THIS PRINT COVERS CALENDAR ITEM NO. : 12

SAN FRANCISCO
MUNICIPAL TRANSPORTATION AGENCY

DIVISION: Finance and Information Technology

BRIEF DESCRIPTION:

Presentation of the results of SFMTA's Transit Economic Benefits Study, a report that quantifies the economic value and highlights other benefits that transit brings to San Francisco.

SUMMARY:

- Consistent with the overarching FY 2013-FY 2018 Strategic Plan, the SFMTA commissioned this Transit Economic Benefits Study to quantify transit's contributions to the San Francisco economy.
- With six percent population and 15 percent employment increases between 2010 and 2014, the relationship between transportation and economic growth is perhaps more pronounced than at any other time in the City's history.
- The study estimates that Muni's annual quantifiable economic benefits exceed its operations and maintenance costs and "state of good repair" capital investments by anywhere from $634 million to $1.25 billion. This equates to about $10.6 to $20.8 billion in net present value terms and a benefit-cost ratio of 2.0 to 2.9.
- Without Muni, San Francisco's automobile ownership rates are projected to increase by over 50 percent, or nearly 195,000 new vehicles, which would bring traffic to a standstill. Accommodating these vehicles and trips generated would consume scarce land resources, hypothetically displacing up to 11% of housing units and 21% of jobs in San Francisco.

ENCLOSURES:
1. Transit Economic Benefits Study

APPROVALS: **DATE**

DIRECTOR _____ 8/10/15

SECRETARY R. Boomer 8/10/15

ASSIGNED SFMTAB CALENDAR DATE: August 18, 2015

PURPOSE

Consistent with Goal 3 of SFMTA's FY 2013-FY 2018 SFMTA Strategic Plan, the agency retained a consultant specializing in econometric research to quantify the economic benefits that the SFMTA's transit operations (Muni) bring to San Francisco. The purpose of this calendar item is to present the high-level findings of this Transit Economic Benefits Study.

GOAL

The Transit Economic Benefits Study addresses the following SFMTA Strategic Goal and Objective:

Goal 3: Improve the environment and quality of life in San Francisco

Objective 3.2: Increase the transportation system's positive impact to the economy.

DESCRIPTION

Consistent with the overarching FY 2013-FY 2018 Strategic Plan, the SFMTA commissioned a first-ever Transit Economic Benefit Study to increase stakeholder awareness of transit's contributions to the San Francisco economy in support of various transportation funding initiatives. The land economics consulting firm, Economic & Planning Systems (EPS), conducted the technical analysis for the study.

The study notes that the relationship between transportation and economic growth is perhaps more pronounced than at any other time in the City's history. Between 2010 and 2014, San Francisco's population and employment surged by 5.9 percent and 15.1 percent, respectively. The City is now home to over 850,000 people and more than 600,000 jobs. Not only are the level and density of the City's population and employment at an all-time high and continuing to grow, but the City's transportation infrastructure is also aging and near capacity. There is also not the physical space to expand parking or the City's road network. Finally, there is growing concern about the impact of vehicle emissions on climate change.

In addition to two transportation measures (Propositions A and B) voters approved in November 2014, the City is now looking at additional funding options to pay for continued transportation network improvements to address growth. This Transit Economic Benefits Study helps stakeholders better understand how essential investing in transit is to the San Francisco economy.

Net Fiscal Year 2014 Muni operating costs total an estimated $651.8 million annually, which includes direct operations and maintenance costs (less fare revenue) as well as State of Good Repair capital costs. The study quantifies five broad areas to assess the benefits relative to these costs. These areas include financial savings from faster travel times resulting from congestion reductions due to transit, reduced travel costs from using Muni instead of driving

(includes parking at destination), travel safety benefits attributable to Muni (from reduced injuries and fatalities), reduced emissions from riding Muni instead of driving, and parking cost savings at one's place of residents from not needing to own a car.

The study also recognizes but does not quantify benefits such as public health improvements since transit promotes active transportation choices, compact and pedestrian-friendly land use, and social equity by providing affordable and accessible transportation to lower-income and other disadvantaged groups. In addition, the SFMTA promotes other sustainable transportation modes such as bicycling and walking, which were beyond the scope of the study.

As summarized in the table below, Muni's annual quantifiable economic benefits exceed its operations and maintenance costs and "state of good repair" capital investments by anywhere from $634 million to $1.25 billion. This equates to about $10.6 to $20.8 billion in net present value terms and a benefit-cost ratio of 2.0 to 2.9.

Summary of Economic Benefits of Muni Transit Services – Fiscal Year 2014

Economic Benefit Category	Annual Impact (2014$) High	Annual Impact (2014$) Low
Monetized value of faster travel times from reduced congestion attributable to Muni	$236,800,000	$192,400,000
Reduced travel costs from using Muni instead of driving (includes parking at destination)	$830,400,000	$515,600,000
Travel Safety Benefits attributable to Muni (Reduced injuries and fatalities)	$191,600,000	$90,100,000
Monetized value of emitting less Pollutants by Using Muni instead of driving	$50,100,000	$29,500,000
Parking Cost Savings at Place of Residence	$588,800,000	$457,900,000
Total quantified economic benefits of Muni	**$1,898,000,000**	**$1,285,500,000**

Muni costs	Annual Impact (2014$) High	Annual Impact (2014$) Low
Muni Net Operations & Maintenance Costs	$471,791,000	$471,791,000
State of Good Repair Capital Investment	$180,000,000	$180,000,000
Total Annual Muni Costs	$651,791,000	$651,791,000
Net Muni Benefits	**$1,246,209,000**	**$633,709,000**
Return on Investment (ROI)	**191%**	**97%**
Benefit-Cost Ratio	**2.91**	**1.97**

Finally, the projects that San Francisco's automobile ownership rates would increase by over 50 percent, or nearly 195,000 new vehicles, without Muni. Accommodating these vehicles and trips generated would consume scarce land resources, hypothetically displacing up to 11% of housing units and 21% of jobs in San Francisco, and result in gridlock.

As significantly, the study developed a methodology for evaluating economic impacts that will undergo additional refinements. As such, the study is a starting point for further investigation into transit's benefits, and more generally, to all SFMTA-managed transportation modes.

PUBLIC OUTREACH

The FY 2013-2018 SFMTA Strategic Plan is the agency's guiding document and calls for significant investments to enhance the transportation network for the future. Already, in supporting various transportation funding initiatives as recently as last November, the public has recognized the economic value of a high-quality transit system. As the City and the SFMTA are investigating additional funding options, including the Transportation Sustainability Program and additional bond measures, it is critical that stakeholders understand the value they are receiving for their investment. This report helps illuminate transit's benefits to the public and policymakers.

ALTERNATIVES CONSIDERED

The Transit Economic Benefits Study explored the hypothetical impacts of not having Muni. The results suggest that the alternative of a San Francisco without the Muni system would not be feasible from a variety of perspectives. Based on the study's calculations, the absence of Muni would have severe impacts on the San Francisco economy since the transit system generates a net benefit ranging from $635 million to $1.25 billion annually. Aside from these financial impacts, without transit the number of vehicles could increase by nearly 195,000, or 50 percent, leading to severe traffic congestion, more pollution and a less pleasant urban environment.

FUNDING IMPACT

This report has no direct impact on either SFMTA's operating or capital budget. However, it does estimate that the transit services the SFMTA manages yield a net annual positive impact to the San Francisco economy of $634 million to $1.25 billion. These figures – which do not include the benefits of other sustainable modes that the SFMTA manages such as bicycling and walking – represent a positive benefit-cost ratio of 1.97 to 2.91, or a return on investment of 97% to 191%. The study underscores that the value that the Muni transit system brings to San Francisco far exceeds the direct costs of providing the service.

ENVIRONMENTAL REVIEW

The Transit Economic Benefits Report is not a "project" under CEQA Guidelines Section 15378 and 15060(c)(2) because neither will result in a physical change to the environment. It is therefore not subject to CEQA review.

OTHER APPROVALS RECEIVED OR STILL REQUIRED

None

RECOMMENDATION

Staff recommends that the Board of Directors receive the report.

Report

SFMTA Transit Economic Benefits Study

The Economics of Land Use

Prepared for:

San Francisco Municipal Transportation Agency

Prepared by:

Economic & Planning Systems, Inc.
CHS Consulting Group

August 2015

EPS #141065
Contract No. SFMTA-2014-40

Economic & Planning Systems, Inc.
One Kaiser Plaza, Suite 1410
Oakland, CA 94612-3604
510.841.9190 tel
510.740.2080 fax

Oakland
Sacramento
Denver
Los Angeles

www.epsys.com

Table of Contents

List of Figures

AUTHORS AND CONTRIBUTORS

This Study has been conducted for the SFMTA by a consultant team led by Economic & Planning Systems (EPS). CHS Consulting Group has served as a sub-consultant to EPS, providing services related to transportation modeling and data collection. A brief description of the consultant team and others that contributed to this study is provided below.

Consultant Team

- **Economic & Planning Systems, Inc. (EPS)**, EPS: Founded in 1983, EPS is an economics consulting firm experienced in the full spectrum of services related to economic, fiscal, and cost-benefit analysis of public investments, regulations, and land use decisions. The firm has provided consulting services to hundreds of public- and private-sector clients in California and throughout the United States. Clients include Federal, State and local agencies, cities, counties, special districts, multi-jurisdictional authorities, property owners, developers, financial institutions, and land use attorneys. For further information on EPS services and clients see www.epsys.com
- **CHS Consulting Group (CHS)**; CHS provides expertise in all modes of transport including vehicle, transit, bicycle, and pedestrian transportation. CHS senior staff has held management-level government positions. Based in San Francisco, CHS has conducted numerous transportation studies in the City, including previous work with the SFMTA. For further information on CHS services and clients see **www.chsconsulting.net**

SFMTA Staff

- Sonali Bose, Chief Financial Officer
- Jason Lee, Project Manager, Finance & Information Technology
- Rachel Om, Planner, Sustainable Streets

Other Contributors

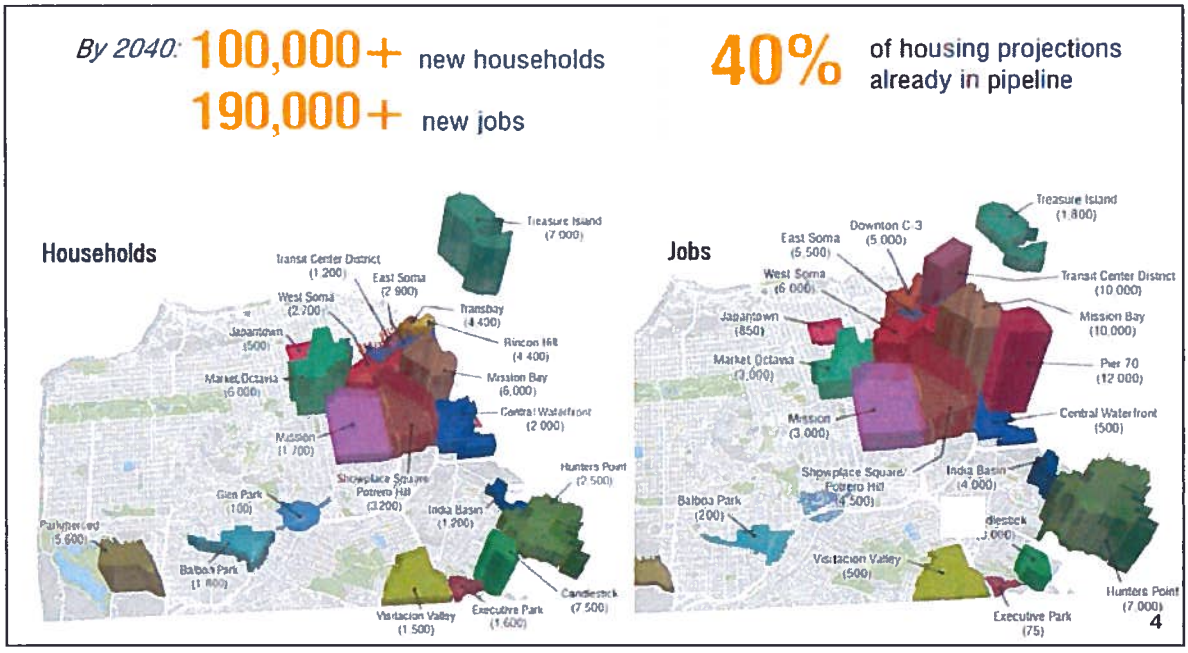
- Dan Tischler, Senior Transportation Planner, San Francisco County Transportation Authority
- Ted Egan, Chief Economist, City and County of San Francisco, Office of the Controller

1. INTRODUCTION AND SUMMARY OF FINDINGS

This study is designed to document and estimate the economic benefits of providing Muni transit service in San Francisco. The San Francisco Municipal Transportation Agency (SFMTA), which operates Muni, has commissioned this study to determine the economic impacts of a robust and properly-funded transportation system.

During its more than 100 years of existence, Muni has played a critical role in the evolution of San Francisco's economy. For the first half of the 20th century, public transportation facilitated the growth of the city's urban core, neighborhood commercial districts and outlying residential areas. Recently, San Francisco's population has reached an all-time high. Between 2010 and 2014 alone, U.S. Census Bureau data indicate that the residential population increased from 805,235 to 852,469 (5.9 percent growth). According to the Bureau of Labor Statistics, City employment surged from 531,599 to 611,717 (15.1 percent growth) during the same period and continued to grow to an estimated 638,466 jobs by June 2014.

At this moment, the relationship between transportation and economic growth is perhaps more pronounced than at any other time in the City's history. Not only are the level and density of the City's population and employment at an all-time high and continuing to grow, but the City's transportation infrastructure is also aging and near capacity. There is also not the physical space to expand parking or the City's road network. Finally, there is growing concern about the impact of vehicle emissions on climate change and the worst drought and hottest temperatures in California's recorded history.



Between 2010 and 2014, San Francisco's population and employment grew by over 47,000 (5.9 percent) and 80,000 (15.1 percent), respectively. By 2040, projections indicate an additional 100,000 new households and 190,000 new jobs. With limited space for road capacity and parking, San Francisco increasingly will rely on Muni to maintain mobility and accessibility. (Source: San Francisco Planning Department)

On November 4, 2014, San Francisco voters overwhelmingly approved two propositions designed to significantly improve and expand Muni services.[1] By rejecting another proposition that would have prioritized automobiles and parking and over walking, public transit and bicycling, voters also reaffirmed San Francisco's landmark "Transit First Policy" adopted in 1973.[2]

With this public mandate for better transportation choices, the SFMTA will be making significant investments in the transportation network to improve travel choices, reduce congestion, maintain affordability and keep its infrastructure in good condition in the coming years. In this context, the SFMTA has commissioned this study to develop an analytical framework that demonstrates how maintaining and expanding Muni services and infrastructure provide a positive return on investment to the City and are essential to ongoing economic sustainability.

Overview of Scope and Methodology

With about 700,000 average weekday boardings, Muni has a significant impact on travel patterns and traffic conditions in the City. Transit also fosters compact and pedestrian-friendly land use patterns that facilitate other sustainable forms of transportation such as walking and biking. Consequently, San Francisco's private automobile mode share is now under 50 percent, one of the lowest rates in the nation.

Of course, several other transit systems serve San Francisco including AC Transit, BART, Caltrain, Golden Gate Transit buses and ferries, SamTrans and the San Francisco Bay Ferry. These transit systems provide critical linkages to the rest of the region and also deliver important economic benefits to San Francisco, an analysis of which is beyond the scope of this study. Within the region, Muni is the largest transit operator with approximately 45 percent of all ridership even though San Francisco has only 11 percent of the Bay Area's total population. Within San Francisco, Muni is almost three times as large as BART, which averages approximately 250,000 weekday trips that begin and/or end at a station within city limits.

Mid-Market is an example of a rapidly-growing San Francisco neighborhood. Investments in Muni transit service, bicycling facilities (including bike share) and pedestrian safety are helping residents, workers and visitors to access Mid-Market and accommodate growth sustainably.

---

[1] Proposition A, which required a two-thirds vote, passed with 71 percent of the vote, dedicating $500 million in bond funds to build a more reliable Muni and safer streets. Proposition B, which required a majority vote, passed with 61 percent of the vote, adding funds to support Muni based on population growth.

[2] Proposition L, which was rejected by 63 percent of the voters, would have changed city transportation policy to prioritize cars. Specifically, it would have encouraged faster speeds on city streets, new parking garages and restrictions on parking demand management through pricing.

A large proportion of Muni trips occur within the most congested areas of the City and during peak commute hours. In this context, while this analysis produces a monetary estimate of Muni's overall economic impact, the reality is that the entire transportation network would likely physically break down at certain times and places if Muni did not exist.

With this major caveat in mind, this analysis monetizes a range of economic benefits associated with Muni related to congestion relief, direct travel cost savings (including parking), increased safety, and other factors. It then compares the monetized economic benefits attributable to Muni to the cost of operating the system and keeping the capital infrastructure in "a state of good repair." The analysis also provides a "net present value" calculation in order to express cumulative impacts over time in current dollars.

Figure 1 provides an overview of the analytical framework for evaluating Muni's economic impacts. As noted, a number of economic benefit categories have not been quantified in this current analysis due to their complexity and data availability. In addition, while this study focuses on the SFMTA's Muni service, the agency provides a range of other services essential to the functioning of the City's multi-modal transportation network. These responsibilities, which include managing public parking and the allocation of street space, supporting bicycle and pedestrian safety (e.g., bike paths, racks, bike share, crosswalks) and regulating taxis, are not directly evaluated as part of this current analysis.

This current study is based on readily available data and a static or "ceteris paribus" set of assumptions related to San Francisco transportation network, future growth, land use, and other factors.[3] As noted, in many ways this is a theoretical exercise that by necessity simplifies a highly complex and dynamic set of variables and relationships related to traffic patterns and likely behavioral responses. Accordingly, this study includes "high" and "low" estimates for key assumptions and further highlights key sources of uncertainty, as appropriate.

[3] The term ceteris paribus is a commonly used Latin term meaning "with other things the same" or "other things being equal or held constant". In economics and finance, the term is used as shorthand for indicating the effect of one variable on another, holding constant all other variables that may affect the outcome. Inferences about a causal, empirical, or logical relation between two states of affairs is ceteris paribus if it is acknowledged that actual outcomes will depend on a range of intervening factors.

Figure 1 Overview of Muni Economic Benefits Analysis Metrics

Benefits Quantified in this Study

Benefit Category	Benefit Description	How Benefit Can be Monetized
Congestion relief and reduced travel time	By reducing the demand for auto trips, Muni improves overall traffic conditions in the City	(Estimated increase in travel time absent Muni) multiplied by (time value of money)
Travel cost savings to Muni riders	Muni riders experience direct savings from avoided auto Operation & Maintenance and life-cycle costs (e.g. fuel, insurance, depreciation)	Total annual passenger savings from reduced or avoided private auto operating and parking costs
Improved travel safety	Muni results in fewer injuries and fatalities passenger per trip (or mile) relative to auto	Value of avoided collisions and related injuries / fatalities based on actuarial statistics
Improved air quality and Greenhouse Gas (GHG) reductions	Muni generates fewer GHG emissions and other air pollutants per trip (or mile) relative to auto.	Economic value of reduced emissions by type based on U.S. Environmental Protection Agency (EPA) and Department of Transportation (DOT) guidelines
Reduced parking Requirements	Muni reduces the need to build and operate parking and frees up land for more productive uses	Average parking costs for residents. Improved productivity and economic value of alternative land uses (relative to parking).
Higher Worker productivity	Muni enhances worker productivity by supporting development density and economic agglomeration effects (e.g. from improved worker interactions)	Third party sources / studies related to job losses associated with congestion and reduced transportation access

Benefits Not Quantified in this Study

Benefit Category	Benefit Description	How Benefit Can be Monetized
Public Health	Muni promotes active transportation choices	Public health benefits from increased walking and associated reduction in medical costs.
Livability / Placemaking	Muni supports local planning efforts and improves overall quality of life by offering or enhancing: • Mode flexibility and choice • Walkability and pedestrian friendliness • Trip quality (experience, effort / stress, views) • Access to cultural, education, recreation assets	• Commuter preference surveys • Increased trips and/or change in travel time to essential daily needs and amenities • "Walk scores", a measure of the pedestrian network connectivity and ease of walking to neighborhood destinations
Social Equity	Muni provides affordable and accessible transportation to lower income and other disadvantaged groups	Descriptive data related to the economic status of Muni customers

The "ceteris paribus" approach to this analysis is particularly relevant to the estimates of costs and benefits that are likely to occur over time. For example, as the City's population and employment levels grow, the benefits of Muni are likely to increase across the board due to more congestion, parking demand, increase land values, and other factors. Meanwhile, the cost of providing Muni service also will change due to changes in technology, energy costs, labor, and other factors. A detailed analysis of these dynamic factors is beyond the scope of this current

analysis. Thus, for the purposes of this analysis, the relationship between Muni costs and benefits is assumed to remain constant over time.

Summary of Findings

Figure 2 summarizes the economic metrics quantified in this current analysis, comparing both costs and monetized benefits over time. The key findings are summarized below.

1. ***Muni's annual quantifiable economic benefits are estimated to exceed its operations and maintenance costs and "state of good repair" capital investments by anywhere from $634 million to $1.25 billion. This equates to about $10.6 to $20.8 billion in net present value terms and a benefit-cost ratio of 2.0 to 2.9.***

   Based on the economic variables monetized as part of this analysis, Muni provides a highly positive return-on-investment to local taxpayers, generating anywhere from $1.97 to $2.91 for every dollar invested (**Figure 2**). Specifically, Muni's approximately $472 million in net operating and maintenance costs plus $180 million in annual capital investments generate between $1.3 billion and $1.9 billion in monetized economic benefits (a subset of total benefits), representing a net surplus of between $634 million and $1.25 billion per year. On an annual basis, Muni's net benefits (after accounting for all costs) equate to $760 to $1,500 per resident and $3.53 to $6.95 per Muni trip. Assuming costs and benefits remain constant over time (a highly conservative approach, as discussed further below), the net present value of Muni's economic benefits fall in the $10.6 to $20.8 billion range, which equates to $12,600 to $24,800 per resident.[4]

2. ***Muni's largest economic benefit categories that have been monetized in this study include (1) reduced travel costs from taking Muni instead of driving, (2) parking cost savings to local residents at their homes attributable to Muni's role in facilitating lower car ownership rates, and (3) the value of reduced travel times attributable to Muni's contribution to congestion relief. These three categories account for about 85 to 90 percent of Muni's total monetized benefits.***

   The aggregated economic benefits realized by Muni riders due to reduced direct travel expenses (relative to fully loaded cost of equivalent auto travel) is estimated to range from $516 million to $830 million per year, or about 40 to 45 percent of the impacts measured in this study. The largest proportion of travel cost savings is attributable to avoided parking expenses at trip destinations. Meanwhile, Muni's estimated contribution to reduced residential parking requirements account for another 30 to 35 percent of the total monetized benefits. Given the high cost and limited supply of parking in San Francisco, it is not surprising that Muni's role in helping residents, commuters, and employers avoid these costs represents a significant economic benefit.

   The total economic benefits associated with Muni's contribution to congestion relief and resulting travel time savings is estimated to range from $192 million to $237 million per year, about 12 to 15 percent of the total impacts measured in this study. While significant,

[4] The net present value calculation expresses future costs and revenues in current dollars. A discount rate of 6 percent is used to convert a future stream of costs and revenues into a present value estimate. The lower the discount rate, the higher the value placed on future costs and benefits.

these benefits are difficult to capture in their entirety given the complex nature of traffic congestion, and thus are not fully monetized in this study. In reality, given limited roadway capacity in the City, the loss of Muni would likely result in a complete breakdown in the transportation system for all users with serious economic consequences.

The total economic benefits associated with Muni's contribution to improved travel safety and reduce emissions of air pollutants together account for about 9 to 13 percent of the total impacts measured in this study, with a combined monetary value of $120 million to $242 million per year.

3. ***Without Muni, San Franciscans would have to purchase many new automobiles and the number of vehicle trips per day would skyrocket on an already congested roadway network.***

   This analysis estimates that without Muni, San Francisco's car ownership patterns would more closely mirror the rest of the Bay Area where transit options are not as prevalent. Hypothetically, automobile ownership rates would increase by over 50 percent, or by nearly 195,000 additional vehicles. New weekday vehicle trips would soar by 188,000 to 230,000. Not only would this influx of automobiles result in gridlock and impose a financial burden on residents, but it would also erode the City's quality of life.

4. ***The estimates included in this analysis reflect a highly conservative methodology and exclude a number of significant economic benefits (e.g., worker productivity, development density, public health, livability) that are difficult to quantify based on readily available data. Moreover, the methodology used for those categories that have quantified are significantly understates the Muni's true economic returns to San Francisco.***

   Many of Muni's most significant economic impacts are extremely difficult to monetize based on readily available data and well established conventions of cost benefit analysis. Probably most significantly, the urban form of San Francisco, and corresponding land productivity, would likely be drastically altered without Muni. Specifically, the amount of land needed to accommodate additional parking demand absent Muni is equivalent to between 32,800 and 40,400 housing units (about 9 to 11 percent to the City total) or 109,000 and 135,000 jobs (about 17 to 21 percent of the City total).

   In addition, transit in general has been shown to support public health (by promoting more active transportation choices), improve worker productivity (by supporting dense clusters of economic activity and social interaction), and support mobility for lower income and other disadvantaged groups who might otherwise be isolated and marginalized. While clearly significant from an economic perspective, these impacts can be difficult to monetize and incorporate into a standard cost-benefit analysis framework and thus are excluded from the estimates in **Figure 2**.

Figure 2 Summary of Economic Benefits of Muni Transit Services

Economic Benefit Category	Annual Impact (2014$)[1] High	Annual Impact (2014$)[1] Low	Net Present Value (NPV)[2] High	Net Present Value (NPV)[2] Low
Monetized value of faster travel times from reduced congestion attributable to Muni	$236,800,000	$192,400,000	$3,946,700,000	$3,206,700,000
Reduced travel costs from using Muni instead of driving (includes parking at destination)	$830,400,000	$515,600,000	$13,840,000,000	$8,593,300,000
Travel Safety Benefits attributable to Muni (Reduced injuries and fatalities)	$191,600,000	$90,100,000	$3,193,300,000	$1,501,700,000
Monetized value of emitting less Pollutants by Using Muni instead of driving[3]	$50,100,000	$29,500,000	$835,000,000	$491,700,000
Parking Cost Savings at Place of Residence	$588,800,000	$457,900,000	$9,818,300,000	$7,636,700,000
Total quantified economic benefits of Muni	**$1,898,000,000**	**$1,285,500,000**	**$31,628,300,000**	**$21,425,100,000**

Muni costs	Annual Impact (2014$)[1] High	Annual Impact (2014$)[1] Low	Net Present Value (NPV)[2] High	Net Present Value (NPV)[2] Low
Muni Net Operations & Maintenance Costs[4]	$471,791,000	$471,791,000	$7,863,200,000	$7,863,200,000
State of Good Repair Capital Investment	$180,000,000	$180,000,000	$3,000,000,000	$3,000,000,000
Total Annual Muni Costs	$651,791,000	$651,791,000	$10,863,200,000	$10,863,200,000
Net Muni Benefits	**$1,246,209,000**	**$633,709,000**	**$20,765,100,000**	**$10,561,900,000**
Return on Investment (ROI)[5]	**191%**	**97%**	**191%**	**97%**
Benefit-Cost Ratio[5]	**2.91**	**1.97**	**2.91**	**1.97**

[1] Estimates embody travel patterns derived from the SFCTA Travel Demand Analysis for 2012, or SF-CHAMP.

[2] A discount rate of 6 percent is used to convert a future stream of costs and revenues into a present value estimate.

[3] Benefits are regional and beyond, and not limited to San Francisco.

[4] Includes $41 million which represents half of the Sustainable Streets operating budget, which supports Muni services.

[5] Return on Investment (ROI) equals Net Muni Benefits/total Muni costs. The Benefit-Cost Ratio equals Total Muni Benefits/Total Muni Costs.

2. ECONOMIC BENEFITS FROM REDUCED CONGESTION

This section provides a monetized estimate of the economic benefits Muni provides by reducing the overall level of traffic congestion in the City. Specifically, by reducing the demand for auto trips, Muni improves overall traffic conditions in the City for both its own customers and the public at large.

Key Assumptions and Methodology

To estimate congestion-related economic impacts, this analysis focuses on how traffic and delay would increase if Muni did not exist. Specifically, many current Muni customers would have no choice but to drive, further burdening an already congested and physically-constrained roadway network. Not only would the absence of Muni directly impact existing transit customers, but also current drivers who would face even more traffic and competition for parking.

Muni helps reduce the number of automobile trips on San Francisco streets. Without Muni, traffic congestion would be even worse and parts of the transportation network could break down.

To derive this theoretical estimate, this analysis uses proxy data and assumptions related to the likely behavioral characteristics of Muni customers and San Francisco traffic patterns. The key data sources include SFMTA's 2014 Systemwide On-Board Survey, the San Francisco County Transportation Authority (SFCTA) 2012 SF-CHAMP model runs, and the Federal Transit Administration's Transit Performance Monitoring System (TPMS). SF-CHAMP, the official travel forecasting tool for San Francisco, is a state-of-the-art, activity-based model that predicts future travel patterns for the City and is used for many SFCTA planning studies and projects. **Figure 3** and **Figure 4** provide detailed calculations and the key methodological assumptions are summarized below.

- **Annual Muni Passenger Trips in 2014**: The calculation of the travel time savings attributable to Muni starts with an estimate of total annual Muni passenger trips based on 2014 data from the SFMTA. Linked trips deduct transfers (unlinked trips include transfers) to obtain a more accurate estimate of a complete trip (i.e. an origin and final destination) that is most closely resembles a typical auto trip.

- **Total estimated new annual auto trips if Muni did not exist**: The analysis includes a "high" and "low" estimate of the number of Muni customers who would drive if Muni transit service were unavailable. The "high" of 57 percent is based on national TPMS survey respondents who report they would likely travel by car, either as a driver or passenger, if transit were not an option. The "low" estimate is based on the SFMTA Systemwide On-Board Survey that suggests about 46 percent of customers own a car (note that if Muni did not

exist, more residents would most likely own vehicles). While the economic impact on individuals who don't have access to cars is not monetized in the study, it is likely to be substantial, as discussed further below.[5]

Figure 3 Value of Travel Time Savings from Congestion Relief Attributable to Muni

Item	Source	Formula	High Estimate	Low Estimate
Annual Unlinked Muni Passenger Trips (FY 2014)	National Transit Database	a	224,893,084	224,893,084
% of Trips that are Linked	SFCTA model	b	79.78%	79.78%
Annual Linked Muni Trips (excludes transfers)	National Transit Database	c = a * b	179,419,702	179,419,702
% of Muni Riders who would shift to automobiles if Muni did not exist – drive alone	High: TPMS Survey. Low: SFMTA survey[1]	d	23.0%	18.7%
% of Muni Riders who would shift to automobiles if Muni did not exist – carpool	High: TPMS Survey. Low: SFMTA survey[1]	e	34.0%	27.6%
Avg. Carpool Size	U.S. Census	f	2.18	2.18
Net new annual vehicle trips if Muni did not exist	-	g = c * d + (c * e / f)	69,249,421	56,269,151
Avg. Trip Length (miles) from New Auto Trips Absent Muni (i.e. former Muni riders)	SFMTA data on Avg. linked trip length	h	2.70	2.70
Net New Annual VMT Absent Muni	-	i = g * h	186,877,361	151,848,641
Δ in Lost VH (vs freeflow) / Δ in VMT	See Table 4	j	0.06	0.06
Estimated Increase in Annual Vehicle Delay Absent Muni (hours)	-	k = i * j	11,455,582	9,308,322
Average Auto Occupancy Rate	U.S. Census American Community Survey	l	1.10	1.10
Estimated Increase in Annual Person VH in SF Absent Muni Due to Congestion	-	m = k * l	12,601,140	10,239,154
Ridership by Type Personal (includes "off-the-clock" commutes)	SFCTA model	n	95%	95%
Ridership by Type Business (Work-based)	SFCTA model	o	5%	5%
Hourly Value of Time Estimates for San Francisco[2] Personal	U.S. DOT	p	$17.90/hr	$17.90/hr
Hourly Value of Time Estimates for San Francisco[2] Business	U.S. DOT	q	$35.30/hr	$35.30/hr
Annual Value of Time Savings from Muni Personal	-	r = m *n * p	$213,975,788	$173,867,676
Annual Value of Time Savings from Muni Business	-	s = m * o * q	$22,845,660	$18,563,417
Total	-	r + s	**$236,821,448**	**$192,431,093**

[1] According to Muni 2014 Systemwide On-Board Survey (p. 34), approximately 46% percent of MUNI riders have access to a car.
[2] Derived for San Francisco based on the methodology and guidance provided by the U.S. Dept of Transportation. Source: U.S. DOT, Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, Updated July 9, 2014.
Acronyms: VMT = Vehicle Miles Traveled; VHT = Vehicle Hours Traveled ; Lost VH (vs freeflow) = Lost vehicle hours due to congestion; Transportation Authority; TPMS = Transit Performance Monitoring System

[5] According to According to Muni 2014 Systemwide On-Board Survey (p. 34), approximately 46 percent of MUNI riders have access to a car.

- **Net New Vehicle Miles Traveled (VMT) Absent Muni:** The net increase in VMT absent Muni is calculated based on the number of former Muni passengers that would elect to drive multiplied by the average Muni trip length.

- **Increase in vehicle delay due to additional auto trips if Muni did not exist**. The analysis relies on outputs from the SFCTA traffic model to estimate the impact of adding new vehicles (e.g., former Muni riders) to San Francisco's road network. Specifically, as shown in **Figure 4**, this analysis estimates the increase in vehicle travel time due to congestion (referred to as "Lost Vehicle Hours (vs freeflow)") when additional vehicle miles traveled (VMT) are added to the network. This factor, (referred to "Δ in Lost Daily VH/Δ in Daily VMT") is based on the change in "Lost Vehicle Hours (vs freeflow)" between 2012 and 2030 under the SF-CHAMP Treasure Island Mobility Management Agency (TIMMA) Baseline scenario.[6] In other words, it quantifies how vehicle delay increases with VMT assuming relatively modest improvements for auto traffic are made to the San Francisco road network over time. The analysis incorporates SFMTA data related to ridership patterns throughout the City (e.g., proportion of total trips destinations to highly congested neighborhoods such as the Central Business District).

The distribution of Clipper® Card boardings on Muni illustrates (a) the widespread usage of transit throughout the city and (b) how essential Muni is to facilitating access to Northern California's hub for employment and economic activity.

[6] The Treasure Island Mobility Management Agency (TIMMA) 2030 Baseline scenario reflects the development in Treasure Island and other planned and foreseeable transportation system changes between 2012 and 2030 as part of the San Francisco Transportation Plan (SFTP) 2040 Baseline Investment Plan and the 2013 Regional Transportation Plan. The transportation improvements include roadway and infrastructure changes consistent with 2014 Bike Plan, Muni Forward, the completion and operation of Central Subway, the implementation of Better Market Street project, the Geary BRT Plan, the Central Corridor Plan, and BART extension to the South Bay.

Figure 4 Change in Travel Time Delay per Mile of Increased Auto Use

Item	Formula	Destination: Regional Core	Destination: Central Business District	Destination: Rest of San Francisco	All Trips
2012 Vehicle Miles Traveled[1]	a	661,094	2,701,240	6,038,188	9,400,522
2012 Vehicle Hours Traveled[1]	b	52,156	125,198	254,007	431,361
2012 Lost Vehicle Hours (vs. free-flow traffic) [1]	c	25,389	49,452	105,511	180,352
2030 Vehicle Miles Traveled[2]	d	720,897	3,075,957	6,994,415	10,791,269
2030 Vehicle Hours Traveled[2]	e	59,147	151,327	311,052	521,527
2030 Lost Vehicle Hours (vs. free-flow traffic)[2]	f	29,972	65,214	138,534	233,720
Distribution of Muni trip boardings[3]	h	60%	20%	20%	100%
Change in Lost Daily Vehicle Hours/Change in Daily Vehicle Miles Traveled	g = (f - c) / (d - a)	0.0766	0.0421	0.0345	**0.0613**

[1] 2012 San Francisco Daily Vehicle Miles Traveled and Vehicle Hours (to/from/within San Francisco). Source: SFCTA SF-CHAMP Treasure Island Mobility Management Agency (TIMMA)
[2] 2030 San Francisco Daily Vehicle Miles Traveled and Vehicle Hours (to/from/within San Francisco). Source: SFCTA SF-CHAMP Treasure Island Mobility Management Agency (TIMMA) (2030 Baseline, No Project Scenario)
[3] Estimated ridership distribution based on locations of Clipper® Card boardings

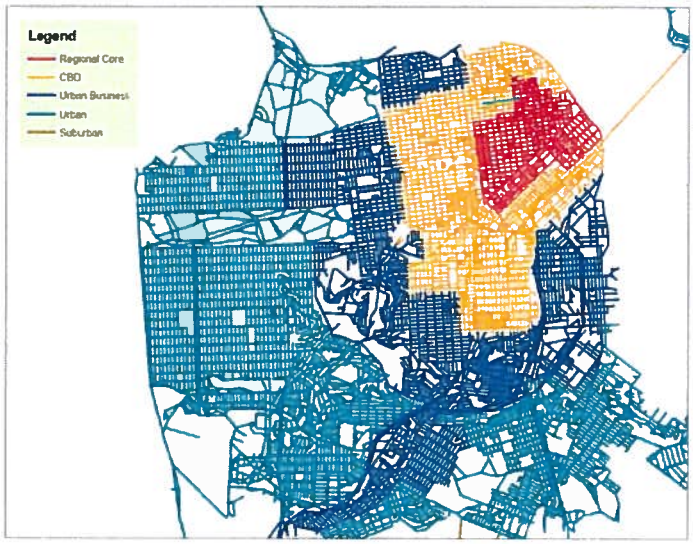
- **Time value of money associated with increased travel delay**: The time value of money estimates are based on standard guidance from the U.S. Department of Transportation, adjusted for the San Francisco Metropolitan Statistical Area (MSA), that distinguishes between business ("on-the-clock") and personal (including commute) time.[7] It accounts for both lost productivity as well as the value individuals place on personal time.

- **Annual Value of Travel Time Savings Attributable to Muni**: The total annual value of time savings attributable to Muni is based on the estimated increase in vehicle hours of delay that would result absent Muni service multiplied by the time value of money.

[7] This guidance is based on academic research related to the value of time for business and personal related activities, respectively. For further reference see http://www.dot.gov/sites/dot.gov/files/docs/TIGER%20BCA%20Resource%20Guide%202014.pdf

Results and Implications

The aggregated economic benefits associated with travel time saving attributable to Muni is estimated to range from $192 million to $237 million per year, about 12 to 15 percent of the total impacts measured in this study. While significant, it is important to note that these estimates are based on a hypothetical scenario that includes a number of simplifying assumptions that likely to understate Muni's contribution to congestion relief. Chief among these include:



The SFCTA 2012 SF-CHAMP model provides detailed data on travel patterns for the various sub-zones in the City illustrated above.

- The analysis relies on outputs from the SFCTA model that predict future travel patterns in the City expected to occur gradually over time based on population and job growth. The future scenario also includes modest improvements to the road network for automobiles and that Muni, and San Francisco transit service in general, is actually improved to accommodate increased demand. Consequently, using the model to estimate the implications of ending Muni service is not necessarily reflective of actual outcomes and does not adequately account for roadway capacity issues.

  In reality, currently there is not enough roadway capacity in the City, especially at peak hours and congested locations, let alone to accommodate a major shift form Muni to auto travel. Consequently, the loss of Muni would likely (1) result in a complete breakdown in the transportation system for all users, and/or (2) necessitate a major expansion in the roadway capacity to accommodate the new vehicles. Of course, new construction would itself have significant cost and delay implications. A comprehensive analysis of the economic implications of such these scenarios is beyond the scope of this current study.

- The above estimates rely on SFCTA model outputs associated with "average daily trips" rather than peak hour commutes. In reality, transit has the largest impact on traffic congestion relief during peak hours when roads are already saturated. Any incremental shift towards cars during peak hours will likely have disproportionately negative impact on congestion and travel delay.

- The estimates do not account for the likely impact of reduced parking supply on travel time. Specifically, as former Muni riders shift to auto, further pressure will be put on the City's already constrained and competitive parking inventory. Increased competition for scarce parking spaces will increase auto travel times as drivers take longer to find a spot and/or park further from their destinations. Double-parking and/or circling for a parking space, in turn, further increases VMT and congestion, compounding delay even more.[8]

[8] A recent SFpark evaluation found that improved parking availability reduced the time spent circling by 43 percent from just over 9 minutes to 6.5 minutes.

3. ECONOMIC BENEFITS OF REDUCED TRAVEL COSTS

This section estimates the economic benefits that Muni customers experience from reduced travel costs by riding transit instead of driving. Specifically, Muni customers save money by avoiding automobile operation and maintenance (e.g., fuel, repairs, insurance) as well as life-cycle costs (vehicle purchase and depreciation).

Key Assumptions and Methodology

This analysis estimates the travel cost savings to Muni riders by comparing typical Muni travel costs (i.e. average fares) to the fully-loaded cost of owning and operating a car (including parking) on a per trip and per mile basis. This methodological framework slightly different than the travel time saving estimates in **Section 2** in that it focuses on the economic benefits to Muni riders rather than auto travelers. **Figure 5** and **Figure 6** present the detailed calculations and the key methodological assumptions are summarized below.

- **Annual Linked Muni Trips**: The calculation of typical direct travel costs savings to Muni riders per trip is multiplied by total annual Muni linked trips to calculate total annual economic benefits. Linked trips deduct transfers (unlinked trips include transfers) to obtain a more accurate estimate of a complete trip (i.e. an origin and final destination) that is most comparable to a typical auto trip.
- **Average Muni Rider Fare per Trip and per Mile**: The cost of Muni travel is based on average Muni fares as derived from the SFMTA 2014 data. The average fare per trip is converted to per mile based on the average Muni linked trip length using the SFMTA 2014 data.
- **Average Auto Operating and Ownership Expenses per Mile**: Average vehicle ownership and operating expenses are based on U.S. DOT guidance, adjusted for the San Francisco MSA.[9] The estimates include auto operation and maintenance (e.g., fuel, repairs, insurance) as well as life-cycle costs (vehicle financing and depreciation). The auto ownership costs estimate excludes the initial purchase price since presumably an auto provides economic value to the consumer.

[9] This guidance incorporates data related to vehicle operating costs (fuel and maintenance), and fixed costs or ownership costs (i.e., insurance, license, registration, taxes, depreciation, and finance charges, but excluding purchase price). For further reference see http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_03_17.html

Figure 5 Travel Cost Savings to Muni Riders

Item	Source	Formula	High Estimate	Low Estimate
Annual Unlinked Muni Trips (includes transfers) (FY 2014)	National Transit Database	a	224,893,084	224,893,084
Muni Riders without Autos	2014 SFMTA Systemwide On-Board Survey[2]	b	54%	54%
Muni Riders with Autos	2014 SFMTA Systemwide On-Board Survey[2]	c	46%	46%
% of Trips that are Linked	SFCTA SF-CHAMP model	d	80%	80%
Annual Linked Muni Trips	-	e = a*d	179,419,702	179,419,702
Total Muni Fixed Route Fare Revenues	National Transit Database	f	211,684,251	211,684,251
Avg. Rider Fare per Muni Linked Trip	-	g = f / e	$1.18	$1.18
Avg. Auto Operating Expense per Mile - Fuel	US DOT Guidance adjusted for Bay Area cost of living	h	$0.21	$0.21
Avg. Auto Operating Expense per Mile - Other (excludes Parking)	US DOT Guidance adjusted for Bay Area cost of living	i	$0.07	$0.07
Avg. Auto Operating Expense per Mile - Subtotal	-	j = h + i	$0.28	$0.28
Fixed Auto Ownership Cost per Mile (excludes Parking)[1]	US DOT Guidance adjusted for Bay Area cost of living	k	$0.44	$0.44
Avg. Muni Trip Length (miles)	National Transit Database	l	$2.70	$2.70
Average Auto Occupancy Rate	US Census – American Community Survey	m	$1.10	$1.10
Avg. Total Cost / Passenger / Auto Trip	-	n = ((j+k) * l) / m	$1.77	$1.77
Avg. Operating Cost / Passenger / Auto Trip	-	o = (j*l) / m	$0.69	$0.69
Avg. Passenger Savings / Linked Trip (excludes parking) - Muni passengers without Autos	-	p = n - g	$0.59	$0.59
Avg. Passenger Savings / Linked Trip (excludes parking) - Muni passengers with Autos	-	q = o - g	$(0.49)	$(0.49)
Weighted Avg. Cost Savings / Passenger / Trip	-	r = (p*b) + (q*c)	$0.09	$0.09
Subtotal Muni Passenger Travel Cost Savings (excludes parking)	-	s = e*r	$15,775,453	$15,775,453
Parking Cost Savings from Taking Transit	Figure 6	t	$814,614,382	$499,811,705
Net Annual Muni Passenger Travel Cost Savings	-	s + t	**$830,389,835**	**$515,587,158**

[1] Includes insurance, registration and financing costs

[2] 2014 Systemwide On-Board Survey – Figures represent the respondents who responded as to whether or not they had access to a vehicle

- **Average Muni Passenger Savings per Linked Trip (excluding parking)**: The average savings per linked trip equals the difference between the typical cost per mile cost for Muni and auto travel (after accounting for carpooling) times the average Muni trip length. Note that the calculations suggest that Muni riders who do not own a car realize significantly higher travel cost savings than those who do since they forego auto ownership costs (i.e.,

insurance, license, registration, taxes, depreciation, and finance charges, but excluding purchase price).

- **Parking Cost Savings from Taking Transit:** In addition to generally lower per mile travel costs relative to auto, Muni passengers benefit from not having to pay for parking at their destination. **Figure 6** provides a more detailed assessment of avoided parking costs by Muni riders at trip destinations. The analysis includes "high" and "low" range estimates for the percentage of trips that would have required paid parking at their destination by trip purpose (from 80 to 95 percent for commute and work-related trips and 50 to 75 percent for "other" trips). Parking destination cost estimates are based on a review of average monthly and hourly rates for City owned facilities in San Francisco (both on and off-street) (see **Figure 7**).[10]

- **Total Muni Passenger Travel Cost Savings:** The total annual travel cost savings to Muni passengers is based on foregone or avoided auto and parking expenses per trip multiplied by annual Muni trips. This estimate represents the direct expenses Muni passengers would have incurred on an annual basis if they had traveled by car rather than Muni.

[10] The real or implicit (e.g., through higher housing costs) parking costs incurred by San Francisco residents at their home are described and calculated separately in **Section 6**.

Figure 6 Parking Cost Savings for Muni Riders (excludes resident parking)

Item	Formula	High Estimate	Low Estimate
Annual Linked Muni Trips	a	179,419,702	179,419,702
Equivalent Trip Destinations (e.g. Round Trips)[1]	b = a / 2	89,709,851	89,709,851
Work Commute Trips as a % of Total Trips[2]	c	41%	29%
Work-Based Trips as a % of Total Trips[2]	d	9%	5%
Other Purpose Trips as a % of Total Trips[2]	e	50%	66%
Annual Muni Employee Commute Trips	f = b*c	36,781,039	25,766,430
Annual Muni Work-Based Trips (On-the-clock Workers)	g = b*d	8,073,887	4,607,436
Annual Other Purpose Trips (Shopping, Recreation, etc.)	h = b*e	44,854,926	59,335,986
Average Occupancy per Vehicle[3]	i	1.10	1.10
Employee Commute Trips requiring paid parking	j	95%	80%
Work-Based Trips (On-the-clock Workers) requiring paid parking	k	95%	80%
Other Purpose Trips (Shopping, Recreation, etc.) requiring paid parking	l	75%	50%
Employee Commute Trips – Annual Avoided Trips with Paid Parking at Destination	m =j * (f / i)	31,765,443	18,739,222
Work-Based Trips – Annual Avoided Trips with Paid Parking at Destination	n = k * (g / i)	6,972,902	3,350,862
Other Purpose Trips– Annual Avoided Trips with Paid Parking at Destination	o = l * (h / i)	30,582,904	26,970,903
Avg. Per-Trip cost of Parking – Employee Commute Trips[4]	p	$22.00	$22.00
Avg. Per-Trip Cost of Parking – Work-based Trips[4]	q	$5.20	$5.20
Avg. Per-Trip Cost of Parking – Other Purpose Trips[4]	r	$2.60	$2.60
Avoided Parking Costs - Employee Commute Trips	s = m * p	$698,839,741	$412,262,873
Avoided Parking Costs - Work-based Trips	t = k * n	$36,259,091	$17,424,485
Avoided Parking Costs - Other Purpose Trips	u = l * o	$79,515,550	$70,124,347
Total Avoided Parking Costs	S + t + u	**$814,614,382**	**$499,811,705**

[1] Assumes that parking costs are only incurred on one-leg of the trip (the destination).

[2] Sources: High estimates - SFMTA Muni Systemwide On-Board Survey; Low estimates - SFCTA SF-CHAMP Model

[3] Source: U.S. Census American Community Survey

[4] Refer to Figure 7 for calculations

Figure 7 Average Parking Space Costs Estimates

Item	Formula	Amount
Average Daily Parking Costs per trip for Commuting Employees – Low (Privately managed) [1]	a	$9.00
Average Daily Parking Costs per trip for Commuting Employees – Mid-Range (SFMTA managed) [1,2]	b	$22.50
Average Daily Parking Costs per trip for Commuting Employees – High (Privately managed) [1]	c	$35.00
Average Parking Costs per Trip for Commuting Employees	(a+b+c)/3	$22.00
Avg. hourly rate / space for work-based and other trips[3]	d	$2.60
Avg. hours parked - Work-based Trips (i.e. "on-the-clock")	e	2.0
Avg. hours parked - Other Purpose Trips (i.e. personal)	f	1.0
Avg. parking cost - Work-based Trips	d * e	**$5.20**
Avg. parking cost - Other Purpose Trips	d * f	**$2.60**

[1] Estimated monthly costs: Low (Privately-Managed) - $180, Mid-Range (SFMTA-managed) - $450, High (Privately-Managed) $700. Daily rates assume 20 workdays per month.

[2] Based on average monthly and daily rate per space at SFMTA owned off street parking facilities. Costs exclude parking citations.

[3] Based on average hourly rate per space at SFMTA owned off-street parking facilities. Costs exclude parking citations.

Results and Implications

The aggregated economic benefits realized by Muni riders due to reduced direct travel expenses (relative to fully loaded cost of equivalent auto travel) is estimated to range from $516 million to $830 million per year. This economic benefit represents the most significant impact measured in this study – about 40 to 45 percent of the total. The largest proportion of this cost savings is attributable to avoided parking expenses, particularly for work related trips. This result is not surprising given the high cost of parking in San Francisco.

Similar to estimated travel time savings in **Section 2**, the methodology for estimating avoided travel cost attributable to Muni is based on a hypothetical scenario that includes a number of simplifying assumptions. For the most part these simplifying assumptions are likely to under-estimate the full economic benefits of Muni. Chief among these include:

- The analysis is based on existing auto-ownership rates of Muni passengers at about 54 percent. In reality, car ownership rates in San Francisco would likely increase absent Muni. Consequently, many residents would incur the additional costs of purchasing vehicle. Given an average cost of a new mid-size sedan about $25,000, this expense could be unaffordable for a significant portion of San Francisco residents who are already facing high costs of housing.

- The above estimates assume that all Muni riders would otherwise travel to their destination by car rather than choose another mode (e.g., walk, bike, or taxi) or forego the trip altogether. While biking or walking would reduce the cost savings estimated above (excluding value of time considerations), a taxi would increase them. Probably more significant,

however, is the economic cost of a foregone trip which would lead to an overall decline in economic activity, as discussed further in **Section 7**.

- The analysis assumes that parking prices remain constant. In reality, parking costs would likely escalate absent Muni due to increased demand. Given that parking costs in the City represent the single largest cost differentiator between transit and auto (since purchase price is excluded from the calculations), even small increases in rates will have a significant on impact the results.
- The analysis ignores the direct travel cost savings to non-Muni riders associated with a more efficient and less congested transportation network. For example, Muni's contribution to reduced congestion (as discussed in **Section 2**), reduces the typical operating cost for autos through smoother travel, less stop and go traffic, more direct routes, reduced parking costs, etc.

4. Economic Benefits of Improved Travel Safety

This section estimates the economic benefits from Muni associated with improved safety relative to auto travel. Specifically, Muni travel generates fewer collisions per passenger trip (or passenger mile) relative to auto travel, resulting in less injuries and fatalities and associated economic costs.

Key Assumptions and Methodology

This analysis estimates the economic benefits associated with Muni's contribution to improved travel safety by comparing the collision and associated injury rates for each mode. The annual economic benefits are based on total Muni ridership multiplied by its lower collision rates, calculated on a per mile ("high" estimate) and per trip ("low" estimate) basis. **Figure 8** presents the detailed calculations and the key methodological assumptions are summarized below.

High Muni ridership helps improve travel safety in San Francisco. Muni has fewer collisions per passenger trip or passenger mile relative to automobile travel.

- **Total Passenger Miles and Linked Trips for Muni and Auto**: The analysis compares total passenger miles and trips in the City for Muni and auto as a basis for developing collision rates for each mode.
- **Number of Traffic Injuries by Mode and Type of Collision**: This study used the 2006-2012 average reported by the Statewide Integrated Traffic Records System (SWITRS) for auto collision data and the 2006-2013 average from Muni transit collision reports. Collisions are differentiated by type (e.g., fatality, severe injury, other injury).
- **Value of Collision Prevention**: The estimated economic costs of various types of collisions are based on U.S. DOT guidance related to the statistical value of each.[11]
- **Annual value of safer travel attributable to Muni:** The total travel safety benefits attributable to Muni subtract Muni's lower per trip or per mile collision rates relative to autos and multiply the result by total Muni passenger miles/trips.

[11] This guidance is based on estimates related to lost economic productivity and health care costs. further reference see:
http://www.dot.gov/sites/dot.gov/files/docs/TIGER%20BCA%20Resource%20Guide%202014.pdf

Figure 8 Muni Economic Benefits from Improved Travel Safety

A. Injury Incidences

Category	Muni	Auto	Difference
Annual Passenger Miles[1]	484,184,273	3,736,309,148	3,252,124,875
Annual Passenger Linked Trips (excludes transfers)[1]	179,419,702	875,184,369	695,764,667
Passenger Miles / Linked Trip	2.70	4.27	1.57
Average Annual Injuries - Fatal[2]	4	30	26
Average Annual Injuries - Injury (Severe)[2]	8	185	177
Average Annual Injuries - Injury (Other Visible)[2]	42	929	887
Average Annual Injuries - Injury (Complaint of Pain)[2]	93	2,031	1,938

B. Economic Impact of Injuries

Low Estimate of Economic Impact of Injuries: Injuries by Type of Collision (per 10,000,000 passenger miles)[2]	Muni Incidents / 10,000,000 Passenger Miles	Auto Incidents / 10,000,000 Passenger Miles	Difference Incidents / 10,000,000 Passenger Miles	Low Estimate of Annual Value Of Safer Travel[3]
Fatalities	0.08	0.08	(0.00)	($1,560,487)
Injury (Severe)	0.17	0.50	0.33	$52,617,559
Injury (Other Visible)	0.87	2.49	1.62	$34,257,338
Injury (Complaint of Pain)	1.92	5.43	3.51	$4,745,085
Total	3.04	8.50	5.46	**$90,059,494**

High Estimate of Economic Impact of Injuries: Injuries by Type of Collision (per 1,000,000 passenger trips)[2]	Muni Incidents / 1,000,000 Passenger Trips	Auto Incidents / 1,000,000 Passenger Trips	Difference Incidents / 1,000,000 Passenger Trips	High Estimate of Annual Value Of Safer Travel[3]
Fatalities	0.02	0.03	0.01	$19,171,400
Injury (Severe)	0.04	0.21	0.17	$98,576,571
Injury (Other Visible)	0.23	1.06	0.83	$64,874,011
Injury (Complaint of Pain)	0.52	2.32	1.80	$9,016,054
Total	0.82	3.63	2.81	**$191,638,036**

[1]Based on NTD Service Characteristics and Key Performance Indicators for FY 2014
[2]Auto based on SWITRS average from 2006-2012. Muni based on 2006-2013 average from Collision Reports
[3]U.S. Department of Transportation, Value of Statistical Life (VSL) 2013 Revised Guidance. Fatalities - $9,295,782; Injury (Severe) - $3,293,960; Injury (Other Visible) - $436,902; Injury (Complaint of Pain) - $27,887

Results and Implications

The aggregated economic benefits attributable to Muni due to improved travel safety in San Francisco (relative to an equivalent level of auto travel), is estimated to range from $90 million to $192 million per year. The wide range reflects the fact that typical Muni trips tend to be much

shorter than typical auto trips. This economic benefit represents between 7 and 10 percent of the total impacts measured in this study.

While travel safety is clearly important, the above estimates exclude the public health effects associated with more active transportation choices. For example, numerous studies have shown that transit riders typically incorporate significantly more walking into their daily commutes than to auto travelers with highly positive health benefits.

5. ECONOMIC BENEFITS FROM REDUCED AIR POLLUTANTS

This section estimates the economic benefits that Muni provides by reducing the level of transportation related air pollutant emissions in the City. Specifically, it compares the average air emissions from Muni with automobile travel on a per trip and per mile basis and monetizes the social costs of various types of air pollutants using guidance from the U.S. DOT, Environmental Protection Agency (EPA), and other sources.

Key Assumptions and Methodology

Air pollutant emissions have environmental impacts, which adversely affect human health and contribute to climate change. Emissions are generally distinguished between greenhouse gases (GHGs) and non-GHG pollutants.

The economic benefits of lower emissions from Muni relative to auto per passenger mile or per trip are based on the social costs of various types of air pollutants using guidance from the U.S. DOT, the EPA and other sources. Specifically, the EPA relies on a variety of academic studies have monetized the social cost of emission based on their impact on human health and the environment. The "high" economic benefit estimate is based on reduced emissions per Muni trip relative to auto (times number of trips) while the "low" estimate relies on passenger miles. **Figure 9** presents the detailed calculations and the key methodological assumptions are summarized below.

- **Annual Air Emissions (Metric Tons) by type and Source in San Francisco**: Annual carbon dioxide (CO_2) emissions by Muni and autos respectively in the City are estimated based on data from the San Francisco Climate Action Strategy, 2010 Emissions. Estimates for "Other" auto emissions (combines carbon monoxide (CO), nitrogen oxide (NOX), particulate matter (PM), and reactive organic gas (ROGs)) are based on average rates published by the California Environmental Protections Agency, Air Resources Board (CARB). Finally, "Other" Muni emission estimates are based on emission rates for the FY 2012-13 fleet, as calculated by SFMTA staff.

- **Annual Air Emissions per Mile or Trip**: Annual Muni and auto emissions per trip and mile are calculated based on the SFMTA data on total Muni miles and the SFCTA data on the VMT in San Francisco.

- **Social Cost of Emissions**: As noted, the social costs of various types of air pollutants are calculated using per metric ton estimates published by the U.S. EPA.[12] Note that the cost per metric ton for "Other Emissions" differ between auto and Muni due to the composition of pollutants from each.

---

[12] See:
http://www.dot.gov/sites/dot.gov/files/docs/TIGER%20BCA%20Resource%20Guide%202014.pdf

- **Annual Muni Emission Benefit Based on Passenger Trips or Miles**: The total annual economic benefit from emission reductions attributable to Muni is based on the difference between Muni and auto emissions per trip or mile multiplied by annual Muni trips. This estimate represents the social cost of emissions that would have incurred on an annual basis if Muni passengers had traveled by car rather than Muni.

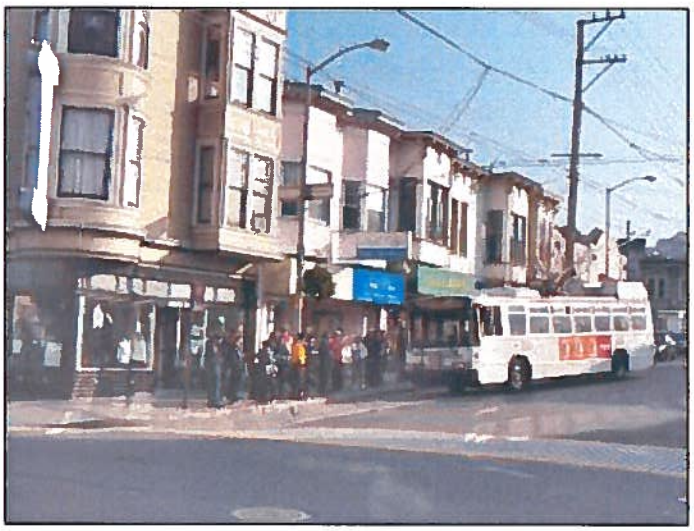
Figure 9 Annual Benefit From Muni Emission Reductions

Category	Muni	Autos	Difference	Value of Emissions Reduction[4]
CO_2 Emissions (metric tons)[1]	45,310	2,118,863	2,073,553	-
Other (combines CO, NOX, PM, and ROGs) (metric tons)[2]	229	10,716	10,486	-
Annual Passenger Miles (unlinked)[3]	484,184,273	3,736,309,148	3,252,124,875	-
Annual Passenger Trips (linked)[3]	179,419,702	875,184,369	695,764,667	-
CO_2 Emissions (mT)/1,000,000 Passenger Miles	94	567	474	$8,941,576
Other Emissions (mT)/1,000,000 Passenger Miles	0.47	2.87	2.39	$20,597,841
Low Estimate of Total Emissions (mT)/1,000,000 Passenger Miles	94.47	569.87	476.39	**$29,539,417 (Low)**
CO_2 Emissions (mT)/1,000,000 Passenger Trips (linked)	253	2,421	2,169	$15,173,872
Other Emissions (mT)/1,000,000 Passenger Trips (linked)	1.28	12.24	10.97	$34,955,238
High Estimate of Total Emissions (mT)/1,000,000 Passenger Miles	254.28	2,433.24	2,179.97	**$50,129,110 (High)**
Social Cost of All Emissions (2013$)[5]	$6,394,920	$273,004,164	$266,609,244	-

[1] Based on San Francisco Climate Action Strategy, 2010 Emissions Inventory.
[2] Based on 2012-2013 Muni Fleet Emission Estimates, CARB Emissions Factors Table 3A (May 2013).
[3] Muni passenger miles and trips based on Muni NTD data. Auto miles and trips based on SFCTA traffic model.
[4] Estimated social costs of emissions: CO2 - $39 per metric ton for both Muni and autos; other (combines carbon monoxide (CO), nitrogen oxides (NOX), particulate matter (PM) and reactive organic gases (ROGs)) - $20,192 per metric ton for Muni and $17,766 per metric ton for autos. Based on Transportation Investment Generating Economic Recovery, or TIGER Benefit-Cost Analysis Guide (2014). Muni Social Cost of Carbon (SCC) factor based on 2012-2013 Muni Fleet Emission Estimates; Autos SCC factor based on CARB Emission Factors Table 3A (May 2013), and intermediate calculations by EPS, applying factors from TIGER Benefit-Cost Analysis Guide and 2010 Emissions Inventory (VMT).
[5] Social costs of all emissions are calculated by multiplying the costs per metric ton by the total annual emissions.

Results and Implications

The aggregated economic benefits attributable to Muni due to emission reductions (relative to an equivalent level of auto travel), is estimated to range from $30 million to $50 million per year. While this range represents less than 5 percent of the total impacts measured in this study, a number of factors suggest the estimate is conservative. Chief among these include



Zero-emission Muni electric trolley buses operate on 14 routes across San Francisco. Over half of all Muni boardings occur on electrically-powered vehicles (historic streetcars, light rail vehicles, trolley buses and cable cars).

- The net present value calculations used to express future values in current dollars assume that the relationship between Muni and auto emissions remain constant over time on a per mile or trip basis. In reality, Muni is likely to experience higher "economies of scale" in emission reductions due to higher passengers per vehicle relative to the auto. Thus, as the City's population and employment base expands, and with it total travel demand, Muni emission levels per mile or trip are likely to decline. Meanwhile, increasing vehicle congestion due to growth (or under the hypothetical scenario in which Muni passengers shift to auto), is likely to have a negative impact on auto emission rates due to increased delay and other inefficiencies (idling, stop and go, more circuitous routes, etc.).

- This methodology only estimates the direct air pollution reduction benefits of Muni. Indirectly, Muni contributes to San Francisco's primarily transit-oriented urban development patterns, relative to other cities; make walking and bicycling also more feasible. These walking and bicycling trips, which might otherwise require an automobile in other cities with less of a transit orientation, are zero-emissions. The improved walkability supported by Muni also has public health impacts, as noted in **Section 4** which are not captured here.

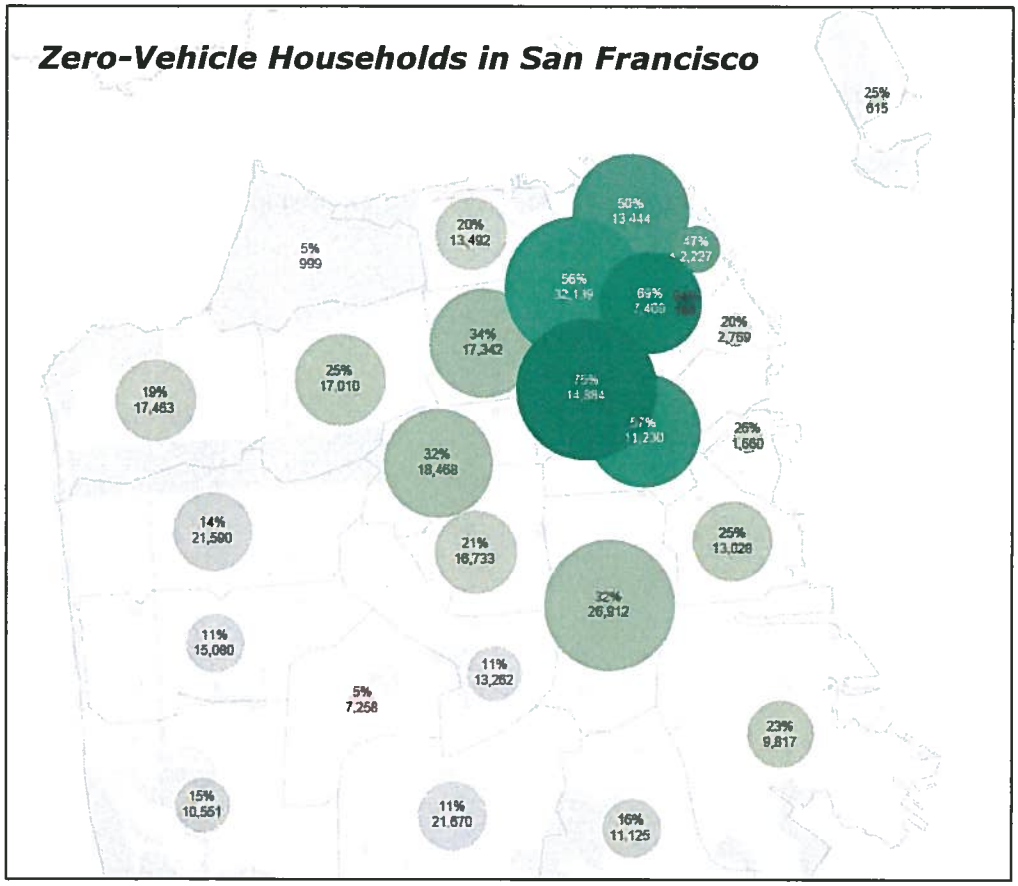
6. ECONOMIC BENEFITS FROM REDUCED RESIDENTIAL PARKING

While **Section 3** evaluated the direct parking costs incurred by drivers at their destination, this Section considers the benefits Muni provides by reducing parking costs at places of residence (San Francisco only). It also considers the economic benefits the Muni provides by freeing up nonresidential land for valuable economic activity (although these impacts are not monetized).

Key Assumptions and Methodology

Reduced Residential Parking Costs Attributable to Muni

Muni transit service in San Francisco reduces the need for car ownership and thus the cost of parking at places of residence. For example, household car ownership rates in San Francisco are significantly below the Bay Area average (e.g., 71 percent compared to 91 percent as reported by the U.S. Census Bureau's American Community Survey) while transit ridership rates are significantly higher (19 percent of all trips compared to 4.3 percent region wide). Likewise, the average number of cars per household in San Francisco is about 1.08 compared to 1.87 in the rest of the Bay Area.



Muni permits many households in San Francisco to avoid or reduce vehicle ownership altogether – either directly by providing affordable transit service or indirectly by fostering compact land use patterns that facilitate walking and bicycling. Car-free households exist throughout the city in numbers far greater than in the rest of the Bay Area, but particularly in the northeast quadrant where parking is already at a premium.

This analysis calculates the economic benefit of reduced residential parking attributable to Muni by estimating the increase in car ownership in the City if Muni did not exist and corresponding added parking costs for households. **Figure 10** presents the detailed calculations and the key methodological assumptions are summarized below.

- **Additional number of SF households owning a vehicle if Muni didn't exist**: Specifically, without Muni, transit ridership in San Francisco theoretically could approach the Bay Area average, with existing Muni riders shifting to automobile, bicycling and/or walking, and other transit service. Based on a pro-rata distribution to these other modes, car ownership for San Francisco would increase by about 34 percent, from an average of 1.08 to 1.44 per household (still below the Bay Area average of 1.87).

- **Percentage of Household Requiring Paid Parking and average cost per space**: Among the new households requiring at least one additional car if Muni were unavailable, 90 percent are assumed to pay the market rate for a parking space under a "high" estimate compared to 70 percent under a "low" estimate (as shown in the above map, zero-vehicle households are disproportionately located in areas which already have a shortage of on-and off-street parking spaces). The assumed market rate for parking is derived from a survey of San Francisco residential garages as well as a review of typical rent premiums for units with parking.

- **Residential Parking Cost Savings for Households Attributable to Muni:** The total annual economic benefit from reduced residential parking costs attributable to Muni is based on average residential parking costs per space multiplied by the number of households that would likely require paid parking due to increased auto ownership if Muni were unavailable.

Figure 10 Reduced Residential Parking Costs Attributable to Muni

A. Hypothetical Redistribution of Transit Mode Share Absent Muni

Travel Mode	San Francisco	Bay Area*	Hypothetical Mode Share Absent Muni[1]	Change in Mode Share
Auto	49.1%	88.3%	74.1%	+51.0%
Transit	35.9%	7.6%	9.7%	-73.0%
Bike / Pedestrian	15.0%	4.2%	16.2%	+7.9%
Total	100%	100%	100%	0%

[1] Without Muni, this analysis assumes that San Francisco would have travel characteristics more like the Bay Area as a whole. Currently, there is a 28.4% transit mode share difference between San Francisco (35.9%) and the rest of the Bay Area (7.6%). The analysis assumes this 28.4% difference would be redistributed among the other modes in proportion to the current mode split in the Bay Area (25.0% to automobiles, 2.1% remaining with transit and 1.2% to bike/pedestrian modes).

B. Residential Parking Cost Calculation

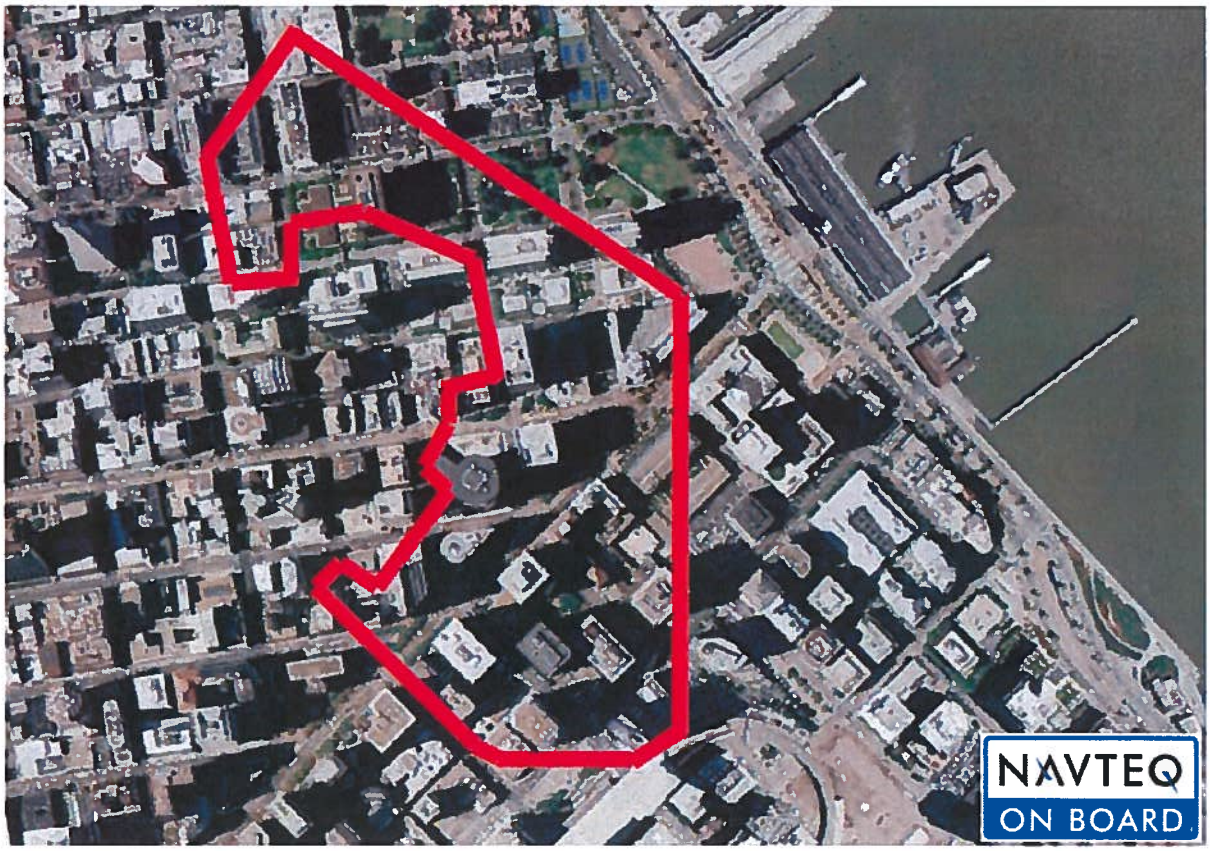
Travel Mode	Calculation	San Francisco
Existing Households in San Francisco	a	354,651
Average Vehicles per Household	b	1.076
Percentage Increase in Vehicles per Households Absent Muni[2]	c	+51.0%
Average Vehicles per Household	d = b* (1+c)	1.625
Additional San Francisco vehicles Absent Muni	e = a * (d – b)	194,703
% of households that would require paid parking (i.e. households without excess parking spots)	f	70% (low) 90% (high)
Average Annual Cost of Residential Parking (estimated at $280 per month)	g	$3,360
Residential Parking Cost Savings for SF Households Attributable to Muni[3]	e * f * g	**$457,942,394 (low)** **$588,783,079 (high)**

[2]From calculation above

[3]Estimate excludes the initial cost of buying a new vehicle.

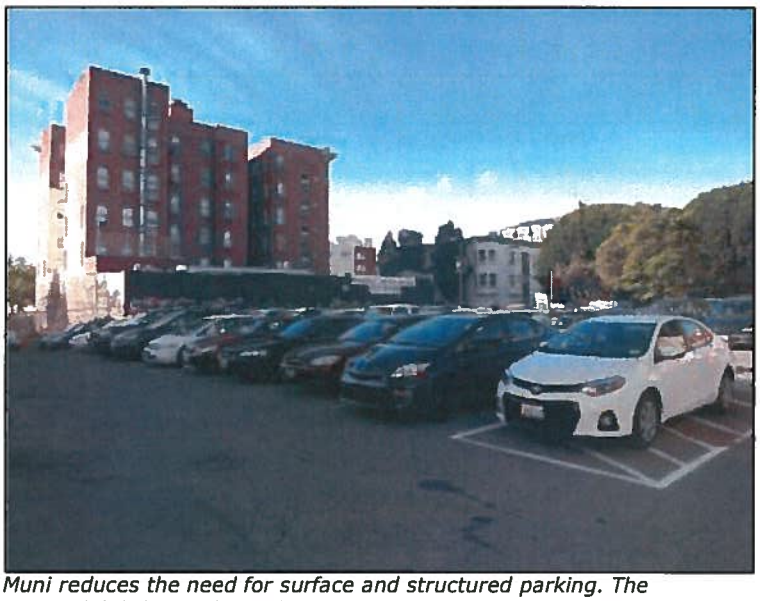
Higher Development and Job Density Attributable to Muni

Muni transit service significantly reduces the need to build and operate expensive and space intensive parking facilities for employees, a major economic opportunity cost in a highly dense employment hub such as San Francisco. In other words, because of Muni, land that might otherwise be devoted to parking can be used for more productive employment-generating uses. This economic benefit (or avoided opportunity cost) of this higher level of employment density manifests itself in San Francisco in many ways, including higher salaries relative to other less transit-rich locations in the Bay Area.



The availability of high-quality transit permits San Francisco's Financial District to be one of the densest employment centers in the United States, with some 42 million square feet of office space housing corporate headquarters, financial institutions, insurance companies, major utilities, business and professional services (Source: San Francisco General Plan prepared by the Planning Department). Muni Metro boardings at the Embarcadero and Montgomery stations average over 25,500 on weekdays—almost three times higher than the capacity of the 8,800-space parking lot at the former Candlestick Park which is superimposed in red. A parking lot to accommodate all these transit customers if they arrived by car would engulf the entire Financial District. ©2015 MapQuest – Portions ©2015 TomTom, i-cubed

While the economic benefit of higher land and worker productivity (relative to parking) is difficult to assess given the myriad of factors involved, **Figure 11** provides an illustrative calculation of the benefits Muni provides by facilitating higher density development patterns. These calculations build in the analysis in **Figure 3** (**section 2**) related to the total estimated new daily auto trips if Muni did not exist. Specifically, **Figure 11** illustrates the amount of land that would be required to adequately park the new vehicles that would be added to San Francisco streets absent Muni.



Muni reduces the need for surface and structured parking. The automobile's large physical footprint consumes a disproportionate amount of land relative to the transport capacity delivered, precluding other land uses such as housing.

As **Figure 11** illustrates, the urban form of San Francisco, and corresponding land productivity, would likely be drastically altered without Muni. Specifically, the amount of land needed to accommodate the new parking is equivalent to between 32,800 and 40,400 housing units, or between 109,000 and 135,000 jobs. This, in turn, represents about 9 to 11 percent of total housing or 17 to 21 percent of total jobs in the City. In other words, these estimates suggest that the entire land use pattern in San Francisco's employment centers has been made possible to a large extent because of transit. However, while significant, the economic value of this profound impact is are difficult to monetize and incorporate into a standard cost-benefit analysis framework. Accordingly they have been excluded from the aggregate impacts shown in **Figure 2**.

Results and Implications

The aggregated economic benefits attributable to Muni's role in reducing residential parking costs is estimated to range from $458 million to $590 million per year. This economic benefit represents the second most significant impact measured in this study at 30 to 35 percent of the total. By comparison, the avoided parking expenses at trip destinations, calculated in Section 3, represent about 40 to 45 percent of the total monetized impacts. Given the high cost and limited supply of parking in San Francisco, it is not surprising that Muni's role in helping residents, commuters, and employers avoid these costs represents a significant economic benefit.

Similar to the calculations of direct travel expenses in **Section 3**, this analysis assumes that parking prices remain constant. In reality, parking costs would likely escalate absent Muni due to increased demand, resulting in a proportionate increase in the monetized impacts calculated herein (i.e. 10% increase in average parking would increase impacts by same amount). However, given the conservative approach to this study, this type of dynamic response has been excluded from the analysis.

While the economic benefits of increased development and employment density facilitated by Muni have not been included in the overall cost benefit analysis summarized in **Figure 2**, preliminary analysis suggests that these impacts, if included could dwarf all others. However, further research and analysis would be needed to appropriately allocate the land use density and employment gains directly to Muni.

Figure 11 Higher Development and Job Density Attributable to Muni (from reduced parking)

Item	Source	Formula	High Estimate	Low Estimate
Annual Unlinked Muni Passenger Trips (FY 2014)	National Transit Database	a	224,893,084	224,893,084
% of Trips that are Linked	SFCTA model	b	79.78%	79.78%
Annual Linked Muni Trips (excludes transfers)	National Transit Database	c = a * b	179,419,702	179,419,702
% of Muni Riders who would shift to automobiles if Muni did not exist – drive alone	High: TPMS Survey. Low: SFMTA survey[1]	d	23.0%	18.7%
% of Muni Riders who would shift to automobiles if Muni did not exist – carpool	High: TPMS Survey. Low: SFMTA survey[1]	e	34.0%	27.6%
Avg. Carpool Size	U.S. Census	f	2.18	2.18
Net new annual vehicle trips if Muni did not exist	-	g = c * d + (c * e / f)	69,249,421	56,269,151
Net new daily vehicle trips	-	g/300	230,830	187,564
Net new daily vehicle trips requiring parking if Muni did not exist (parking is available at one trip end only)	-	h = (g / 2) / 300	115,415	93,782
Parking Structure Sq. Ft. per Parking Space	-	i	350	350
Total Parking Space Sq. Ft.	-	j = h * i	40,395,496	32,823,671
Avg. Parking Facility Floor Area Ratio	-	k	5	5
Acres of lost productive land use (43,560 Sq. Ft./acre)		l = j/(k * 43,560)	185	151
Hypothetical Housing Units Displaced by Parking Without Muni	Assume 1,000 sq ft per unit	m = j/1,000	**40,395**	**32,824**
Hypothetical Jobs Displaced by Parking Without Muni	Assume 300 sq ft per unit	n = j/300	**134,651**	**109,412**
Hypothetical Percentage of Housing Units Displaced by Parking without Muni (354,651 units in San Francisco)	U.S. Census American Community Survey	m/354,651	**11.4%**	**9.3%**
Hypothetical Percentage of Jobs Displaced by Parking without Muni (638,466 jobs in San Francisco)	California Economic Development Department	n/638,466	**21.1%**	**17.1%**

[1] According to Muni 2014 Systemwide On-Board Survey (p. 34), approximately 46% percent of MUNI riders have access to a car.

Acronyms: VMT = Vehicle Miles Traveled; VHT = Vehicle Hours Traveled; Lost VH (vs freeflow) = Lost vehicle hours due to congestion; Transportation Authority; TPMS = Transit Performance Monitoring System

7. CONCLUSIONS

The foregoing analysis has provided a monetary estimate of Muni's economic benefits in San Francisco based on readily available data and a "ceteris paribus" analytical approach. As noted at the outset, by its very nature such a monetization can only provide a proxy estimate for a subset of the economic benefits provided by Muni. This study has not quantified a number of economic benefits, including Muni's impact on worker productivity (by supporting dense clusters of economic activity and social interaction), public health (by promoting more active transportation choices), and the City's existing urban form and overall livability. Despite the limitations noted above, this analysis demonstrates that Muni provides a highly positive return-on-investment or cost benefit ratio.

Even for those variables that have been quantified, this study has identified a variety of factors that suggest that the results are highly conservative. Chief among these include, without limitation:

- **Growth effects**. This analysis is based on current conditions and data and assumes that the relationship between Muni costs and benefits remain constant over time. In reality, all of the metrics are likely to become more pronounced since they are based on current (2014) Muni ridership rates. In reality, ridership may increase even faster than the City's population and/or employment growth. Because San Francisco has finite land, any population and/or employment growth will increase density, and transit ridership typically grows non-linearly with density increases.

- **Price effects**: This analysis has assumed that prices that affect transportation costs and decisions remain constant. For example, the monetization of direct travel costs of residential parking assumes that parking prices remain constant. In reality, parking costs would likely escalate absent Muni due to increased demand, resulting in at least a proportionate increase in the monetized impacts calculated herein.

- **Infrastructure constraints**: The analysis relies on model outputs from the SFCTA that assume continue improvements in the City's transportation system, including Muni and other transit. In reality, there is not enough roadway capacity in the City, especially at peak hours and congested locations, to accommodate a major shift form Muni to auto travel. Consequently, the loss of Muni would likely (1) result in a complete breakdown in the transportation system for all users, and/or (2) necessitate a major expansion in the roadway capacity to accommodate the new vehicles, which would radically alter the city's urban fabric and create other deleterious environmental impacts.

In addition to the above list, another important issue that is not directly addressed in subsequent chapters relates to the value of foregone trip if Muni went away (or if service levels were cut). For the most part, the monetization of many of the identified Muni benefits assumes that Muni riders would find some alternative transportation mode, however inconvenient or costly. However, a significant portion of Muni riders include lower income groups that cannot afford other means of travel. Many others are unable to drive due to physical disability, age, and/or other considerations (e.g., legal status).

Population groups that lack other transportation options would likely suffer from economic and social isolation and further marginalization if Muni service were unavailable or curtailed. Some would lose their jobs, access to important services such as health care, or participation in the City's economic and cultural assets more generally. Some groups may also be forced to relocate out of the City (or conversely forego a trip to the City). While the economic implications from a loss of mobility and access of this nature are difficult to quantify, they clearly warrant consideration in the context of Muni's contribution to the City's economic health.