Webster Street Reconstruction

HGAC ID - #1230

Benefit-Cost Analysis
August 2024

midtown HOUSTON

The 2024 USDOT Benefit-Cost Analysis (BCA) Guidance for Discretionary Grant Programs forms the basis for the methodologies employed to estimate quantified and, subsequently, monetized benefits for the Webster Street Reconstruction project.[1] The evaluation process examines the fundamental question of whether the anticipated societal benefits of the project justify the associated costs, acknowledging the inherent difficulty in quantifying some benefits and costs. This analysis examines how the No-Build and Build Scenarios enhance societal benefits over the planning horizon.

This BCA analysis quantifies the net difference between the No-Build and Build Scenarios for the Webster Street Reconstruction Project ("Project"). The project limits are detailed in Table 1.

Table 1. Project Limits

Street	Terminus A	Terminus B
Webster Street	Matthews Street	Hamilton Street

BCA Result Summary

Benefits and costs in real dollars and discounted real dollars are shown in the table below. The benefit-cost ratio is 3.6 in 2022 real dollars and 2.8 when discounted at 3.1%.

Table 2. BCA Summary

Scenario	$2022 Real Dollars	$2022 Real Dollars 3.1% Discount
Benefits	$100,267,000	$68,946,000
Costs	$28,232,000	$24,824,000
BCA	3.6	2.8

BCA Methodology and Foundations to BCA

The baseline (No-Build) and Build methodology and calculations for each benefit are contained within this technical memorandum, supported by the BCA Excel Workbook. The calculation is based on the following methodologies and general assumptions.

Real Dollars & Discount Rate

All monetized values in the analysis are standardized to 2022 (real dollars). Costs from previous years were adjusted using a 2.79% annual inflation factor, derived from Table A-7 of the 2024 USDOT BCA Guide, to **reflect real dollars in 2022**.[1] The final present-value estimates in this **Benefit-Cost Analysis (BCA) utilized a 3.1% discount rate** recommended by OMB Circular A-94 for both benefits and costs. Real dollars, also known as inflation-free or constant dollars, allow for consistent comparisons over time by negating the effects of inflation.

1 United States Department of Transportation (2024). Benefit-Cost Analysis Guidance for Discretionary Grant Programs. Retrieved January 2024 from https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0

Summarized Costs

The costs for the Project in the year of expenditure amount to $31,721,000 (nominal dollars). Applying an annual inflation factor of 2.79%, the costs were discounted from the expenditure year to reflect real dollars in 2022. Consequently, the total project cost in 2022 real dollars is $28,232,000. These costs are discounted at 3.1% from the expenditure year to 2022, resulting in total discounted costs of $24,824,000.

Table 3. Project Costs

Cost	Nominal $ Year of Expenditure No Discount	Real $ $2022 No Discount	3.1% Discount $2022
Planning	$26,000	$25,000	$24,000
Design/Environmental	$4,110,000	$3,836,000	$3,555,000
Construction	$27,585,000	$24,371,000	$21,245,000
Project Costs	$31,721,000	$28,232,000	$24,824,000

Planning Horizon

The planning horizon spans from 2022 to 2047, initiating from the project's planning phase. The Project is expected to begin operations in 2027, with a projected 20-year operating period. Consequently, benefits are quantified over the 20-year period from 2027 to 2047.

No-Build Scenario

The No-Build scenario assumes minimal planned improvements to the project corridor's roadway. It considers factors such as future changes in traffic volumes and routine maintenance that would occur irrespective of the proposed project.

Build Scenario

The Build scenario assumes a complete reconstruction of the roadway, from Matthews Street to Hamilton Street, that includes pavement improvement, stormwater, sanitary sewer, and water supply lines. Emphasizing pedestrian safety and accessibility, the project includes upgrading sidewalks to 8 feet wide where applicable, alongside improvement to curb and gutter and inlets for effective stormwater management. ADA ramps will be improved to ensure accessibility compliance, and the installation of pavement markings and high-visibility crosswalks will create a safer environment for pedestrians, cyclists, and motorists.

Major Key Data Points

To measure the economic value of outcomes to be achieved by a project, several key data points are used throughout the analysis.

Annual Average Daily Traffic

Current and future vehicle daily volumes are obtained from the Texas Department of Transportation (TxDOT) Statewide Planning Map.[2]

Table 4. Average Daily Traffic Volume

Segment	2022	2047	CAGR
Matthews to Brazos	6,360	9,685	1.70%
Brazos to Milam	6,360	9,685	1.70%
Milam to Main	6,360	9,685	1.70%
Main to La Branch	3,874	5,900	1.70%
La Branch to Hamilton	6,175	9,404	1.70%

Daily Vehicle Miles Traveled

Vehicle miles traveled are calculated by multiplying the daily AADT by the length of the project corridor.

Table 5. Average Daily Vehicle Miles Traveled (**Without** Modal Diversion)

Segment	Corridor Length Miles	2022	2047
Matthews to Brazos	0.35	2,212	3,368
Brazos to Milam	0.37	2,360	3,594
Milam to Main	0.34	2,158	3,286
Main to La Branch	0.35	1,349	2,054
La Branch to Hamilton	0.70	4,305	6,556

Daily Vehicle Miles Traveled with Modal Diversion

The benefits of active transportation improvements of the Project are mostly derived from the new projected walking and cycling trips diverted from automobile usage. New daily induced trips are gathered from the Activity-Connectivity Explorer (ACE) Advance viewer interactive web app on H-GAC website. The induced daily trips are multiplied by the average pedestrian trip length (0.93) pedestrian facility length to estimate the VMT reduction derived from modal diversion.

Table 6. Daily VMT Reduced by Modal Diversion

Mode	Daily Induced Demand 2028	Daily Induced Demand 2047	Daily VMT Reduced 2028	Daily VMT Reduced 2047
Pedestrian	52	72	49	67

[2] TxDOT – Statewide Planning Map. Accessed on March 2024, from https://www.txdot.gov/apps/statewide_mapping/StatewidePlanningMap.html

Table 7. Average Daily Vehicle Miles Traveled (**With** Modal Diversion)

Segment	Corridor Length Miles	2028	2047
Matthews to Brazos	0.35	2,397	3,301
Brazos to Milam	0.37	2,561	3,527
Milam to Main	0.34	2,338	3,219
Main to La Branch	0.35	1,443	1,987
La Branch to Hamilton	0.70	4,713	6,489

Project Specific Monetized Benefits

The 2024 USDOT BCA guidance provides guidance on an array of benefits that can be monetized using parameters provided by the USDOT. Proceeding with the **Build** scenario will yield the following monetizable societal benefits; however, there are also associated disbenefits with the project, as explained below:

Benefit 1: Remaining Useful Life of Asset

The asset is expected to have a 50-year useful life. After 20 years of operation, 60% of its useful life will remain at the end of the planning horizon.

Table 8. Useful Life Monetized Benefits

Useful Life Calculation	No Build	Build
Construction Cost	$0	$24,371,000
(x) Remaining Life at End of Planning Horizon		60%
Total in Real $	$0	*$14,622,000*
Total Monetized Benefit Real $	**$14,622,000**	
Total Monetized Benefit Discounted @ 3.1%	**$6,816,000**	

Benefit 2: State of Good Repair

Maintenance and user costs associated with the condition of a roadway's surface are significant factors in the decision to continue with the current pavement or to replace it. The capital expenditure required for a reconstruction project may make economic sense if it saves money over the planning horizon. Demonstrating a roadway's current surface condition, or state of good repair (SOGR), and projecting the costs and benefits for alternative maintenance strategies will provide the information needed to make this decision.

Table 9. State of Good Repair Monetized Benefits

State of Good Repair Calculation	No Build	Build
On-Going Maintenance Cost	$362,800	$64,700
Rehab Cost	$3,487,800	$0
Residual Life of Rehab	($937,200)	$0
User Costs (Value of Travel Time)	$1,241,100	$0
Vehicle Wear and Tear	$633,800	$43,300
Total in Real $	$4,788,200	$108,000
Total Monetized Benefit Real $	**$4,680,300**	
Total Monetized Benefit Discounted @ 3.1 %	**$3,359,700**	

Benefit 3: Safety Improvements

The analysis uses the average number of crashes by type over the last 5 years (2019-2023) from TxDOT Crash Record Information System (CRIS) database. The appropriate reduction factor was given by TxDOT based on the 2022 TxDOT Highway Safety Improvement Program (HSIP) work codes, and the damages avoided are quantified using USDOT parameters by injury type.[3] A crash can only be assigned to one work code. If multiple work codes are applicable to one crash, the work code with the highest crash reduction rate will be assigned to that crash. For the Project, crashes and corresponding injuries were assigned to codes listed in tables below.

Table 10. Roadway Related Crashes - Injury Data (5-Year Average)

Injury	First Harmful Event - Auto					
	2018	2019	2020	2021	2022	Average (No-Build)
Non-Injury	195	119	167	190	166	*167.4*
Possible Injury	25	10	24	28	25	*22.4*
Non-Incap. Injury	12	3	5	24	6	*10.0*
Serious Injury	0	0	3	5	4	*2.4*
Fatality	0	0	0	0	1	*0.2*
Unknown Injury	29	11	18	32	18	*21.6*

3 Texas Department of Transportation (2022). Highway Safety Improvement Manual. Retrieved August 2022 from https://www.txdot.gov/inside-txdot/forms-publications/publications/highway-safety.html

Table 11. Roadway Countermeasure #1 - 101, 303 Install Warning/Guide Signs, Resurfacing

Injury	Roadway Countermeasure #1 - 101, 303 Install Warning/Guide Signs, Resurfacing Reduction Factor: 44% Service Life: 10 Years						
	2018	2019	2020	2021	2022	Average (No-Build)	Average (Build)
Non-Injury	0	1	0	4	0	*1.0*	*0.6*
Possible Injury	0	0	0	2	0	*0.4*	*0.2*
Non-Incap. Injury	0	0	0	0	0	*0.0*	*0.0*
Serious Injury	0	0	0	0	0	*0.0*	*0.0*
Fatality	0	0	0	0	1	*0.2*	*0.1*
Unknown Injury	2	1	1	1	0	*1.0*	*0.6*

Table 12. Roadway Countermeasure #2 - 303, 401 Resurfacing, Install Pavement Markings

Injury	Roadway Countermeasure #2 - 303, 401 Resurfacing, Install Pavement Markings Reduction Factor: 50% Service Life: 10 Years						
	2018	2019	2020	2021	2022	Average (No-Build)	Average (Build)
Non-Injury	195	118	167	186	166	*166.4*	*83.2*
Possible Injury	25	10	24	26	25	*22.0*	*11.0*
Non-Incap. Injury	12	3	5	24	6	*10.0*	*5.0*
Serious Injury	0	0	3	5	4	*2.4*	*1.2*
Fatality	0	0	0	0	0	*0.0*	*0.0*
Unknown Injury	27	10	17	31	18	*20.6*	*10.3*

Table 13. Pedestrian Related Crashes - Injury Data (5-Year Average)

Injury	First Harmful Event – Pedestrian					
	2018	2019	2020	2021	2022	Average (No-Build)
Non-Injury	3	1	0	3	1	*1.6*
Possible Injury	3	1	0	0	1	*1.0*
Non-Incap. Injury	0	1	0	3	0	*0.8*
Serious Injury	0	0	0	0	0	*0.0*
Fatality	0	0	0	0	0	*0.0*
Unknown Injury	1	1	0	0	0	*0.4*

Table 14. Pedestrian Countermeasure #1 - 303, 401 Resurfacing, Install Pavement Markings

Injury	Pedestrian Countermeasure #1 - 303, 401 Resurfacing, Install Pavement Markings Reduction Factor: 50% Service Life: 10 Years						
	2018	2019	2020	2021	2022	Average (No-Build)	Average (Build)
Non-Injury	3	1	0	3	1	*1.6*	*0.8*
Possible Injury	3	1	0	0	1	*1.0*	*0.5*
Non-Incap. Injury	0	1	0	3	0	*0.8*	*0.4*
Serious Injury	0	0	0	0	0	*0.0*	*0.0*
Fatality	0	0	0	0	0	*0.0*	*0.0*
Unknown Injury	1	1	0	0	0	*0.4*	*0.2*

Table 15. Safety - Auto Monetized Benefits

Safety - Auto Monetized Benefits	No Build	Build
Countermeasure #1 - 101, 303 Install Warning/Guide Signs, Resurfacing	$5,988,600	$3,353,600
Countermeasure #2 - 303, 401 Resurfacing, Install Pavement Markings	$130,509,600	$65,254,800
Total in Real $	*$136,498,200*	*$68,608,400*
Total Monetized Benefit Real $	**$67,890,000**	
Total Monetized Benefit Discounted @ 3.1%	**$49,460,000**	

Table 16. Safety – Pedestrian Monetized Benefits

Safety – Pedestrian Monetized Benefits	No Build	Build
Countermeasure #1 - 303, 401 Resurfacing, Install Pavement Markings	$39,198,000	$19,599,000
Total in Real $	*$39,198,000*	*$19,599,000*
Total Monetized Benefit Real $	**$19,599,000**	
Total Monetized Benefit Discounted @ 3.1%	**$14,279,000**	

Table 17. Safety – Total Benefits

Safety – Total Benefits	No Build	Build
Auto	$136,498,200	$68,608,400
Pedestrian	$39,198,000	$19,599,000
Total in Real $	$175,696,200	$88,207,400
Total Monetized Benefit Real $	**$87,489,000**	
Total Monetized Benefit Discounted @ 3.1%	**$63,739,000**	

Benefit 4: Emissions

The Project will install new sidewalks that can accommodate both pedestrians and bicyclists, these amenities will result in modal shift with a reduction in overall VMT.

H-GAC models NOx using the following emissions factor:

- Nitrogen Oxides (NO_X): 0.19 grams (g) per VMT

United Environmental Protection Agency (EPA) uses the following emissions factor for CO_2:[4]

- Carbon Dioxide (CO_2): 0.0089 metric tons per gallon of gasoline used.

NOx and CO_2 have measurable societal economic impacts on the economy. The 2023 USDOT BCA Guide provides recommended monetized values of damage costs for NOx and CO_2 emissions per metric ton by year between 2022 and 2050. These values are used to calculate the Project's benefit derived from the reduction of harmful air pollutants.

Table 18. Emission Benefits

Emission Calculation	No Build	Build
Nitrogen Oxides (NO_X)	$100	$0
Carbon Dioxide (CO_2)	$23,800	$0
Total in Real $	*$23,800*	*$0*
Total Monetized Benefit Real $	**$24,000**	
Total Monetized Benefit Discounted @ 3.1%	**$15,000**	

4 Environmental Protection Agency. (n.d.). EPA. Retrieved April 2024, from https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

Benefit 5: Facility Improvements

Improvements to pedestrian, cycling, transit facilities, and transit vehicles often provide amenities that can improve the quality and comfort of journeys made by active transportation (e.g., cyclists and pedestrians) and public transportation users. The improvements will not only benefit the existing users, but also encourage more people walking, biking, and using public transit. Major Key Data Points section on page 3. The 2023 USDOT BCA Guidance provides recommended monetized values for facility improvement benefits based on research on system users' preferences.

Sidewalk Expansion Benefit = $0.11 * Added Width (foot) * (½ New Walking Trips) * Trip Length
Trip Length = Proposed Length of Expanded Sidewalk or 0.86 Miles (whichever is smaller)

Cycling Facility Improvement Benefit = Value per Cycling Mile * (½ New Cycling Trips) * Trip Length
Trip Length = Proposed Cycling Facility Length or 2.38 Miles (whichever is smaller)

Table 19. Facility Improvements Benefits

Facility Improvements Calculation	No Build	Build
Pedestrian Facility	$0	$85,000
Total in Real $	*$0*	*$85,000*
Total Monetized Benefit Real $	**$85,000**	
Total Monetized Benefit Discounted @ 3.1%	**$53,000**	

Benefit 6: Mortality Reduction

To monetize the reduction in mortality risks associated with increased walking, the 2023 USDOT BCA Guide recommends $7.20 ($2021) per induced walking trip. This is based on the following factors: an assumed average walking speed of 3.2 miles per hour, an assumed average age of the relevant age range (20-74 years) of 45, a corresponding baseline mortality risk of 267.1 per 100,000, an annual risk reduction of 8.6 percent per daily mile walked, and an average walking trip distance of 0.86 miles. This monetized value can only be applied to trips induced from non-active transportation modes within the relevant age range. A general assumption of 68% of overall induced trips falling into the walking age range (20-74 years), assuming a distribution matching the national average, is applied in the absence of more localized data on the proportion of the expected users falling into the age range.

Mortality Reduction Benefits = Number of New Walking Trips Induced from Non-Active Transportation Modes * 68% * $7.20

The 2023 USDOT BCA Guide recommends $6.42 ($2021) per induced cycling trip to monetize reduced mortality risks associated with increased cycling. It is based on an assumed average cycling speed of 9.8 miles per hour, an assumed average age of the relevant age range (20-64 years) of 42, a corresponding baseline mortality risk of 217.9 per 100,000, an annual risk reduction of 4.3 percent per daily mile cycled, and an average cycling trip distance of 2.38 miles. This monetization value can only be applied to trips induced from non-active transportation modes within the relevant age ranges. A general assumption of 59% of overall induced trips falling into the cycling age range (20-64 years), assuming a

distribution matching the national average, is applied in the absence of more localized data on the proportion of the expected users falling into the age range.

Mortality Reduction Benefits = Number of New Cycling Trips Induced from Non-Active Transportation Modes * 59% * $6.42

Table 20. Mortality Reduction Monetized Benefits

Mortality Reduction Calculation	No Build	Build
Pedestrian Facility	$0	$1,661,000
Total in Real $	*$0*	*$1,661,000*
Total Monetized Benefit Real $	**$1,661,000**	
Total Monetized Benefit Discounted @ 3.1%	**$1,033,000**	

Benefit 7: Other Externalities

The 2023 USDOT BCA Guide provides recommended monetized values for external highway use costs. The recommended costs per vehicle mile traveled including all kinds of vehicles in urban locations are $0.144 for congestion and $0.0048 for noise.

Other Externalities Reduction = VMT * ($0.144+$0.0048)
VMT = Vehicle Miles Traveled Reduced because of Modal Diversion

Table 21. Other Externalities Monetized Benefits

Other Externalities Calculation	No Build	Build
Congestion Externality	$0	$42,400
Noise Externality	$0	$1,400
Total in Real $	*$0*	*$44,000*
Total Monetized Benefit Real $	**$44,000**	
Total Monetized Benefit Discounted @ 3.1%	**$27,000**	

Summary of Benefits and Costs

The table below summarizes the Project benefits detailed above.

Table 22. Project Benefits Summary

Benefit #	Benefit Name	Current Status/Baseline and Problem to be Addressed	Change to Baseline or Alternatives	Types of Impacts	$2022 Monetized Value	$2022 Real Dollars 3.1% Discount Rate
1	Remaining Useful Life of Asset	The current asset has 0% remaining useful life	Replace infrastructure within public right-of-way	Extend useful life	$14,622,000	$6,816,000
2	State of Good Repair	Ongoing expensive maintenance of roadway pavement	Low maintenance required of new facility through the planning horizon	Maintenance cost savings	$4,680,000	$3,360,000
3	Safety Benefits	Outdated design, disproportionally higher crash rates	Safety improvement resulting in reduction in traffic crashes	Reduced crashes resulting in reduced fatalities and injuries	$79,150,000	$57,641,000
6	Emissions Reduction	The current facilities are not conducive for active transportation or using transit	Improvements to the existing facilities will induce demand for walking, cycling, and taking transit	Reduced emission derived from modal shift from driving personal vehicles to walking, biking, and taking transit	$24,000	$15,000
4	Facility Improvements	The current facilities are not conductive for active transportation or using transit	Improvements to the current facilities will improve the quality or comfort of journeys	Improved comfort for active transportation and public transportation users	$85,000	$53,000
5	Mortality Reduction Benefits	Roadway is not conducive for active transportation.	New and improved active transportation facilities will encourage more walking and cycling	Reduced mortality risks associated with increased walking and cycling	$1,661,000	$1,033,000

Benefit #	Benefit Name	Current Status/Baseline and Problem to be Addressed	Change to Baseline or Alternatives	Types of Impacts	$2022 Monetized Value	$2022 Real Dollars 3.1% Discount Rate
7	Congestion Externalities Reduction	Roadway is not conducive for active transportation.	New and improved facilities will encourage more walking and cycling	Reduced congestion externalities	$44,000	$27,000
Totals					**$100,267,000**	**$68,946,000**