square footage of the proposed bridge. A detailed cost estimate is shown in Appendix A.

CATEGORY	Estimated Project Costs (\$2020)
Proposed Bridge Cost	\$ 15,500,000.00
Removal of Structure	\$ 1,520,000.00
Roadway Costs	\$ 300,000.00
Maintenance of Traffic Costs	\$ 980,000.00
Construction Costs	\$ 18,300,000.00
Construction Engineering	
Contingency	\$ 2,570,000.00
Accelerated Premium	\$ 1,830,000.00
Total Construction Costs with CEC	\$ 22,700,000.00
Preliminary Engineering	\$ 2,300,000.00
Right-of-Way	\$ 550,000.00
Public Participation	\$ 450,000.00
Total Project Costs (\$2020)	\$ 26,000,000.00

Comparing Benefits to Costs

A summary of the benefits and costs quantified for the proposed project are summarized in the table below. Benefits and costs are expressed in real dollars (\$2020) and have been discounted at 7% over the analysis period. The comparison of the benefits to the costs are presented in terms of a Benefit to Cost Ratio (BCR), which for this project is 8.16.

CATEGORY	\$2020 Benefit-Cost (Discounted 7%)
Time Savings Benefit	\$ 90,441,585
Vehicle Operating Costs Benefit	\$ 32,314,958
Crash Reduction Benefit	\$ 471,831
Residual Value Benefit	\$ 1,215,403
Total Benefit	\$ 124,443,777
Design/Engineering/ROW Cost	\$ 2,440,780
Construction Cost	\$ 12,808,713
Total Cost	\$ 15,249,493
Benefit-Cost Ratio	8.16

**Winooski US 2 & US 7
BENEFIT-COST ANALYSIS**

April 13, 2022

Benefits								
Calendar Year	Project Year ¹	Value of Time Savings (\$2020)	Value of O&M Saved (\$2020) ⁴	Value of Crash Reductions Savings (\$2020) ⁵	Residual Value of New Bridge (\$2020)	Total Benefits (\$2020)	7% Rate	Total Benefits (\$2020) Discounted 7%
2023	1	\$0	\$0	\$0		\$0	0.82	\$0
2024	2	\$0	\$0	\$0		\$0	0.76	\$0
2025	3	\$0	\$0	\$0		\$0	0.71	\$0
2026	4	\$0	\$0	\$0		\$0	0.67	\$0
2027	5	\$0	\$0	\$0		\$0	0.62	\$0
2028	6	\$0	\$0	\$0		\$0	0.58	\$0
2029	7	\$0	\$0	\$0		\$0	0.54	\$0
2030	8	\$0	\$0	\$0		\$0	0.51	\$0
2031	9	\$0	\$0	\$74,797		\$74,797	0.48	\$35,536
2032	10	\$1,172,257	-\$179,679	\$74,797		\$1,067,376	0.44	\$473,928
2033	11	\$1,172,257	-\$179,679	\$74,797		\$1,067,376	0.41	\$442,923
2034	12	\$1,172,257	-\$179,679	\$74,797		\$1,067,376	0.39	\$413,947
2035	13	\$1,172,257	-\$179,679	\$74,797		\$1,067,376	0.36	\$386,866
2036	14	\$1,172,257	-\$179,679	\$74,797		\$1,067,376	0.34	\$361,557
2037	15	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.32	\$9,868,951
2038	16	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.30	\$9,223,319
2039	17	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.28	\$8,619,924
2040	18	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.26	\$8,056,004
2041	19	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.24	\$7,528,976
2042	20	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.23	\$7,036,426
2043	21	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.21	\$6,576,099
2044	22	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.20	\$6,145,887
2045	23	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.18	\$5,743,819
2046	24	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.17	\$5,368,056
2047	25	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.16	\$5,016,874
2048	26	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.15	\$4,688,668
2049	27	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.14	\$4,381,932
2050	28	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.13	\$4,095,264
2051	29	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.12	\$3,827,349
2052	30	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.11	\$3,576,962
2053	31	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.11	\$3,342,955
2054	32	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.10	\$3,124,257
2055	33	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.09	\$2,919,867
2056	34	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.09	\$2,728,847
2057	35	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.08	\$2,550,325
2058	36	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.08	\$2,383,481
2059	37	\$22,691,555	\$8,407,841	\$74,797		\$31,174,193	0.07	\$2,227,552
2060	38	\$22,691,555	\$8,407,841	\$74,797	\$18,200,000	\$49,374,193	0.07	\$3,297,227
Totals		\$550,458,603	\$200,889,785	\$2,243,920	\$18,200,000	\$771,792,308		\$124,443,777

Costs				
Initial Project Costs (\$2022) ¹		7% Rate	Total Costs (\$2020) Discounted 7%	Net Present Value AT 7%
\$825,000		0.82	\$673,446	(\$673,446)
\$825,000		0.76	\$629,389	(\$629,389)
\$825,000		0.71	\$588,214	(\$588,214)
\$825,000		0.67	\$549,732	(\$549,732)
\$5,675,000		0.62	\$3,534,105	(\$3,534,105)
\$5,675,000		0.58	\$3,302,902	(\$3,302,902)
\$5,675,000		0.54	\$3,086,824	(\$3,086,824)
\$5,675,000		0.51	\$2,884,882	(\$2,884,882)
\$0		0.48	\$0	\$35,536
\$0		0.44	\$0	\$473,928
\$0		0.41	\$0	\$442,923
\$0		0.39	\$0	\$413,947
\$0		0.36	\$0	\$386,866
\$0		0.34	\$0	\$361,557
\$0		0.32	\$0	\$9,868,951
\$0		0.30	\$0	\$9,223,319
\$0		0.28	\$0	\$8,619,924
\$0		0.26	\$0	\$8,056,004
\$0		0.24	\$0	\$7,528,976
\$0		0.23	\$0	\$7,036,426
\$0		0.21	\$0	\$6,576,099
\$0		0.20	\$0	\$6,145,887
\$0		0.18	\$0	\$5,743,819
\$0		0.17	\$0	\$5,368,056
\$0		0.16	\$0	\$5,016,874
\$0		0.15	\$0	\$4,688,668
\$0		0.14	\$0	\$4,381,932
\$0		0.13	\$0	\$4,095,264
\$0		0.12	\$0	\$3,827,349
\$0		0.11	\$0	\$3,576,962
\$0		0.11	\$0	\$3,342,955
\$0		0.10	\$0	\$3,124,257
\$0		0.09	\$0	\$2,919,867
\$0		0.09	\$0	\$2,728,847
\$0		0.08	\$0	\$2,550,325
\$0		0.08	\$0	\$2,383,481
\$0		0.07	\$0	\$2,227,552
\$0		0.07	\$0	\$3,297,227
\$26,000,000			\$15,249,493	\$109,194,284

Notes

1. Based on Conceptual Cost Estimate (\$2020) dated April 2022

Benefit Cost Ratio	
Real Dollars	29.68
7% Discount Rate	8.16

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JOB Winooksi BCA - RAISE

SHEET NO.	1	OF	9
CALCULATED BY	SRL	DATE	04/04/22
CHECKED BY	BRC	DATE	4/6/2022
PROJECT NO.	18502.03	SCALE	N.T.S.

PROJECT FUNDING ASSUMPTIONS

Begin Design Year	=	2023	Final Design Costs	\$	2,300,000
End Design Year	=	2026	ROW Costs	\$	550,000
Pre-Construction Costs	=	\$ 3,300,000	Mitigation Costs	\$	450,000
PE/ROW Costs Per Year	=	\$ 825,000.00	Utility Reloc. Costs	\$	-
Begin Construction Year	=	2027			
End Construction Year	=	2030			
Construction Costs	=	\$ 22,700,000			
Construction Costs Per Year	=	\$ 5,675,000.00			
Project Opening Year	=	2030			
Analysis Period	=	30 Years			
End Analysis Year	=	2060 Years			

Calendar Year	Project Year ¹	Design Costs	Construction Costs	Total Project Costs
2022	1	\$ -		\$ -
2023	2	\$ 825,000.00		\$ 825,000.00
2024	3	\$ 825,000.00		\$ 825,000.00
2025	4	\$ 825,000.00		\$ 825,000.00
2026	5	\$ 825,000.00		\$ 825,000.00
2027	6		\$ 5,675,000.00	\$ 5,675,000.00
2028	7		\$ 5,675,000.00	\$ 5,675,000.00
2029	8		\$ 5,675,000.00	\$ 5,675,000.00
2030	9		\$ 5,675,000.00	\$ 5,675,000.00
2031	10			\$ -
2032	11			\$ -
2033	12			\$ -
2034	13			\$ -
2035	14			\$ -

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SHEET NO.	2	OF	9
CALCULATED BY	SRL	DATE	04/04/22
CHECKED BY	BRC	DATE	4/6/2022
PROJECT NO.	18502.03	SCALE	N.T.S.

RESIDUAL BRIDGE VALUE

Estimated Cost of Bridge \$ 22,700,000.00

Estimated Cost of Design \$ 3,300,000.00

Total Estimated Project Cost (\$2026) = \$ 26,000,000.00

Service Life of Bridge = 100 Years

Bridge Opening Year = 2030

End of Analysis Year = 2060

Residual Value at End of Analysis Year (\$2020)= \$18,200,000

(rounded to nearest 100,000)

Value of Vehicle Operating Costs Savings

Calendar Year	Project Year	Average Annual VMT (Compared to NO BUILD)	Value of O&M Saved (\$2020)
2022	0	0	\$0
2023	1	0	\$0
2024	2	0	\$0
2025	3	0	\$0
2026	4	0	\$0
2027	5	0	\$0
2028	6	0	\$0
2029	7	0	\$0
2030	8	0	\$0
2031	9	0	\$0
2032	10	-371,007	-\$179,679
2033	11	-371,007	-\$179,679
2034	12	-371,007	-\$179,679
2035	13	-371,007	-\$179,679
2036	14	-371,007	-\$179,679
2037	15	17,360,811	\$8,407,841
2038	16	17,360,811	\$8,407,841
2039	17	17,360,811	\$8,407,841
2040	18	17,360,811	\$8,407,841
2041	19	17,360,811	\$8,407,841
2042	20	17,360,811	\$8,407,841
2043	21	17,360,811	\$8,407,841
2044	22	17,360,811	\$8,407,841
2045	23	17,360,811	\$8,407,841
2046	24	17,360,811	\$8,407,841
2047	25	17,360,811	\$8,407,841
2048	26	17,360,811	\$8,407,841
2049	27	17,360,811	\$8,407,841
2050	28	17,360,811	\$8,407,841
2051	29	17,360,811	\$8,407,841
2052	30	17,360,811	\$8,407,841
2053	31	17,360,811	\$8,407,841
2054	32	17,360,811	\$8,407,841
2055	33	17,360,811	\$8,407,841
2056	34	17,360,811	\$8,407,841
2057	35	17,360,811	\$8,407,841
2058	36	17,360,811	\$8,407,841
2059	37	17,360,811	\$8,407,841
2060	38	17,360,811	\$8,407,841
			\$200,889,785

50% CLOSURE PERIOD

100% CLOSURE PERIOD

	DAILY VALUES			ANNUAL VALUES		
	NO BUILD	50% CLOSURE	100% CLOSURE	NO BUILD	50% CLOSURE	100% CLOSURE
	2027	2032	2037	2027	2032	2037
VMT (miles)	5,145,024	5,143,967	5,194,485	1,805,903,424	1,805,532,417	1,823,264,235
Change in VMT	0	-1,057	49,461	-	-371,007	17,360,811
O&M Light Duty	\$ -	\$ (442.35)	\$ 20,699.43	\$ -	\$ (155,266.43)	\$ 7,265,499.40
O&M Commercial	\$ -	\$ (69.55)	\$ 3,254.53	\$ -	\$ (24,412.26)	\$ 1,142,341.36
Total	\$ -	\$ (511.91)	\$ 23,953.96	\$ -	\$ (179,678.69)	\$ 8,407,840.77

VMT Reduction at 50% capacity reflects congestion dissuading leisure trips.

Light Duty \$ 0.45 Table A-5 - Value of Travel Time Savings - USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs
 Commercial Duty \$ 0.94 Table A-5 - Value of Travel Time Savings - USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs, Note 2

Daily Values are multiplied by 351 (not 365) to arrive at annual values.

This was done based on the relationship between the Vtrans annual VMT number and the value generated by the traffic model.

Assuming 7% ; (Per 2019 Scoping Study)
 93% Passenger Vehicles

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SHEET NO.	5	OF	9
CALCULATED BY	SRL	DATE	04/04/22
CHECKED BY	BRC	DATE	4/6/2022
PROJECT NO.	18502.03	SCALE	N.T.S.

Value of Crash Reductions

Calendar Year	Project Year	Widen Shoulder 0' to 2'	Total Crash Reduction Benefit
2022		\$0.00	\$0
2023	1	\$0.00	\$0
2024	2	\$0.00	\$0
2025	3	\$0.00	\$0
2026	4	\$0.00	\$0
2027	5	\$0.00	\$0
2028	6	\$0.00	\$0
2029	7	\$0.00	\$0
2030	8	\$0.00	\$0
2031	9	\$74,797.33	\$74,797
2032	10	\$74,797.33	\$74,797
2033	11	\$74,797.33	\$74,797
2034	12	\$74,797.33	\$74,797
2035	13	\$74,797.33	\$74,797
2036	14	\$74,797.33	\$74,797
2037	15	\$74,797.33	\$74,797
2038	16	\$74,797.33	\$74,797
2039	17	\$74,797.33	\$74,797
2040	18	\$74,797.33	\$74,797
2041	19	\$74,797.33	\$74,797
2042	20	\$74,797.33	\$74,797
2043	21	\$74,797.33	\$74,797
2044	22	\$74,797.33	\$74,797
2045	23	\$74,797.33	\$74,797
2046	24	\$74,797.33	\$74,797
2047	25	\$74,797.33	\$74,797
2048	26	\$74,797.33	\$74,797
2049	27	\$74,797.33	\$74,797
2050	28	\$74,797.33	\$74,797
2051	29	\$74,797.33	\$74,797
2052	30	\$74,797.33	\$74,797
2053	31	\$74,797.33	\$74,797
2054	32	\$74,797.33	\$74,797
2055	33	\$74,797.33	\$74,797
2056	34	\$74,797.33	\$74,797
2057	35	\$74,797.33	\$74,797
2058	36	\$74,797.33	\$74,797
2059	37	\$74,797.33	\$74,797
2060	38	\$74,797.33	\$74,797

\$2,243,920

WINOOSKI RIVER BRIDGE
Value of Life Crash Cost by Type

Type	Cost (\$2020)
PDO ¹	\$4,600
Injury ²	\$151,000
Fatality ³	\$11,600,000

Sources: USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs

- (1) Table A-2 - Property Damage Only (PDO) Crashes
- (2) Table A-1 - Non-Incapacitating Injury Crashes
- (3) Table A-1 - Value of Reduced Fatalities and Injuries (Fatal)

Observed Crashes (20116-2021) ⁴	Average per year
Total	62
PDO	53
Injury	9
Fatal	0

(4) Source: Vermont Agency of Transportation

Crash Modification Factor	
Widen Shoulder 0' to 2'	0.93

CMF ID: 8712 PRIOR CONDITION: ROADWAY WITH NARROWER SHOULDERS
STUDY: EVALUATION OF SAFETY EFFECTIVENESS OF MULTIPLE CROSS SECTIONAL FEATURES ON URBAN ARTERIALS, PARK AND ABDEL-ATY, 2016

Source: www.cmfclearinghouse.org

Crash Modification Factor	
Widen Lanes	0.72

CMF ID: 3936 INCREASE LANE WIDTH
STUDY: A
COMPARATIVE FULL BAYESIAN BEFORE-AND-AFTER ANALYSIS AND APPLICATION TO URBAN ROAD SAFETY COUNTERMEASURES IN NEW JERSEY, YANMAZ-TUZEL AND OZBAY, 2010

Using the Dominant Common Residuals Method

CMF1	0.72
CMF2	0.93
CMFT	0.75

If CMF1 is < CMT, use CMF1 per Dominant Effect Method

CMF	0.72
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Year	Crashes per year based on % increase in traffic volume per year (Expected Crashes per year (Build) Using CMF			Expected reduction in crashes per year			Cost Savings (\$2020)
	PDO Crashes	Injury Crashes	Fatal Crashes	PDO Crashes	Injury Crashes	Fatal Crashes	PDO Crashes	Injury Crashes	Fatal Crashes	
2022	8.83	1.50	0.00	6.36	1.08	0.00				\$0
2023	8.83	1.50	0.00	6.36	1.08	0.00				\$0
2024	8.83	1.50	0.00	6.36	1.08	0.00				\$0
2025	8.83	1.50	0.00	6.36	1.08	0.00				\$0
2026	8.83	1.50	0.00	6.36	1.08	0.00				\$0
2027	8.83	1.50	0.00	6.36	1.08	0.00				\$0
2028	8.83	1.50	0.00	6.36	1.08	0.00				\$0
2029	8.83	1.50	0.00	6.36	1.08	0.00				\$0
2030	8.83	1.50	0.00	6.36	1.08	0.00				\$0
2031	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2032	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2033	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2034	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2035	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2036	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2037	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2038	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2039	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2040	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2041	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2042	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2043	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2044	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2045	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2046	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2047	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2048	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2049	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2050	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2051	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2052	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2053	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2054	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2055	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2056	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2057	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2058	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2059	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
2060	8.83	1.50	0.00	6.36	1.08	0.00	2.47	0.42	0.00	\$74,797
Total										\$2,243,920

JOB		Winooksi BCA - RAISE	
SHEET NO.	8	OF	9
CALCULATED BY	SRL	DATE	04/04/22
CHECKED BY	BRC	DATE	4/6/2022
PROJECT NO.	18502.03	SCALE	N.T.S.

DETERMINE VALUE OF BENEFIT OF LESS TRAVEL TIME THROUGH CORRIDOR

TRAVEL TIME SAVINGS = 112.00 DAILY VEHICLE HOURS DURING 50% CLOSURE
 TRAVEL TIME SAVINGS = 2168.00 DAILY VEHICLE HOURS DURING 100% CLOSURE

351 DAYS PER YEAR

TOTAL TRAVEL TIMES SAVINGS = 39,312.00 VEHICLE HOURS SAVED DURING 50% CLOSURE
 760,968.00 VEHICLE HOURS SAVED DURING 100% CLOSURE

Recommended Hourly Values of Travel Time Savings (Per Person-Hour) ¹		
Category		(\$2020)
Private Vehicle		
Personal		\$16.20
Business		\$29.40
Commercial Vehicle		
Truck Driver		\$32.00

Sources:

- (1) Table A-3 - Value of Travel Time Savings - USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs
- (2) Table A-3 - Value of Travel Time Savings - USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs, Note 2
- (3) Table A-4 - Average Vehicle Occupancy - USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs

Daily Values are multiplied by 351 (not 365) to arrive at annual values.

This was done based on the relationship between the Vtrans annual VMT number and the value generated by the traffic model.

Estimated Percentage of Personal and Business Travel ²	
Business	11.80%
Personal	88.20%

Average Vehicle Occupancy ³	
Passenger Vehicle	1.67
Trucks	1.00

Assuming 7% Trucks (Per 2019 Scoping Study)
 93% Passenger Vehicles
 11.80% Business Passenger Vehicles
 88.20% Personal Passenger Vehicles

Weighted Cost of Truck = % Trucks x Truck Driver Rate x Vehicle Occupancy
 = \$2.24

Weighted Cost of Business Passenger Vehicle = % Business Passenger Vehicle x Business Passenger Vehicle Rate x Vehicle Occupancy
 = \$5.39

Weighted Cost of Personal Passenger Vehicle = % Personal Passenger Vehicle x Personal Passenger Vehicle Rate x Vehicle Occupancy
 = \$22.19

Total Weighted Averages per Vehicle = Weighted Cost of Truck + Weighted Cost of Business Passenger Vehicle + Weighted Cost of Personal Passenger Vehicle
 = \$29.82

TOTAL ANNUAL SAVINGS OF TRAVEL TIME COSTS PER YEAR 50% CLOSURE = \$1,172,257.44 IN 2020 DOLLARS

TOTAL ANNUAL SAVINGS OF TRAVEL TIME COSTS PER YEAR 100% CLOSURE = \$22,691,554.82 IN 2020 DOLLARS

McFARLAND JOHNSON
Engineering, Planning & Construction Administration
www.mjinc.com

JOB	Winooksii BCA - RAISE		
SHEET NO.	9	OF	9
CALCULATED BY	SRL	DATE	04/04/22
CHECKED BY	BRC	DATE	4/6/2022
PROJECT NO.	18502.03	SCALE	N.T.S.

Value of VHT Savings

Calendar Year	Project Year	VEHICLE HOURS SAVED (Compared to NO BUILD)	Value of Time Savings (\$2020)
2022	0	0	\$0
2023	1	0	\$0
2024	2	0	\$0
2025	3	0	\$0
2026	4	0	\$0
2027	5	0	\$0
2028	6	0	\$0
2029	7	0	\$0
2030	8	0	\$0
2031	9	0	\$0
2032	10	39,312	\$1,172,257
2033	11	39,312	\$1,172,257
2034	12	39,312	\$1,172,257
2035	13	39,312	\$1,172,257
2036	14	39,312	\$1,172,257
2037	15	760,968	\$22,691,555
2038	16	760,968	\$22,691,555
2039	17	760,968	\$22,691,555
2040	18	760,968	\$22,691,555
2041	19	760,968	\$22,691,555
2042	20	760,968	\$22,691,555
2043	21	760,968	\$22,691,555
2044	22	760,968	\$22,691,555
2045	23	760,968	\$22,691,555
2046	24	760,968	\$22,691,555
2047	25	760,968	\$22,691,555
2048	26	760,968	\$22,691,555
2049	27	760,968	\$22,691,555
2050	28	760,968	\$22,691,555
2051	29	760,968	\$22,691,555
2052	30	760,968	\$22,691,555
2053	31	760,968	\$22,691,555
2054	32	760,968	\$22,691,555
2055	33	760,968	\$22,691,555
2056	34	760,968	\$22,691,555
2057	35	760,968	\$22,691,555
2058	36	760,968	\$22,691,555
2059	37	760,968	\$22,691,555
2060	38	760,968	\$22,691,555
			\$550,458,603

50% CLOSURE PERIOD

100% CLOSURE PERIOD

	DAILY VALUES			ANNUAL VALUES		
	NO BUILD	50% CLOSURE	100% CLOSURE	NO BUILD	50% CLOSURE	100% CLOSURE
	2027	2032	2037	2027	2032	2037
VHT (hours)	179,865	179,977	182,033	63,132,615	63,171,927	63,893,583
VMT (miles)	5,145,024	5,143,967	5,194,485	1,805,903,424	1,805,532,417	1,823,264,235
Change in VHT	-	112	2,168	-	39,312	760,968
Change in VMT	-	-1,057	49,461	-	-371,007	17,360,811

Daily Values are multiplied by 351 (not 365) to arrive at annual values.
This was done based on the relationship between the Vtrans annual VMT number and the value generated by the traffic model.