HAMILTON ROAD EAST-WEST CONNECTION BENEFIT COST ANALYSIS

City of Bloomington Illinois

Jewel of Midwest Cities

Hanson Professional Services performed a Benefit Cost Analysis (BCA) for the project, which is attached and included in the online appendix available at www.BUILDingBloomington.com. A direct link to the BCA computations file is also available here. The BCA utilizes the Benefit-Cost Analysis Guidance for Discretionary Grant Programs document issued by the Office of the Secretary of the USDOT in January 2020. The spreadsheet provides present value estimates of the project's benefits and costs relative to a no-build baseline. The consultant applied a real discount rate of 7 percent per year to the project's streams of benefits and costs. All costs use a 1.074 percent per year GDP deflator using Appendix B: Sample Calculations[1]. **The Hamilton Road Extension Project's benefit-cost ratio is projected to be 1.63, showing that the benefits of the project outweigh the costs.**

The City of Bloomington uses a citywide Travel Demand Model (TDM), which was built by Hanson Professional Services using Cube and is a standard four -step travel demand model with mode choice removed from the computational process. Mode choice was removed, because so few trips within the region are completed using modes other than vehicles. The city-wide model was built with 2010 socioeconomic data for land use, population, income, and employment type and the most current version of the road network. Attributes for the roadway network include number of lanes, posted speed limit, functional classification, and intersection controls. GIS files illustrating the existing (2010) socioeconomic conditions and modeled existing road network as well as a GIS file with the proposed road network, which includes the Hamilton Road, Bunn Street to Commerce Parkway connection, are available online.

The BCA makes a comparison between the existing condition and proposed condition to show the savings The Rhodes Lane condition in Table 1 is used as the existing condition, because Rhodes Lane is currently open. The Hamilton Road condition the proposed condition, because Hamilton Road is connected and Rhodes Lane is closed with the proposed project.

Table 1: Existing Condition and Proposed Condition

		(D) Total Vehicle Hours	(E) Total Vehicle Miles
(A)	Rhodes Lane	42613	1633389
(B)	Hamilton	42559	1631935
(C)	Change (% Change)	-54 (0%)	-1454 (0%)

(C) = (B) - (A), [(B) - (A)]/(A)

(D) = Total Delay from Citywide Traffic Demand Model in Cube

(E) = Total Vehicles from Citywide Traffic Demand Model in Cube

[1]Office of the Secretary of the United States Department of Transportation. 2020. "Benefit-Cost Analysis Guidance for Discretionary Grant Programs." https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf

Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT) values used for the benefit cost analysis are calculated using a combination of the road (link) length from the road network file and the modeled Average Daily Traffic (ADT) volumes and congested travel speeds for each link as calculated by the Cube model. A standard script within Cube is used to multiply these factors over the city-wide network for a 24-hour period. The multiplication renders the VHT and VMT for the scenarios provided in the benefit-cost analysis. Using the TDM and the variables below, Hanson Professional Services found a **total benefit of $13,739,288** through 2052, as shown in Table 9.

1.1 Primary Economic Benefits

Table 2: Total Benefits Before Inflation and Discount Rate

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
	Existing	Proposed	Project Benefit	Unit Value (Year $)		GDP Deflator	Unit Value (2022 $)	Benefit/ Time	Times/ Year	Annual Project Benefit (2021$)	Annual Project Benefit
Hamilton Road - Bunn to Commerce Improvement										**$918,911.14**	
Delay Reduction Benefits											
Travel Efficiency											
(Miles/Day)	1,633,389	1,631,935	1,454	$0.41	(2018)	1.074	$0.44	$640.23	365	$233,685.76	530,710 Miles
(Hours/Day)	42,613	42,559	54	$16.60	(2018)	1.074	$17.83	$962.70	365	$351,387.11	19,710 Hours
CO2 Emissions *(Metric Tons/Day)*	659.88856	659.30114	0.58742	$1.00	(2018)	1.074	$1.07	$0.63	365	$230.27	214.40665 Metric Tons
NOx Emissions *(Short Tons/Day)*	1.67298	1.67149	0.001	$8,600.00	(2018)	1.074	$9,236.12	$13.75	365	$5,020.50	0.54357 Short Tons
PM Emissions *(Short Tons/Day)*	0.05187	0.05182	0.00005	$387,300.00	(2018)	1.074	$415,947.59	$19.20	365	$7,009.51	0.01685 Short Tons
Safety Benefits											
Property Damage Only Crashes *(Crashes/Year)*	7.33	4.80	2.53	$4,400.00	(2018)	1.074	$4,725.46	$11,963.09	1	$11,963.09	2.53 Crashes
Injury/Fatality Crashes *(Crashes/Year)*	3.03	1.88	1.15	$250,600.00	(2018)	1.074	$269,136.24	$309,614.90	1	$309,614.90	1.15 Crashes

(A) = Existing Values, calculations shown elsewhere
(B) = Proposed Values, calculations shown elsewhere
(C) = (A) - (B)
(D) = Unit Values, sources in this document
(E) = Year of Unit Values, sources in this document
(F) = Change in GDP Deflator; Source is BUILD BCA Guidance
(G) = (D) x (F)
(H) = (C) x (G)
(I) = How Many Times the Benefit Can Be Claimed Annually
(J) = (H) x (I)
(K) = (C) x (I)

Source: https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf

1.1.1 Savings for Existing Users and New Users

1.1.1.1 Savings in Travel Time Costs

The BCA uses the recommended monetized values from Table A-3: Value of Travel Time for In-Vehicle Travel – All Purposes Category[2], which is an hourly value of $16.60 in 2018 dollars. Using the TDM referenced above, the consultant calculated total vehicle hours for the project and the no-build scenario. The TDM showed Total Vehicle Hours of 42,613 for the no-build scenario and a value of 42,559 if the project is built. The difference between these numbers shows that the project provides for an additional 54 hours per day, or 19,710 hours per year, in travel efficiency when compared to the no-build scenario. This amounts to an annual project benefit of $351,387.11 in 2021 dollars.

Table A-3: Value of Travel Time Savings

Recommended Monetized Value(s)	
Recommended Hourly Values of Travel Time Savings (2018 U.S. $ per person-hour)	
Category	Hourly Value
In-Vehicle Travel[1]	
Personal[2]	$15.20
Business[3]	$27.10
All Purposes[4]	$16.60

1.1.1.2 Savings in Vehicle Operating Costs

Using Table-A-5: Vehicle Operating recommended monetized values for the Light Duty Vehicles category[2], which has a recommended value per mile of $0.41 in 2018 dollars, the BCA found that the project provides a 4,454 mile-per-day benefit by using the Total Vehicle Miles data calculated for the TDM and subtracting the build scenario from the no-build scenario. The calculations showed that Total Vehicle Miles would be 1,633,389 for the no-build scenario and 1,631,935 if the project is built. The difference between the scenarios amounts to a 530,710 mile-per-year benefit with annual savings of $233,685.76.

Table A-5: Vehicle Operating Costs

Recommended Monetized Value(s)	
Vehicle Type	Recommended Value per Mile ($2018)
Light Duty Vehicles[1]	$0.41
Commercial Trucks[2]	$0.96

1.1.1.3 Reduced Property Damage Only Crashes and Injury/Fatality Crashes

To calculate the savings in in safety costs for both existing users of the improved facility and new users who may be attracted to it as a result of the project, the consultant calculated the reduction in Property Damage Only (PDO) crashes and Injury/Fatality Crashes using historical crash data at the three involved intersections and crash modification factors for the

[2] Office of the Secretary of the United States Department of Transportation. 2020. "Benefit-Cost Analysis Guidance for Discretionary Grant Programs." https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf

improvements to the intersections that are part of this project. The PDO crash data shows a reduction of 2.53 crashes per year. Using Table A-2: Property Damage Only (PDO) Crashes[2] that shows a recommended monetized value of $4,400 per vehicle in 2018 dollars, the BCA shows an annual savings of $11,955.41. The BCA uses the Injury Crash monetized value of $250,600 in 2018 dollars from Table A-1[3], multiplied by a reduction in 1.15 crashes per year, which amounts to a savings of $308,430.13 per year.

		Annual Crashes	CMFs Applied		Remaining Crashes	Reduced Crashes
Intersection Bunn at Hamilton	Injury	0.33	0.614		0.20	
	PDO	1.33	0.614		0.82	
Roadway Segment	Injury	0.67	0.89	0.564	0.33	
	PDO	0.00	0.89	0.564	0	
Intersection Morrissey at Hamilton	Injury	2.00	0.72	0.922	1.32768	
	PDO	6.00	0.72	0.922	3.98304	
Total	Injury	3.03			1.88	1.15
	PDO	7.33			4.80	2.53

The following assumptions were made:

• The existing crashes at Rhodes and Morrissey were reduced assuming the traffic would move to the signalized intersection at Hamilton and Morrissey. A CMF from the Highway Safety Manual for switching from a stop controlled intersection to a signal was applied.

· Hamilton Road will have curb and gutter which will reduce crashes from the no shouldered Rhodes Road. A CMF from the clearinghouse was applied (http://www.cmfclearinghouse.org/detail.cfm?facid=2375)

• The intersection at Bunn and Hamilton would become signalized

• The Morrissey Rail crossing and Hamilton Road crossing would both have gates installed

• Traffic volumes for the proposed Morrissey Crossing and Hamilton Crossing were pulled from the 2035 TDM and reduced backward at 3% to the 10 year ADT required for the IDOT BLR Expected Crash Frequency Equation

• Expected Rail Crossing Crashes would result in an injury or fatality.

• Cost of Crashes from Highway Safety Manual Appendix

• CMFs are from the Crash Modification Factors Clearinghouse

• An HSM-level crash analysis was completed and done with information provided by the Illinois Department of Transportation and using the CMF from the HSM and Clearing House

• The crash data is from 2009 to 2014, but, since the road network has not changed, the crash reductions would still apply, since we are using the CMF

[3] Office of the Secretary of the United States Department of Transportation. 2020. "Benefit-Cost Analysis Guidance for Discretionary Grant Programs." https://www.transportation.gov/sites/dot.gov/files/2020-01/benefit-cost-analysis-guidance-2020_0.pdf

Condition	Rhodes	New Hamilton Rd	CMF	Source
Roadside Element	Two-Lanes	TWLTL	0.564	CMF 9418
Roadside Element	No Shoulder	Curb and Gutter	0.89	CMF 2375
Intersection - Bunn	Stop Control	Signal	0.614	CMF 7982
Intersection - Morrissey	1 Signal Head	1 per lane	0.72	CMF 1414
Intersection - Morrissey	P/P	FYA	0.922	CMF 4176

Table A-2: Property Damage Only (PDO) Crashes

Recommended Monetized Value(s)
$4,400 per vehicle ($2018)

Table A-1: Value of Reduced Fatalities and Injuries

Recommended Monetized Value(s)

Crash Type	Monetized Value ($2018)
Injury Crash	$250,600
Fatal Crash	$10,636,600

Table 3: Bunn at Hamilton Crash Data from Illinois Department of Transportation

KA			
N/A			
BC			
201001057540	2010	B-Non-incapacitating injury crash	5-Overturned
PDO 2009			
200901045145	2009	0-Property damage crash	11-Rear end
200901283836	2009	0-Property damage crash	10-Turning
PDO 2010			
N/A			
PDO 2009			
200901045145	2009	0-Property damage crash	11-Rear end
200901283836	2009	0-Property damage crash	10-Turning
	Total	**3-Year Average (2009-2011)**	
KA	0	0	
B	1	0.333333333	
C	0	0	
PDO	4	1.333333333	

Table 4: Roadway Segment Crash Data from Illinois Department of Transportation

KA			
201101328751	2011	A-Incapacitating injury crash	11-Rear end
BC			
200901283728	2009	C-Injury reported, not evident crash	11-Rear end
PDO 2009			
N/A			
PDO 2010			
N/A			
PDO 2011			
N/A			
	Total	**3-Year Average (2009-2011)**	
KA	1	0.333333333	
B	0	0	
C	1	0.333333333	
PDO	0	0	

Table 5: Morrissey at Hamilton Crash Data from Illinois Department of Transportation

2011			
20110971	6/15/2011	Rear End	
20111405	8/31/2011	Rear End	
20111498	9/15/2011	Rear End	
20111540	9/26/2011	Rear End	B
20112045	12/16/2011	Angle	
2012			
20120075	1/9/2012	Turning	C
20120311	2/24/2012	Angle	
20120702	5/14/2012	Turning	B
20120749	5/23/2012	Angle	
20120864	6/12/2012	Angle	A
20120960	6/19/2012	Rear End	
20121010	7/10/2012	Angle	
20121260	8/21/2012	Angle	
20121373	8/24/2012	Fixed Object	
2013			
20130715	4/26/2013	Turning	
20131213	7/22/2013	Rear End	
20131330	8/13/2013	Sideswipe Same	

20131382	8/22/2013	Rear End	
10131523	9/16/2013	Angle	
20131696	10/16/2013	Rear End	
20131090	7/1/2013	Turning	A
2014			
20140083	1/13/2014	Angle	B
20140364	2/18/2014	Angle	
20140427	2/25/2014	Angle	
	Total	**3-Year Average (Jun 2011 to Feb 2011)**	
A	2	0.666666667	
B	3	1	
C	1	0.333333333	
PDO	18	6	

Table 6: Rail Crossing Data

		A		B	T	A x B x T	Total	
	ADT 20	**Factor**	**Components**	**Factor**	**Trains/Day**	**Expected Crash Frequency**	**Expected Crashes**	**Reduced Crashes/Year**
Morrissey Crossing - Existing	23667	0.029051	Flashing Lights, Urban	0.23	5	0.03340865		
							0.03340865	
Morrissey Crossing - Proposed	18878	0.021736	Gates, Urban	0.08	5	0.0086944		
Hamilton Crossing - Proposed	17100	0.021736	Gates, Urban	0.08	5	0.0086944		
							0.0173888	0.01601985

	ADT 2035	3% ADT 2024
Morrissey Crossing - Existing	32760	23667
Morrissey Crossing - Proposed	26132	18878
Hamilton Crossing - Proposed	23671	17100

1.1.1.4 Reduced Damage from Carbon Dioxide Emissions

The BCA calculated reduced damage from Carbon Dioxide emissions by first calculating the amount of carbon dioxide that would be emitted in the no-build scenario and the build scenario using Total Vehicle Miles from the TDM discussed above. According to the United States Environmental Protection agency, 404 grams of CO_2 are emitted by the average passenger vehicle per mile.[4] Using the difference of 530,710 miles per year, and making the conversion to metric tons, and multiplying by the recommended monetized value from Table A-7, the BCA shows an annual project benefit of $230.27 per year.

[4]United States Environmental Protection Agency. 2018. "Greenhouse Gas Emissions from a Typical Passenger Vehicle." https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle.

Table A-7: Social Cost of Carbon (SCC) per metric ton of CO_2

Recommended Monetized Value(s)

Year	SCC ($2018)
2017	$1
2020	$1
2025	$1
2030	$1
2035	$2
2040	$2
2045	$2
2050	$2

1.1.1.5 Reduced Damage from Nitrogen Oxides Emissions

To calculate the reduced damage from Nitrogen Oxides, the BCA uses the calculated grams per mile of Nitrogen Oxides that would be emitted per mile (approximately 0.929 for Average Emissions Per Vehicle, Gasoline and Diesel Fleet for 2018), according to the US Department of Transportation's Bureau of Transportation Statistics.[5] Using the 530,710-mile difference between the no-build scenario and the build scenario, and making the conversion to short tons, the calculation uses the recommended monetized value from Table A-6 and shows an annual project benefit of $5,020.50.

Table A-6: Damage Costs for Pollutant Emissions

Recommended Monetized Value(s)

Emission Type	$ / short ton* ($2018)
Carbon dioxide (CO_2)	**
Volatile Organic Compounds (VOCs)	$2,100
Nitrogen oxides (NOx)	$8,600
Particulate matter ($PM_{2.5}$)	$387,300
Sulfur dioxide (SO_2)	$50,100

1.1.1.6 Reduced Damage from Particulate Matter Emissions

Similarly, the BCA uses the average of approximately 0.029 grams per mile of Particulate Matter emissions per vehicle (Gasoline and Diesel Fleet for 2018) according to the Bureau of Transportation Statistics[5] Making the conversion to short tons and multiplying it by the 530,710-mile difference between the no-build scenario and the build scenario, and calculating with the recommended monetized value from Table A-6 the calculation shows an annual project benefit of $7,009.51.

1.1.2 Costs of Developing, Constructing, Operating, and Maintaining the Project

As part of Phase I engineering, City engineers produced the following estimates of cost (Table 5) with Hanson Professional Services.

[5] United States Department of Transportation Bureau of Transportation Statistics. 2018. "National Transportation Statistics 2018 4th Quarter" https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/national-transportation-statistics/223001/ntsentire2018q4.pdf

Table 7: Costs of Constructing the Project

Category	Cost
Traffic Signals	$300,000
Storm Sewer	$700,000
Water Main	$250,000
Roadway	$5,500,000
Grade Crossing	$1,000,000
Total	**$7,750,000**

The schedule for costs and costs of maintaining the project are shown in Table 11 and Table 12 attached BCA. Hanson Professional Services calculated maintenance costs by using average unit costs for Class B patches, 2.5-inch surface removal, 2.5-inch HMA overlay, and assuming no crack filling, five percent patching done with mill and fill, with mill and fill every 12 years, and approximately 4,528 tons for an HMA overlay. Using the GDP Deflator and the 7% discounted rate, the **total maintenance costs through 2052 are $664,575**.

Table 8: Maintenance Costs

Pavement Year	BUILD Timeline Year	Calender Year	Maintenance
	0	2020	
	1	2021	
0	2	2022	
1	3	2023	
2	4	2024	
3	5	2025	
4	6	2026	
5	7	2027	
6	8	2028	
7	9	2029	
8	10	2030	
9	11	2031	
10	12	2032	
11	13	2033	
12	14	2034	$ 1,135,329.00
13	15	2035	
14	16	2036	
15	17	2037	
16	18	2038	
17	19	2039	
18	20	2040	
19	21	2041	
20	22	2042	
21	23	2043	
22	24	2044	

23	25	2045	
24	26	2046	$ 1,135,329.00
25	27	2047	
26	28	2048	
27	29	2049	
28	30	2050	
29	31	2051	
30	32	2052	
31	33	2053	
32	34	2054	
33	35	2055	$ 1,135,329.00
34	36	2056	
35	37	2057	
36	38	2058	
37	39	2059	
38	40	2060	
39	41	2061	
40	42	2062	

Pavement Amount		32345.55556	sq. yd.
Class B Patches Unit Cost	$	150.00	/ sq. yd.
Surface Removal, 2.5"	$	8.00	/ sq. yd.
2.5" HMA Overlay		4528.377778	tons
2.5" HMA Overlay	$	140.00	/ ton

The following assumptions were made:

- No crack filling
- 5% patching done with Mill/Fill
- Mill/Fill 12 year @ $140/ton
- Do NOT use BUILD to Pay for Land Acq

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
		2021 $		1.8 % Inflation		7% Discounted	
Year	Calendar Year	Benefits	Costs	Benefits	Costs	Benefits	Costs
0	2021	$ -	$ 4,000,000	$ -	$ 4,000,000	$ -	$ 4,000,000
1	2022	$ -	$ 3,750,000	$ -	$ 3,750,000	$ -	$ 3,750,000
2	2023	$ 918,911	$ -	$ 935,452	$ -	$ 874,254	$ -
4	2024	$ 918,911	$ -	$ 969,431	$ -	$ 791,344	$ -
5	2025	$ 918,911	$ -	$ 986,881	$ -	$ 752,887	$ -
6	2026	$ 918,911	$ -	$ 1,004,644	$ -	$ 716,298	$ -
7	2027	$ 918,911	$ -	$ 1,022,728	$ -	$ 681,487	$ -
8	2028	$ 918,911	$ -	$ 1,041,137	$ -	$ 648,368	$ -
9	2029	$ 918,911	$ -	$ 1,059,878	$ -	$ 616,858	$ -
10	2030	$ 918,911	$ -	$ 1,078,955	$ -	$ 586,880	$ -
11	2031	$ 918,911	$ -	$ 1,098,377	$ -	$ 558,359	$ -
12	2032	$ 918,911	$ -	$ 1,118,147	$ -	$ 531,224	$ -
13	2033	$ 918,911	$ -	$ 1,138,274	$ -	$ 505,407	$ -
14	2034	$ 918,911	$ 1,135,329	$ 1,158,763	$ 1,175,718	$ 480,845	$ 455,964
15	2035	$ 918,911	$ -	$ 1,179,621	$ -	$ 457,477	$ -
16	2036	$ 918,911	$ -	$ 1,200,854	$ -	$ 435,245	$ -
17	2037	$ 918,911	$ -	$ 1,222,469	$ -	$ 414,093	$ -
18	2038	$ 918,911	$ -	$ 1,244,474	$ -	$ 393,969	$ -
19	2039	$ 918,911	$ -	$ 1,266,874	$ -	$ 374,822	$ -
20	2040	$ 918,911	$ -	$ 1,289,678	$ -	$ 356,607	$ -
21	2041	$ 918,911	$ -	$ 1,312,892	$ -	$ 339,276	$ -
22	2042	$ 918,911	$ -	$ 1,336,524	$ -	$ 322,788	$ -
23	2043	$ 918,911	$ -	$ 1,360,582	$ -	$ 307,101	$ -
24	2044	$ 918,911	$ -	$ 1,385,072	$ -	$ 292,177	$ -
25	2045	$ 918,911	$ -	$ 1,410,003	$ -	$ 277,977	$ -
26	2046	$ 918,911	$ 1,135,329	$ 1,435,384	$ 1,211,478	$ 264,468	$ 208,611
27	2047	$ 918,911	$ -	$ 1,461,220	$ -	$ 251,616	$ -
28	2048	$ 918,911	$ -	$ 1,487,522	$ -	$ 239,388	$ -
29	2049	$ 918,911	$ -	$ 1,514,298	$ -	$ 227,754	$ -
30	2050	$ 918,911	$ -	$ 1,541,555	$ -	$ 216,685	$ -
31	2051	$ 918,911	$ -	$ 1,569,303	$ -	$ 206,155	$ -
32	2052	$ 918,911	$ -	$ 1,597,551	$ -	$ 196,136	$ -
Residual Life		$ 1,974,024		$ 3,431,891		$ 421,344	
Total						**$ 13,739,288**	**$ 8,414,575**
Benefit Cost Ratio						**1.63**	

(C) = Annual Benefit

(D) = Construction Costs in 2021 $

(E) = (C) x $1.018^{(A-1)}$, total annual benefit with a 1.8% annual inflation

(D) = Cost Already Include Inflation Contigency

(G) = (E)/($1.07^{(A-1)}$)

(H) = (F)/($1.07^{(A-1)}$)

Benefit Cost Ratio = Total (G)/Total (H)

Useful Service Life = 30 years for initial Construction

Useful Service Life = 12 years for maintenance

Table 9: Project Benefits, Costs of Maintaining the Project, and Schedule for Benefits and Costs