Foster Drive Widening

HGAC ID - #659
Benefit-Cost Analysis
August 2024

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 Airport Road Widening project..[1] The BCA 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 Foster Drive Widening Project ("Project"). The project limits are detailed in Table 1.

Table 1. Project Limits

Street	Terminus A	Terminus B
Foster Drive	N Porter Road	South Frazier 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 5.3 in 2022 real dollars and 3.6 when discounted at 3.1%.

Table 2. BCA Summary

Scenario	$2022 Real Dollars	$2022 Real Dollars 3.1% Discount
Benefits	$158,165,000	$94,220,000
Costs	$29,835,000	$26,203,000
BCA	5.30	3.60

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 $36,294,000 (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 $32,268,000. These costs are discounted at 3.1% from the expenditure year to 2022, resulting in total discounted costs of $28,335,000.

Table 3. Project Costs

Cost	Nominal $ Year of Expenditure No Discount	Real $ $2022 No Discount	3.1% Discount $2022
Planning	$51,000	$53,000	$54,000
Design/Environmental	$4,956,000	$4,564,000	$4,164,000
Construction	$28,545,399	$25,218,900	$21,984,305
Project Costs	$33,553,000	$29,835,000	$26,203,000

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 2028, with a projected 20-year operating period. Consequently, benefits are quantified over the 20-year period from 2028 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 replacement of infrastructure within public ROW along the project limits, which will include the following major components:

- Expand lanes from 2 lanes to 4 lanes
- Convert traffic signal from span wire to mast arm at the intersection of Foster and Porter Rd.
- Convert controlled stop to traffic signal at the intersection of Foster and Frazier.
- Add new 5 feet with ADA-compliant ramps
- Reconstruct the roadway to concrete.
- Install curb and gutter using 24 inches reinforced concrete pipe along the corridor.
- Relocate both above ground and below ground utilities as necessary to avoid obstructions.

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
Foster Drive: From Porter Road to South Frazier Street	3,095	4,620	1.61%

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
Foster Drive: From Porter Road to South Frazier Street	1.63	5,045	7,531

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 of 0.86 mi to estimate the reduction of VMT 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	31	40	27	35
Total	31	40	27	35

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

Segment	Corridor Length Miles	2028	2047
Foster Drive: From Porter Road to South Frazier Street	1.63	5,618	7,496

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

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	$25,218,900
(x) Remaining Life at End of Planning Horizon		60%
Total in Real $	*$0*	*$15,131,000*
Total Monetized Benefit Real $	**$15,131,000**	
Total Monetized Benefit Discounted @ 3.1%	**$7,054,000**	

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	$1,045,000	$1,711,000
Rehab Cost	$5,643,000	$3,783,000
Residual Life of Rehab	($1,840,000)	$0
User Costs (Value of Travel Time)	$2,885,000	$2,887,000
Vehicle Wear and Tear	$766,000	$499,000
Total in Real $	*$8,498,000*	*$3,973,000*
Total Monetized Benefit Real $	**$4,525,000**	
Total Monetized Benefit Discounted @ 3.1%	**$8,193,100**	

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					
	2019	2020	2021	2022	2023	Average (No-Build)
Non-Injury	28	26	32	12	37	27
Possible Injury	12	3	8	5	1	5.8
Non-Incap. Injury	1	7	5	1	4	3.6
Serious Injury	0	0	0	0	0	0
Fatality	0	0	0	0	0	0
Unknown Injury	2	2	6	2	1	2.6

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 - 108, 538 Improve Traffic Signals, Convert 2 Lane Facility to 4 Lane Divided

Injury	Roadway Countermeasure #1 - 108, 538 Improve Traffic Signals, Convert 2 Lane Facility to 4 Lane Divided Reduction Factor: 64% Service Life: 20 Years						
	2019	2020	2021	2022	2023	Average (No-Build)	Average (Build)
Non-Injury	19	15	27	9	24	*18.8*	*6.8*
Possible Injury	11	2	8	5	1	*5.4*	*1.9*
Non-Incap. Injury	1	2	5	1	3	*2.4*	*0.9*
Serious Injury	0	0	0	0	0	*0.0*	*0.0*
Fatality	0	0	0	0	0	*0.0*	*0.0*
Unknown Injury	1	0	3	2	0	*1.2*	*0.4*

Table 12. Roadway Countermeasure #2 - 538 Convert 2 Lane Facility to 4 Lane Divided

Injury	Roadway Countermeasure #2 - 538 Convert 2 Lane Facility to 4 Lane Divided Reduction Factor: 45% Service Life: 20 Years						
	2019	2020	2021	2022	2023	Average (No-Build)	Average (Build)
Non-Injury	9	11	5	3	13	*8.2*	*4.5*
Possible Injury	1	1	0	0	0	*0.4*	*0.2*
Non-Incap. Injury	0	5	0	0	1	*1.2*	*0.7*
Serious Injury	0	0	0	0	0	*0.0*	*0.0*
Fatality	0	0	0	0	0	*0.0*	*0.0*
Unknown Injury	1	2	3	0	1	*1.4*	*0.8*

Table 13. Safety - Auto Monetized Benefits

Safety - Auto Monetized Benefits	No Build	Build
Countermeasure #1 - 517 Add Through Lane	$30,388,000	$10,940,000
Countermeasure #2 - 108, 305 Improve Traffic Signals, Safety Lighting at Intersection	$13,418,000	$7,380,000
Total in Real $	*$43,806,000*	*$18,320,000*
Total Monetized Benefit Real $	**$25,486,000**	
Total Monetized Benefit Discounted @ 3.1%	**$16,125,000**	

Benefit 4: Value of Time

The impact of a project on congestion can be measured through the value of travel time (VoTT) on the network. Travel time has a direct relationship with overall network congestion. The more congested a roadway or network is, the longer the travel time is, thereby increasing person hours traveled. The methodology for determining congestion benefits uses Synchro software to analyze delay reduction at intersections with a micro-level model during the AM and PM peak hour. This method requires collecting the current traffic counts, including pedestrian counts, along the affected roadways and project the future volume under the Build and No-build scenarios. The Synchro analysis shows the operational impacts of the proposed Project, which includes intersection delay (see table below).

Table 14. Delay Seconds Per Vehicle 2025

Delay (Sec/Vehicle) (2025)	No-build		Build	
Intersection	**AM**	**PM**	**AM**	**PM**
Frazier St. & Foster (Convert Stop Controlled to Signal)	**116.4**	**115.7**	**10.8**	**12.2**
Porter & Foster	**40.7**	**46.9**	**11.4**	**15.1**
Ed Kharbat Dr./7th St. & Foster	**11.9**	**10.3**	**10.3**	**9.5**
1st St./1 St. & Foster	**10.0**	**14.4**	**9.4**	**10.8**

Table 15. Delay Seconds Per Vehicle 2045

Delay (Sec/Vehicle) (2045)	No-build		Build	
Intersection	**AM**	**PM**	**AM**	**PM**
Frazier St. & Foster (Convert Stop Controlled to Signal)	**146.2**	**60.9**	**21.6**	**28.3**
Porter & Foster	**465.4**	**531.7**	**13.5**	**27.5**
Ed Kharbat Dr./7th St. & Foster	**26.6**	**72.6**	**14.1**	**16.9**
1st St./1 St. & Foster	**21.2**	**19.7**	**12.8**	**34.4**

The 2023 USDOT BCA Guidance provides recommended hourly values ($2022) of travel time savings for occupants of passenger vehicles ($19.60/person-hour and 1.67 persons per vehicle) and for commercial vehicle operators ($33.50/person-hour). A separate value is provided for reductions in other components or aspects of travel time, including walking, cycling, waiting time, transfer time, and time spent standing in a crowded transit vehicle ($35.80/person-hour). The factors are multiplied by the total

hours of delay experienced by each person derived from the delay seconds per vehicle above (note each vehicle is assumed to have 1.67 persons per vehicle).

Table 16. Value of Time Benefits

Value of Time Calculation	No Build	Build
Auto Vehicles	$64,825,000	$14,532,000
Commercial Vehicles	$2,193,000	$492,000
Total in Real $	*$67,018,000*	*$15,024,000*
Total Monetized Benefit Real $	**$51,995,000**	
Total Monetized Benefit Discounted @ 3.1%	**$30,930,000**	

Benefit 5: 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. Additionally, environmental benefits for auto idling are quantified. Idle emissions are a direct output of the Synchro Model.

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.

Additionally, environmental benefits for auto idling are quantified. Idle emissions are a direct output of the Synchro Model. 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 17. Emission Benefits

Emission Calculation	No Build	Build
Nitrogen Oxides (NO_X)	$3,872,050	$545,010
Carbon Dioxide (CO_2) (Discounted @ 2%)	$35,330,590	$4,773,950
Total in Real $	*$39,202,640*	*$5,319,960*
Total Monetized Benefit Real $	**$33,883,000**	
Total Monetized Benefit Discounted @ 3.1%)	**$22,291,000**	

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

Benefit 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 18. Mortality Reduction Monetized Benefits

Mortality Reduction Calculation	No Build	Build
Pedestrian Facility	$0	$953,000
Total in Real $	$0	$953,000
Total Monetized Benefit Real $	**$953,000**	
Total Monetized Benefit Discounted @ 3.1%	**$595,000**	

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 19. Other Externalities Monetized Benefits

Other Externalities Calculation	No Build	Build
Congestion Externality	$26,230	$3,280
Noise Externality	$870	$110
Total in Real $	*$27,100*	*$3,390*
Total Monetized Benefit Real $	**$24,000**	
Total Monetized Benefit Discounted @ 3.1%	**$15,000**	

Benefit 8: Auto Fuel Consumption

Fuel consumption is modeled through Synchro for the AM and PM peak hours in the No-Build and Build scenarios. The 2021 U.S. Energy Information Administration shows that the fuel cost per gallon in Texas is $2.73. The Texas Comptroller shows the fuel taxes as $0.38.

Total Cost of Fuel = (Fuel Cost per Gallon in Texas – Fuel Taxes) *Daily Gallons of Fuel Consumed * 365

Table 20. Auto Idle Fuel Consumption

Auto Idle Fuel Consumption	No Build	Build
Auto Idle Fuel Consumption	$12,951,900	$2,004,700
Total in Real $	*$30,372,150*	*$4,701,050*
Total Monetized Benefit Real $	**$26,089,000**	
Total Monetized Benefit Discounted @ 3.1%	**$14,253,000**	

Summary of Benefits and Costs

The table below summarizes the Project benefits detailed above.

Table 2121. 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	$15,131,000	$7,054,000
2	State of Good Repair	Ongoing expensive maintenance of roadway pavement	Low maintenance required of new facility through the planning horizon	Maintenance cost savings	$4,525,000	$2,909,000
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	$25,486,000	$16,125,000
4	Value of Travel Time	The current facilities lead to delay of users.	Improvements to the current facilities will reduce delay	Travel time savings	$51,995,000	$30,930,000
5	Emissions Reduction	The current facilities are not conductive for active transportation and create delays with idling	Improvements to the existing facilities will induce demand for walking and biking	Reduced emission derived from modal shift from driving personal vehicles to walking and biking and idling	$33,883,000	$22,291,000
6	Mortality Reduction Benefits	Roadway is not conducive for active transportation.	New and improved active transportation facilities will	Reduced mortality risks associated with	$953,000	$595,000

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
			encourage more walking and cycling	increased walking and cycling		
7	Externalities Reduction	Roadway is not conducive for active transportation.	New and improved facilities will encourage more walking and cycling	Reduced various externalities	$24,000	$15,000
8	Automobile Idling Fuel Consumption	Vehicle idling results in consumption of fuel	Improvements slightly decreases fuel consumption	Increased fuel consumption	$26,089,000	$14,253,000
Totals					**$158,086,000**	**$94,172,000**