

Kirby Drive Extension

HGAC ID - #857

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 in this BCA.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 Kirby Drive Extension (“Project”). The project limits are detailed in Table 1.

Table 1. Project Limits

Street	Terminus A	Terminus B
Kirby Drive Extension	Holmes Road	Beltway 8

BCA Result Summary

Benefits and costs in real dollars and discounted real dollars are shown in the table below. The benefit-cost ratio is 2.04 in 2022 real dollars and 1.34 when discounted at 3.1%.

Table 2. BCA Summary

Scenario	\$2022 Real Dollars	\$2022 Real Dollars 3.1% Discount
Benefits	\$239,785,000	\$132,578,000
Costs	\$117,649,000	\$98,628,000
BCA	2.04	1.34

BCA Methodology and Foundations

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** as 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 \$138,039,000 (nominal dollars). Applying an annual inflation factor of 2.79%, the costs are discounted from the expenditure year to reflect real dollars in 2022. Consequently, the total project cost in 2022 real dollars is \$117,649,000. These costs are discounted at 3.1% from the expenditure year to 2022, resulting in total discounted costs of \$98,628,000.

Table 3. Project Costs

Cost	Nominal \$ Year of Expenditure No Discount	Real \$ \$2022 No Discount	3.1% Discount \$2022
Planning	\$195,000	\$189,000	\$184,000
Design/Environmental	\$10,265,000	\$9,322,000	\$8,378,000
Construction	\$127,579,000	\$108,138,000	\$90,066,000
Project Costs	\$138,039,000	\$117,649,000	\$98,628,000

Planning Horizon

The planning horizon spans from 2022 to 2049, initiating from the project's planning phase. The Project is expected to begin operations in 2030, with a projected 20-year operating period. Consequently, benefits are quantified over the 20-year period from 2030 to 2049.

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 encompasses all of the proposed project. The Kirby Drive Extension (new roadway with shared use path) fulfills the ideals of the 2045 Regional Transportation Plan – the new road segment connects disparate streets, creating a grid network in a rapidly growing area of the region. Once the proposed project is built, Kirby Drive will connect from its current northern terminus inside the 610 loop all the way to the city of Pearland.

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 by adding this new link into the 2024 H-GAC Travel Demand Model and subsequent outputs.²

Table 4. Average Daily Traffic Volume

Segment	2030	2049	CAGR
Kirby Drive Extension	16,787	21,656	1.35%

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	2030	2049
Kirby Drive Extension	5.23	87,799	113,259

Daily Vehicle Miles Traveled with Modal Diversion

The benefits of active transportation improvements of the Project are mostly derived from the projected new walking and cycling trips, diverted from automobile use. 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 national average for pedestrian trips (0.86 national average walking distance) and bike trips (2.36 mi) to estimate the VMT reduction derived from modal diversion.

Table 6. Daily VMT Reduced by Modal Diversion

Mode	Daily Induced Demand 2030	Daily Induced Demand 2049	Daily VMT Reduced 2030	Daily VMT Reduced 2049
Pedestrian	73	101	63	86
Bike	131	180	311	428
Total	204	280	374	514

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

Segment	Corridor Length Miles	2021	2041
Kirby Drive Extension	5.23	87,425	112,745

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:

² H-GAC Travel Demand Model – Conformity Run 2023.

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	\$108,138,000
(x) Remaining Life at End of Planning Horizon		60%
Total in Real \$	\$0	\$64,883,000
Total Monetized Benefit Real \$ (No Build – Build)	\$64,883,000	
Total Monetized Benefit Discounted @ 3.1% (No Build – Build)	\$28,454,000	

Benefit 2: 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 walking, biking, and using public transit. The methodology used to estimate new active or public transportation demand is explained in the Major Key Data Points section on page 3. The 2023 USDOT BCA Guidance provides recommended monetized values for facility improvement benefits based on research of 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 9. Facility Improvements Benefits

Facility Improvements Calculation	No Build	Build
Pedestrian Facility	NA	\$297,000
Bike Facility	NA	\$2,100,000
Total in Real \$	NA	\$2,397,000
Total Monetized Benefit Real \$ (No Build – Build)	\$2,397,000	
Total Monetized Benefit Discounted @ 3.1% (No Build – Build)	\$1,403,000	

Benefit 3: Value of Time

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). The Kirby Drive Extension project will serve as a congestion relief route for US-288 from IH-610 to Beltway-8. As such, the total VMT was examined along this segment between the no build H-GAC Travel Demand Model run and the Build (Kirby Drive Ext. included) H-GAC Travel Demand Model run, as shown below in **Figure 1**.

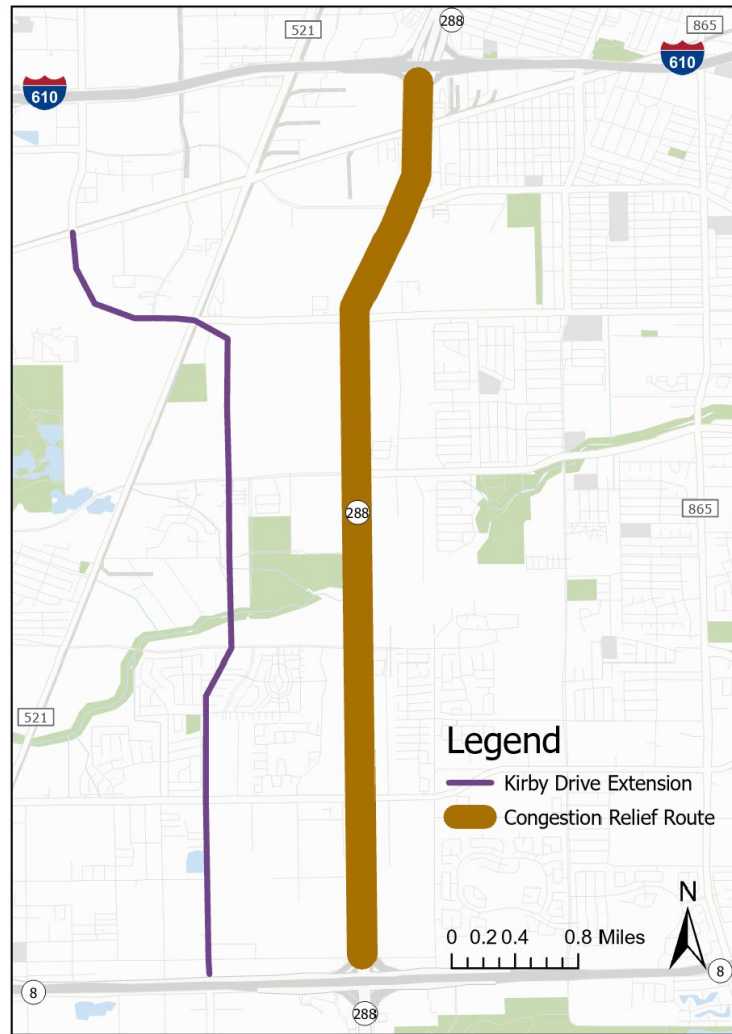


Figure 1: Kirby Drive Extension

Table 10. Value of Time Benefits

Value of Time Calculation	No Build	Build
Auto Vehicles	\$7,412,934,726	\$7,251,614,215
Commercial Vehicles	\$234,645,355	\$229,538,995
Total in Real \$	\$7,647,580,080	\$7,481,153,211
Total Monetized Benefit Real \$ (No Build – Build)	\$166,427,000	
Total Monetized Benefit Discounted @ 3.1% (No Build – Build)	\$99,160,000	

Benefit 4: Mortality Reduction

To monetize the reduction in mortality risks associated with increased walking, the 2023 USDOT BCA Guide recommends \$7.20 (\$2022) 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 (45) within the relevant age range (20-74 years), 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 (42) within the relevant age range (20-64 years), 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 11. Mortality Reduction Monetized Benefits

Mortality Reduction Calculation	No Build	Build
Pedestrian Facility	NA	\$2,322,000
Bike Facility	NA	\$3,212,000
<i>Total in Real \$</i>	NA	<i>\$5,534,000</i>
Total Monetized Benefit Real \$ (No Build – Build)	\$5,534,000	
Total Monetized Benefit Discounted @ 3.1% (No Build – Build)	\$3,239,000	

Benefit 5: Emissions

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

H-GAC models NO_x 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 CO₂:³

- Carbon Dioxide (CO₂): 0.0089 metric tons per gallon of gasoline used.

NO_x and CO₂ have measurable societal economic impacts on the economy. The 2023 USDOT BCA Guide provides recommended monetized values of damage costs for NO_x and CO₂ 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 12. Emission Benefits (Cost)

Emission Calculation	No Build	Build
Nitrogen Oxides (NO _x)	NA	\$200,500
Carbon Dioxide (CO ₂)	NA	\$500
<i>Total in Real \$</i>	<i>NA</i>	<i>\$201,000</i>
Total Monetized Benefit Real \$ (No Build – Build)	\$201,000	
Total Monetized Benefit Discounted @ 3.1% (No Build – Build)	\$119,000	

Benefit 6: Other Externalities

The 2023 USDOT BCA Guide provides recommended monetized values for external costs associated with highways. 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 13. Other Externalities Monetized Benefits

Other Externalities Calculation	No Build	Build
Congestion Externality	NA	\$326,560
Noise Externality	NA	\$10,810
<i>Total in Real \$</i>	<i>NA</i>	<i>\$343,000</i>
Total Monetized Benefit Real \$ (No Build – Build)	\$343,000	
Total Monetized Benefit Discounted @ 3.1% (No Build – Build)	\$204,000	

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

Summary of Benefits and Costs

The table below summarizes the Project benefits detailed above.

Table 14. 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	\$64,883,000	\$28,454,000
2	Facility Improvements	The current facilities are not conducive 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	\$2,397,000	\$1,403,000
3	Value of Travel Time	The current facilities lead to delay of users.	Improvements to the current facilities will reduce delay	Travel time savings	\$166,427,000	\$99,160,000
4	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	\$5,534,000	\$3,239,000
5	Emissions Reduction	The current facilities are not conducive for active transportation	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	\$201,000	\$119,000
6	Externalities Reduction	Roadway is not conducive for active transportation.	New and improved facilities will encourage more walking and cycling	Reduced various externalities	\$343,000	\$204,000
Totals					\$239,785,000	\$132,578,000

