MEMORANDUM

To: East Bay Recreational Park District

From: Alta Planning + Design

Date: February 2023

Re: RAISE Benefit-Cost Analysis Technical Memo

Benefit-Cost Analysis for Sustainably Connecting Easy Bay Communities – Expanding Equitable Access RAISE Grant Application

Executive Summary

This Benefit-Cost Analysis (BCA) includes the benefits and costs for the proposed project that would be fully constructed if the RAISE grant is awarded. The proposed project contains five distinct components that each have independent utility. Per the USDOT BCA Guidance, a separate analysis was conducted for each component. Results are presented for each component and the overall combined project. A separate BCA spreadsheet will be included for each component in the application.

The analysis period for each component includes three years of construction and 20 years of operation, and assumes a useful service life of 30 years. All costs and benefits are presented in 2021 dollars.

The following categories of benefits were considered in the BCA:

- **Safety:** The expected reduction in collisions and associated costs.
- **Environmental Sustainability:** Includes reductions in the following pollutants that impact air quality, CO_2, NO_X SO_2, and $PM_{2.5}$.
- **Quality of Life:** The expected reduction in mortality rates due to increased physical activity from new users of the project.
- **Economic Competitiveness:** Includes savings in household transportation costs and traffic congestion costs.
- **State of Good Repair:** Includes reductions in roadway maintenance costs.
- **Maintenance costs (dis-benefit):** Covers the ongoing costs of upkeep to the proposed project

Result Summary

Table 1 displays the total benefits by category included in the BCA for each project component and the overall project. The capital costs included in the overall BCA are $23.7 million. This BCA estimates the project compared to the no-build scenario over the evaluation period (2023-2046) and at a 7 percent real discount rate will have a net present value of $22.5 million and a benefit-cost ratio of **2.2 : 1.0.** This is summarized in Table 2.[1]

[1] A 7% discount rate was used for all benefits and costs with the exception of carbon benefits which were discounted at 3% per year.

Table 1:Total Undiscounted Benefits over 20 years of Operation

MONETARY VALUE: (In 2021 dollars)	Overall (all five project components)	George Miller Regional Trail	Iron Horse Trail Extension – Concord to Benicia Bridge	Marsh Creek Trail Extension	Oakland Bay Trail Extension	Richmond Bay Trail Extension
Safety Benefits	$38,980,000	$6,670,000	$17,110,000	-	$ 6,200,000	$9,000,000
Environmental Sustainability	$206,000	$11,800	$18,100	$21,500	$119,500	$35,100
Quality of Life	$64,110,000	$5,630,000	$10,660,000	$8,390,000	$25,410,000	$14,020,000
Economic Competitiveness	$2,066,200	$121,200	$181,000	$210,400	$1,199,900	$353,700
State of Good Repair	$279,100	$16,300	$24,000	$28,600	$162,400	$47,800
Maintenance Costs	($5,080,000)	$(600,000)	$(200,000)	$(3,000,000)	$(80,000)	$(1,200,000)
Residual Value	$7,900,000	$1,166,667	$1,000,000	$2,833,300	$400,000	$2,500,000
TOTAL BENEFITS (UNDISCOUNTED)	**$108,541,267**	**$13,015,967**	**$28,793,100**	**$8,400,000**	**$33,490,000**	**$24,620,000**

Table 2: Benefit-Cost Analysis Summary

DISCOUNTED VALUE[2] (in 2021 dollars)	Overall (all five project components)	George Miller Regional Trail to Martinez Intermodal Station Extension	Iron Horse Trail Extension – Concord to Benicia Bridge	Marsh Creek Trail Extension	Oakland Bay Trail Extension	Richmond Bay Trail Extension
Net Discounted Benefits	**$40,760,000**	$4,860,000	$11,000,000	$2,530,000	$13,120,000	$9,250,000
Net Discounted Capital Costs	**($18,230,000)**	$(2,760,000)	$(2,360,000)	$(6,250,000)	$(950,000)	$(5,910,000)
Net Present Value	**$22,530,000**	$2,110,000	$8,620,000	$(3,730,000)	$12,180,000	$3,350,000
Benefit - Cost Ratio	**2.2**	**1.76**	**4.65**	**0.40**	**13.89**	**1.57**

Background

The benefit-cost analysis (BCA) for this project follows the principles documented in the USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs (2023), and uses the recommended parameter values where applicable. The BCA includes the benefits and costs for the project that would be fully constructed if the RAISE grant is awarded. The analysis period for each project was the length of construction and 20 years of operation, and assumes a useful service life of 30 years for each project. All costs and benefits are presented in 2021 base year dollars. Benefits and cost streams were discounted using a 7% per year discount rate, with the exception of carbon benefits which were discounted at 3% per year. This memo contains a detailed explanation of the BCA methodology and the parameter values that were used.

Approach to Benefits and Study Area

This BCA approach expands on the methods suggested by the National Cooperative Highway Research Program (NCHRP) Report 552: Guidelines for Analysis of Investments in Bicycle Facilities by incorporating detailed local demographic information and using new data and research that has become available since Guidelines for Analysis was published in 2006.

[2] A 7% discount rate was used for all benefits and costs with the exception of carbon benefits which were discounted at 3% per year.

While construction of the project will benefit all residents of and visitors to the region, those living within three miles (about a 15-minute bike ride) and one-half mile (about a 10-minute walk) of the project will have the most convenient access and will gain the most from its completion. Accordingly, this BCA focuses on the bicycling benefits attributed to residents living within three miles of the project and on the walking benefits attributed to residents living within one-half mile project. There are several benefit categories that benefit the region more widely (reduced roadway maintenance, healthcare costs), but these ranges are used to constrain this analysis to the main beneficiaries.

Benefits were primarily calculated by comparing walking and biking activity (including collisions) under the baseline to a Build scenario in which the Connecting Communities project has been implemented. The baseline and build scenarios encompass an identical geography (Census Tracts within 3 miles of the project). **The benefits included in the Net Present Value and Benefit-Cost Ratio calculations are the net difference between the two scenarios.** The proposed improvements and expected benefits are summarized in Table 3.

Table 3: Summary Matrix

Baseline	Build Scenario	Type of Impacts
Walking and biking activity within 3 miles of the study area.	Construction of multi-use trails to close five critical gaps in the study area and the estimated impacts on walking and biking activity within 3 miles of the study area. Refer to the application narrative for a full description of the project.	Reduced pollution, reduced mortality costs, reduced bicycle and pedestrian collisions, reduced roadway maintenance, reduced traffic congestion, and reduced household transportation costs.

Capital Costs

Refer to the main application for a detailed breakdown of project costs. The capital cost schedule is shown in Table 4**.** This schedule includes design, engineering, permitting, contracting and installation.

Table 4: Project Construction Schedule and Cost

Construction Year	George Miller Regional Trail to Martinez Intermodal Station Extension	Iron Horse Trail Extension – Concord to Benicia Bridge	Marsh Creek Trail Extension	Oakland Bay Trail Extension	Richmond Bay Trail Extension
2023	$525,000	$450,000		$180,000	$1,100,000
2024	$525,000	$450,000	$1,275,000	$180,000	$1,150,000
2025	$2,450,000	$2,100,000	$1,275,000	$840,000	$5,250,000
2026			$5,950,000		
Total Capital Costs	**$3,500,000**	**$3,000,000**	**$8,500,000**	**$1,200,000**	**$7,500,000**

The estimated maintenance costs are $50,000 per mile per year. These values were determined based on maintenance costs of similar facilities in Contra Costa County and Alameda County. The total annual maintenance costs included in the BCA were $264,900 per year (undiscounted) and they were included as a disbenefit in the benefit-cost ratio.

Useful Life

The expected useful life of the proposed trail facilities is 30 years. The window of analysis used was 20 years. A residual value for each component was claimed as a benefit in the final year of the analysis period, assuming linear depreciation.

Demand

To understand the benefits of the proposed project, a demand analysis was conducted to estimate the expected number of biking and walking trips that would occur after the project is implemented. The primary inputs to demand analysis were counts at similar location to proposed project and a connectivity analysis. Counts were selected based on land use, comparable trail function within the larger system and count type, with preference being given to automated count locations. **Table 5** displays the location and count data that was used in the analysis.

Table 5: Trail Counts at Similar Facilities

Trail (Location)	Count Location	Land Use*	Average Daily Users	Daily User Percentile Rank**	Count Method	Source
East Bay Greenway, Oakland, CA	Hegenberger Road	Urban	180	15%	Automated 24 hour	*East Bay Greenway Counts: January 1, 2021 - May 6, 2021.* Eco-Counter (2021).

Alameda Creek Trail S, Fremont, CA	Ardenwood Blvd	Urban	849	85%	Automated 13 hour***	*2016-2018 Bicycle & Pedestrian Count Data (BPTAC Presentation)*. City of Fremont (April 17, 2019).
Alameda Creek Trail N, Union City, CA	Ardenwood Blvd	Urban	340	31%	Automated 13 hour***	*2016-2018 Bicycle & Pedestrian Count Data (BPTAC Presentation)*. City of Fremont (April 17, 2019).
Alameda Creek Trail SW, Fremont, CA	Isherwood Way	Urban	702	69%	Automated 13 hour***	*2016-2018 Bicycle & Pedestrian Count Data (BPTAC Presentation)*. City of Fremont (April 17, 2019).
Alameda Creek Trail SE, Fremont, CA	Isherwood Way	Urban	1,596	92%	Automated 13 hour***	*2016-2018 Bicycle & Pedestrian Count Data (BPTAC Presentation)*. City of Fremont (April 17, 2019).
CA-84 Toll Plaza Overpass, Fremont, CA	Marshlands Rd	Rural	441	46%	Automated 13 hour***	*2016-2018 Bicycle & Pedestrian Count Data (BPTAC Presentation)*. City of Fremont (April 17, 2019).
Benicia-Martinez Bridge, Solano County, CA	N/A	Urban	451	54%	Automated 24 hour	*Benicia Bridge Bicycle and Pedestrian Traffic.* mySidewalk (Accessed May 17, 2021).
Iron Horse Trail, Walnut Creek, CA	Arroyo Way	Urban	675	62%	Automated 24 hour	*Iron Horse Trail Daily Average Trail Counts (2016-10-25 to 2017-10-26).* TRAFx (2017).
Iron Horse Trail, San Ramon, CA	Crow Canyon Rd	Urban	272	23%	Automated 24 hour	*Iron Horse Trail Daily Average Trail Counts (2016-10-25 to 2017-10-26).* TRAFx (2017).
Iron Horse Trail, Contra Costa County, CA	Love Lane	Urban	381	38%	Automated 24 hour	*Iron Horse Trail Daily Average Trail Counts (2016-10-25 to 2017-10-26).* TRAFx (2017).
Iron Horse Trail, Contra Costa County, CA	Treat Blvd	Urban	813	77%	Automated 24 hour	*Iron Horse Trail Daily Average Trail Counts (2016-10-25 to 2017-10-26).* TRAFx (2017).
Iron Horse Trail, Pleasanton, CA	Pleasanton	Urban	95	8%	Automated 24 hour	*Iron Horse Trail Daily Average Trail Counts (2016-10-25 to 2017-10-26).* TRAFx (2017).

* Land use classified as Urban or Rural based on 2010 US Census Bureau Urban Areas Data

** Percentile ranks were used to assign average daily users to proposed trails based on relative matching of percentile ranks expected demand.

*** Extrapolated to 24-hour counts using National Bicycle and Pedestrian Documentation Project Extrapolation Factors

The connectivity analysis estimated the gains in access to jobs and population. The planned alignments were integrated into a network dataset by assuming all bikeable and walkable facilities were potential connections along the alignment. This excludes largely highways and other types of similar facilities. These connections were then selectively turned on and off per tested alignment as part of a 20-minute Level of Traffic Stress (LTS) adjusted bike shed analysis from evaluation points placed at every location the trail connected with existing network segments.

The approach for the Level of Traffic Stress analysis was based on Conveyal's[3] suggested methodology for adjusting travel costs along segments based on LTS, where biking speeds of 10 MPH are assumed on low-stress segments (1 or 2), and walking speeds of 3 MPH are assumed on high stress segments. The average change in acreage gain from evaluation points was measured along the network. This average was then combined with population and job density estimates to evaluate how changes in connectivity relate to changes in demand by assuming that the average density of jobs and population within 1 mile of the trail would be approximately the same in the gained area. Finally, the Jobs and Population Gain Score was compared to the count location percent rank and the closest comparable count was selected as an estimate of average daily use (**Table 6).** The average mode split between bicyclists and pedestrians at the count locations was 37 percent and 63 percent, respectively. This mode split was applied to the demand estimates for the proposed projects.

Table 6. Demand Estimate

Project Name	Urban / Rural	Len (Mi)	Connectivity Gains (Acres)	Pop. & Job Density Per Acre	Jobs & Pop Gain Score	Average Daily Users Estimate
George Miller Regional Trail to Martinez Intermodal Station Extension	Urban	0.55	16	5.4	11%	180
Iron Horse Trail Extension – Concord to Benicia Bridge	Urban	0.29	415	5.5	33%	340
Marsh Creek Trail Extension	Rural	3.09	570	0.5	22%	272
Richmond Bay Trail Extension	Urban	1.27	982	4.3	56%	451
Oakland Bay Trail Extension	Urban	0.09	815	18.3	78%	813
						Total estimate: 2,056

[3] Better Measures of Bike Accessibility. Conveyal. https://blog.conveyal.com/better-measures-of-bike-accessibility-d875ae5ed831

Benefits

Walking and Biking Activity

The BCA estimated current levels of walking and biking within the project area using American Community Survey (ACS) data. **Table 7** displays the existing commute to work mode share for people within walking and biking distance of the proposed project. Population and demographic forecasts from the Metropolitan Transportation Commission (MTC) at the Transportation Analysis Zone (TAZ) level were used to estimate population growth in the study area over the analysis period.[4] Population forecasts were collected for 2020, 2030, and 2040, and were interpolated for each intermediate year in the analysis.

Table 7. Means of Transportation to Work of People Living in the Study Area (2019 American Community Survey)

GSP Corridor	Population	Drove Alone	Carpool	Public Transit	Bicycled	Walked	Other	Work From Home
Walkshed (within half-mile)	66,454	67%	12%	12%	1%	2%	1%	5%
Bikeshed (within 3 miles)	679,606	60%	11%	16%	2%	3%	1%	6%

The means of transportation to work data was converted to daily estimates and extrapolated to annual trip volumes and broken into different trip types (i.e. commute, school, college, and utilitarian) using the existing travel patterns (**Table 7**) and data from the National Household Transportation Survey (**Table 8**). The annual extrapolations account for the expected number of trips per week by trip type (i.e., commute, school, and college trips are expected five out of seven days a week, and other trip types are expected to occur seven days a week).

Table 8: Trip Purpose Multiplier[5]

	Bike	Walk
Utilitarian Trip Multiplier	5.33	8.77

Increase in Walking and Biking Activity

The Baseline assumes that the walking and biking mode share will remain constant and that trips will increase annually with expected population growth. In the Build scenario, the demand estimates for the proposed project **(Table 6)** were added to the existing walking and biking activity starting in the expected opening year(s). The demand estimates were escalated by the expected population growth factor each year.

[4] Plan Bay Area 2040 Forecast - Population and Demographics
https://opendata.mtc.ca.gov/datasets/f97bf7c12f024f3e919e3f41ec802595_0/explore
[5] Travel Day Person Trips (in millions), NHTSA 2017 https://nhts.ornl.gov/

Decrease in Motor Vehicle Trips

Some of the estimated annual bicycle and pedestrian trips within the proposed project area are expected to replace motor vehicle trips. Calibrated to modal shift factors reported in literature[6], a univariate regression model estimates the motor vehicle trip replacement factor based on the percentage of trips that terminate in census block groups within ¼-mile of the proposed facility that are less than 4 miles. Additional details on the methodology are included in **Appendix I**. Trip distance data is provided by Replica for a typical travel Thursday in the Bay Area region in Fall 2019[7]. The motor vehicle trip replacement factor for all active mode trips for each project component is shown in Table 9.

Table 9: Trip Replacement Factors

	George Miller Regional Trail	Iron Horse Trail Extension	Marsh Creek Trail Extension	Oakland Bay Trail Extension	Richmond Bay Trail Extension
Trip Replacement Factor	0.12	0.10	0.15	0.27	0.15

To estimate the number of vehicle-miles that might be replaced by bicycling and walking trips, Table 10 shows the average trip distance of bicycling and walking trips by trip purpose. The number of vehicle miles reduced due to bicycle and pedestrian trips was calculated by multiplying the number of biking or walking trips by the trip replacement and trip distance factors. The estimated reduction in vehicle miles traveled is shown in the results section for each project component.

Table 10: Average Trip Distance (miles)

	Bike	Walk
Commute Trips[8]	2.47	0.72
College Trips[9]	1.31	0.43
K-12 School Trips[10]	1.36	0.69
Utilitarian Trips[11]	2.28	0.83

[6] Volker et al (2019). Quantifying Reductions in Vehicle Miles Traveled from New Bike Paths, Lanes, and Cycle Tracks
[7] Replica Places (2019). https://replicahq.com/
[8] NHTS (2017). http://nhts.ornl.gov/tables09/fatcat/2009/aptl_TRPTRANS_WHYTRP1S.html
[9] Ibid.
[10] Safe Routes National Center for Safe Routes to School, Trends in Walking and Bicycling to School from 2007 to 2013 (2015). http://www.saferoutesinfo.org/sites/default/files/SurveyTrends_2007-13_final1.pdf
[11] NHTS (2017). http://nhts.ornl.gov/tables09/fatcat/2009/aptl_TRPTRANS_WHYTRP1S.html

Environmental Sustainability Benefits

For every vehicle-mile reduced, there is an assumed decrease in greenhouse gases and criteria pollutants. Table 11 lists the reduction in greenhouse gases and criteria pollutants by vehicle-mile traveled. The cost to mitigate or clean-up those pollutants was calculated using the monetary values provided by the 2023 USDOT BCA Guidance Table A-6 for the corresponding year. Emission types not listed in that table were not included in the analysis. The estimated annual emission reduction benefits are shown in the results section for each project component.

Table 11: Environmental Sustainability Multipliers

	Value (metric tons/VMT)
Particulate Matter 2.5 ($PM_{2.5}$) [12]	0.0000000044
Nitrous Oxides (NOx) [13]	0.0000008284
Sulfur Oxides (SO_2) [14]	0.000000077
Carbon Dioxide[15]	0.0004204662

Quality of Life Benefits

More people bicycling and walking can help encourage an increase in physical activity levels, increased cardiovascular health, and other positive outcomes for users. The benefits from reduced mortality were calculated using the recommended values provided in the 2023 USDOT BCA Guidance (Table A-13) and the national distribution of age ranges and travel patterns. These benefits were only applied to the estimated number of walking and biking trips induced by the project (see **Demand** section). Table 12 displays the multipliers that were used. The estimated annual mortality benefits are shown in Table 19.

[12] The Safer Affordable Fuel-Efficient Vehicles Rule for MY2021-MY2026 Passenger Cars, BUILD Guidance 2020, Table A-7 and Light Trucks Preliminary Regulatory Impact Analysis (October 2018) https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/ld_cafe_co2_nhtsa_2127-al76_epa_pria_181016.pdf

[13] The Safer Affordable Fuel-Efficient Vehicles Rule for MY2021-MY2026 Passenger Cars, BUILD Guidance 2020, Table A-7 and Light Trucks Preliminary Regulatory Impact Analysis (October 2018) https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/ld_cafe_co2_nhtsa_2127-al76_epa_pria_181016.pdf

[14] The Safer Affordable Fuel-Efficient Vehicles Rule for MY2021-MY2026 Passenger Cars, BUILD Guidance 2020, Table A-7 and Light Trucks Preliminary Regulatory Impact Analysis (October 2018) https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/ld_cafe_co2_nhtsa_2127-al76_epa_pria_181016.pdf

[15] Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf

Table 12: Mortality Reduction Multipliers

Mortality Reduction Benefits of Induced Active Transportation	Value
Walking Value per Induced Trip	$7.20
Cycling Value per Induced Trips	$6.42
Walking Age Proportion (20-74 years old)	68%
Cycling Age Proportion (20-64 years old)	59%
Trips induced from non-active modes	89%

Economic Competitiveness Benefits

For every vehicle-mile reduced, there is a reduction in household transportation costs and congestion costs. Table 13 displays the multipliers use to calculate economic competitiveness benefit. The estimated annual economic competitiveness benefits are shown in Table 20.

Table 13: Economic Competitiveness Multipliers

	Value
Household Transportation Cost Savings	**$0.43 per VMT**[16]
Congestion Cost Savings	**$0.06 per VMT**[17,18]

Safety Benefits

The proposed project would decrease conflicts between people walking and biking with motor vehicles. Collision data was covering an eleven-year period between 2011 and 2021 was extracted from the Transportation Injury Mapping System (TIMS) maintained by the University of California, Berkeley. Collisions under consideration all involved a bicycle and/or pedestrian and were located within the immediate vicinity of proposed project where it would be expected that people walking and biking would use the proposed project facilities when implemented **(Table 14**), based on the surrounding facilities and street connectivity.

[16] Our Driving Costs, AAA (2016). http://exchange.aaa.com/automobiles-travel/automobiles/driving-costs/#.Vw_xCPkrKUk
[17] Crashes vs. Congestion: What's the Cost to Society? AAA (2011). http://www.camsys.com/pubs/2011_AAA_CrashvCongUpd.pdf
[18] Crashes vs. Congestion: What's the Cost to Society? AAA (2011). http://www.camsys.com/pubs/2011_AAA_CrashvCongUpd.pdf

The Crash Modification Factors (CMF) Install Shared Path (CMF ID: 9250) and Install Sidewalk (CMF ID: 11246) were applied to the were applied to the annual average of bicycle and pedestrian crashes, respectively. The benefits of the resultant reduction in crashes were monetized using the values provided in the 2023 USDOT BCA Guidance Appendix A Table A-1 for KABCO accident data.

Table 14. Summary of Collisions

Trail (Location)	Number of Collisions (2011-2021)	KILLED	INCAPACITATING	NON-INCAPACITATING	POSSIBLE INJURY	NO INJURY	INJURED (SEVERITY UNKNOWN)	PDO	Maximum Collision Buffer Distance	Rationale
George Miller Regional Trail to Martinez Intermodal Station Extension	19	1	2	8	8	0	0	0	0.33 Mile	Closes existing trail gap multiple destinations served
Iron Horse Trail Extension – Concord to Benicia Bridge	10	2	1	2	5	0	0	0	0.5 Mile	Closes connectivity gap over major barrier, only other routes are unimproved.
Oakland East Bay Greenway Trail Extension	10	1	1	4	4	0	0	0	1,000 feet	Closes existing trail gap multiple destinations served
Richmond Bay Trail Extension	3	1	1	0	1	0	0	0	0.25 Mile	Closes gap between existing regional trails. Will serve traffic on adjacent, unimproved routes

State-of-good Repair Benefits

Table 15 shows the estimated roadway maintenance cost savings associated with a reduction in vehicle-miles traveled.

Table 15: State of Good Repair Multiplier

	Value (metric tons/VMT)
Roadway Maintenance Cost Savings	$0.06 per VMT[19]

[19] Kitamura, R., Zhao, H., and Gubby, A. R. Development of a Pavement Maintenance Cost Allocation Model. Institute of Transportation Studies, University of California, Davis. https://trid.trb.org/view.aspx?id=261768

Results

This section presents the BCA results for each of the five project components. For more detailed information, refer to the unlocked spreadsheets provided with the application.

George Miller Regional Trail to Martinez Intermodal Station Extension

Table 16 through Table 25 display the results of the benefit-cost analysis for each year of the analysis period. This BCA estimates the project compared to the no-build scenario over a 23-year evaluation (2023-2045) and at a 7 percent real discount rate will have a net present value of **$2.1 million** and a benefit-cost ratio of **1.76 : 1.0.**

Table 16: Estimated Annual Bicycle and Walk Trips

Year	Baseline	Build Scenario	Additional Trips
2023	962,000	962,000	-
2024	977,600	977,600	-
2025	993,300	993,300	-
2026	1,009,000	1,069,800	60,800
2027	1,024,600	1,086,500	61,900
2028	1,040,300	1,103,200	62,900
2029	1,056,000	1,119,900	63,900
2030	1,071,700	1,136,500	64,800
2031	1,087,300	1,153,200	65,900
2032	1,103,000	1,169,900	66,900
2033	1,118,700	1,186,600	67,900
2034	1,134,300	1,203,300	69,000
2035	1,150,000	1,220,000	70,000
2036	1,165,700	1,236,700	71,000
2037	1,181,300	1,253,400	72,100
2038	1,197,000	1,270,000	73,000
2039	1,212,700	1,286,700	74,000
2040	1,228,400	1,303,400	75,000
2041	1,244,000	1,320,100	76,100
2042	1,259,700	1,336,800	77,100
2043	1,275,400	1,353,500	78,100
2044	1,291,000	1,370,200	79,200
2045	1,306,700	1,386,800	80,100
		Total Additional Trips:	**1,409,700**

Table 17: Estimated Annual Vehicle Miles Reduced

Year	Baseline	Build Scenario	Additional Vehicle Miles Reduced
2023	199,600	199,600	-
2024	202,900	202,900	-
2025	206,200	206,200	-
2026	209,500	219,500	10,000
2027	212,700	223,000	10,300
2028	216,000	226,400	10,400
2029	219,300	229,900	10,600
2030	222,600	233,300	10,700
2031	225,900	236,800	10,900
2032	229,100	240,200	11,100
2033	232,400	243,700	11,300
2034	235,700	247,100	11,400
2035	239,000	250,600	11,600
2036	242,300	254,000	11,700
2037	245,500	257,400	11,900
2038	248,800	260,900	12,100
2039	252,100	264,300	12,200
2040	255,400	267,800	12,400
2041	258,700	271,200	12,500
2042	261,900	274,700	12,800
2043	265,200	278,100	12,900
2044	268,500	281,600	13,100
2045	271,800	285,000	13,200
Total Additional Vehicle Miles Reduced:			**233,100**

Table 18: Estimated Annual Environmental Sustainability Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$9,500	$10,000	$500
2027	$9,800	$10,300	$500
2028	$10,100	$10,600	$500
2029	$10,500	$11,000	$500
2030	$10,900	$11,400	$500
2031	$11,200	$11,700	$500
2032	$11,400	$12,000	$600
2033	$11,700	$12,300	$600
2034	$12,000	$12,500	$500
2035	$12,200	$12,800	$600
2036	$12,600	$13,200	$600
2037	$12,900	$13,500	$600
2038	$13,200	$13,800	$600
2039	$13,500	$14,100	$600
2040	$13,800	$14,400	$600
2041	$14,200	$14,900	$700
2042	$14,500	$15,200	$700
2043	$14,800	$15,500	$700
2044	$15,100	$15,800	$700
2045	$15,400	$16,100	$700
		Total Benefits:	**$11,800**

Table 19: Estimated Annual Quality of Life Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$3,800,000	$4,040,000	$240,000
2027	$3,850,000	$4,100,000	$250,000
2028	$3,910,000	$4,160,000	$250,000
2029	$3,970,000	$4,230,000	$260,000
2030	$4,030,000	$4,290,000	$260,000
2031	$4,090,000	$4,350,000	$260,000
2032	$4,150,000	$4,420,000	$270,000
2033	$4,210,000	$4,480,000	$270,000
2034	$4,270,000	$4,540,000	$270,000
2035	$4,330,000	$4,610,000	$280,000
2036	$4,390,000	$4,670,000	$280,000
2037	$4,440,000	$4,730,000	$290,000
2038	$4,500,000	$4,800,000	$300,000
2039	$4,560,000	$4,860,000	$300,000
2040	$4,620,000	$4,920,000	$300,000
2041	$4,680,000	$4,980,000	$300,000
2042	$4,740,000	$5,050,000	$310,000
2043	$4,800,000	$5,110,000	$310,000
2044	$4,860,000	$5,170,000	$310,000
2045	$4,920,000	$5,240,000	$320,000
		Total Benefits:	**$5,630,000**

Table 20: Estimated Annual Economic Competitiveness Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$108,900	$114,100	$5,200
2027	$110,600	$115,900	$5,300
2028	$112,300	$117,700	$5,400
2029	$114,000	$119,500	$5,500
2030	$115,700	$121,300	$5,600
2031	$117,400	$123,100	$5,700
2032	$119,100	$124,900	$5,800
2033	$120,800	$126,700	$5,900
2034	$122,500	$128,500	$6,000
2035	$124,200	$130,300	$6,100
2036	$125,900	$132,000	$6,100
2037	$127,600	$133,800	$6,200
2038	$129,400	$135,600	$6,200
2039	$131,100	$137,400	$6,300
2040	$132,800	$139,200	$6,400
2041	$134,500	$141,000	$6,500
2042	$136,200	$142,800	$6,600
2043	$137,900	$144,600	$6,700
2044	$139,600	$146,400	$6,800
2045	$141,300	$148,200	$6,900
		Total Benefits:	**$121,200**

Table 21: Estimated Annual Safety Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$20,000	$20,000
2027	$-	$350,000	$350,000
2028	$-	$350,000	$350,000
2029	$-	$350,000	$350,000
2030	$-	$350,000	$350,000
2031	$-	$350,000	$350,000
2032	$-	$350,000	$350,000
2033	$-	$350,000	$350,000
2034	$-	$350,000	$350,000
2035	$-	$350,000	$350,000
2036	$-	$350,000	$350,000
2037	$-	$350,000	$350,000
2038	$-	$350,000	$350,000
2039	$-	$350,000	$350,000
2040	$-	$350,000	$350,000
2041	$-	$350,000	$350,000
2042	$-	$350,000	$350,000
2043	$-	$350,000	$350,000
2044	$-	$350,000	$350,000
2045	$-	$350,000	$350,000
		Total Benefits:	**$6,670,000**

Table 22: Estimated Annual State of Good Repair Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$14,700	$15,400	$700
2027	$15,000	$15,700	$700
2028	$15,200	$15,900	$700
2029	$15,400	$16,200	$800
2030	$15,700	$16,400	$700
2031	$15,900	$16,600	$700
2032	$16,100	$16,900	$800
2033	$16,300	$17,100	$800
2034	$16,600	$17,400	$800
2035	$16,800	$17,600	$800
2036	$17,000	$17,900	$900
2037	$17,300	$18,100	$800
2038	$17,500	$18,300	$800
2039	$17,700	$18,600	$900
2040	$18,000	$18,800	$800
2041	$18,200	$19,100	$900
2042	$18,400	$19,300	$900
2043	$18,600	$19,600	$1,000
2044	$18,900	$19,800	$900
2045	$19,100	$20,000	$900
		Total Benefits:	**$16,300**

Table 23: Estimated Annual Maintenance Disbenefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023			
2024			
2025			
2026	$-	$(30,000)	$(30,000)
2027	$-	$(30,000)	$(30,000)
2028	$-	$(30,000)	$(30,000)
2029	$-	$(30,000)	$(30,000)
2030	$-	$(30,000)	$(30,000)
2031	$-	$(30,000)	$(30,000)
2032	$-	$(30,000)	$(30,000)
2033	$-	$(30,000)	$(30,000)
2034	$-	$(30,000)	$(30,000)
2035	$-	$(30,000)	$(30,000)
2036	$-	$(30,000)	$(30,000)
2037	$-	$(30,000)	$(30,000)
2038	$-	$(30,000)	$(30,000)
2039	$-	$(30,000)	$(30,000)
2040	$-	$(30,000)	$(30,000)
2041	$-	$(30,000)	$(30,000)
2042	$-	$(30,000)	$(30,000)
2043	$-	$(30,000)	$(30,000)
2044	$-	$(30,000)	$(30,000)
2045	$-	$(30,000)	$(30,000)
		Total Benefits:	**$(600,000)**

Table 24: Estimated Annual Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$3,930,000	$4,170,000	$240,000
2027	$3,990,000	$4,570,000	$580,000
2028	$4,050,000	$4,630,000	$580,000
2029	$4,110,000	$4,690,000	$580,000
2030	$4,170,000	$4,760,000	$590,000
2031	$4,240,000	$4,830,000	$590,000
2032	$4,300,000	$4,900,000	$600,000
2033	$4,360,000	$4,960,000	$600,000
2034	$4,420,000	$5,020,000	$600,000
2035	$4,480,000	$5,090,000	$610,000
2036	$4,540,000	$5,150,000	$610,000
2037	$4,600,000	$5,220,000	$620,000
2038	$4,660,000	$5,280,000	$620,000
2039	$4,720,000	$5,350,000	$630,000
2040	$4,790,000	$5,420,000	$630,000
2041	$4,850,000	$5,480,000	$630,000
2042	$4,910,000	$5,550,000	$640,000
2043	$4,970,000	$5,610,000	$640,000
2044	$5,030,000	$5,680,000	$650,000
2045	$5,090,000	$6,910,000	$1,820,000
		Total Benefits:	**$13,060,000**

Table 25: *Estimated Discounted Net Costs and Benefits (discounted at 7%)*[20]

Year	Discounted Costs	Discounted Benefits	Net Cumulative Discounted Costs and Benefits
2023	$(460,000)	$-	$(460,000)
2024	$(430,000)	$-	$(890,000)
2025	$(1,870,000)	$-	$(2,760,000)
2026	$-	$170,000	$(2,580,000)
2027	$-	$380,000	$(2,200,000)
2028	$-	$360,000	$(1,840,000)
2029	$-	$340,000	$(1,500,000)
2030	$-	$320,000	$(1,180,000)
2031	$-	$300,000	$(880,000)
2032	$-	$280,000	$(590,000)
2033	$-	$270,000	$(330,000)
2034	$-	$250,000	$(80,000)
2035	$-	$240,000	$160,000
2036	$-	$220,000	$380,000
2037	$-	$210,000	$590,000
2038	$-	$200,000	$790,000
2039	$-	$190,000	$970,000
2040	$-	$170,000	$1,150,000
2041	$-	$160,000	$1,310,000
2042	$-	$150,000	$1,470,000
2043	$-	$150,000	$1,610,000
2044	$-	$140,000	$1,750,000
2045	$-	$360,000	$2,110,000
Total Net Discounted Costs: $ 2,760,000		**Total Discounted Net Benefits: $4,860,000**	**Net Present Value: $2,110,000**
			Benefit-Cost Ratio: 1.76:1

[20] Carbon reduction benefits were discounted at 3%

Iron Horse Trail Extension - Concord to Benicia Bridge

Table 26 through Table 35 display the results of the benefit-cost analysis for each year of the analysis period. This BCA estimates the project compared to the no-build scenario over a 23-year evaluation (2023-2045) and at a 7 percent real discount rate will have a net present value of **$8.6 million** and a benefit-cost ratio of **4.65 : 1.0.**

Table 26: Estimated Annual Bicycle and Walk Trips

Year	Baseline	Build Scenario	Additional Trips
2023	2,246,200	2,246,200	-
2024	2,282,800	2,282,800	-
2025	2,319,400	2,319,400	-
2026	2,356,000	2,471,200	115,200
2027	2,392,600	2,509,700	117,100
2028	2,429,200	2,548,200	119,000
2029	2,465,800	2,586,800	121,000
2030	2,502,400	2,625,300	122,900
2031	2,539,100	2,663,800	124,700
2032	2,575,700	2,702,400	126,700
2033	2,612,300	2,740,900	128,600
2034	2,648,900	2,779,400	130,500
2035	2,685,500	2,818,000	132,500
2036	2,722,100	2,856,500	134,400
2037	2,758,700	2,895,000	136,300
2038	2,795,300	2,933,600	138,300
2039	2,831,900	2,972,100	140,200
2040	2,868,600	3,010,600	142,000
2041	2,905,200	3,049,200	144,000
2042	2,941,800	3,087,700	145,900
2043	2,978,400	3,126,200	147,800
2044	3,015,000	3,164,800	149,800
2045	3,051,600	3,203,300	151,700
		Total Additional Trips:	**2,668,600**

Table 27: Estimated Annual Vehicle Miles Reduced

Year	Baseline	Build Scenario	Additional Vehicle Miles Reduced
2023	389,700	389,700	-
2024	396,100	396,100	-
2025	402,500	402,500	-
2026	408,900	423,900	15,000
2027	415,300	430,600	15,300
2028	421,700	437,200	15,500
2029	428,100	443,900	15,800
2030	434,500	450,500	16,000
2031	440,900	457,200	16,300
2032	447,300	463,800	16,500
2033	453,700	470,500	16,800
2034	460,100	477,100	17,000
2035	466,500	483,800	17,300
2036	472,900	490,400	17,500
2037	479,300	497,100	17,800
2038	485,700	503,700	18,000
2039	492,100	510,400	18,300
2040	498,500	517,000	18,500
2041	504,900	523,700	18,800
2042	511,300	530,400	19,100
2043	517,700	537,000	19,300
2044	524,100	543,700	19,600
2045	530,500	550,300	19,800
Total Additional Vehicle Miles Reduced:			**348,200**

Table 28: Estimated Annual Environmental Sustainability Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$18,500	$19,200	$700
2027	$19,200	$19,900	$700
2028	$19,800	$20,500	$700
2029	$20,500	$21,200	$700
2030	$21,300	$22,100	$800
2031	$21,800	$22,600	$800
2032	$22,300	$23,100	$800
2033	$22,800	$23,700	$900
2034	$23,400	$24,200	$800
2035	$23,900	$24,800	$900
2036	$24,600	$25,600	$1,000
2037	$25,200	$26,100	$900
2038	$25,700	$26,700	$1,000
2039	$26,300	$27,300	$1,000
2040	$26,900	$27,900	$1,000
2041	$27,700	$28,700	$1,000
2042	$28,200	$29,300	$1,100
2043	$28,800	$29,900	$1,100
2044	$29,400	$30,500	$1,100
2045	$30,000	$31,100	$1,100
		Total Benefits:	**$18,100**

Table 29: Estimated Annual Quality of Life Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$8,700,000	$9,160,000	$460,000
2027	$8,840,000	$9,310,000	$470,000
2028	$8,970,000	$9,450,000	$480,000
2029	$9,110,000	$9,590,000	$480,000
2030	$9,240,000	$9,740,000	$500,000
2031	$9,380,000	$9,880,000	$500,000
2032	$9,520,000	$10,020,000	$500,000
2033	$9,650,000	$10,160,000	$510,000
2034	$9,790,000	$10,310,000	$520,000
2035	$9,920,000	$10,450,000	$530,000
2036	$10,060,000	$10,590,000	$530,000
2037	$10,190,000	$10,740,000	$550,000
2038	$10,330,000	$10,880,000	$550,000
2039	$10,460,000	$11,020,000	$560,000
2040	$10,600,000	$11,160,000	$560,000
2041	$10,730,000	$11,310,000	$580,000
2042	$10,870,000	$11,450,000	$580,000
2043	$11,000,000	$11,590,000	$590,000
2044	$11,140,000	$11,740,000	$600,000
2045	$11,270,000	$11,880,000	$610,000
		Total Benefits:	**$10,660,000**

Table 30: Estimated Annual Economic Competitiveness Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$212,600	$220,400	$7,800
2027	$215,900	$223,800	$7,900
2028	$219,200	$227,300	$8,100
2029	$222,600	$230,800	$8,200
2030	$225,900	$234,200	$8,300
2031	$229,200	$237,700	$8,500
2032	$232,500	$241,100	$8,600
2033	$235,900	$244,600	$8,700
2034	$239,200	$248,000	$8,800
2035	$242,500	$251,500	$9,000
2036	$245,800	$255,000	$9,200
2037	$249,200	$258,400	$9,200
2038	$252,500	$261,900	$9,400
2039	$255,800	$265,300	$9,500
2040	$259,200	$268,800	$9,600
2041	$262,500	$272,300	$9,800
2042	$265,800	$275,700	$9,900
2043	$269,100	$279,200	$10,100
2044	$272,500	$282,600	$10,100
2045	$275,800	$286,100	$10,300
		Total Benefits:	**$181,000**

Table 31: Estimated Annual Safety Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$10,000	$10,000
2027	$-	$900,000	$900,000
2028	$-	$900,000	$900,000
2029	$-	$900,000	$900,000
2030	$-	$900,000	$900,000
2031	$-	$900,000	$900,000
2032	$-	$900,000	$900,000
2033	$-	$900,000	$900,000
2034	$-	$900,000	$900,000
2035	$-	$900,000	$900,000
2036	$-	$900,000	$900,000
2037	$-	$900,000	$900,000
2038	$-	$900,000	$900,000
2039	$-	$900,000	$900,000
2040	$-	$900,000	$900,000
2041	$-	$900,000	$900,000
2042	$-	$900,000	$900,000
2043	$-	$900,000	$900,000
2044	$-	$900,000	$900,000
2045	$-	$900,000	$900,000
		Total Benefits:	**$17,110,000**

Table 32: Estimated Annual State of Good Repair Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$28,800	$29,800	$1,000
2027	$29,200	$30,300	$1,100
2028	$29,700	$30,700	$1,000
2029	$30,100	$31,200	$1,100
2030	$30,600	$31,700	$1,100
2031	$31,000	$32,100	$1,100
2032	$31,500	$32,600	$1,100
2033	$31,900	$33,100	$1,200
2034	$32,400	$33,500	$1,100
2035	$32,800	$34,000	$1,200
2036	$33,300	$34,500	$1,200
2037	$33,700	$35,000	$1,300
2038	$34,200	$35,400	$1,200
2039	$34,600	$35,900	$1,300
2040	$35,100	$36,400	$1,300
2041	$35,500	$36,800	$1,300
2042	$36,000	$37,300	$1,300
2043	$36,400	$37,800	$1,400
2044	$36,900	$38,200	$1,300
2045	$37,300	$38,700	$1,400
		Total Benefits:	**$24,000**

Table 33: Estimated Annual Maintenance Disbenefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023			
2024			
2025			
2026	$-	$(10,000)	$(10,000)
2027	$-	$(10,000)	$(10,000)
2028	$-	$(10,000)	$(10,000)
2029	$-	$(10,000)	$(10,000)
2030	$-	$(10,000)	$(10,000)
2031	$-	$(10,000)	$(10,000)
2032	$-	$(10,000)	$(10,000)
2033	$-	$(10,000)	$(10,000)
2034	$-	$(10,000)	$(10,000)
2035	$-	$(10,000)	$(10,000)
2036	$-	$(10,000)	$(10,000)
2037	$-	$(10,000)	$(10,000)
2038	$-	$(10,000)	$(10,000)
2039	$-	$(10,000)	$(10,000)
2040	$-	$(10,000)	$(10,000)
2041	$-	$(10,000)	$(10,000)
2042	$-	$(10,000)	$(10,000)
2043	$-	$(10,000)	$(10,000)
2044	$-	$(10,000)	$(10,000)
2045	$-	$(10,000)	$(10,000)
		Total Benefits:	**$(200,000)**

Table 34: Estimated Annual Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$8,960,000	$9,430,000	$470,000
2027	$9,100,000	$10,460,000	$1,360,000
2028	$9,240,000	$10,610,000	$1,370,000
2029	$9,380,000	$10,760,000	$1,380,000
2030	$9,520,000	$10,910,000	$1,390,000
2031	$9,660,000	$11,050,000	$1,390,000
2032	$9,800,000	$11,200,000	$1,400,000
2033	$9,940,000	$11,350,000	$1,410,000
2034	$10,080,000	$11,500,000	$1,420,000
2035	$10,220,000	$11,650,000	$1,430,000
2036	$10,360,000	$11,790,000	$1,430,000
2037	$10,500,000	$11,940,000	$1,440,000
2038	$10,640,000	$12,090,000	$1,450,000
2039	$10,780,000	$12,240,000	$1,460,000
2040	$10,920,000	$12,380,000	$1,460,000
2041	$11,060,000	$12,530,000	$1,470,000
2042	$11,200,000	$12,680,000	$1,480,000
2043	$11,340,000	$12,830,000	$1,490,000
2044	$11,480,000	$12,980,000	$1,500,000
2045	$11,620,000	$14,120,000	$2,500,000
		Total Benefits:	**$28,700,000**

Table 35: *Estimated Discounted Net Costs and Benefits (discounted at 7%)*[21]

Year	Discounted Costs	Discounted Benefits	Net Cumulative Discounted Costs and Benefits
2023	$(390,000)	$-	$(390,000)
2024	$(370,000)	$-	$(760,000)
2025	$(1,600,000)	$-	$(2,360,000)
2026	$-	$340,000	$(2,030,000)
2027	$-	$910,000	$(1,120,000)
2028	$-	$850,000	$(270,000)
2029	$-	$800,000	$540,000
2030	$-	$750,000	$1,290,000
2031	$-	$710,000	$2,000,000
2032	$-	$670,000	$2,660,000
2033	$-	$630,000	$3,290,000
2034	$-	$590,000	$3,880,000
2035	$-	$550,000	$4,430,000
2036	$-	$520,000	$4,950,000
2037	$-	$490,000	$5,440,000
2038	$-	$460,000	$5,900,000
2039	$-	$430,000	$6,330,000
2040	$-	$410,000	$6,730,000
2041	$-	$380,000	$7,120,000
2042	$-	$360,000	$7,470,000
2043	$-	$340,000	$7,810,000
2044	$-	$320,000	$8,120,000
2045	$-	$490,000	$8,620,000
Total Net Discounted Costs: $ 2,360,000		**Total Discounted Net Benefits: $11,000,000**	**Net Present Value: $8,620,000**
			Benefit-Cost Ratio: 4.65:1

[21] Carbon reduction benefits were discounted at 3%

Table 1636 through Table 2545 display the results of the benefit-cost analysis for each year of the analysis period. This BCA estimates the project compared to the no-build scenario over a 23-year evaluation (2023-2046) and at a 7 percent real discount rate will have a net present value of **$(3,730,000)** and a benefit-cost ratio of **0.4 : 1.0.**

Table 36: Estimated Annual Bicycle and Walk Trips

Year	Baseline	Build Scenario	Additional Trips
2023	1,261,100	1,261,100	-
2024	1,281,600	1,281,600	-
2025	1,302,100	1,302,100	-
2026	1,322,500	1,322,500	-
2027	1,343,000	1,433,800	90,800
2028	1,363,400	1,455,800	92,400
2029	1,383,900	1,477,700	93,800
2030	1,404,300	1,499,700	95,400
2031	1,424,800	1,521,600	96,800
2032	1,445,200	1,543,600	98,400
2033	1,465,700	1,565,500	99,800
2034	1,486,100	1,587,400	101,300
2035	1,506,600	1,609,400	102,800
2036	1,527,000	1,631,300	104,300
2037	1,547,500	1,653,300	105,800
2038	1,568,000	1,675,200	107,200
2039	1,588,400	1,697,200	108,800
2040	1,608,900	1,719,100	110,200
2041	1,629,300	1,741,100	111,800
2042	1,649,800	1,763,000	113,200
2043	1,670,200	1,785,000	114,800
2044	1,690,700	1,806,900	116,200
2045	1,711,100	1,828,800	117,700
2046	1,731,600	1,850,800	119,200
		Total Additional Trips:	**2,100,700**

Table 37: Estimated Annual Vehicle Miles Reduced

Year	Baseline	Build Scenario	Additional Vehicle Miles Reduced
2023	334,200	334,200	-
2024	339,700	339,700	-
2025	345,200	345,200	-
2026	350,700	350,700	-
2027	356,100	373,600	17,500
2028	361,600	379,400	17,800
2029	367,100	385,200	18,100
2030	372,500	390,900	18,400
2031	378,000	396,700	18,700
2032	383,500	402,400	18,900
2033	389,000	408,200	19,200
2034	394,400	414,000	19,600
2035	399,900	419,700	19,800
2036	405,400	425,500	20,100
2037	410,800	431,200	20,400
2038	416,300	437,000	20,700
2039	421,800	442,800	21,000
2040	427,200	448,500	21,300
2041	432,700	454,300	21,600
2042	438,200	460,000	21,800
2043	443,700	465,800	22,100
2044	449,100	471,500	22,400
2045	454,600	477,300	22,700
2046	460,100	483,100	23,000
Total Additional Vehicle Miles Reduced:			**405,100**

Table 38: Estimated Annual Environmental Sustainability Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$-	$-
2027	$16,500	$17,300	$800
2028	$17,000	$17,800	$800
2029	$17,500	$18,400	$900
2030	$18,300	$19,200	$900
2031	$18,700	$19,600	$900
2032	$19,100	$20,100	$1,000
2033	$19,600	$20,500	$900
2034	$20,000	$21,000	$1,000
2035	$20,500	$21,500	$1,000
2036	$21,100	$22,200	$1,100
2037	$21,600	$22,700	$1,100
2038	$22,100	$23,200	$1,100
2039	$22,500	$23,700	$1,200
2040	$23,000	$24,200	$1,200
2041	$23,700	$24,900	$1,200
2042	$24,200	$25,400	$1,200
2043	$24,700	$25,900	$1,200
2044	$25,200	$26,500	$1,300
2045	$25,700	$27,000	$1,300
2046	$26,400	$27,800	$1,400
		Total Benefits:	**$21,500**

Table 39: Estimated Annual Quality of Life Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$-	$-
2027	$4,910,000	$5,270,000	$360,000
2028	$4,980,000	$5,350,000	$370,000
2029	$5,060,000	$5,430,000	$370,000
2030	$5,130,000	$5,510,000	$380,000
2031	$5,210,000	$5,590,000	$380,000
2032	$5,280,000	$5,670,000	$390,000
2033	$5,350,000	$5,750,000	$400,000
2034	$5,430,000	$5,830,000	$400,000
2035	$5,500,000	$5,920,000	$420,000
2036	$5,580,000	$6,000,000	$420,000
2037	$5,650,000	$6,080,000	$430,000
2038	$5,730,000	$6,160,000	$430,000
2039	$5,800,000	$6,240,000	$440,000
2040	$5,880,000	$6,320,000	$440,000
2041	$5,950,000	$6,400,000	$450,000
2042	$6,030,000	$6,480,000	$450,000
2043	$6,100,000	$6,560,000	$460,000
2044	$6,180,000	$6,640,000	$460,000
2045	$6,250,000	$6,720,000	$470,000
2046	$6,330,000	$6,800,000	$470,000
		Total Benefits:	**$8,390,000**

Table 40: Estimated Annual Economic Competitiveness Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$-	$-
2027	$185,100	$194,200	$9,100
2028	$188,000	$197,200	$9,200
2029	$190,800	$200,200	$9,400
2030	$193,700	$203,200	$9,500
2031	$196,500	$206,200	$9,700
2032	$199,400	$209,200	$9,800
2033	$202,200	$212,200	$10,000
2034	$205,000	$215,200	$10,200
2035	$207,900	$218,200	$10,300
2036	$210,700	$221,200	$10,500
2037	$213,600	$224,200	$10,600
2038	$216,400	$227,200	$10,800
2039	$219,300	$230,200	$10,900
2040	$222,100	$233,200	$11,100
2041	$225,000	$236,200	$11,200
2042	$227,800	$239,100	$11,300
2043	$230,600	$242,100	$11,500
2044	$233,500	$245,100	$11,600
2045	$236,300	$248,100	$11,800
2046	$239,200	$251,100	$11,900
		Total Benefits:	**$210,400**

Table 41: Estimated Annual Safety Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$-	$-
2027	$-	$-	$-
2028	$-	$-	$-
2029	$-	$-	$-
2030	$-	$-	$-
2031	$-	$-	$-
2032	$-	$-	$-
2033	$-	$-	$-
2034	$-	$-	$-
2035	$-	$-	$-
2036	$-	$-	$-
2037	$-	$-	$-
2038	$-	$-	$-
2039	$-	$-	$-
2040	$-	$-	$-
2041	$-	$-	$-
2042	$-	$-	$-
2043	$-	$-	$-
2044	$-	$-	$-
2045	$-	$-	$-
2046	$-	$-	$-
		Total Benefits:	

Table 42: Estimated Annual State of Good Repair Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$-	$-
2027	$25,000	$26,300	$1,300
2028	$25,400	$26,700	$1,300
2029	$25,800	$27,100	$1,300
2030	$26,200	$27,500	$1,300
2031	$26,600	$27,900	$1,300
2032	$27,000	$28,300	$1,300
2033	$27,300	$28,700	$1,400
2034	$27,700	$29,100	$1,400
2035	$28,100	$29,500	$1,400
2036	$28,500	$29,900	$1,400
2037	$28,900	$30,300	$1,400
2038	$29,300	$30,700	$1,400
2039	$29,700	$31,100	$1,400
2040	$30,000	$31,500	$1,500
2041	$30,400	$31,900	$1,500
2042	$30,800	$32,300	$1,500
2043	$31,200	$32,800	$1,600
2044	$31,600	$33,200	$1,600
2045	$32,000	$33,600	$1,600
2046	$32,300	$34,000	$1,700
		Total Benefits:	**$28,600**

Table 43: Estimated Annual Maintenance Disbenefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023			
2024			
2025			
2026			
2027	$-	$(150,000)	$(150,000)
2028	$-	$(150,000)	$(150,000)
2029	$-	$(150,000)	$(150,000)
2030	$-	$(150,000)	$(150,000)
2031	$-	$(150,000)	$(150,000)
2032	$-	$(150,000)	$(150,000)
2033	$-	$(150,000)	$(150,000)
2034	$-	$(150,000)	$(150,000)
2035	$-	$(150,000)	$(150,000)
2036	$-	$(150,000)	$(150,000)
2037	$-	$(150,000)	$(150,000)
2038	$-	$(150,000)	$(150,000)
2039	$-	$(150,000)	$(150,000)
2040	$-	$(150,000)	$(150,000)
2041	$-	$(150,000)	$(150,000)
2042	$-	$(150,000)	$(150,000)
2043	$-	$(150,000)	$(150,000)
2044	$-	$(150,000)	$(150,000)
2045	$-	$(150,000)	$(150,000)
2046	$-	$(150,000)	$(150,000)
		Total Benefits:	**$(3,000,000)**

Table 44: Estimated Annual Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$-	$-
2027	$5,130,000	$5,350,000	$220,000
2028	$5,210,000	$5,440,000	$230,000
2029	$5,290,000	$5,520,000	$230,000
2030	$5,370,000	$5,610,000	$240,000
2031	$5,450,000	$5,690,000	$240,000
2032	$5,530,000	$5,780,000	$250,000
2033	$5,600,000	$5,860,000	$260,000
2034	$5,680,000	$5,940,000	$260,000
2035	$5,760,000	$6,030,000	$270,000
2036	$5,840,000	$6,120,000	$280,000
2037	$5,920,000	$6,200,000	$280,000
2038	$6,000,000	$6,290,000	$290,000
2039	$6,070,000	$6,360,000	$290,000
2040	$6,150,000	$6,450,000	$300,000
2041	$6,230,000	$6,540,000	$310,000
2042	$6,310,000	$6,620,000	$310,000
2043	$6,390,000	$6,710,000	$320,000
2044	$6,470,000	$6,790,000	$320,000
2045	$6,550,000	$6,880,000	$330,000
2046	$6,620,000	$9,790,000	$3,170,000
		Total Benefits:	**$8,400,000**

Table 45: *Estimated Discounted Net Costs and Benefits (discounted at 7%)*[22]

Year	Discounted Costs	Discounted Benefits	Net Cumulative Discounted Costs and Benefits
2023	$-	$-	$-
2024	$(1,040,000)	$-	$(1,040,000)
2025	$(970,000)	$-	$(2,010,000)
2026	$(4,240,000)	$-	$(6,260,000)
2027	$-	$150,000	$(6,110,000)
2028	$-	$140,000	$(5,970,000)
2029	$-	$140,000	$(5,830,000)
2030	$-	$130,000	$(5,700,000)
2031	$-	$120,000	$(5,580,000)
2032	$-	$120,000	$(5,460,000)
2033	$-	$110,000	$(5,340,000)
2034	$-	$110,000	$(5,240,000)
2035	$-	$100,000	$(5,130,000)
2036	$-	$100,000	$(5,030,000)
2037	$-	$100,000	$(4,940,000)
2038	$-	$90,000	$(4,840,000)
2039	$-	$90,000	$(4,760,000)
2040	$-	$80,000	$(4,670,000)
2041	$-	$80,000	$(4,590,000)
2042	$-	$80,000	$(4,520,000)
2043	$-	$70,000	$(4,450,000)
2044	$-	$70,000	$(4,380,000)
2045	$-	$70,000	$(4,310,000)
2046	$-	$580,000	$(3,730,000)
Total Net Discounted Costs: $ 6,250,000		**Total Discounted Net Benefits: $2,530,000**	**Net Present Value: $3,730,000**
			Benefit-Cost Ratio: 0.4:1

[22] Carbon reduction benefits were discounted at 3%

Oakland Bay Trail Extension

Table 1646 through Table 2557 display the results of the benefit-cost analysis for each year of the analysis period. This BCA estimates the project compared to the no-build scenario over a 23-year evaluation (2023-2045) and at a 7 percent real discount rate will have a net present value of **$12,180,000** and a benefit-cost ratio of **13.9 : 1.0.**

Table 46: Estimated Annual Bicycle and Walk Trips

Year	Baseline	Build Scenario	Additional Trips
2023	25,423,200	25,423,200	-
2024	25,838,100	25,838,100	-
2025	26,252,900	26,252,900	-
2026	26,667,800	26,942,300	274,500
2027	27,082,700	27,361,800	279,100
2028	27,497,500	27,781,200	283,700
2029	27,912,400	28,200,700	288,300
2030	28,327,300	28,620,100	292,800
2031	28,742,100	29,039,600	297,500
2032	29,157,000	29,459,000	302,000
2033	29,571,900	29,878,500	306,600
2034	29,986,700	30,297,900	311,200
2035	30,401,600	30,717,400	315,800
2036	30,816,500	31,136,800	320,300
2037	31,231,300	31,556,300	325,000
2038	31,646,200	31,975,700	329,500
2039	32,061,100	32,395,200	334,100
2040	32,475,900	32,814,600	338,700
2041	32,890,800	33,234,100	343,300
2042	33,305,700	33,653,500	347,800
2043	33,720,500	34,073,000	352,500
2044	34,135,400	34,492,400	357,000
2045	34,550,300	34,911,900	361,600
		Total Additional Trips:	**6,361,300**

Table 47: Estimated Annual Vehicle Miles Reduced

Year	Baseline	Build Scenario	Additional Vehicle Miles Reduced
2023	14,496,000	14,496,000	-
2024	14,734,300	14,734,300	-
2025	14,972,700	14,972,700	-
2026	15,211,100	15,310,700	99,600
2027	15,449,400	15,550,700	101,300
2028	15,687,800	15,790,700	102,900
2029	15,926,100	16,030,800	104,700
2030	16,164,500	16,270,800	106,300
2031	16,402,900	16,510,800	107,900
2032	16,641,200	16,750,800	109,600
2033	16,879,600	16,990,900	111,300
2034	17,118,000	17,230,900	112,900
2035	17,356,300	17,470,900	114,600
2036	17,594,700	17,710,900	116,200
2037	17,833,000	17,950,900	117,900
2038	18,071,400	18,191,000	119,600
2039	18,309,800	18,431,000	121,200
2040	18,548,100	18,671,000	122,900
2041	18,786,500	18,911,000	124,500
2042	19,024,900	19,151,100	126,200
2043	19,263,200	19,391,100	127,900
2044	19,501,600	19,631,100	129,500
2045	19,739,900	19,871,100	131,200
Total Additional Vehicle Miles Reduced:			**2,308,200**

Table 48: Estimated Annual Environmental Sustainability Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$689,800	$694,300	$4,500
2027	$713,600	$718,300	$4,700
2028	$736,600	$741,400	$4,800
2029	$761,200	$766,200	$5,000
2030	$792,200	$797,400	$5,200
2031	$811,100	$816,500	$5,400
2032	$830,300	$835,800	$5,500
2033	$849,700	$855,300	$5,600
2034	$869,400	$875,100	$5,700
2035	$889,200	$895,000	$5,800
2036	$917,000	$923,100	$6,100
2037	$937,400	$943,600	$6,200
2038	$958,000	$964,300	$6,300
2039	$978,800	$985,200	$6,400
2040	$999,700	$1,006,400	$6,700
2041	$1,029,300	$1,036,100	$6,800
2042	$1,050,800	$1,057,800	$7,000
2043	$1,072,600	$1,079,700	$7,100
2044	$1,094,500	$1,101,800	$7,300
2045	$1,116,700	$1,124,100	$7,400
		Total Benefits:	**$119,500**

Table 49: Estimated Annual Quality of Life Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$92,610,000	$93,710,000	$1,100,000
2027	$94,050,000	$95,160,000	$1,110,000
2028	$95,490,000	$96,620,000	$1,130,000
2029	$96,930,000	$98,080,000	$1,150,000
2030	$98,370,000	$99,540,000	$1,170,000
2031	$99,810,000	$101,000,000	$1,190,000
2032	$101,250,000	$102,460,000	$1,210,000
2033	$102,690,000	$103,920,000	$1,230,000
2034	$104,130,000	$105,380,000	$1,250,000
2035	$105,570,000	$106,830,000	$1,260,000
2036	$107,010,000	$108,290,000	$1,280,000
2037	$108,450,000	$109,750,000	$1,300,000
2038	$109,890,000	$111,210,000	$1,320,000
2039	$111,330,000	$112,670,000	$1,340,000
2040	$112,780,000	$114,130,000	$1,350,000
2041	$114,220,000	$115,590,000	$1,370,000
2042	$115,660,000	$117,050,000	$1,390,000
2043	$117,100,000	$118,500,000	$1,400,000
2044	$118,540,000	$119,960,000	$1,420,000
2045	$119,980,000	$121,420,000	$1,440,000
		Total Benefits:	**$25,410,000**

Table 50: Estimated Annual Economic Competitiveness Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$7,907,600	$7,959,400	$51,800
2027	$8,031,500	$8,084,200	$52,700
2028	$8,155,400	$8,208,900	$53,500
2029	$8,279,300	$8,333,700	$54,400
2030	$8,403,300	$8,458,500	$55,200
2031	$8,527,200	$8,583,300	$56,100
2032	$8,651,100	$8,708,100	$57,000
2033	$8,775,000	$8,832,800	$57,800
2034	$8,898,900	$8,957,600	$58,700
2035	$9,022,800	$9,082,400	$59,600
2036	$9,146,700	$9,207,200	$60,500
2037	$9,270,700	$9,331,900	$61,200
2038	$9,394,600	$9,456,700	$62,100
2039	$9,518,500	$9,581,500	$63,000
2040	$9,642,400	$9,706,300	$63,900
2041	$9,766,300	$9,831,100	$64,800
2042	$9,890,200	$9,955,800	$65,600
2043	$10,014,100	$10,080,600	$66,500
2044	$10,138,100	$10,205,400	$67,300
2045	$10,262,000	$10,330,200	$68,200
		Total Benefits:	**$1,199,900**

Table 51: Estimated Annual Safety Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$310,000	$310,000
2027	$-	$310,000	$310,000
2028	$-	$310,000	$310,000
2029	$-	$310,000	$310,000
2030	$-	$310,000	$310,000
2031	$-	$310,000	$310,000
2032	$-	$310,000	$310,000
2033	$-	$310,000	$310,000
2034	$-	$310,000	$310,000
2035	$-	$310,000	$310,000
2036	$-	$310,000	$310,000
2037	$-	$310,000	$310,000
2038	$-	$310,000	$310,000
2039	$-	$310,000	$310,000
2040	$-	$310,000	$310,000
2041	$-	$310,000	$310,000
2042	$-	$310,000	$310,000
2043	$-	$310,000	$310,000
2044	$-	$310,000	$310,000
2045	$-	$310,000	$310,000
		Total Benefits:	**6,200,000**

Table 52: Estimated Annual State of Good Repair Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$1,069,500	$1,076,500	$7,000
2027	$1,086,300	$1,093,400	$7,100
2028	$1,103,000	$1,110,300	$7,300
2029	$1,119,800	$1,127,200	$7,400
2030	$1,136,600	$1,144,000	$7,400
2031	$1,153,300	$1,160,900	$7,600
2032	$1,170,100	$1,177,800	$7,700
2033	$1,186,800	$1,194,700	$7,900
2034	$1,203,600	$1,211,500	$7,900
2035	$1,220,400	$1,228,400	$8,000
2036	$1,237,100	$1,245,300	$8,200
2037	$1,253,900	$1,262,200	$8,300
2038	$1,270,600	$1,279,100	$8,500
2039	$1,287,400	$1,295,900	$8,500
2040	$1,304,200	$1,312,800	$8,600
2041	$1,320,900	$1,329,700	$8,800
2042	$1,337,700	$1,346,600	$8,900
2043	$1,354,400	$1,363,400	$9,000
2044	$1,371,200	$1,380,300	$9,100
2045	$1,388,000	$1,397,200	$9,200
		Total Benefits:	**$162,400**

Table 53: Estimated Annual Maintenance Disbenefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$ (4,000)	$ (4,000)
2027	$-	$ (4,000)	$ (4,000)
2028	$-	$ (4,000)	$ (4,000)
2029	$-	$ (4,000)	$ (4,000)
2030	$-	$ (4,000)	$ (4,000)
2031	$-	$ (4,000)	$ (4,000)
2032	$-	$ (4,000)	$ (4,000)
2033	$-	$ (4,000)	$ (4,000)
2034	$-	$ (4,000)	$ (4,000)
2035	$-	$ (4,000)	$ (4,000)
2036	$-	$ (4,000)	$ (4,000)
2037	$-	$ (4,000)	$ (4,000)
2038	$-	$ (4,000)	$ (4,000)
2039	$-	$ (4,000)	$ (4,000)
2040	$-	$ (4,000)	$ (4,000)
2041	$-	$ (4,000)	$ (4,000)
2042	$-	$ (4,000)	$ (4,000)
2043	$-	$ (4,000)	$ (4,000)
2044	$-	$ (4,000)	$ (4,000)
2045	$-	$ (4,000)	$ (4,000)
		Total Benefits:	**$(80,000)**

Table 54: Estimated Annual Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$102,280,000	$103,750,000	$1,470,000
2027	$103,880,000	$105,370,000	$1,490,000
2028	$105,490,000	$107,000,000	$1,510,000
2029	$107,090,000	$108,620,000	$1,530,000
2030	$108,700,000	$110,250,000	$1,550,000
2031	$110,300,000	$111,870,000	$1,570,000
2032	$111,900,000	$113,490,000	$1,590,000
2033	$113,500,000	$115,110,000	$1,610,000
2034	$115,100,000	$116,730,000	$1,630,000
2035	$116,710,000	$118,350,000	$1,640,000
2036	$118,310,000	$119,970,000	$1,660,000
2037	$119,920,000	$121,600,000	$1,680,000
2038	$121,520,000	$123,220,000	$1,700,000
2039	$123,120,000	$124,840,000	$1,720,000
2040	$124,720,000	$126,460,000	$1,740,000
2041	$126,330,000	$128,090,000	$1,760,000
2042	$127,930,000	$129,710,000	$1,780,000
2043	$129,540,000	$131,340,000	$1,800,000
2044	$131,140,000	$132,960,000	$1,820,000
2045	$132,740,000	$134,980,000	$2,240,000
		Total Benefits:	**$33,490,000**

Table 55: *Estimated Discounted Net Costs and Benefits (discounted at 7%)*[23]

Year	Discounted Costs	Discounted Benefits	Net Cumulative Discounted Costs and Benefits
2023	$(160,000)	$-	$(160,000)
2024	$(150,000)	$-	$(300,000)
2025	$(640,000)	$-	$(940,000)
2026	$-	$1,050,000	$100,000
2027	$-	$990,000	$1,100,000
2028	$-	$940,000	$2,040,000
2029	$-	$890,000	$2,930,000
2030	$-	$840,000	$3,770,000
2031	$-	$800,000	$4,570,000
2032	$-	$750,000	$5,320,000
2033	$-	$710,000	$6,030,000
2034	$-	$680,000	$6,710,000
2035	$-	$640,000	$7,350,000
2036	$-	$600,000	$7,950,000
2037	$-	$570,000	$8,520,000
2038	$-	$540,000	$9,060,000
2039	$-	$510,000	$9,570,000
2040	$-	$480,000	$10,060,000
2041	$-	$460,000	$10,510,000
2042	$-	$430,000	$10,940,000
2043	$-	$410,000	$11,350,000
2044	$-	$390,000	$11,740,000
2045	$-	$440,000	$12,180,000
Total Net Discounted Costs: $ 950,000		**Total Discounted Net Benefits: $13,120,000**	**Net Present Value: $12,180,000**
			Benefit-Cost Ratio: 13.89:1

[23] Carbon reduction benefits were discounted at 3%

Table 1656 through Table 2565 display the results of the benefit-cost analysis for each year of the analysis period. This BCA estimates the project compared to the no-build scenario over a 23-year evaluation (2023-2045) and at a 7 percent real discount rate will have a net present value of **$3,350,000** and a benefit-cost ratio of **1.57 : 1.0.**

Table 56: Estimated Annual Bicycle and Walk Trips

Year	Baseline	Build Scenario	Additional Trips
2023	1,072,900	1,072,900	-
2024	1,090,300	1,090,300	-
2025	1,107,800	1,107,800	-
2026	1,125,200	1,276,700	151,500
2027	1,142,600	1,296,600	154,000
2028	1,160,000	1,316,500	156,500
2029	1,177,400	1,336,500	159,100
2030	1,194,800	1,356,400	161,600
2031	1,212,200	1,376,400	164,200
2032	1,229,600	1,396,300	166,700
2033	1,247,000	1,416,200	169,200
2034	1,264,500	1,436,200	171,700
2035	1,281,900	1,456,100	174,200
2036	1,299,300	1,476,100	176,800
2037	1,316,700	1,496,000	179,300
2038	1,334,100	1,515,900	181,800
2039	1,351,500	1,535,900	184,400
2040	1,368,900	1,555,800	186,900
2041	1,386,300	1,575,800	189,500
2042	1,403,700	1,595,700	192,000
2043	1,421,200	1,615,600	194,400
2044	1,438,600	1,635,600	197,000
2045	1,456,000	1,655,500	199,500
		Total Additional Trips:	**3,510,300**

Table 57: Estimated Annual Vehicle Miles Reduced

Year	Baseline	Build Scenario	Additional Vehicle Miles Reduced
2023	178,100	178,100	-
2024	181,100	181,100	-
2025	184,000	184,000	-
2026	186,900	216,300	29,400
2027	189,800	219,700	29,900
2028	192,700	223,100	30,400
2029	195,600	226,500	30,900
2030	198,600	229,900	31,300
2031	201,500	233,300	31,800
2032	204,400	236,700	32,300
2033	207,300	240,100	32,800
2034	210,200	243,500	33,300
2035	213,200	246,900	33,700
2036	216,100	250,300	34,200
2037	219,000	253,700	34,700
2038	221,900	257,200	35,300
2039	224,800	260,600	35,800
2040	227,800	264,000	36,200
2041	230,700	267,400	36,700
2042	233,600	270,800	37,200
2043	236,500	274,200	37,700
2044	239,400	277,600	38,200
2045	242,300	281,000	38,700
Total Additional Vehicle Miles Reduced:			**680,500**

Table 58: Estimated Annual Environmental Sustainability Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$8,500	$9,800	$1,300
2027	$8,800	$10,100	$1,300
2028	$9,000	$10,500	$1,500
2029	$9,400	$10,800	$1,400
2030	$9,700	$11,300	$1,600
2031	$10,000	$11,500	$1,500
2032	$10,200	$11,800	$1,600
2033	$10,400	$12,100	$1,700
2034	$10,700	$12,400	$1,700
2035	$10,900	$12,700	$1,800
2036	$11,300	$13,000	$1,700
2037	$11,500	$13,300	$1,800
2038	$11,800	$13,600	$1,800
2039	$12,000	$13,900	$1,900
2040	$12,300	$14,200	$1,900
2041	$12,600	$14,600	$2,000
2042	$12,900	$15,000	$2,100
2043	$13,200	$15,300	$2,100
2044	$13,400	$15,600	$2,200
2045	$13,700	$15,900	$2,200
		Total Benefits:	**$35,100**

Table 59: Estimated Annual Quality of Life Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$4,640,000	$5,250,000	$610,000
2027	$4,720,000	$5,330,000	$610,000
2028	$4,790,000	$5,410,000	$620,000
2029	$4,860,000	$5,500,000	$640,000
2030	$4,930,000	$5,580,000	$650,000
2031	$5,000,000	$5,660,000	$660,000
2032	$5,070,000	$5,740,000	$670,000
2033	$5,150,000	$5,820,000	$670,000
2034	$5,220,000	$5,900,000	$680,000
2035	$5,290,000	$5,990,000	$700,000
2036	$5,360,000	$6,070,000	$710,000
2037	$5,430,000	$6,150,000	$720,000
2038	$5,510,000	$6,230,000	$720,000
2039	$5,580,000	$6,310,000	$730,000
2040	$5,650,000	$6,400,000	$750,000
2041	$5,720,000	$6,480,000	$760,000
2042	$5,790,000	$6,560,000	$770,000
2043	$5,870,000	$6,640,000	$770,000
2044	$5,940,000	$6,720,000	$780,000
2045	$6,010,000	$6,810,000	$800,000
		Total Benefits:	**$14,020,000**

Table 60: Estimated Annual Economic Competitiveness Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$97,200	$112,400	$15,200
2027	$98,700	$114,200	$15,500
2028	$100,200	$116,000	$15,800
2029	$101,700	$117,700	$16,000
2030	$103,200	$119,500	$16,300
2031	$104,700	$121,300	$16,600
2032	$106,300	$123,100	$16,800
2033	$107,800	$124,800	$17,000
2034	$109,300	$126,600	$17,300
2035	$110,800	$128,400	$17,600
2036	$112,300	$130,100	$17,800
2037	$113,800	$131,900	$18,100
2038	$115,400	$133,700	$18,300
2039	$116,900	$135,500	$18,600
2040	$118,400	$137,200	$18,800
2041	$119,900	$139,000	$19,100
2042	$121,400	$140,800	$19,400
2043	$122,900	$142,500	$19,600
2044	$124,500	$144,300	$19,800
2045	$126,000	$146,100	$20,100
		Total Benefits:	**$353,700**

Table 61: Estimated Annual Safety Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$-	$450,000	$450,000
2027	$-	$450,000	$450,000
2028	$-	$450,000	$450,000
2029	$-	$450,000	$450,000
2030	$-	$450,000	$450,000
2031	$-	$450,000	$450,000
2032	$-	$450,000	$450,000
2033	$-	$450,000	$450,000
2034	$-	$450,000	$450,000
2035	$-	$450,000	$450,000
2036	$-	$450,000	$450,000
2037	$-	$450,000	$450,000
2038	$-	$450,000	$450,000
2039	$-	$450,000	$450,000
2040	$-	$450,000	$450,000
2041	$-	$450,000	$450,000
2042	$-	$450,000	$450,000
2043	$-	$450,000	$450,000
2044	$-	$450,000	$450,000
2045	$-	$450,000	$450,000
		Total Benefits:	**$9,000,000**

Table 62: Estimated Annual State of Good Repair Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$13,100	$15,200	$2,100
2027	$13,300	$15,400	$2,100
2028	$13,600	$15,700	$2,100
2029	$13,800	$15,900	$2,100
2030	$14,000	$16,200	$2,200
2031	$14,200	$16,400	$2,200
2032	$14,400	$16,600	$2,200
2033	$14,600	$16,900	$2,300
2034	$14,800	$17,100	$2,300
2035	$15,000	$17,400	$2,400
2036	$15,200	$17,600	$2,400
2037	$15,400	$17,800	$2,400
2038	$15,600	$18,100	$2,500
2039	$15,800	$18,300	$2,500
2040	$16,000	$18,600	$2,600
2041	$16,200	$18,800	$2,600
2042	$16,400	$19,000	$2,600
2043	$16,600	$19,300	$2,700
2044	$16,800	$19,500	$2,700
2045	$17,000	$19,800	$2,800
		Total Benefits:	**$47,800**

Table 63: Estimated Annual Maintenance Disbenefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023			
2024			
2025			
2026	$-	$(60,000)	$(60,000)
2027	$-	$(60,000)	$(60,000)
2028	$-	$(60,000)	$(60,000)
2029	$-	$(60,000)	$(60,000)
2030	$-	$(60,000)	$(60,000)
2031	$-	$(60,000)	$(60,000)
2032	$-	$(60,000)	$(60,000)
2033	$-	$(60,000)	$(60,000)
2034	$-	$(60,000)	$(60,000)
2035	$-	$(60,000)	$(60,000)
2036	$-	$(60,000)	$(60,000)
2037	$-	$(60,000)	$(60,000)
2038	$-	$(60,000)	$(60,000)
2039	$-	$(60,000)	$(60,000)
2040	$-	$(60,000)	$(60,000)
2041	$-	$(60,000)	$(60,000)
2042	$-	$(60,000)	$(60,000)
2043	$-	$(60,000)	$(60,000)
2044	$-	$(60,000)	$(60,000)
2045	$-	$(60,000)	$(60,000)
		Total Benefits:	**$(1,200,000)**

Table 64: Estimated Annual Benefits (Undiscounted)

Year	Baseline	Build Scenario	Benefits
2023	$-	$-	$-
2024	$-	$-	$-
2025	$-	$-	$-
2026	$4,760,000	$5,770,000	$1,010,000
2027	$4,840,000	$5,860,000	$1,020,000
2028	$4,910,000	$5,940,000	$1,030,000
2029	$4,980,000	$6,020,000	$1,040,000
2030	$5,060,000	$6,110,000	$1,050,000
2031	$5,130,000	$6,190,000	$1,060,000
2032	$5,210,000	$6,280,000	$1,070,000
2033	$5,280,000	$6,360,000	$1,080,000
2034	$5,350,000	$6,440,000	$1,090,000
2035	$5,430,000	$6,530,000	$1,100,000
2036	$5,500,000	$6,610,000	$1,110,000
2037	$5,570,000	$6,690,000	$1,120,000
2038	$5,650,000	$6,780,000	$1,130,000
2039	$5,720,000	$6,860,000	$1,140,000
2040	$5,800,000	$6,950,000	$1,150,000
2041	$5,870,000	$7,030,000	$1,160,000
2042	$5,940,000	$7,110,000	$1,170,000
2043	$6,020,000	$7,200,000	$1,180,000
2044	$6,090,000	$7,290,000	$1,200,000
2045	$6,170,000	$9,880,000	$3,710,000
		Total Benefits:	**$24,620,000**

Table 65: *Estimated Discounted Net Costs and Benefits (discounted at 7%)*[24]

Year	Discounted Costs	Discounted Benefits	Net Cumulative Discounted Costs and Benefits
2023	$(960,000)	$-	$(960,000)
2024	$(940,000)	$-	$(1,900,000)
2025	$(4,010,000)	$-	$(5,900,000)
2026	$-	$720,000	$(5,190,000)
2027	$-	$680,000	$(4,510,000)
2028	$-	$640,000	$(3,870,000)
2029	$-	$600,000	$(3,260,000)
2030	$-	$570,000	$(2,690,000)
2031	$-	$540,000	$(2,150,000)
2032	$-	$510,000	$(1,640,000)
2033	$-	$480,000	$(1,170,000)
2034	$-	$450,000	$(710,000)
2035	$-	$430,000	$(280,000)
2036	$-	$400,000	$120,000
2037	$-	$380,000	$500,000
2038	$-	$360,000	$860,000
2039	$-	$340,000	$1,200,000
2040	$-	$320,000	$1,520,000
2041	$-	$300,000	$1,820,000
2042	$-	$280,000	$2,100,000
2043	$-	$270,000	$2,370,000
2044	$-	$250,000	$2,620,000
2045	$-	$730,000	$3,350,000
Total Net Discounted Costs: $ 5,910,000		**Total Discounted Net Benefits: $9,250,000**	**Net Present Value: $3,350,000**
			Benefit-Cost Ratio: 1:57:1

[24] Carbon reduction benefits were discounted at 3%

To: BCA Reviewers

From: Grace Young, Rohan Oprisko, Mike Sellinger, and David Wasserman, Alta Planning + Design

Date: April 1, 2022

Re: Modal Shift Model Notes

Modal Substitution Rates: Introduction

Modal substitution rates refer to the percentage of users of a facility who substituted one mode for another (Volker et al. 2019). These rates are often determined from survey instruments asking about alternative modes. When users substitute a carbon-free mode like biking for a carbon-intensive mode like driving, there is an associated emissions savings, proportional to the length of the trip. The following model provides a means for estimating the percentage of future facility users that will substitute a carbon-free mode in place of driving. This serves as a crucial step in identifying reductions in vehicle miles traveled and the emissions-saving benefits of the proposed facility.

Methodology

A series of univariate regression models were tested on peer-reviewed auto-to-bike substitution rates for projects in 10 cities around the United States. Six variables were collected at the city level and tested as inputs in a univariate regression model predicting the modal shift factor using an ordinary least squares regression from the statsmodels Python library. The variables are described in Table 1. The same variables were also tested in predicting the natural log of the modal shift percentage.

Data Review

Table 1. Peer-reviewed auto-to-bike modal shift factor and six demographic variables reported for the respective project cities[1]

City	Modal Shift (ratio)	Population Density (people per sq. mi.)	Median Income ($)	Travel Time to Work (min.)	% of Trips <4 Miles (ratio)	Active Mode Split (ratio)	Bike Mode Split (ratio)	Source
Los Angeles, CA	0.109	8,092	62,142	32	0.471	0.147	0.030	Matute et al. (2016)
Denver, CO	0.237	3,923	68,592	26	0.531	0.251	0.015	Piatkowski et al. (2015)
Boulder, CO	0.571	3,948	69,520	20	0.652	0.283	0.045	Piatkowski et al. (2015)
Littleton, CO[2]	0.724	3,215	76,105	26	0.512	0.254	0.060	Piatkowski et al. (2015)
Sacramento, CA	0.273	4,764	62,335	26	0.437	0.195	0.090	Piatkowski et al. (2015)

City	Modal Shift (ratio)	Population Density (people per sq. mi.)	Median Income ($)	Travel Time to Work (min.)	% of Trips <4 Miles (ratio)	Active Mode Split (ratio)	Bike Mode Split (ratio)	Source
Davis, CA	0.250	6,637	69,3709	23	0.636	0.220	0.095	Piatkowski et al. (2015)
Austin, TX	0.146	2,653	71,576	25	0.502	0.179	0.016	Monsere et al. (2014)
Chicago, IL	0.374	11,841	58,247	35	0.598	0.377	0.070	Monsere et al. (2014)
Portland, OR	0.202	4,375	71,005	27	0.538	0.267	0.027	Monsere et al. (2014)
San Francisco, CA	0.263	17,179	112,449	34	0.547	0.245	0.060	Monsere et al. (2014)
Washington, DC	0.202	9,856	86,420	31	0.564	0.311	0.018	Monsere et al. (2014)

Notes:

min. : minute

sq. mi. : square mile

1. Adapted from Volker et al. 2019.
2. Littleton, CO, was removed as an outlier in this modeling exercise for both final models.
3. All sources can be found in the Volker, J et. al (2019) paper specified in the references section.

Results

We found two acceptable models for contextual estimation of modal substitution rates given the available data: the examination of short trips (under 4 miles) and the active mode split model. Alta's preferred model is the examination of short trips due to its theoretical consistency with the idea that short trips are indicators that a higher proportion of vehicle trips can be converted to active modes given improved infrastructure and support. Alta uses the active mode split model depending on the available data sources on a given project or for sensitivity analysis to generate a conservative estimate.

Correlation and R-Squared

Table 2. Variable performance in correlation test and ordinary least squares univariate regression

Variable	Source	Correlation with Modal Shift	Correlation with ln (Modal Shift)	Adjusted R-Squared Predicting Modal Shift		Adjusted R-Squared Predicting ln (Modal Shift)	
				No Constant	With Constant	No Constant	With Constant
Population Density	Census	-0.21	-0.11	0.411	-0.063	0.663	-0.098

Variable	Source	Correlation with Modal Shift	Correlation with ln (Modal Shift)	Adjusted R-Squared Predicting Modal Shift		Adjusted R-Squared Predicting ln (Modal Shift)	
				No Constant	With Constant	No Constant	With Constant
Median Income	Census	-0.01	0.03	0.689	-0.111	0.813	-0.110
Travel Time to Work	Census	-0.32	-0.30	0.653	0.001	0.864	-0.014
Percent of Trips Under 4 Miles	Replica Places (2022)	0.31	0.41	0.744	-0.005	0.805	0.076
Active Mode Split (all trips)	Replica Places (2022)	0.39	0.53	0.763	0.057	0.709	0.200
Bike Mode Split	Replica Places (2022)	0.32	0.43	0.654	0.003	0.479	0.090

Note:

All values reported in this table are for models without the Littleton, CO outlier removed.

Linear Relationship Plots

Figure 1 and Figure 2 show the linear relationship between the log of modal shift and the percentage of trips less than 4 miles or active mode share, respectively. Littleton, CO, is identified as an outlier in both cases and thus removed for the final model development.

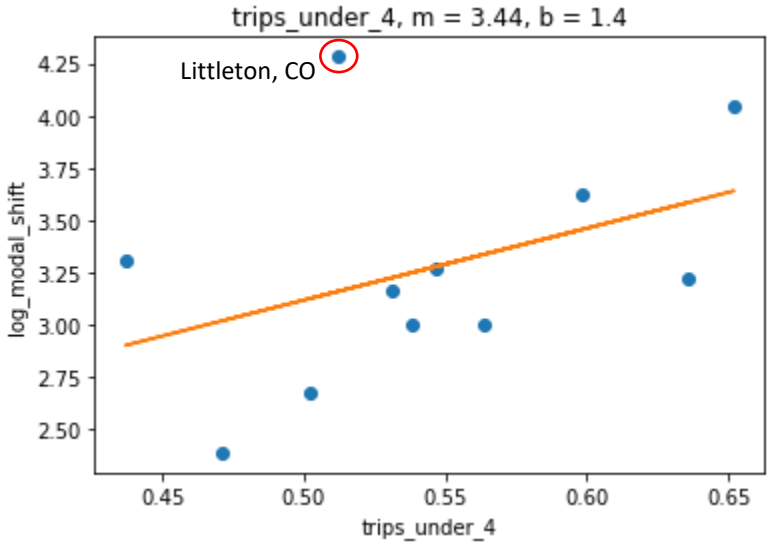

Figure 1. Modeled Relationships Between the Percentage of Short Trips and the Log of Modal Shift

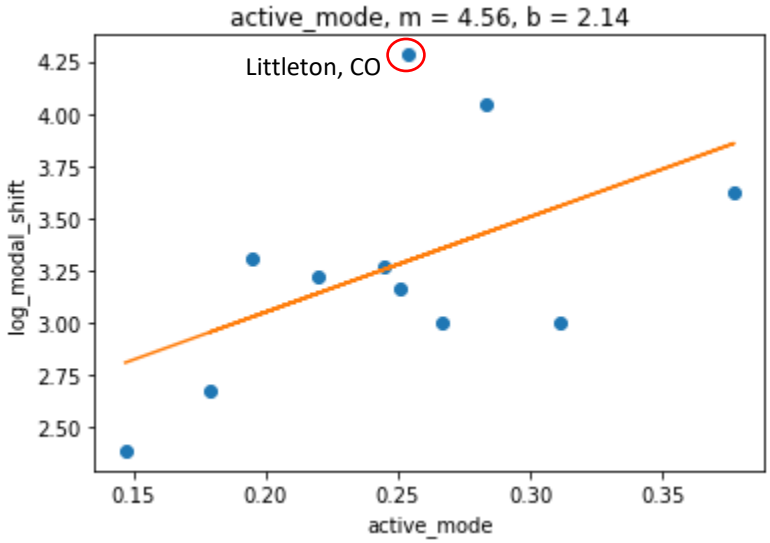

Figure 2. Modeled Relationships Between Active Mode Share and the Log of Modal Shift

Final Model Summaries

The two acceptable models are summarized in Table 3, along with the derived equations for applying each to a project-specific context.

Table 3. Model summaries for acceptable final models

Dependent Variable	*Log modal shift percentage*		Dependent Variable	*Log modal shift percentage*	
R-squared	*0.424*		R-squared	*0.414*	
Independent Variable	Coefficient	P-Value	Independent Variable	Coefficient	P-Value
Percent of trips under 4 miles	4.39	0.041	Active mode share	1.85	0.045
Constant	0.77	0.462	Constant	2.08	0.002
Equation			Equation		
ln(modal shift %) = 0.77 + 4.39*(% trips under 4 miles)			ln(modal shift %) = 2.08 + 1.85*(% active mode share)		

Discussion

These models enable a flexible and actionable approach to provide context-sensitive estimates of potential modal substitution rates given investments in multimodal infrastructure that are suitable for transportation planning practice. This approach aligns well with the understanding that compact, mixed-use locations with small urban footprints and high destination access encourage shorter trips and active travel (NASEM 2014). These models provide a decision-support tool to make informed and context-sensitive assessments of potential modal substitution rates given a project study boundary. Understanding how much reduction in vehicle miles traveled is possible given investments in active transportation is relevant to choosing a quick and responsive model.

However, there are limitations to this approach worth considering:

- While significant relationships were identified between these variables and modal substitution rates from literature, they are based on small sample sizes and depend on the removal of outliers.
- These models are not using any control variables. These univariate linear regression models are intended to enable quick determinations of possible modal substitution given a specific built context. While other variables such as population density or travel time to work were evaluated, they were not used as controls within the same model.
- Many other factors can influence rates of modal substitution beyond those identified here, and they warrant further study. It is highly complex result of localized intercept surveys, but their ranges from literature benefit from a context sensitive approach for analysis.

References

NASEM (National Academies of Sciences, Engineering, and Medicine). (2014). *Estimating Bicycling and Walking for Planning and Project Development: A Guidebook*. Washington, DC: The National Academies Press. https://doi.org/10.17226/22330

Volker, J., S. Handy, A. Kendall, and E. Barbour. (2019). *Quantifying Reductions in Vehicle Miles Traveled from New Bike Paths, Lanes, and Cycle Tracks: Summary Report.* California Air Resources Board (CARB). March 25, 2019.

Replica Places (2022). Replica Platform. Retrieved from https://replicahq.com/

CBI Rationale

These regression equations are the result of internal R&D at Alta and represent a data-driven approach to identifying realistic modal substitution rates given contextual information about a project area. Disclosure of these models before they can be further published in peer review research represents a disincentive for firms to advance research and development to advance context sensitive practice. This research was based on Alta Planning + Designs proprietary know-how and understanding of active transportation research and available data resources to inform them.