The Value of Time Saved: An Economic Evaluation of B-Line's High-Frequency Transit Proposal.

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Abstract

This report conducts a Benefit-Cost Analysis (BCA) of the proposed Mid-Term High-Frequency Service Project for Chico's B-Line proposed in the 2024 B-Line Routing Study, which introduces 15-minute weekday frequencies and Transit Signal Priority (TSP) on Routes 3 and 14. Using a 20-year analysis period and 2025 USDOT guidelines, the study finds a baseline Benefit-Cost Ratio (BCR) of 0.94 and a Net Present Value (NPV) of –$1.29 million, driven primarily by $18 million in travel time savings for transit-dependent populations against a $1.18 million annual increase in operating costs. Sensitivity analysis demonstrates that the project achieves a positive NPV under a 5% discount rate or higher projected ridership growth, and qualitative benefits like agglomeration economies and improved reliability further strengthen the case for investment. The paper ultimately recommends implementation, emphasizing that a transition to zero-emission vehicles and the prioritization of TSP capital investments will maximize societal net benefits and regional labor market efficiency.

I. Introduction

A safe and efficient transportation system forms the backbone of the nation's economy and is vital to the well-being of its population. Transportation infrastructure requires ongoing capital improvements to repair, rebuild, and modernize aging facilities to meet the needs of a growing economy. For mid-sized urban centers, investments that enhance public transit accessibility directly impact economic geography, supporting greater labor market efficiency and the positive spillovers associated with agglomeration economies.

In Chico, California, the Butte Regional Transit (B-Line) network faces the critical task of adapting its services to better meet current demands, recover from regional disruptions, and foster future growth. The B-Line Routing Study was developed precisely to evaluate and address areas of low performance and shift resources to better meet community needs within existing financial constraints.

This paper focuses on a significant, but under-investigated proposed service enhancement from the study's recommendations: the Mid-Term High-Frequency Service Project. This project proposes introducing 15-minute weekday service frequency on two high-ridership corridors, Route 3 (Nord/East) and Route 14 (Park/Forest/MLK) which can be seen in **Figure 38**. This upgrade, which targets key activity centers from the campus area to downtown and commercial hubs, necessitates an increase of 13,244 annual vehicle-hours and a capital investment in Transit Signal Priority (TSP) technology, along with the purchase of four additional buses.

The core challenge is quantifying the net economic worth of this enhancement. Although a compelling ridership increase of 56,000 boardings annually is forecast, the project carries a significant increase in operational costs, estimated at $1.18 Million annually. Therefore, this study undertakes a rigorous Benefit-Cost Analysis (BCA), adhering to the methodological framework and parameter values recommended by the U.S. Department of Transportation, to assess whether the project's societal benefits, such as monetized time savings and reduced external costs, outweigh its capital and operating expenditures.

Roadmap.

The remainder of this paper details the methodology, inputs, and results of the Benefit-Cost Analysis (BCA) to rigorously assess the economic feasibility of the Mid-Term High-Frequency Service Project.

Section II: Background and context establishes the necessity of the investment by defining the current B-Line system and the strategic importance of the two target corridors, Routes 3 and 14, in connecting core activity centers across Chico. This section justifies why high-frequency service is the appropriate intervention to address current congestion and maximize regional mobility. Additionally, this section will clearly define the scope of the project proposed in the *B-Line Routing Plan* in the context of B-line's current operations plan and budget.

Section III: Data and methodology clearly lays out the approach to this BCA in accordance with USDOT recommendations. Additionally, this section provides the sources and justifications for specific estimation values and techniques, as well as defines the end goal of the BCA – to estimate key valuation metrics which will be used to justify or reject the proposed project.

Section IV: Benefit cost analysis: calculations executes the core analysis. It systematically calculates the Net Benefits by monetizing Time Savings (for 56,000 induced boardings), External Highway Cost Reductions (congestion, noise, safety), and the Net Emission Benefit (offsetting increased bus emissions against reduced auto emissions).

Section VI: Results and discussion presents the final quantitative metrics: the Net Present Value and the Benefit-Cost Ratio. The discussion interprets these findings, analyzes the project's sensitivity to changes in key variables such as value of time and the discount rate, and includes a qualitative assessment of unmonetized benefits, such as Agglomeration Economies and Reliability Improvements.

Section VII: Conclusion and Policy Recommendation summarizes the economic findings and delivers the final policy recommendation to the Butte County Association of Governments regarding the fiscal justification and optimal timeline for implementing the high-frequency service upgrade.

II. Background & Context

The Butte County Association of Governments (BCAG) operates the B-Line system, which faced compelling economic and social challenges leading to the Routing Study. These challenges include the dramatic effects of the Camp Fire and COVID-19 pandemic, which collectively caused ridership to drop by 61% from its peak in FY 2012/13. The system must now utilize resources efficiently to serve current needs and implement longer-term plans.

Butte County exhibits a high need for public transit, a key justification for this investment:

- Transit Dependence: An onboard survey found that 70% of B-Line passengers do not have a car available for their trip.
- Vulnerable Populations: Butte County has a disproportionately high percentage of low-income residents (17.8% vs. 12.8% national average) and residents with a mobility-related disability (17.0% vs. 12.5% national average).
- Trip Purpose: The main reasons for riding the B-Line are essential trips: school (30%), work (25%), and shopping/personal errands (31%).

The proposed high-frequency investment targets Routes 3 (Nord/East) and Route 14 (Park/Forest/MLK) because they constitute the high-ridership potential corridors linking Chico's core activity centers. These routes connect the downtown/CSUC campus area (which generates approximately 30% of B-Line ridership) to the North Valley Plaza, major commercial centers, and the Butte College Chico Campus.

This focus aligns directly with the region's long-term planning, as the RTP/SCS calls for establishing a high-capacity transit corridor connecting North Valley Plaza, Chico State, Downtown, and the Chico Mall area.

The Baseline Problem: Poor On-Time Performance

The “No-Build” Baseline is defined by a system that fails to achieve reliable service, which actively discourages discretionary ridership. The need for Transit Signal Priority (TSP), a major capital component of this project, is grounded in documented on-time performance failures:

- Route 3 (Nord/East): This route has “relatively poor on-time performance,” operating late 25% of its runs
- Route 14 (Park/Forest/MLK): This route has “fair on-time performance,” operating late 17% of its runs.

The goal of the mid-term plan is to dramatically reduce the subjective user cost associated with these late arrivals and long headways, maximizing the ridership potential in these dense urban corridors.

III. Data and Methodology

This section will define the key assumptions, data sources, and calculations used to compare the societal benefits and costs of implementing the proposed 15-minute frequency service on B-Line Routes 3 and 14. The methodology and benefit estimation values for this BCA is drawn from USDOT’s *Benefit-Cost Analysis Guidance for Discretionary Grant Programs (2025).* Case specific data, projections, ridership numbers and cost estimates are primarily drawn from the *B-Line Routing Study (2024)* prepared by LSC Transportation Consultants, Inc. for Butte County Association of Governments (BCAG). Additional data sources and value estimates will be referenced as needed.

The goal of this benefit cost analysis is to estimate the net present value (NPV), the return on investment (ROI), and the benefit cost ratio (BCR) for the proposed project. Additional unquantified costs and benefits will be discussed as well.

General principles and scope

According to the USDOT, any estimates must be inflation adjusted, discounted, and compared to a well defined baseline or “no-build” alternative projection over the realistic service life of the project.

- All costs and benefits will be expressed in real 2023 dollars using the GDP deflator.
- The recommended discount real discount rate for streams of benefits and costs is 7%.
- The baseline “no-build” comparison will be defined as the continuation of the existing B-Line service on Routes 3 and 14 without the proposed 15-minute frequency upgrade or additional TSP installations.

- Projected ridership growth over the analysis period will be based on data and projections from *B-Line Routing Study*.
- In line with USDOT recommendations, a 20-year operating period will be used, plus any construction/implementation period.

Net Benefit Estimation
The benefits of the project can be broken down into three main categories: travel time savings, net emission reduction, and external highway use cost reduction.

Travel time savings: The primary quantifiable benefit is the time savings experienced by existing and new riders due to the reduction in service headway (waiting time) and potentially faster travel (reduced mean travel time). USDOT advises to estimate benefits for existing users and new additional user attracted to the improved service separately using the rule of ½ "reflecting the fact that additional users attracted by the improvement are each willing to pay less for trips than were original users, as evidenced by the fact that they were unwilling to incur the higher cost to use it in its unimproved condition."(USDOT, pp 29).

Therefore:

$$Total\ User\ Benefits\ =\ Benefits\ to\ Existing\ Users\ +\ Benefits\ to\ Additional\ Users$$

The USDOT provides value of time (VTTS) estimates of \$38.80 per person-hour for time spent waiting and \$19.40 per person-hour for travel time.

Benefits to existing users is the total reduction in wait and travel time for existing users multiplied by their respective VTTS estimates.

$$BEU\ =\ BPB\ \times\ \Delta WT\ \ \times\ \$38.80\ \ +BPB\ \times\ \Delta TR\ \ \times\ \$19.40$$

Where:
BEU: Benefits to existing users.
BPB: The total projected baseline number of boardings for a given year.
ΔWT: Change in average wait times
ΔTR: Change in average travel time

Benefit to additional users is ½ the total reduction in wait time for additional users multiplied by their respective VTTS estimates

$$BAU\ =\ 0.5\ \times\ \ (\ PAU\ \times\ \Delta WT\ \ \times\ \$38.80\ \ +PAU\ \times\ \Delta TR\ \ \times\ \$19.40)$$

Where:
BAU: Benefits to additional users.
PAU: Projected number of additional boardings for a given year.

Net emission reduction: The mode shift of induced riders from driving to transit will reduce VMT and thus reduce the emissions of air pollutants which has a measurable benefit. There is also an increase in air pollutants caused by the additional operational hours of the vehicles required to increase the service availability. Total emission reduction and additions will be estimated in metric tons per year and multiplied with values provided by USDOT in *Table A-6: Damage Costs for Emissions per Metric Ton.* The net benefit will be calculated by subtracting the additional emission damage cost from the reduction in emission damage cost.

- Note: B-line recently announced the delivery of 5 new electric, zero emission buses. If they continue to exclusively replace aging vehicles with zero emission vehicles the net benefits will be higher than estimated. However the zero emission replacement schedule is not readily available nor are capital expenditure costs, operation and maintenance costs, and expected operational lifespan values readily available. For these reasons this analysis assumes continuation of diesel bus usage throughout the analysis period.

External highway use cost reduction: This benefit consists of total safety cost reduction from reduced crashes, total congestion cost reduction, total noise cost reduction. The USDOT recommends multiplying the change in VMT by the values in *Table A-14: External Highway Use Costs* to estimate these benefits. This analysis will be using the *Light-Duty Vehicles - Urban* row as the service area of lines 3 and 14 are within the Chico urban area and the primary vehicles being substituted away from are civilian cars and trucks.

Vehicle operating costs: Additional riders will drive their cars less and therefore incur lower annual operating costs such as gasoline, maintenance, tires, and depreciation. The benefit is calculated by multiplying change in VMT by the value in Table A-4 ($0.56/VMT) provided by USDOT.

Unquantified Benefits (qualitative discussion): Two additional benefit areas – enhancement of Agglomeration Economies, and Reliability Improvements – are difficult to estimate, however their potential benefits will be discussed.

Cost Estimation

The cost of the project can be divided into two parts; Capital expenditures and operating and maintenance costs.

Capital expenditures:

- The cost for the four additional buses required for the 15-minute service will be included. The average service life of a transit bus in the U.S. is 14 years. A replacement cost for these vehicles will be included within the 20-year analysis period.

- Transit Signal Priority for Routes 3 & 14: The upfront cost, additional recapitalization costs, and maintenance costs for TSP will be used to calculate the present cost of the system over the analysis period. Values are drawn from the *B-Line Routing Plan.*
    - 5 intersections on route 3 plus 10 intersections on route 14.
    - $30,000 per intersection.
    - Lifespan - 30 years
    - $2,000 for equipment per bus
    - 20 busses
    - Lifespan - 7 years

Operating and maintenance costs (O&M):

- Net O&M Change: According to the *B-line Routing Plan* annual O&M costs will increase by $1.18 million per year. This will be projected over the 20-year analysis period.

Residual values (RV):

Because the replacement timeline and operational lifespans of the assets do not align perfectly with the 20-year analysis period, a residual value will be calculated. For example the buses will need to be replaced at year 14, meaning by the end of the 20 year period the new buses will have a useful remaining life of 8 years. Therefore a residual economic worth of the assets at the end of the analysis period will be calculated. This RV is essentially a positive cash flow at the end of the analysis period and will be added as a benefit to the end of year 20.
USDOT recommends a linear depreciation approach to estimate the RV of a given asset.

$$RV = \left(\frac{U-Y}{U}\right) \times Asset\ cost$$

Where:
RV: Residual value
U: Useful service life of the final asset
Y: Years of Analysis Period Project Operation remaining for the final asset

Valuation Metrics

All estimated costs and benefits will be discounted to their present value for FY 2025. From these estimates net present value, return on investment, and the cost benefit ratio will be calculated using the following formulas:

$NPV = \Sigma\, Benefits - \Sigma\, costs$
$BCR = \Sigma\, Benefits \div \Sigma\, costs : 1$
$ROI = (\Sigma\, Benefits - \Sigma\, costs) \div (\Sigma\, costs) \times 100$

Additional Intermediate Estimations:

UPT to VMT conversion:

Methodology provided by California Air Resources Board

Equation 1: Annual Auto VMT Reduced in Miles per Year

$$AutoVMT = [(R) * (A) * (L)]$$

Where,

			Units
R	=	Annual **increase** in unlinked passenger trips[1] directly associated with the proposed project	Riders
A	=	Adjustment factor to account for transit dependency Use: documented project-specific data or system average developed from recent, statistically valid survey or default. Default: 0.5 for local service or 0.83 for long-distance service, shuttle and vanpools.	Unitless
L	=	Estimated length of average unlinked passenger trip directly associated with the proposed project, calculated as passenger-miles[2] divided by unlinked trips. Applicants may use data reported to National Transit Database[i] for similar service or refer to Appendix C.	Mile-rider

Average trip lengths (L) were estimated conservatively based on the system wide average of 4.6 miles. In a regional system like B-Line, the system average is heavily skewed by intercity routes like Route 20 to Oroville or Route 40 to Paradise. These regional trips are much longer which pulls the average up significantly.

The estimated trip lengths are based on total route lengths for each route and intuitive estimation.

- Route 3 (Nord/East): 4.0 miles is used It's a longer corridor with more spread-out residential areas.
- Route 14 (Park/Forest/MLK): 3.2 miles is used. This is a dense corridor where trips are likely shorter and more frequent.

Average time saved

- **Wait time**

The baseline wait time is calculated as a weighted average of current service levels. While Routes 3 and 14 offer 30-minute headways during morning peaks, frequencies drop to 60 minutes during midday and evening periods. Under the Mid-Term Service Scenario, headways are standardized to 15 minutes between 6:30 AM and 6:00 PM. Using the random arrival method (Headway / 2), this improvement results in an average wait time reduction of 11.5 mins for route 14 and 20.1 mins for route 3.

Route	Weekday Service	Frequency Breakdown	Weighted Avg	Proposed Mid-Term	wait time reduction
Route 3 (Nord/East)	6:18 AM – 9:00 PM (14.7 hrs)	2.4h @ 30m / 12.3h @ 60m	**55.2**	15	20.1
Route 14 (Park/MLK)	6:24 AM – 9:45 PM (15.3 hrs)	11.3h @ 30m / 4.0h @ 60m*	**37.8**	15	11.4

In travel time saved due to TSP

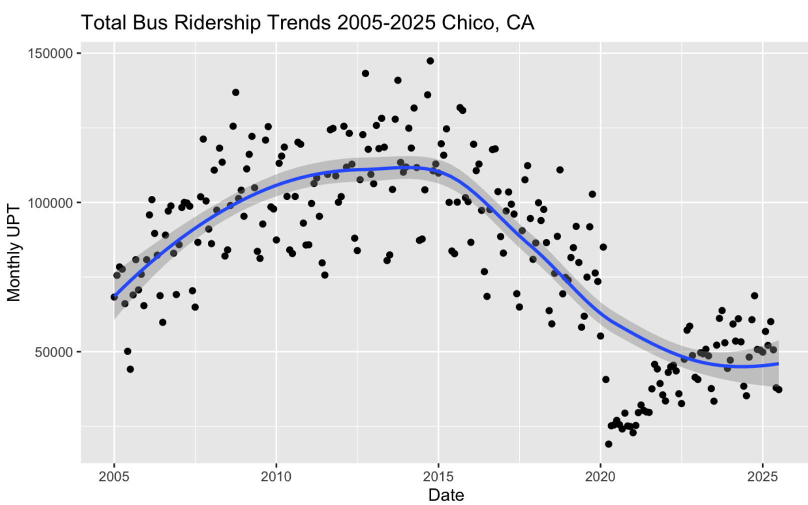
To estimate travel time savings from the Transit Signal Priority (TSP) component, this analysis draws on empirical data summarized in TCRP Report 118. Specifically the Cermak Road (Chicago) study, which evaluated a similar scope of 15 signalized intersections. The study observed transit travel time reductions of 7% to 20%. Additionally, results from Bremerton, WA, a mid-sized urban peer, showed a 10% reduction in running time. To remain conservative and

ensure a rigorous BCA, this study assumes an 8% reduction in total travel time (approximately 10 seconds of delay reduction per signalized intersection) for the impacted corridors.
Ridership projection

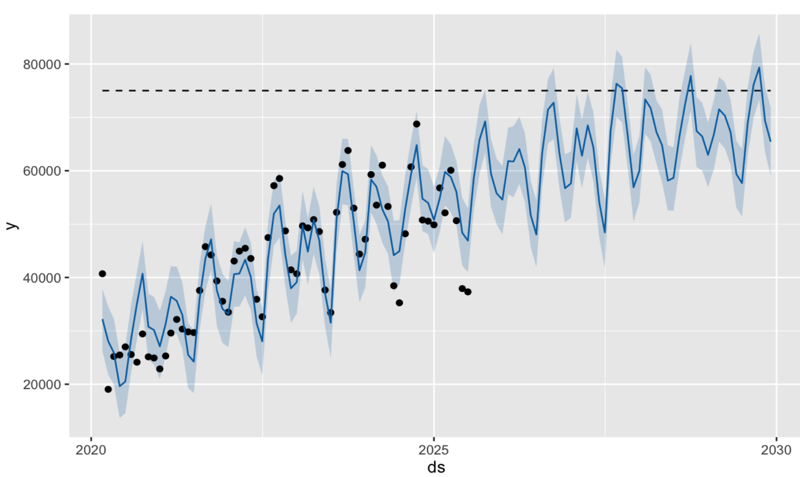
Ridership Forecasting

The methodology for forecasting ridership in Chico, CA, follows a top-down, hybrid time-series approach designed to capture immediate post-pandemic recovery trends and long-term regional growth.

Monthly UPT were extracted from National Transit Database records for the Chico, CA urbanized area. The study uses the Prophet forecasting procedure, an additive model developed by Meta (Facebook), to fit non-linear trends with strong yearly seasonality. A logistic growth model was applied to account for "carrying capacity." A theoretical maximum ridership (cap) of 75,000 monthly boardings was set to prevent the forecast from growing indefinitely beyond pre-pandemic peaks.

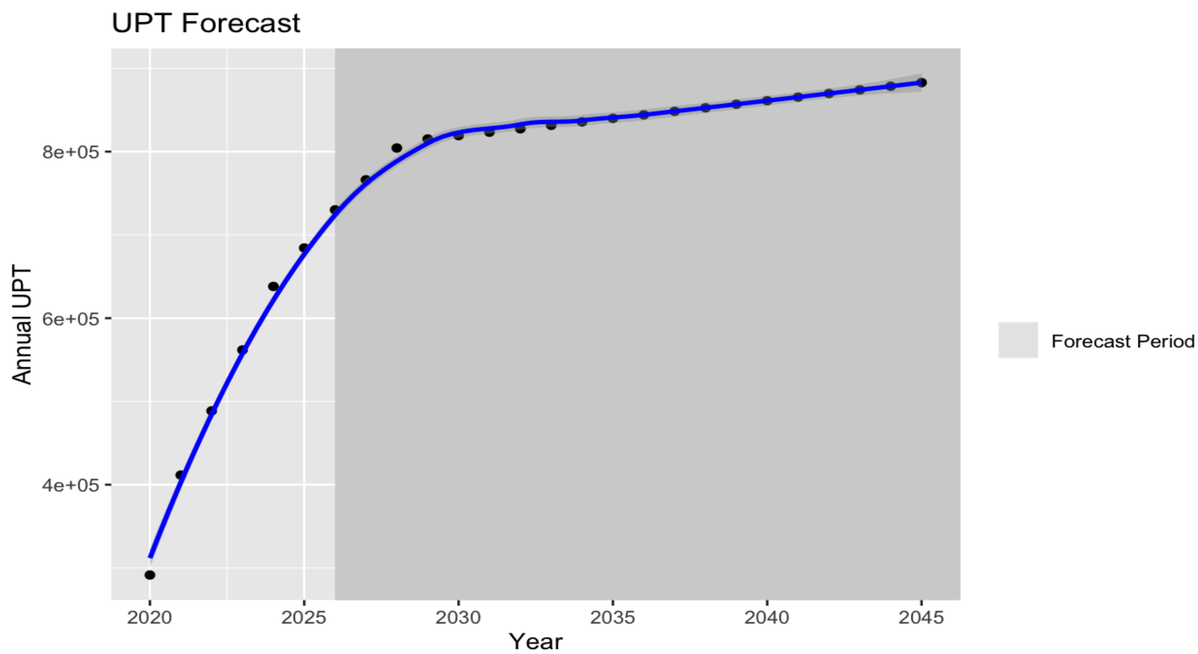


Total ridership trends were already falling pre-pandemic due to lower enrollment at CSU Chico, along with national trends such as the rise of ride-share platforms like Uber and Lyft. During the pandemic, ridership fell off sharply, but has recovered off its lows. Ridership appears to be heading towards around its pre-pandemic numbers around 75,000 UPT per month. Ridership exhibits strong seasonality patterns due to the influx of students during fall/ spring semesters, and the opposite during winter and summer breaks.

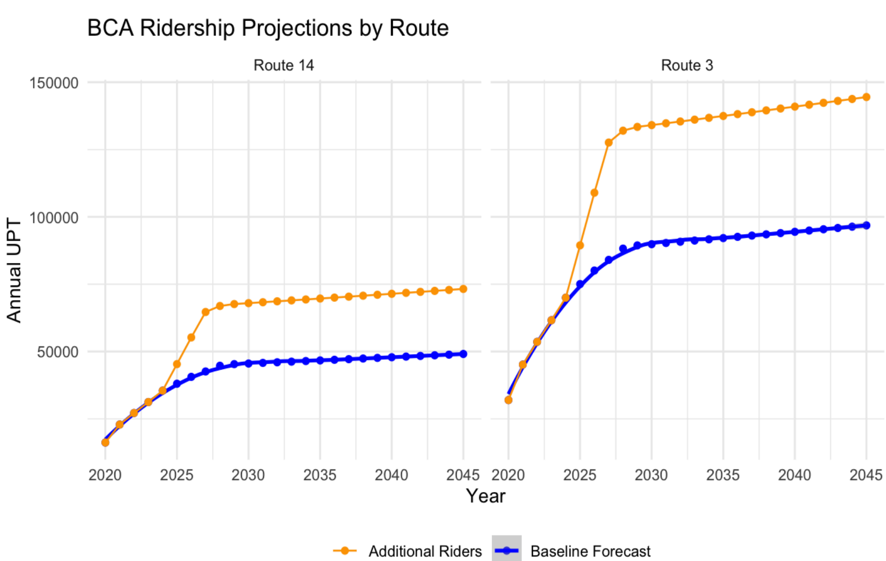


This figure shows the short-run projection generated by the Prophet model based on 2020 - 2025 trends, projecting up until 2030.
Because statistical models can become unstable over decades, the Prophet forecast was used for the initial recovery phase (through approximately 2030).

For the remainder of the 20-year analysis period (through 2045), the model transitions to a steady 0.5% annual growth rate. This rate reflects conservative regional population growth rather than continued post-pandemic recovery.



In order to extract the Route-Specific Allocations, system-wide annual forecasts were scaled down to Routes 3 and 14 using 2022 "anchor" data. Route 3 was allocated approximately 10.97% and Route 14 approximately 5.56% of the system-wide total, based on their documented historical shares of B-Line ridership.



The induced ridership figure of 56,000 was divided proportionally between the two routes and "ramped up" over the first 3 years after the improvement to account for the fact that not all new riders will take advantage of the improvements on day 1.[1]

[1] A full version of the forecasting code and methodology is attached in a separate pdf or can be found on my github for reproducibility.

IV. Benefit Cost Analysis: Calculations: The full spreadsheet can be found here

Table 1: Comprehensive list of assumptions and sources

Category	Variable Description	Unit	Value	Source
Capital Costs	Total Number of New Buses	Count	4	B-Line Routing Study
Capital Costs	TSP Cost per Intersection	$	$30,000	B-Line Routing Study
Capital Costs	TSP On-Board Equipment (per bus)	$	$2,000	B-Line Routing Study
O&M Costs	Annual Operating & Maintenance Increase	$	$1,180,000	B-Line Routing Study
Operations	Forecasted Annual Induced Boardings	UPT	56,000	B-Line Routing Study
Operations	Existing Service Headway R 3	Minutes	55.2	B-Line Routing Study
Operations	Existing Service Headway R 14	Minutes	37.8	B-Line Routing Study
Operations	Proposed Service Headway	Minutes	15	B-Line Routing Study
Travel Time	Number of TSP-Enabled Intersections	Count	15	B-Line Routing Study
VRH Impact	Additional Vehicle Revenue Hours	VRH	14,039	B-Line Routing Study
Capital Costs	Cost per New Transit Bus	$	$500,000	B-Line Routing Study / Market
Travel Time	Total Ride Time Saved per Trip	Minutes	2.5	Calc: (15 signals * 10s) / 60
Travel Time	Avg. Wait Time Reduction (ΔWT) R 3	Minutes	20.1	Calc: (Old Headway/2 - 7.5)
Travel Time	Avg. Wait Time Reduction (ΔWT) R 14	Minutes	11.4	Calc: (Old Headway/2 - 7.5)
VMT Impact	Mode Shift / Adjustment Factor (A)	%	0.5	CARB / APTA Standard
VMT Impact	NOx produced per VMT	MT/VMT	0.000000072	EMFAC PC Application.
VMT Impact	SOx produced per VMT	MT/VMT	0.0000000012	EMFAC PC Application.
VMT Impact	PM2.5 produced per VMT	MT/VMT	0.0000000068	EMFAC PC Application.
VRH Impact	NOx produced per hour	MT/hr	0.00000529	EMFAC PC Application.
VRH Impact	SOx produced per hour	MT/hr	0.00000016	EMFAC PC Application.
VRH Impact	PM2.5 produced per hour	MT/hr	0.00000069	EMFAC PC Application.
VMT Impact	Average Trip Length (L)	Miles	4.78	Estimated
VMT Impact	Average Trip Length (L) R 3	Miles	4	Estimated
Lifecycle	Useful Life - Transit Bus	Years	14	FTA Standard
Lifecycle	Useful Life - TSP Infrastructure	Years	30	Industry Standard
Operations	Baseline Annual Boardings (Current)	UPT	projected by year	National Transit Database
VMT Impact	Average Trip Length (L) R 14	Miles	3.5	NTD Data
Lifecycle	Real Discount Rate	%	7%	OMB Circular A-94 / USDOT
Travel Time	TSP Delay Reduction per Signal	Seconds	10	TCRP Report 118 / USDOT
Monetization	Value of Travel Time - In-Vehicle	$/Hour	$19.40	USDOT BCA Guidance (2025)
Monetization	Value of Travel Time - Waiting	$/Hour	$38.80	USDOT BCA Guidance (2025)
Monetization	External Highway Cost - Safety	$/VMT	$0.0180	USDOT Guidance Table A-14
Monetization	External Highway Cost - Congestion	$/VMT	$0.1430	USDOT Guidance Table A-14
Monetization	External Highway Cost - Noise	$/VMT	$0.0020	USDOT Guidance Table A-14
Monetization	Operating cost per VMT	$/VMT	$0.56	USDOT Guidance Table A-14
Lifecycle	Analysis Period	Years	20	USDOT Standard

Financials	Base Year for Constant Dollars	Year	2023	USDOT Standard (Real $)

Table 2: Ridership Forecast by route and VMT reduction calculations

Year	Baseline R3	baseline R14	Induced R3	InducedR 14	Added VRH	reduction in VMT R3	reduction in VMT R14
2025	75046.76	38037.4	14378.79	7287.879	14,039	28758	14576
2026	80065.25	40581.02	28901.36	14648.636	14,039	57803	29297
2027	84024.6	42587.81	43568.81	22082.819	14,039	87138	44166
2028	88214.71	44711.56	43786.65	22193.233	14,039	87573	44386
2029	89403.53	45314.12	44005.58	22304.2	14,039	88011	44608
2030	89850.54	45540.69	44225.61	22415.721	14,039	88451	44831
2031	90299.8	45768.39	44446.74	22527.799	14,039	88893	45056
2032	90751.3	45997.23	44668.97	22640.438	14,039	89338	45281
2033	91205.05	46227.22	44892.32	22753.64	14,039	89785	45507
2034	91661.08	46458.35	45116.78	22867.409	14,039	90234	45735
2035	92119.38	46690.65	45342.36	22981.746	14,039	90685	45963
2036	92579.98	46924.1	45569.07	23096.654	14,039	91138	46193
2037	93042.88	47158.72	45796.92	23212.138	14,039	91594	46424
2038	93508.09	47394.51	46025.9	23328.198	14,039	92052	46656
2039	93975.63	47631.49	46256.03	23444.839	14,039	92512	46890
2040	94445.51	47869.64	46487.31	23562.063	14,039	92975	47124
2041	94917.74	48108.99	46719.75	23679.874	14,039	93440	47360
2042	95392.33	48349.54	46953.35	23798.273	14,039	93907	47597
2043	95869.29	48591.28	47188.12	23917.265	14,039	94376	47835
2044	96348.64	48834.24	47424.06	24036.851	14,039	94848	48074
2045	96830.38	49078.41	47661.18	24157.035	14,039	95322	48314

Table 3: Net Environmental benefits by route

Year	NOX reduction r3	SOX reductio n r3	PM2.5 reduction r3	NOX reduction r14	SOX reduction r14	PM2.5 reduction r14	NOX added	SOX added	PM2.5 added
2025	$39	$2	$181	$20	$1	$92	-$1,411	-$117	-$8,989
2026	$81	$4	$371	$41	$2	$188	-$1,441	-$119	-$9,132
2027	$124	$6	$567	$63	$3	$288	-$1,470	-$121	-$9,277
2028	$127	$6	$579	$64	$3	$294	-$1,493	-$123	-$9,424
2029	$130	$6	$592	$66	$3	$300	-$1,522	-$125	-$9,575
2030	$133	$6	$604	$67	$3	$306	-$1,552	-$128	-$9,727
2031	$134	$6	$607	$68	$3	$308	-$1,552	-$128	-$9,727
2032	$134	$6	$610	$68	$3	$309	-$1,552	-$128	-$9,727
2033	$135	$6	$613	$68	$3	$311	-$1,552	-$128	-$9,727
2034	$136	$6	$616	$69	$3	$312	-$1,552	-$128	-$9,727
2035	$136	$6	$619	$69	$3	$314	-$1,552	-$128	-$9,727
2036	$137	$6	$622	$70	$3	$315	-$1,552	-$128	-$9,727
2037	$138	$6	$625	$70	$3	$317	-$1,552	-$128	-$9,727
2038	$139	$6	$629	$70	$3	$319	-$1,552	-$128	-$9,727
2039	$139	$6	$632	$71	$3	$320	-$1,552	-$128	-$9,727
2040	$140	$6	$635	$71	$3	$322	-$1,552	-$128	-$9,727
2041	$141	$6	$638	$71	$3	$323	-$1,552	-$128	-$9,727
2042	$141	$6	$641	$72	$3	$325	-$1,552	-$128	-$9,727
2043	$142	$6	$644	$72	$3	$327	-$1,552	-$128	-$9,727
2044	$143	$6	$648	$72	$3	$328	-$1,552	-$128	-$9,727
2045	$143	$6	$651	$73	$3	$330	-$1,552	-$128	-$9,727
Nominal	$2,712	$123	$12,324	$1,375	$62	$6,247	-$32,172	-$2,646	-$202,023
Discount	$1,322.36	$59.94	$6,014.40	$670.24	$30.38	$3,048.39	-$16,456.17	-$1,354.00	-$103,478.77

Table 4: Net External Benefits and Reductions in vehicle operating costs

Year	Safety r3	Congestion r3	Noise r3	Safety r14	Congestion r14	Noise r14	op cost r3	op cost r14
2025	$518	$4,112	$58	$262	$2,084	$29	$8,052	$4,081
2026	$1,040	$8,266	$116	$527	$4,190	$59	$16,185	$8,203
2027	$1,568	$12,461	$174	$795	$6,316	$88	$24,399	$12,366
2028	$1,576	$12,523	$175	$799	$6,347	$89	$24,521	$12,428
2029	$1,584	$12,586	$176	$803	$6,379	$89	$24,643	$12,490
2030	$1,592	$12,649	$177	$807	$6,411	$90	$24,766	$12,553
2031	$1,600	$12,712	$178	$811	$6,443	$90	$24,890	$12,616
2032	$1,608	$12,775	$179	$815	$6,475	$91	$25,015	$12,679

2033	$1,616	$12,839	$180	$819	$6,508	$91	$25,140	$12,742
2034	$1,624	$12,903	$180	$823	$6,540	$91	$25,265	$12,806
2035	$1,632	$12,968	$181	$827	$6,573	$92	$25,392	$12,870
2036	$1,640	$13,033	$182	$831	$6,606	$92	$25,519	$12,934
2037	$1,649	$13,098	$183	$836	$6,639	$93	$25,646	$12,999
2038	$1,657	$13,163	$184	$840	$6,672	$93	$25,775	$13,064
2039	$1,665	$13,229	$185	$844	$6,705	$94	$25,903	$13,129
2040	$1,674	$13,295	$186	$848	$6,739	$94	$26,033	$13,195
2041	$1,682	$13,362	$187	$852	$6,772	$95	$26,163	$13,261
2042	$1,690	$13,429	$188	$857	$6,806	$95	$26,294	$13,327
2043	$1,699	$13,496	$189	$861	$6,840	$96	$26,425	$13,394
2044	$1,707	$13,563	$190	$865	$6,875	$96	$26,557	$13,461
2045	$1,716	$13,631	$191	$870	$6,909	$97	$26,690	$13,528
NOMINAL	$32,739	$260,093	$3,638	$16,594	$131,828	$1,844		
DISCOUNTED	$16,061.89	$127,602.81	$1,784.65	$8,140.96	$64,675.40	$904.55	$249,851.66	$126,637.15

Table 5: Value of time saved by route

Year	waiting - existing R3	waiting - existing R14	Waiting - induced R3	Waiting - induced R14	Riding - existing	Riding - induced
2025	$975,457.79	$280,411.71	$46,723.88	$26,863.12	$91,409.70	$8,756.95
2026	$1,040,688.12	$299,163.28	$93,914.97	$53,994.87	$97,522.40	$17,601.46
2027	$1,092,151.75	$313,957.34	$141,576.85	$81,397.27	$102,345.03	$26,534.20
2028	$1,146,614.80	$329,613.62	$142,284.72	$81,804.26	$107,448.73	$26,666.87
2029	$1,162,067.08	$334,055.69	$142,996.13	$82,213.28	$108,896.77	$26,800.20
2030	$1,167,877.32	$335,725.97	$143,711.12	$82,624.35	$109,441.24	$26,934.20
2031	$1,173,716.80	$337,404.57	$144,429.68	$83,037.47	$109,988.45	$27,068.88
2032	$1,179,585.40	$339,091.58	$145,151.82	$83,452.65	$110,538.40	$27,204.22
2033	$1,185,483.24	$340,787.07	$145,877.59	$83,869.92	$111,091.08	$27,340.24
2034	$1,191,410.72	$342,490.96	$146,606.98	$84,289.27	$111,646.54	$27,476.94
2035	$1,197,367.70	$344,203.47	$147,340.00	$84,710.72	$112,204.77	$27,614.33
2036	$1,203,354.58	$345,924.47	$148,076.69	$85,134.27	$112,765.80	$27,752.40
2037	$1,209,371.35	$347,654.08	$148,817.09	$85,559.94	$113,329.63	$27,891.16
2038	$1,215,418.15	$349,392.33	$149,561.16	$85,987.74	$113,896.27	$28,030.61
2039	$1,221,495.24	$351,139.34	$150,308.97	$86,417.68	$114,465.76	$28,170.77
2040	$1,227,602.74	$352,894.99	$151,060.51	$86,849.76	$115,038.08	$28,311.62
2041	$1,233,740.78	$354,659.47	$151,815.83	$87,284.02	$115,613.27	$28,453.18
2042	$1,239,909.51	$356,432.81	$152,574.91	$87,720.43	$116,191.34	$28,595.45
2043	$1,246,109.03	$358,214.92	$153,337.80	$88,159.04	$116,772.29	$28,738.43

2044	$1,252,339.62	$360,006.02	$154,104.48	$88,599.83	$117,356.16	$28,882.12
2045	$1,258,601.28	$361,806.04	$154,875.00	$89,042.83	$117,942.94	$29,026.53
NOMINAL	$24,820,363.01	$7,135,029.71	$2,955,146.19	$1,699,012.71	$2,325,904.66	$553,850.75
DISCOUNTED	$12,526,070.56	$3,600,829.12	$1,449,808.90	$833,543.79	$1,173,812.24	$271,721.84

TotalNet Benefits	$20,341,302.30

Table 6: Cost Estimation less residual value

	TSP - Bus	TSP - Intersection	Opp costs	Bus	
2025	-$40,000	-$7,500,000	-$1,180,000	-$2,000,000	
2026			-$1,180,000		
2027			-$1,180,000		
2028			-$1,180,000		
2029			-$1,180,000		
2030			-$1,180,000		
2031			-$1,180,000		
2032	-$40,000		-$1,180,000		
2033			-$1,180,000		
2034			-$1,180,000		
2035			-$1,180,000		
2036			-$1,180,000		
2037			-$1,180,000		
2038			-$1,180,000		
2039	-$40,000		-$1,180,000	-$2,000,000	
2040			-$1,180,000		
2041			-$1,180,000		
2042			-$1,180,000		
2043			-$1,180,000		
2044			-$1,180,000		
2045			-$1,180,000		
2046	$5,714	$2,500,000		$1,200,000	RESIDUAL VALUE
NOMINAL	-$120,000	-$7,500,000	-$24,780,000	-$4,000,000	
NPV	-$73,872	-$6,445,063	-$12,785,922	-$2,323,195	

V. Results & Discussion

The results of the benefit cost analysis are presented in Table 7. Under the current assumptions and forecasting, the project is expected to have an NPV of -$1,286,749.55 and a BCR of 0.94 which means that in strict economic terms the project's monetized costs outweigh its monetized benefits. However, the project is likely viable from a policy standpoint because the margin is very slim (0.94 is nearly 1.0).

Table 7.1: Base assumptions, Metrics

Total Net Benefits	$20,341,302.30
Total Net Costs	$21,628,051.85
Net Present Value	-$1,286,749.55
Benefit Cost Ratio	0.94
ROI	-5.95

The primary driver of societal value in this model is Travel Time Savings, particularly the reduction in waiting time. By standardizing headways to 15 minutes, the project generates over $18 million in discounted benefits from time savings alone over the 20 year period. This underscores the high "opportunity cost" currently borne by B-Line's transit-dependent population, of which 70% lack access to a personal vehicle. When waiting times are slashed from nearly an hour to 15 minutes, the cumulative economic impact on labor accessibility and personal efficiency is profound.

Despite these substantial benefits, the project faces a significant fiscal barrier due to its heavy cost burden. The analysis identifies total net costs of approximately $21.6 million. This is driven largely by a $1.18 million annual increase in Operating and Maintenance (O&M) costs required to sustain the increased vehicle revenue hours. Additionally, the upfront capital requirement of $2 million for four new buses and the investment in Transit Signal Priority (TSP) infrastructure represent significant hurdles for a mid-sized transit agency. These high recurring and capital costs result in a Benefit-Cost Ratio (BCR) of 0.94, placing the project just below the traditional break-even threshold for economic viability.

A critical factor suppressed in the current BCR is the Emission Trade-off resulting from the choice of technology. The current model assumes the continued use of diesel-powered buses, which leads to a "Net Emission" penalty. While the shift of riders from cars to transit reduces light-duty vehicle emissions, these gains are currently offset by the added pollutants (NO_x, SO_x, and PM2.5) produced by the 14,039 additional annual vehicle-hours of bus operation. In the current calculations, the damage costs from added bus emissions significantly mitigate the environmental benefits of reduced auto VMT. While electric buses have higher upfront costs, $800,000 - $1.2 million, they often yield lower O&M costs over their lifetime due to lower energy price per mile and fewer moving parts. Exact O&M figures for electric buses are highly dependent on the scale of the EV infrastructure for the entire network. This is due to high upfront and fixed costs relative to variable operating costs so as fleet size increases, costs are spread over a larger number of vehicles, reducing O&M per vehicle. However, in order to evaluate this alternative, an analysis including these assumptions, and how this fits into the current charging infrastructure of Chico B-line would need to be conducted.

Sensitivity Analysis

Any BCA is only as good as its assumptions. In order to evaluate the true viability an alternative estimation was calculated as an upper bound. The current BCA assumptions are the most conservative estimates in order to show the "worst case scenario" in an attempt to prove the robustness of the project. An alternative estimations were also conducted with the following assumptions:

- Value of time: All purpose = $21.10 instead of Personal = $19.40 (Table A-2)
- Ridership Growth: Induced ridership of 70,000 instead of 56,000 as projected by the B-Like routing study.
- Discount Rate: The USDOT recommends a 7% discount rate as of May 2025, however previous versions of their guidelines assumed 5% or even 3.1%. An alternative at 5% will be considered.

Table 7.2: VOT = $21.10

Simply increasing the value of time while riding is not enough to boost benefits high enough to turn NPV positive. This is because time savings due to TSP efficiencies are relatively small compared to the benefits from waiting time saved.

Net Benefits	$20,595,017.92
Net Costs	$21,628,051.85
Net Present Value	-$1,033,033.93
Benefit Cost Ratio	0.95
ROI	-4.78

Table 7.3: Induced ridership = 70,000

Raising the assumed induced ridership to 70,000 from 56,000 per year has a significant impact on NPV, cutting losses to around half a million per year.

Net Benefits	$21,116,361.87
Net Costs	$21,628,051.85
Net Present Value	-$511,689.98
Benefit Cost Ratio	0.98
ROI	-2.37

Table 7.4: Discount rate = 5%

A lower discount rate of 5% greatly impacts NPV, swinging it from -$1.3 million to +$300 thousand. This significant swing is caused by the combination of high near-term costs paired with latent accumulation of benefits as ridership numbers grow gradually in the long-run. Additionally the BCR is now above 1, passing the generally accepted threshold of viability.

Net Benefits	$24,255,815.24
Net Costs	$23,956,224.98
Net Present Value	$299,590.26
Benefit Cost Ratio	1.01
ROI	1.25

Table 7.5: Combined

Net Benefits	$25,518,042.39
Net Costs	$23,956,224.98
Net Present Value	$1,561,817.41
Benefit Cost Ratio	1.07
ROI	6.52

Combining all three assumptions, NPV climbs to $1.5 million with a BCR of 1.07, suggesting under these assumptions the monetized benefits alone justify the project.

The sensitivity analysis demonstrates that the project's economic viability is highly sensitive to the chosen parameters, particularly the discount rate and ridership projections. While the primary Benefit-Cost Analysis (BCA) used conservative "worst-case" assumptions to test project robustness, the alternative estimations reveal a clear path to a positive Net Present Value (NPV).

To justify the proposed investment in Routes 3 and 14, it is essential to look beyond direct travel time savings and consider the broader economic geography of Chico. Two key qualitative factors, agglomeration economies and service reliability, serve as significant wider economic benefits that are often omitted from standard monetized BCA calculations but are critical for regional growth and are recommended to be taken into account by the USDOT guidelines.

Agglomeration economies refer to the productivity gains that occur when firms and workers cluster together in close physical proximity. In a mid-sized city like Chico, high-frequency transit acts as a "virtual densifier," effectively shrinking the distance between key activity centers. Route 3 and 14 act as an essential spine for the transportation network in Chico. Route 3 links the semi-dense urban housing and population zones in the north of Chico and dense student living centers along Nord ave, to downtown shopping, restaurants, businesses, and the CSU Chico campus. Additionally, increasing frequency and reliability of connections to the Downtown Transit Hub expands access to the rest of the network by reducing both physical and psychological friction for riders. Route 14 connects the Downtown Transit Hub, and South of Campus living centers to key "big box" stores, shopping centers, supermarkets, and fast-casual restaurants along east 20th and Forest avenue. This economic activity center, along E 20th is largely inaccessible to any alternative mode of transportation than personal vehicles due to its distal positioning on the east side of highway 99. Foot traffic and bicycle connectivity to this area are underdeveloped, inconvenient, and risky, due to a strong focus on vehicular traffic prioritization and poor bikepath, traffic crossing, and sidewalk infrastructure, especially for hwy 99 crossing points.

Additionally, public transportation is competing with rideshare and delivery platforms such as Uber, Lyft, Doordash, and InstaCart which have been providing similar agglomeration services at artificially deflated prices to gain market share and change consumer behavior patterns. However, the excess surplus which has been injected into the market by VC funding and financing over the last decade is coming to an end with many of these apps, now with no real competition, tweaking their algorithms, raising prices, and squeezing Chico residents who have no alternative. The timing of this improvement project gives B-Line an opportunity to increase competitive behavior and reduce exploitation of market power, minimizing the transfer of surplus from Chico residents and consumers to multinational corporations employing algorithmic pricing.

An improvement in frequency and reliability of service for these two routes would facilitate greater labor market efficiency by effectively shrinking the distance between Chico's residential clusters and its primary employment centers. By providing 15-minute headways, the B-Line enables a virtual densification of the Nord and Park/Forest corridors, allowing businesses to draw from a wider pool of workers who are currently sidelined by the No-Build system's long wait times. For the 70% of riders who are transit-dependent, this increased connectivity to the commercial centers along Route 14 is not merely a convenience, it is a critical expansion of their economic geography, providing access to lower-cost goods, essential stores such as Winco, Walmart, Target, Costco, Home Depot, and diverse employment opportunities that are currently gated behind the barrier of Highway 99.

Beyond agglomeration, the qualitative benefit of reliability is a cornerstone of this project's value proposition. The baseline data shows that Route 3 operates late 25% of the time, creating a "reliability tax" on its users. This unreliability forces riders to incorporate significant buffer time into their commutes, arriving at stops much earlier than scheduled to ensure they are not late for work or school. The implementation of Transit Signal Priority (TSP) and standardized 15-minute headways serves as a direct intervention against this lost productivity. By reducing the subjective user cost of waiting and increasing the predictability of the commute, the B-Line can begin to attract "choice riders." That is, residents with cars who currently avoid the system due to its poor on-time performance. For Chico's workforce, this means fewer missed shifts and reduced stress; for the B-Line, it means a more robust, stable ridership base that justifies the capital expenditure in TSP and vehicle fleet expansion. Ultimately, these reliability improvements act as a multiplier for the monetized time savings calculated in the BCA, providing a more stable foundation for the region's economic health.

VI. Conclusion & Policy Recommendation

This benefit-cost analysis of BCAG's Mid-Term High-Frequency Service Project (15-minute weekday headways on B-Line Routes 3 and 14 plus Transit Signal Priority at 15 intersections) finds the project is near break-even under conservative assumptions: BCR 0.94 and NPV –$1.29M (discounted). The largest quantified benefit is rider time savings, driven primarily by reduced waiting time from more consistent, frequent service.

The main reason the base case falls slightly below the standard threshold is the recurring operating cost increase (about $1.18M per year). Environmental impacts are also sensitive to fleet technology: additional bus-hours can reduce the emissions advantage if service expansion relies on diesel buses, while further zero-emission fleet deployment would improve net benefits. Sensitivity results indicate the project can cross the break-even line under plausible policy-relevant conditions such as alternative discount rates and ridership response. In addition, several benefits are only partially captured in monetized terms - particularly improved reliability and broader access/equity effects for transit-dependent riders.

Policy Recommendations to BCAG

Based on these findings, it is recommended that the Butte County Association of Governments proceed with the High-Frequency Service upgrade according to the following guidelines:

1. **Adopt the mid term timeline:** Proceed with the implementation of 15-minute weekday service on Routes 3 and 14 to capture the latent demand and recovery trends identified in the Prophet ridership forecast.
2. **Prioritize TSP capital investment:** Immediate installation of Transit Signal Priority at the 15 identified intersections is essential to improve on-time performance and attract “choice riders” back to the system.
3. **Transition to Zero-Emission Vehicles:** To improve the Benefit-Cost Ratio, BCAG should prioritize using zero-emission buses for this expansion. This would eliminate the net emission penalty caused by diesel bus operation, further increasing the project's societal net benefits.
4. **Monitor and Evaluate:** BCAG should track ridership ramp-up during the first three years of service to validate the induced ridership projections and adjust O&M allocations accordingly.

In conclusion, while the project faces a significant fiscal burden, its role as an economic spine for Chico justifies the investment. The broader impacts on labor accessibility, regional productivity, and equity for vulnerable populations outweigh the slim negative margin of the monetized baseline analysis.

Appendix

Table A-2: Value of Travel Time Savings

Recommended Monetized Value(s)		References and Notes
Recommended Hourly Values of Travel Time Savings (2023 $ per person-hour)		*Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis (2016)* https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-valuation-travel-time-economic
Category	**Hourly Value**	
General Travel Time		
Personal[1]	$19.40	
Business[2]	$33.50	
All Purposes[3]	$21.10	
Walking, Cycling, Waiting, Standing, and Transfer Time[4]	$38.80	
Commercial Vehicle Operators[5]		
Truck Drivers	$35.70	
Bus Drivers	$42.60	
Transit Rail Operators	$59.60	
Locomotive Engineers	$52.90	

1) Values for personal travel based on local travel values as described in USDOT's Value of Travel Time guidance. Where applicants also have specific information on the mix of local versus long-distance intercity travel (i.e., trips over 50 miles in length) on a facility, then the local travel values of time may be blended with the long-distance intercity personal travel value of $27.10 per hour.

2) Weighted average based on a typical distribution of local travel by surface modes (88.2% personal, 11.8% business). Applicants should apply their own distribution of business versus personal travel where such information is available.

3) Note that business travel does not include commuting travel, which should be valued at the personal travel rate. Travel on high-speed rail service that would be competitive with air travel should be valued at $51.50 per hour for personal travel and $83.30 for business travel.

4) Should be applied only when actions affect those elements of travel time.

5) Includes only the value of time for the operator, not passengers or freight.

Table A-4: Vehicle Operating Costs

Vehicle Type	Recommended Value per Mile (2023 $)
Light Duty Vehicles[1]	$0.56
Commercial Trucks[2]	$1.27

1) Based on an average light duty vehicle and includes operating costs such as gasoline, maintenance, tires, and depreciation (assuming an average of 15,000 miles driven per year). The value omits other ownership costs that are mostly fixed or transfers (insurance, license, registration, taxes, and financing charges).

2) Value includes fuel costs, truck/trailer lease or purchase payments, repair and maintenance, truck insurance premiums, permits and licenses, and tires. The value omits tolls (which are transfers), and driver wages and benefits (which are already included in the value of travel time savings).

References and Notes

American Automobile Association, Your Driving Costs – 2023 Edition (2023)
https://newsroom.aaa.com/wp-content/uploads/2023/08/YDC-Fact-Sheet-FINAL-8.30.23-1.pdf

American Transportation Research Institute, An Analysis of the Operational Costs of Trucking: 2024 Update
https://truckingresearch.org/wp-content/uploads/2024/06/ATRI-Operational-Cost-of-Trucking-06-2024.pdf

*Table A-6: Damage Costs for Emissions per Metric Ton**

Recommended Monetized Value(s)	References and Notes
(see table below)	*Technical Support Document: Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors (February 2018)"* https://www.epa.gov/sites/default/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf NO_X, SO_X, and $PM_{2.5}$ values are inflated from 2015 to 2023 dollars using the GDP deflator. **Note:** Fuel saved (gasoline, diesel, natural gas, etc.) can be converted into metric tons of emissions using EPA guidelines available at https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

Emission Type	NO_X	SO_X	$PM_{2.5}$**
2024	$18,800	$50,900	$912,200
2025	$19,000	$51,900	$928,000
2026	$19,400	$52,900	$942,700
2027	$19,800	$53,800	$957,700
2028	$20,100	$54,800	$972,900
2029	$20,500	$55,800	$988,400
2030	$20,900	$56,800	$1,004,100
2031	$20,900	$56,800	$1,004,100
2032	$20,900	$56,800	$1,004,100
2033	$20,900	$56,800	$1,004,100
2034	$20,900	$56,800	$1,004,100
2035	$20,900	$56,800	$1,004,100
2036	$20,900	$56,800	$1,004,100
2037	$20,900	$56,800	$1,004,100
2038	$20,900	$56,800	$1,004,100
2039	$20,900	$56,800	$1,004,100
2040	$20,900	$56,800	$1,004,100
2041	$20,900	$56,800	$1,004,100
2042	$20,900	$56,800	$1,004,100
2043	$20,900	$56,800	$1,004,100
2044	$20,900	$56,800	$1,004,100
2045	$20,900	$56,800	$1,004,100
2046	$20,900	$56,800	$1,004,100
2047	$20,900	$56,800	$1,004,100
2048	$20,900	$56,800	$1,004,100
2049	$20,900	$56,800	$1,004,100
2050	$20,900	$56,800	$1,004,100
2051	$20,900	$56,800	$1,004,100
2052	$20,900	$56,800	$1,004,100
2053	$20,900	$56,800	$1,004,100
2054	$20,900	$56,800	$1,004,100

*Applicants should carefully note whether their emissions data is reported in short tons or metric tons. A metric ton is equal to 1.1023 short tons.

**Applicants should be careful to not apply the $PM_{2.5}$ value to estimates of total emissions of PM_{10}.

Table A-14: External Highway Use Costs

Recommended Monetized Value(s)

Vehicle Type and Location	Recommended Value of Cost per Vehicle Mile Traveled (2023 $)[1]			
	Cong. Cost	Noise	Safety Cost	Emission Cost[2]
Light-Duty Vehicles - Urban	$0.143	$0.0020	$0.018	*
Light-Duty Vehicles - Rural	$0.030	$0.0002	$0.102	*
Light-Duty Vehicles – All Locations	$0.120	$0.0011	$0.042	$0.013
Buses and Trucks - Urban	$0.358	$0.0453	$0.017	*
Buses and Trucks - Rural	$0.078	$0.0038	$0.029	*
Buses and Trucks – All Locations	$0.245	$0.0228	$0.022	$0.037
All Vehicles - Urban	$0.159	$0.0053	$0.018	*
All Vehicles - Rural	$0.037	$0.0007	$0.091	*
All Vehicles – All Locations	$0.133	$0.0032	$0.040	$0.015

1) Congestion costs updated from the 1997 Highway Cost Allocation Study to reflect increased traffic volumes, changes in vehicle occupancy, and increases in the value of time per person-hour since that time. Both congestion and noise costs are also adjusted from 1994 dollars to 2023 dollars using the GDP deflator.

References and Notes

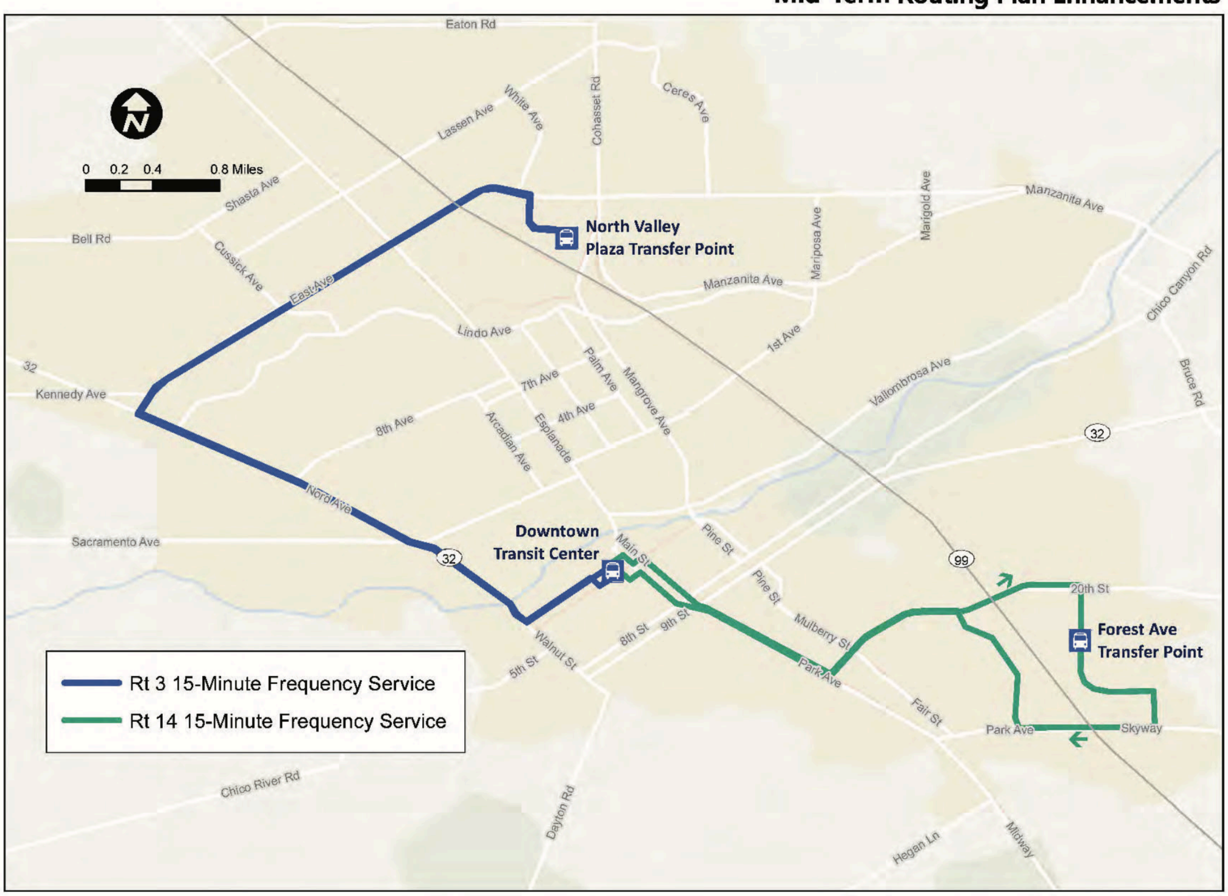
Highway Cost Allocation Study (1997)
https://www.fhwa.dot.gov/policy/otps/costallocation.cfm

NHTSA Fatality Analysis Reporting System (2019)
https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars

NHTSA Crash Report Sampling System (2019)
https://www.nhtsa.gov/crash-data-systems/crash-report-sampling-system

EPA MOVES Model (2022)
https://www.epa.gov/moves

Figure 38:
Mid-Term Routing Plan Enhancements



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