

LINK21

CONNECT NORTHERN CALIFORNIA

MARKET ANALYSIS REPORT

DRAFT

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Prepared By:
Link21 Program Management Consultants (PMC)

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ACRONYMS AND ABBREVIATIONS

ACRONYM/ABBREVIATION	DEFINITION
BART	San Francisco Bay Area Rapid Transit
CCJPA	Capitol Corridor Joint Powers Authority
ACE	Altamont Corridor Express
AC Transit	Alameda-Contra Costa Transit
AM	morning
AMBAG	Association of Monterey Bay Area Governments
BEA	Bureau of Economic Analysis
BIPOC	Black, Indigenous, and People of Color
BLS	Bureau of Labor Statistics
BP	Baseline Projects
CAGR	compound annual growth rate
Caltrain	Peninsula Corridor Joint Powers Authority
Caltrans	California Department of Transportation
CNT	Center for Neighborhood Technology
EPC	Equity Priority Communities
FTA	Federal Transit Administration
GDP	gross domestic product
GRP	gross regional product
H+T	Housing and Transportation
HG	Housing Growth And Patterns
HJG	Housing/Job Growth and Patterns
HUD	Department of Housing and Urban Development
JG	Job Growth and Patterns
MAST	Market Analysis Spreadsheet Tool
MCAG	Merced County Association of Governments
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
OD	Origin-Destination
OTP	on-time performance
PBA	Plan Bay Area
PM	afternoon

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ACRONYM/ABBREVIATION	DEFINITION
PMC	Program Management Consultants
SACOG	Sacramento Area Council of Governments
SFCTA	San Francisco County Transportation Authority
SFMTA	San Francisco Municipal Transportation Agency
SFO	San Francisco International Airport
SJRRC	San Joaquin Regional Rail Commission
SMART	Sonoma-Marín Area Rail Transit
SR	State Route
StanCOG	Stanislaus Council of Governments
TAZ	transportation analysis zone
TC	Travel Costs
TCM	Three-County Model
TM	travel model
tph	trains per hour
U.S.	United States
WP	Working Patterns

LINK21 PROGRAM TEAM NAMES

TEAM NAME	TEAM MEMBERS
PMC	The HNTB Team
Program Management Team (PMT)	BART/CCJPA + PMC
Consultants	Consultants supporting program identification/project selection
Link21 Team	PMT + Consultants

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GLOSSARY OF TERMS

TERM	DEFINITION
Baseline	A future 'do minimum' scenario that follows the land use and transportation capital projects in adopted MPO plans; use cases include baseline population and employment growth forecasts and baseline rail ridership.
Cluster	Groups of hexcells, with a single hub hexcell at the center, that represent neighborhoods or municipalities.
Corridor	Geographically proximate and bundled sets of markets.
Emergent network	An abstract network of seamless and ubiquitous rail and transit services in the Bay Area that is used to identify corridors with high unmet rail potential and to validate findings from the market analysis.
Equity weighted	Potential trips made by priority populations are counted twice, which is consistent with FTA guidance on equity analysis.
Gini Index	Measures degree of income inequality in an area with higher indices that correspond to more inequality.
Good (rail) service	A theoretical, idealized concept of rail service that is fast, frequent, affordable, direct, and has plenty of available seats.
Hexcell	Uniform hexagonal areas, 0.5 miles in diameter, that cover the entire Megaregion and are the main geographic unit of analysis for the market analysis.
Housing and/or transportation cost burden	Share of household income spent on housing and/or transportation expenses; spending over 30% of household income on housing alone qualifies as cost burdened based on HUD's definition.
Market	A single geographic location by which to measure rail potential that is represented by a cluster.
Miles weighted	Rail potential between two clusters is weighted by the distance between them, which elevates the importance of long-distance trips.
Planning capacity	Target capacity set by individual rail/transit operators for service and fleet planning. It usually assumes some amount of standing but not overly crowded conditions.
Rail potential	Number of potential rail passengers for a given market, corridor, etc. — it is not a ridership forecast for a specific service.
Rail/transit propensity	Likelihood to use rail/transit as a mode of travel, which is determined by market segmentation



TERM	DEFINITION
Technical panels	Groups of expert stakeholders from peer agencies and other organizations that provided critical review of the market analysis methodology and findings.
Uncertainty analysis	Analysis to compare the relative performance of corridors under different future scenarios that involve changes in housing and job growth, working patterns, travel costs, and baseline projects.
Unmet rail potential	Number of additional riders that could be captured with good rail service that is calculated as the difference between the good service rail potential and the baseline rail ridership.



EXECUTIVE SUMMARY

Introduction

The *Market Analysis Report* (Report) summarizes the results of the market analysis work supporting the Link21 Program (Link21).

Link21 and its partners will transform the San Francisco Bay Area Rapid Transit (BART) and Regional Rail (including commuter, intercity, and high-speed rail) network in the Northern California Megaregion (Megaregion) into a **faster**, more **integrated** system that provides a **safe, efficient, equitable**, and **affordable** means of travel for all types of trips.

The key goals of the Report are to:

- Provide insight into the existing and future distribution of travel demand, population, and employment within the Megaregion.
- Provide an evidence base for the Link21 problem statement¹.
- Identify market opportunities and corridors with high ridership potential that could be served by Link21 to support the development of program concepts.

To achieve these goals, the market analysis work focused on three key areas, as follows:

1. **Existing Conditions:** An investigation of the historical socioeconomic, equity, and transportation conditions of the Megaregion, providing an understanding of existing travel patterns.
2. **Future Conditions:** An overview of forecast megaregional population and employment growth, and future travel demand patterns and transportation investments for the Megaregion.
3. **Link21 Market and Corridor Potential:** Identification of specific markets with high rail ridership potential, in particular unmet rail potential, and identification of corridors with high market potential for new or enhanced rail service.

The key findings from each of these three areas are summarized in the following sections.

¹ The Link21 problem statement is included in the Strategic Case Framework.



Existing Conditions

Population and Employment

According to California state figures, the Megaregion was home to over 12.7 million residents and 6.2 million jobs in 2019. The majority of the Megaregion's population and employment are based in the Bay Area with the share of jobs in the Bay Area being greater than the population share.

Between 1990 and 2019, the megaregional population increased by 37%, which is faster than the national average of 32%. The Megaregion's gross regional product (GRP) increased at a compound annual growth rate (CAGR) of 3.6%, outperforming national and statewide growth. Over 73% of the Megaregion's GRP in that period was generated in the Bay Area.

However, the distribution of this growth has been uneven, while growth has been fastest in the Sacramento Area and the Northern San Joaquin Valley, the existing size of population and employment in the Bay Area means that most of the Megaregion's growth in absolute terms has been concentrated there. Moreover, the Bay Area's share of employment growth has been higher than its corresponding share of population growth, particularly in the West Bay (including San Francisco).

This uneven distribution of population and employment growth, both at a macrolevel across the Megaregion and at a microlevel between Bay Area counties, has implications for travel demand within the Megaregion; specifically, increased travel demand within the Transbay Corridor (BART Transbay Tube [Transbay Tube] and the San Francisco-Oakland Bay Bridge [Bay Bridge]).

Equity

Promoting equity (along with livability) has been identified as one of Link21's goals, and it is also a lens through which to analyze metrics that underpin Link21's objectives.

To support Link21's efforts to address inequities across the Megaregion, a program-specific, geographic designation of equity was defined. The 'priority populations' definition was developed to support Link21's efforts to address inequities across the Megaregion; all other Megaregion areas are referred to as 'general populations'. This definition will be used in the Business Case Evaluation to review the distribution of program benefits and negative impacts. In the market analysis, it is used to explore disparities and disadvantages experienced by priority populations in livability, affordability, and accessibility compared to general populations.

Link21 has defined equity as "a state in which an individual's background does not predetermine or predict their opportunity." To assess how Link21 advances equity, the program must first understand how current conditions across the Megaregion are distributed both geographically and demographically.



The key equity finding from the market analysis was that while the Megaregion has grown rapidly, this growth was inequitable:

- The Bay Area leads the Megaregion in household income and in income inequality. Moreover, there is evidence of increasing inequality in household income over time in the Megaregion, especially in the Bay Area.
- As home values and rents continue to increase in the Megaregion, lower-income households face an increasing housing cost burden with 43% of the Megaregion's priority populations households spending 30% or more of their income on housing costs.
- Black, Indigenous, and People of Color (BIPOC) comprise a large and growing proportion of the Megaregion's population and are disproportionately likely to have low incomes.
- High-housing costs are pushing low-income households, including many BIPOC households, further from the transbay core and potentially further away from employment opportunities and areas with more frequent rail service. Therefore, access to transit is a critical issue for priority populations, especially the 12% of priority populations who do not have access to a vehicle at home.

Increasing inequality constrains where residents can live and work, impacting their travel patterns and transportation decisions.

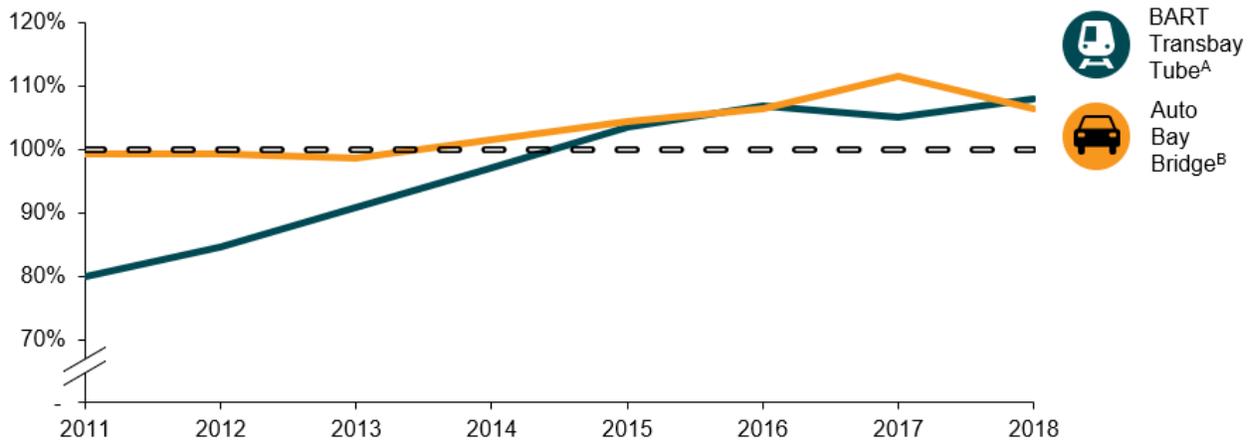
Megaregional Travel

The market analysis analyzed travel demand across the Megaregion and in the Transbay Corridor in terms of trips made by auto, rail, and other non-rail transit.

In 2015, travelers within the Megaregion made a combined total of 32.2 million average weekday trips, of which almost two thirds occurred within the Bay Area. Auto was the dominant mode of travel in the Megaregion with over 95% of the total daily trips. However, rail was much more prominent for transbay trips with BART capturing a 32% daily share (38% during the peak). In the key San Francisco – East Bay (Alameda and Contra Costa counties) market, BART's share was 49% throughout the day and 56% during the peak.

Inaccessibility of rail stations, combined with limited parking facilities at stations, likely serves as a deterrent to greater rail usage. In 2015, only 30% of trips started within 1 mile of a rail station, and 27% of trips started more than 5 miles from a station.

There is insufficient capacity to accommodate growing travel demand across the Megaregion, particularly in the Transbay Corridor. Fueled by sustained population and employment growth in the Megaregion and the geographic concentration of this growth as described previously, demand for travel has grown to approach or exceed the capacity of key links and infrastructure. Since 2015, the Bay Bridge and Transbay Tube are operating consistently above their planned capacities during peak periods, as shown in **Figure ES-1**.

**Figure ES-1. Percent Peak Demand Volume Over Capacity**

Source: Program Management Consultants (PMC) analysis of BART peak loadings and California Department of Transportation (Caltrans) Census Traffic Program data

^A BART capacity assumed to be 25,300 passengers per hour per direction

^B Bay Bridge capacity assumed to be at 9,250 vehicles per hour per direction

Elsewhere in the Megaregion, key highways and rail links are also operating close to or above their planned capacity, including highway approaches to the various bridges crossing the San Francisco Bay and Caltrain links between San Francisco and San Jose. Therefore, many travelers in the Megaregion face congested highways and crowded trains.

These and other factors are having a detrimental impact on travel experiences in the Megaregion with long commutes increasingly prevalent. Long and unpredictable rail travel times cause many travelers to choose auto, while others may not travel at all. An improved rail network could encourage new trips and grow new markets.

Future Conditions

Future Population and Employment Growth

Based on the 2040 adopted regional transportation plans of the Megaregion's Metropolitan Planning Organizations (MPO), between 2015 and 2040 the Megaregion's population is forecast to increase to over 15.3 million at a CAGR of 1.0% with employment growing to 7.1 million at a slightly slower CAGR of 0.9%.

- While the Northern San Joaquin Valley is forecast to remain the fastest growing area by both population and employment, the Bay Area is forecast to have the highest population and employment growth in absolute terms.
- The historically uneven distribution of population and employment growth is expected to continue with a greater concentration of employment growth in the Bay Area in general and in specific counties within the Bay Area.



In the Bay Area, the Metropolitan Transportation Commission's (MTC) *Plan Bay Area* (PBA) 2040 was updated with the recently adopted PBA 2050 that incorporates uncertainty using three different forecast scenarios developed in MTC's Horizon Futures initiative. These scenarios present divergent patterns of change impacting the lives of Bay Area residents that are based on various political, technological, economic, and environmental challenges and the responses to these challenges. While population and employment growth projections vary widely between the Horizon Futures scenarios, all three scenarios project significantly higher employment growth in San Francisco than PBA 2040. Furthermore, for two of the three scenarios, San Francisco's share of Bay Area employment growth is vastly greater than its share of population growth, making the potential imbalance between population and employment even more marked.

Future Megaregional Travel

In Link21's baseline forecast, which is based on MPOs' 2040 adopted regional transportation plans, the Megaregion is projected to experience substantial growth in travel. By 2040, 8.8 million additional average weekday trips are forecast, representing a 27% increase over 2015 volumes.

The largest absolute growth in travel is expected to occur within the Bay Area, particularly its core regions of San Francisco, San Mateo County, Santa Clara County, and the East Bay. In particular, demand for travel through the Transbay Corridor is projected to grow by 35% between 2015 and 2040, which is driven by an increasing geographic imbalance of population and employment growth.

It is likely the significant growth in Transbay Corridor travel will further strain the already overcrowded and congested crossings. Travel demand is projected to exceed capacity despite planned capacity increases to both the Transbay Tube and the Bay Bridge. Of the range of demand growth scenarios analyzed, the most aggressive one could result in the Transbay Tube operating at 107% above its planned capacity by 2050 and the Bay Bridge at 97% above its planned capacity. Conversely, the most conservative growth scenario could result in the planned BART and bridge capacities being exceeded by 33% and 23%, respectively.

The large disparity between unconstrained demand and available capacity for both road and rail crossings underscores the need for substantial investment in a new crossing to serve the entirety of projected demand growth.

Link21 Market and Corridor Potential

This third and final phase of the market analysis builds on the analysis of existing and future conditions and investigates the potential for enhancement of rail in the Megaregion.

Link21's market analysis approach goes beyond a typical market analysis, which only considers existing and future travel patterns in the light of socioeconomic and demographic trends. Instead, it focuses on identifying markets and corridors that might



be best served by rail, deploying a regression model and custom spreadsheet tool to estimate the unmet rail potential for a given market or corridor. This unmet rail potential is used to inform the development of program concepts.

Equity is central to all aspects of Link21's work, including the market analysis. Trips made by priority populations are double counted when estimating unmet rail potential, reflecting the importance of serving areas with high priority populations shares and totals.

Market Rail Potential Analysis

The market rail potential analysis identifies individual neighborhoods or entire municipalities with the greatest unmet rail potential. Rail potential is estimated using a regression model, which is a function of key factors including socioeconomic characteristics (such as population and employment density) and rail level of service characteristics (such as travel time, cost, frequency, and transfers). Unmet rail potential is then defined as follows:

- **Unmet rail potential** is the difference between good service rail potential and baseline ridership.
 - **Baseline ridership** represents future rail demand, including the impact of population and employment growth and also the land use and project assumptions that are included in adopted MPO plans. The impact of crowding is modeled using a capacity constraint curve, whereby the proportion of travelers prepared to use rail gradually decreases as load factors increase towards and beyond 100%.
 - **Good service rail potential** represents rail demand under an idealized network with (potentially unrealistic) good rail service and no capacity constraints between all cluster pairs in the Megaregion. Good service is defined as fast, frequent, cheap, direct, and with plenty of available seats.

A key finding is that the core of the Megaregion has the highest potential for attracting new transbay riders. Forty-five percent of all equity-weighted unmet rail potential in the Megaregion involves a trip through the Transbay Corridor. The majority of this unmet rail potential can be found in San Francisco and in inner East Bay cities between Richmond and Oakland. These high-potential markets exist in several categories:

- New markets without existing rail service, such as western San Francisco, Lower Pacific Heights/Japantown in San Francisco, and the Grand Lake District and MacArthur corridor in Oakland
- Markets with poor transbay rail service, such as southeastern San Francisco and Emeryville
- Markets with large capacity constraints, such as the existing BART corridor along Market Street in San Francisco



Beyond the core of the Megaregion, relatively high to medium unmet transbay rail potential exists in markets further from the Transbay Corridor. These markets include San Pablo, Hercules, Martinez, Vallejo, Napa, San Ramon, and parts of San Mateo County.

Markets with more limited potential stand to benefit from Link21 in other ways:

- All markets benefit when good transbay rail service is provided (e.g., from improved journey times and the elimination of transfers).
- Markets located a long distance from the Transbay Corridor, such as Sacramento, have relatively modest unmet transbay rail potential in terms of trips, but they involve longer trip distances and therefore higher passenger miles potential.
- Link21 benefits could extend beyond transbay trips, particularly for Santa Clara County. For example, a new transbay passenger rail crossing that connects San Francisco to Oakland with improvements to San Jose could attract new, non-transbay riders between San Jose and Oakland.

Corridor Rail Potential Analysis

The corridor rail potential analysis seeks to identify corridors and segments with high unmet rail potential, using similar approaches and tools to the preceding market rail potential analysis. Once individual high-potential markets are identified, they can be connected to form segments, which in turn can be grouped to form corridors. The high-potential corridors and segments that are identified in this analysis subsequently inform the development of program concepts, alongside other sources such as public studies/plans and stakeholder engagement. Note that at this point, these corridors reflect market potential only and do not take into account the engineering, operational, cost, or other factors that need to be considered in the design of transit corridors.

Twelve corridors were identified, and they are further described in Chapter 9:

- Nine East Bay corridors, originating in Alameda/Oakland and extending to Sacramento, San Jose, Stockton, and Modesto.
- Three West Bay corridors, originating in San Francisco and taking three different paths before converging on one main segment through San Mateo and Santa Clara counties.

A key finding is that the greatest potential for attracting new transbay rail riders is at the core of the Megaregion, closest to the Transbay Corridor, in and around San Francisco and Oakland, and to/from inner East Bay cities between Richmond and Oakland.

For East Bay corridors, the greatest unmet rail potential is driven by new markets without existing service such as parts of East Oakland outside the existing BART corridor, or with poor existing transbay rail service such as Emeryville.

By contrast, on the three West Bay corridors, the high unmet potential in San Francisco can be attributed not only to new markets in western San Francisco (e.g., Lower Pacific



Heights/Japantown, Richmond District, and Sunset District), but also to crowded trains on existing BART transbay rail service through downtown San Francisco. In particular, the Embarcadero — Daly City (Central) segment is highly capacity constrained, and new rail service could unlock demand that is unable or unwilling to use the existing service.

Other findings from the corridor rail potential analysis include the following:

- Several segments located a medium distance from the Transbay Corridor have transbay unmet potential. Most of this potential is due to new markets without existing transbay rail service or poor existing transbay rail service, including San Pablo, Hercules, Martinez, Vallejo, Napa, San Ramon, and parts of San Mateo County.
- Segments further from the Transbay Corridor have relatively low unmet rail potential. The low market potential, of markets such as Sacramento, Stockton, and Modesto identified previously, translates into low unmet potential for segments connecting these markets.
- Some segments have high non-transbay unmet potential compared to their transbay unmet potential, particularly in San Mateo and northern Santa Clara counties.

Robustness Testing

The robustness of the market analysis methods and outputs was demonstrated in two ways:

- **Uncertainty analysis:** tests the impacts of changes to key parameters.
 - The key finding from this analysis was that while the absolute performance of the various corridors and segments changed considerably under many of the uncertainty scenarios, there were no significant impacts on relative performance. The uncertainty analysis indicates that the findings from the market and corridor rail potential analyses are very robust.
- **Emergent network modeling:** applies an alternative methodology that the San Francisco County Transportation Authority (SFCTA) uses to assess rail transit market potential in promising but yet-to-be-studied corridors.
 - The emergent network analysis findings corroborate those from Link21's main analyses of market and corridor rail potential.



SECTION I: ABOUT THE MARKET ANALYSIS REPORT

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1. INTRODUCTION

Link21 is a proposed set of BART and Regional Rail (including commuter, intercity, and high-speed rail) projects that will transform the rail network in the Megaregion into a **faster**, more **integrated** system that provides a **safe, efficient, equitable**, and **affordable** means of travel for all types of trips.

This program, including a new transbay passenger rail crossing between Oakland and San Francisco, will promote **equity and livability, economic opportunity, and environmental quality** in the Megaregion while improving the **travel experience**. With key investments that leverage the existing rail network and increase capacity and system reliability, rail and transit will become a feasible option for many trips throughout the Megaregion.

The key goals of the Report are to:

- Assess the distribution of travel demand and population and employment land use within the Megaregion.
- Provide evidence to support Link21's problem statement and the development of program concepts.
- Identify market opportunities for a potential new rail corridor.



1.1. Overview

The geographic scope of Link21 spans the 21-county Megaregion, which includes counties within the San Francisco Bay Area, Sacramento Area, Northern San Joaquin Valley, and Monterey Bay Area.

BART and the Capitol Corridor Joint Powers Authority (CCJPA) have partnered to advance Link21.

1.1.1. Purpose of the Report

The purpose of this Report is to provide insight into the distribution of travel demand within the Megaregion and to identify markets and corridors with high ridership potential that can be served by Link21. These outputs will inform the development of Link21 concepts (using metrics associated with goals and objectives described in Section 1.1.2), and they provide evidence to support the Link21 problem statement.

1.1.2. Link21's Goals

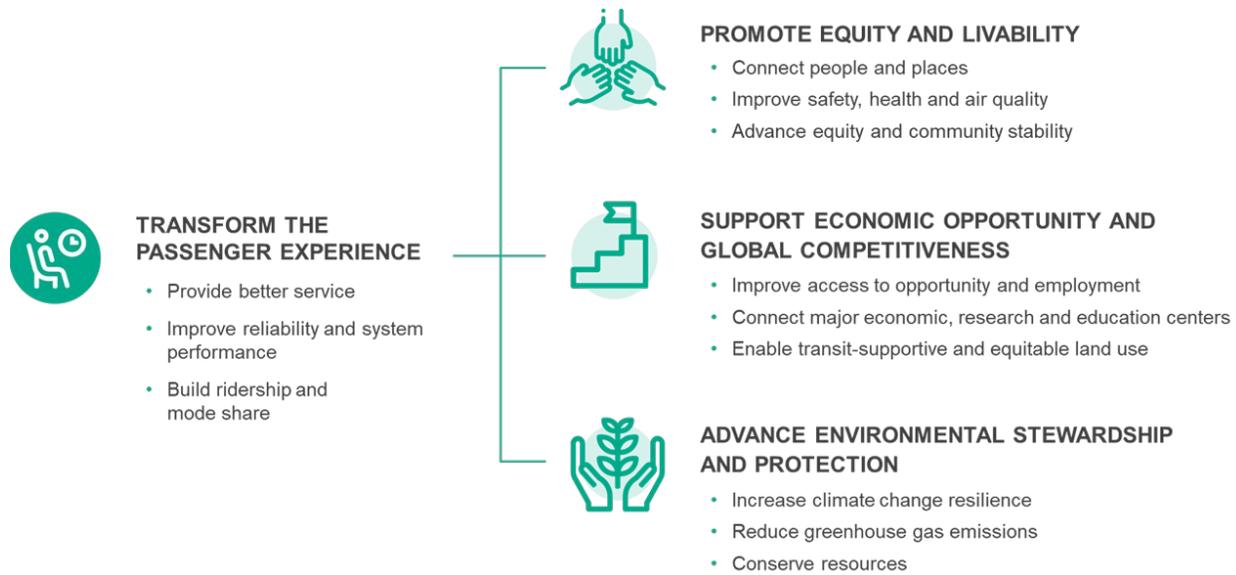
Link21 has four key goals, as described in **Figure 1-1**. *Goal 1: Transform the Passenger Experience* is considered a foundational goal that helps achieve the remaining three goals. Each goal has objectives describing how Link21 will achieve the goal. Metrics were developed to determine how well Link21 can achieve these objectives.²

Equity has a central role across all goals and objectives. The program has defined it as “a state in which an individual’s background does not predetermine or predict their opportunity.” Equity is considered across the goals and objectives, and multiple metrics assess how benefits are distributed between general population and priority populations census tracts.

² Additional information on the metrics can be found in the Strategic Case Framework.



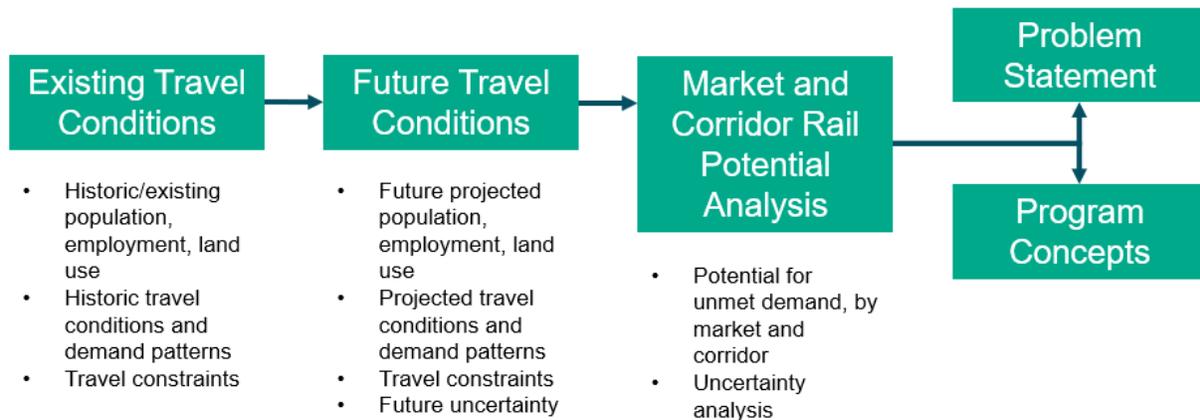
Figure 1-1. Goals for Link21



Key: Goals in **BOLD CAPS**, Objectives in bullets below

The Report assesses the existing and future socioeconomic and travel conditions for the Megaregion, and it provides insight into market opportunities that can support new or increased service under Link21 (**Figure 1-2**). As a result, the findings of this report support the development of program concepts.

Figure 1-2. Steps of the Market Analysis



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1.2. Report Structure

This Report consists of four sections with chapters, as illustrated in **Table 1-1**.

Section I: About the Market Analysis Report provides an overview of the Report.

Section II: Existing Conditions contains three chapters describing the historical socioeconomic, equity, and transportation conditions of the Megaregion.

Section III: Future Conditions provides an overview of the forecast population and employment growth for the Megaregion and an overview of the future

travel demand and transportation investments for the Megaregion.

Section IV: Rail Potential Analysis contains five chapters. Four chapters describe the methodology that was undertaken to analyze potential market opportunities to be served by Link21, and the fifth chapter summarizes the key findings and next steps arising from the analysis.

Supporting analyses and additional documentation can be found in the appendices referenced throughout the Report.

Table 1-1. Report Structure

SECTION I: ABOUT THE MARKET ANALYSIS REPORT	SECTION II: EXISTING CONDITIONS	SECTION III: FUTURE CONDITIONS	SECTION IV: RAIL POTENTIAL ANALYSIS
Chapter 1 Introduction	Chapter 2 Population and Employment	Chapter 5 Future Population and Employment Growth	Chapter 7 Market Analysis Approach
	Chapter 3 Equity	Chapter 6 Future Megaregional Travel	Chapter 8 Market Rail Potential Analysis
	Chapter 4 Megaregional Travel		Chapter 9 Corridor Rail Potential Analysis
			Chapter 10 Robustness Testing
			Chapter 11 Conclusions

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1.3. Data Assumptions and Sources

The market analysis uses a number of different public and private-sector sources for analysis and cross-validation.

1.3.1. Historical Data Sources

Socioeconomic data, such as (but not limited to) population, employment, and race/ethnicity, were accumulated primarily from public sources, including the California Department of Finance and the California Employment Development Department. This data was supplemented and validated with data from the United States (U.S.) Census Bureau *Census* and *American Community Survey* and U.S. Bureau of Labor Statistics (BLS). Other private industry data sources were used for the analyses or were used for validation purposes, including Apartment List, Experian *Mosaic*, Woods and Poole *Complete Economic and Demographic Data Source*, and Zillow.

Travel- and traffic-related data was used from StreetLight Data Origin-Destination (OD) Tour (six-month average), Caltrans Traffic Census Counts and Performance Measurement System (PeMS), U.S. Federal Transit Administration (FTA), BART, San Francisco Bay Area Water Emergency Transportation Authority (WETA), Peninsula Corridor Joint Powers Authority (Caltrain), CCJPA, and Alameda-Contra Costa (AC) Transit ridership.

1.3.2. Existing and Future Data Sources

Base year socioeconomic data and travel trip tables are from the following four

models (referred to as the Base Year MPO Models): the MTC Travel Model 1.5 (TM 1.5), Sacramento Area Council of Governments (SACOG) Activity-Based Travel Simulation Model, Northern San Joaquin Valley Three-County Model (TCM), and Association of Monterey Bay Area Governments (AMBAG) *Regional Travel Demand Model*, as well as from the California High-Speed Rail Ridership and Revenue Model from Business Plan Model – Version 3.

There are several socioeconomic data sources that form the forecast scenarios used in this Report. For the baseline forecast scenario, the PMC adopted MPO 2040 forecasts, including MTC PBA 2040, SACOG *2040 Medium Term Plan – Sustainability Communities Strategy*, TCM *2040 Regional Transportation Plan*, and AMBAG *2040 Medium Term Plan – Sustainable Communities Strategy*.

Other forecast scenarios are informed by MTC's *Horizon Forecasts 2050* and are adapted to incorporate the uncertainty of external forces into the early stages of its 2050 regional planning process. This Report incorporates the project performance and round 2 forecasts, including three scenarios: *Back to the Future*, *Clean and Green*, and *Rising Tides, Falling Fortunes*. Further details regarding these scenarios can be found in Section 5.3.

1.3.3. COVID-19 Assumptions

The data used and analyses presented in this Report do not account for changes in travel patterns experienced as a result of the COVID-19 pandemic or for future



changes in population and employment. All data and figures represent the pre-pandemic state as the pandemic may cause significant and unknown (as of yet) future changes in population and employment patterns.

1.4. Terminology

1.4.1. Geographies

The Megaregion is a 21-county region covering the counties of Alameda, Contra Costa, El Dorado, Marin, Merced, Monterey, Napa, Placer, Sacramento, San Benito, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Sutter, Yolo, and Yuba counties.

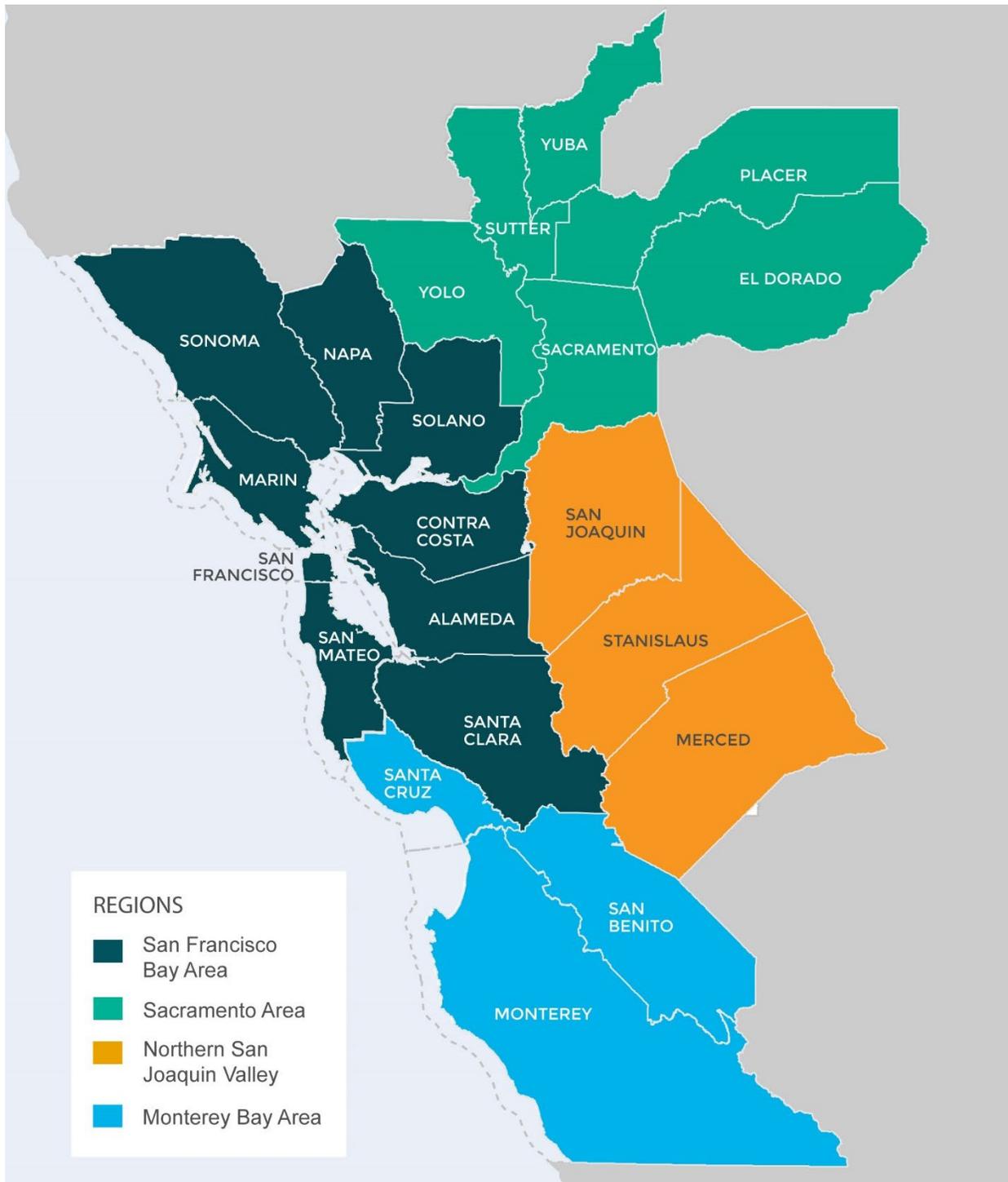
These counties are referred to as the following areas in the report:

- **San Francisco Bay Area:** West Bay counties of San Francisco, San Mateo, and Santa Clara; East Bay counties of Alameda and Contra Costa; and North Bay counties of Marin, Napa, Sonoma, and Solano
 - The West Bay, East Bay, and North Bay are referred to as Bay Area subregions (subregions) in this Report
- **Monterey Bay Area:** Monterey, San Benito, and Santa Cruz counties
- **Sacramento Area:** El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba counties
- **Northern San Joaquin Valley:** San Joaquin, Stanislaus, and Merced counties

Counties within the Monterey Bay Area, the Sacramento Area, and the Northern San Joaquin Valley are referred to as 'halo counties.' **Figure 1-3** provides an illustration of the four regions, counties, and subregions that form the Megaregion.



Figure 1-3. Northern California Megaregion



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1.4.2. Priority and General Population Groups

As discussed in Section 1.1, advancing equity is a core goal across the Megaregion. It is a cross-cutting theme that is considered across other goals and objectives as well.

To facilitate the evaluation of equity impacts related to Link21, a program-specific geographic designation of equity has been defined. The version of Link21 priority populations used for the market analysis combines state disadvantaged and low-income communities with Equity Priority Communities (previously called Communities of Concern) as defined by MTC and local counties. All other Megaregion areas are referred to as general populations.

This designation will be used in the business case evaluation to review the distribution of program benefits or negative impacts. In the market analysis, it is used to explore disparities and disadvantages experienced by priority populations in livability, affordability, and accessibility compared to general populations.³

1.4.3. Transbay and Travel Corridor Terminology

Transbay: Refers to the crossings between San Francisco and Oakland, including the Bay Bridge and the Transbay Tube crossing between the Embarcadero and West Oakland stations. While ferry services also connect San Francisco and Oakland, they have been excluded from Transbay Corridor analysis in this Report as they account for a very small proportion of travel demand in the corridor.

Bay Crossings: Includes the Transbay Corridor as well as the crossings between Alameda and San Mateo counties via the San Mateo-Hayward and Dumbarton bridges.

Other Crossings: Refers to all other bridge crossings for the San Francisco Bay, such as, but not limited to, the Golden Gate and Richmond-San Rafael bridges.

1.4.4. Other Terminology

A [full list of acronyms](#) is found at the beginning of the Report.

³ The detailed definitions of priority and general populations can be found in Chapter 3 and are based on early working definitions for the purposes of the Report. After completion of the market analysis, the Link21 Team updated its priority populations definition. This updated definition is not a part of this report but will be used in future work.



SECTION II: EXISTING CONDITIONS

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2. POPULATION AND EMPLOYMENT

The analysis of the geographic distribution of population and employment across the Megaregion is important to understanding interregional travel demand patterns.

- According to California state figures, the Megaregion was home to over 12.7 million residents and 6.2 million jobs in 2019.
- While the Sacramento Area and the Northern San Joaquin Valley have experienced the fastest growth rates in population and employment, most of the Megaregion's growth in absolute terms has been concentrated within the Bay Area. San Francisco has had a higher proportion of the Megaregion's employment growth than of population growth.
 - Since 2010, the county has observed a 128,000 increase in number of jobs, 13% of the total Megaregion's growth, while population has only increased by 86,000, just 5% of the Megaregion's total population growth.
- This uneven distribution of population and employment growth, both at a macrolevel across the Megaregion and at a microlevel among Bay Area counties, has implications for travel demand within the Megaregion and within the Transbay Corridor (Transbay Tube and Bay Bridge).

This chapter examines historical population and employment growth of the Megaregion and its 21 counties.



2.1. Megaregion Population and Employment 2019

The majority of the Megaregion's population and employment are based in the Bay Area.

2.1.1. Population

In 2019, an estimated 12.7 million people resided within the Megaregion comprising around 32% of the total California population. Over 7.8 million, or 61%, of the total Megaregion population resided within the Bay Area, as illustrated in **Figure 2-1**. In 2019, most of the Megaregion's residents and jobs were located within the Bay Area. The share of jobs in the Bay Area was greater than the population share.

This is followed by the Sacramento Area (with a population of 2.5 million or 20% share of the Megaregion population), the Northern San Joaquin Valley (1.6 million or 13%) and the Monterey Bay Area (0.8 million or 6%).

Within the Bay Area, the East Bay counties of Alameda and Contra Costa had the highest populations, followed by Santa Clara County, and the West Bay

counties of San Francisco and San Mateo.

2.1.2. Employment

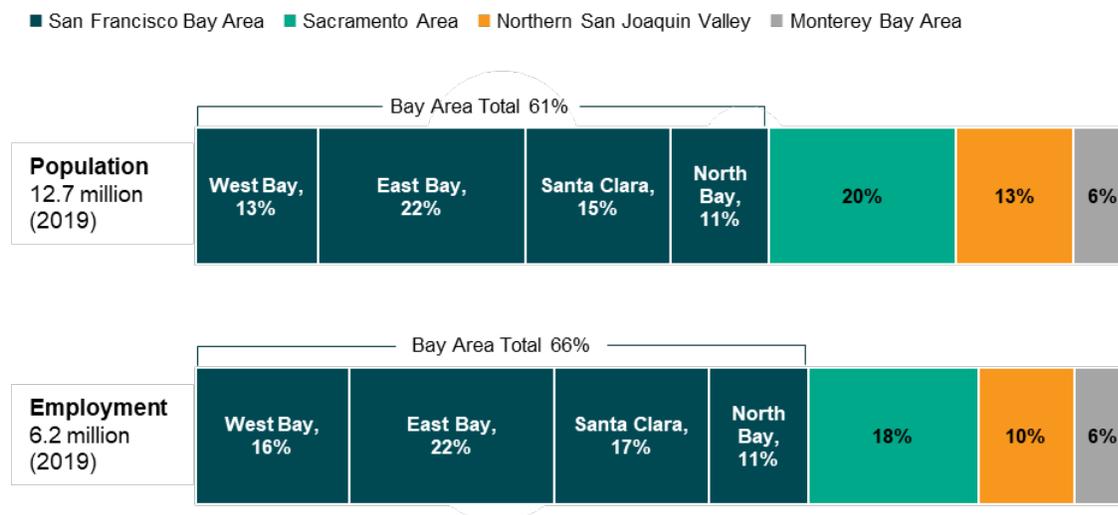
There were an estimated 6.2 million jobs within the Megaregion in 2019, an estimated 33% share of total employment in California, as illustrated in Figure 2-1.

With over 66% of the Megaregion's jobs, the Bay Area had the highest concentration of employment compared to population distribution in the Megaregion. Given that most occupations require employees travel to work, the uneven geographic distributions of residents and workplaces can directly impact interregional travel demand. In other words, for the Megaregion this could lead to increased demand for trips from the halo counties in the Sacramento Area, Northern San Joaquin Valley, and Monterey Bay Area into the Bay Area, specifically into San Francisco, San Mateo, and Santa Clara counties. These implications are further explored in Section 2.2.



Figure 2-1. Geographic Distribution of Megaregional Population and Employment

In 2019, most of the Megaregion’s residents and jobs were located within the Bay Area. The share of jobs in the Bay Area was greater than the population share.



Source: PMC analysis of data from the California Department of Finance and the California Employment Development Department.

High densities of population and jobs are clustered in the Bay Area.

2.1.3. Population Density

Across the Megaregion, there are many densely populated areas, as illustrated in **Figure 2-2**. The most densely populated areas are contained within the Bay Area and Sacramento with typically less dense populations located within the southern counties of the Monterey Bay Area and Northern San Joaquin Valley.

Within the Bay Area, the most densely populated areas are San Francisco, San Mateo, and Santa Clara counties and across in the East Bay (Alameda and Contra Costa counties), as illustrated in **Figure 2-3**. There are, however, some less densely populated areas within these counties such as in western San Francisco.

The population density distributions and relative proximities to regional rail stations are examined further in Section 3.3.

2.1.4. Employment Density

As illustrated in **Figure 2-4**, there are many dense employment centers situated within the Bay Area and Sacramento. Employment density is typically lower in the Northern San Joaquin Valley and Monterey Bay Area, especially in their southern regions.

Within the Bay Area, the most densely populated employment centers are located within San Francisco, San Mateo, and Santa Clara counties and across in the East Bay (Alameda County), as displayed in **Figure 2-5**.

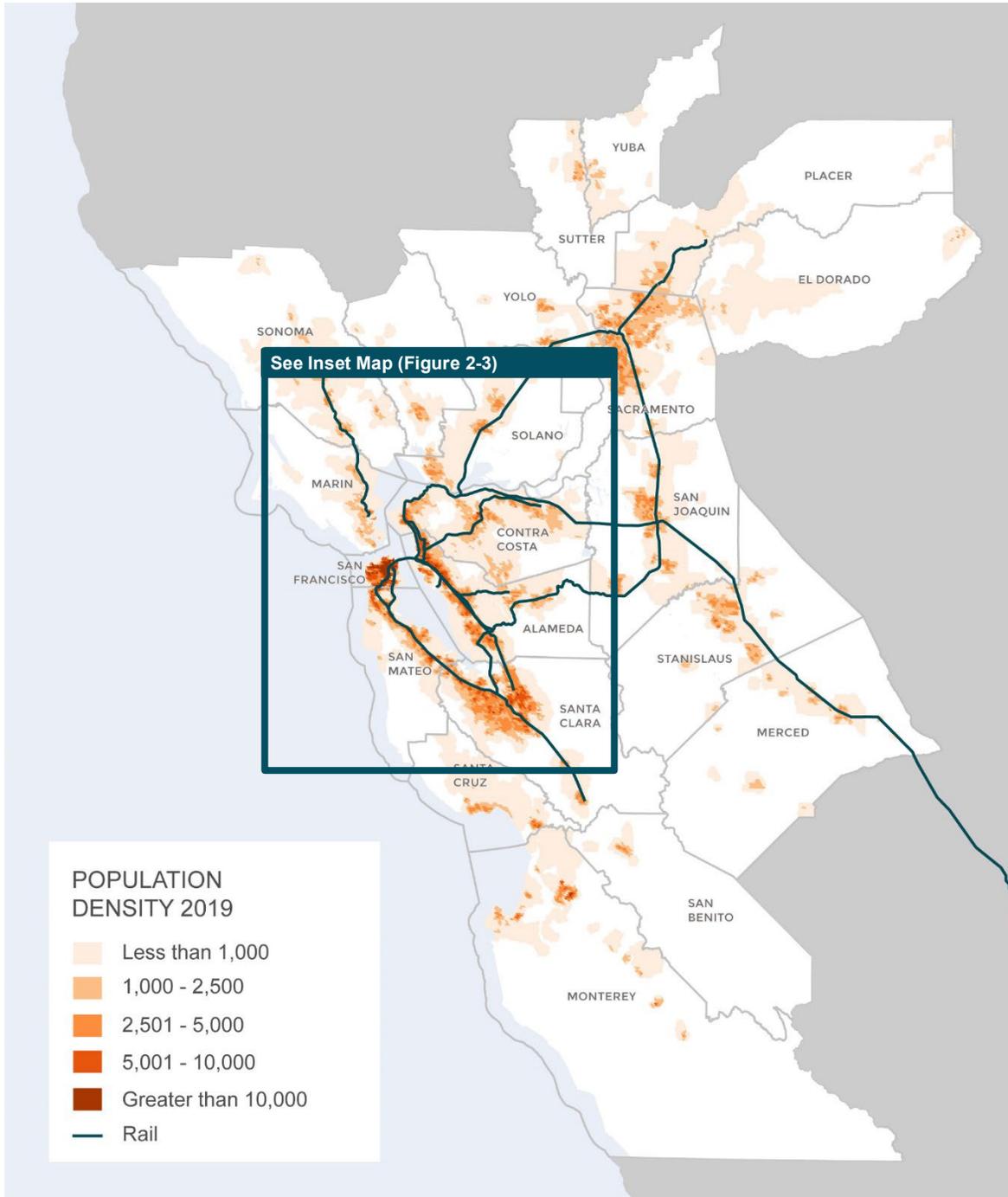
Section 3.3 provides further analysis of employment density distributions and relative proximities to regional rail stations.

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Figure 2-2. 2019 Population Density in the Megaregion

Most of the high-density population areas in the Megaregion are located within the Bay Area and certain parts of Sacramento Area.



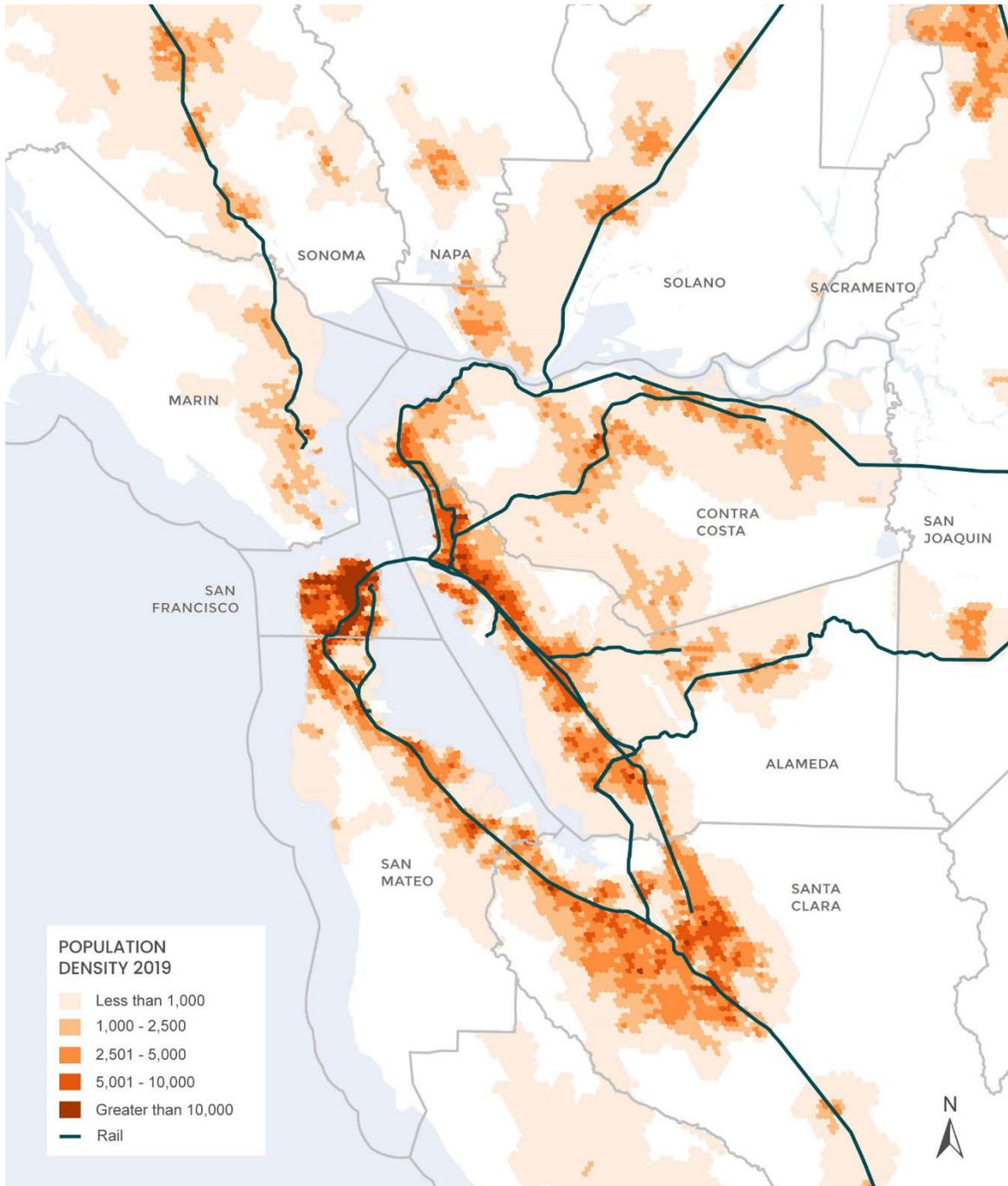
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Source: PMC analysis of data from the U.S. Census Bureau American Community Survey



Figure 2-3. 2019 Population Density: San Francisco Bay Area

There are high concentrations of housing located in downtown San Francisco, Oakland, and San Jose.



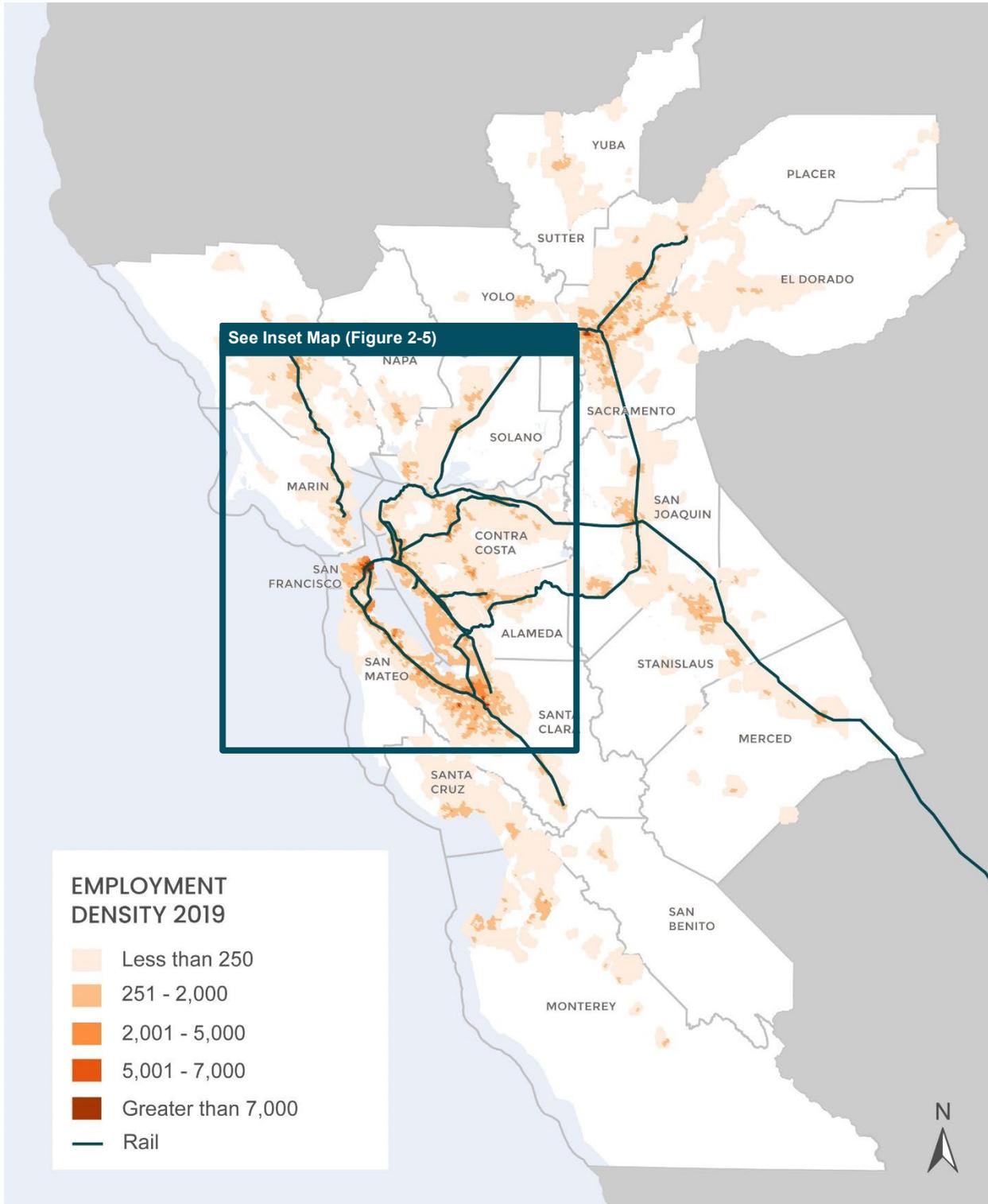
Source: PMC analysis of data from the U.S. Census Bureau American Community Survey

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Figure 2-4. 2019 Employment Density in the Megaregion

High concentrations of employment are centered in downtown San Francisco, Oakland, and San Jose.



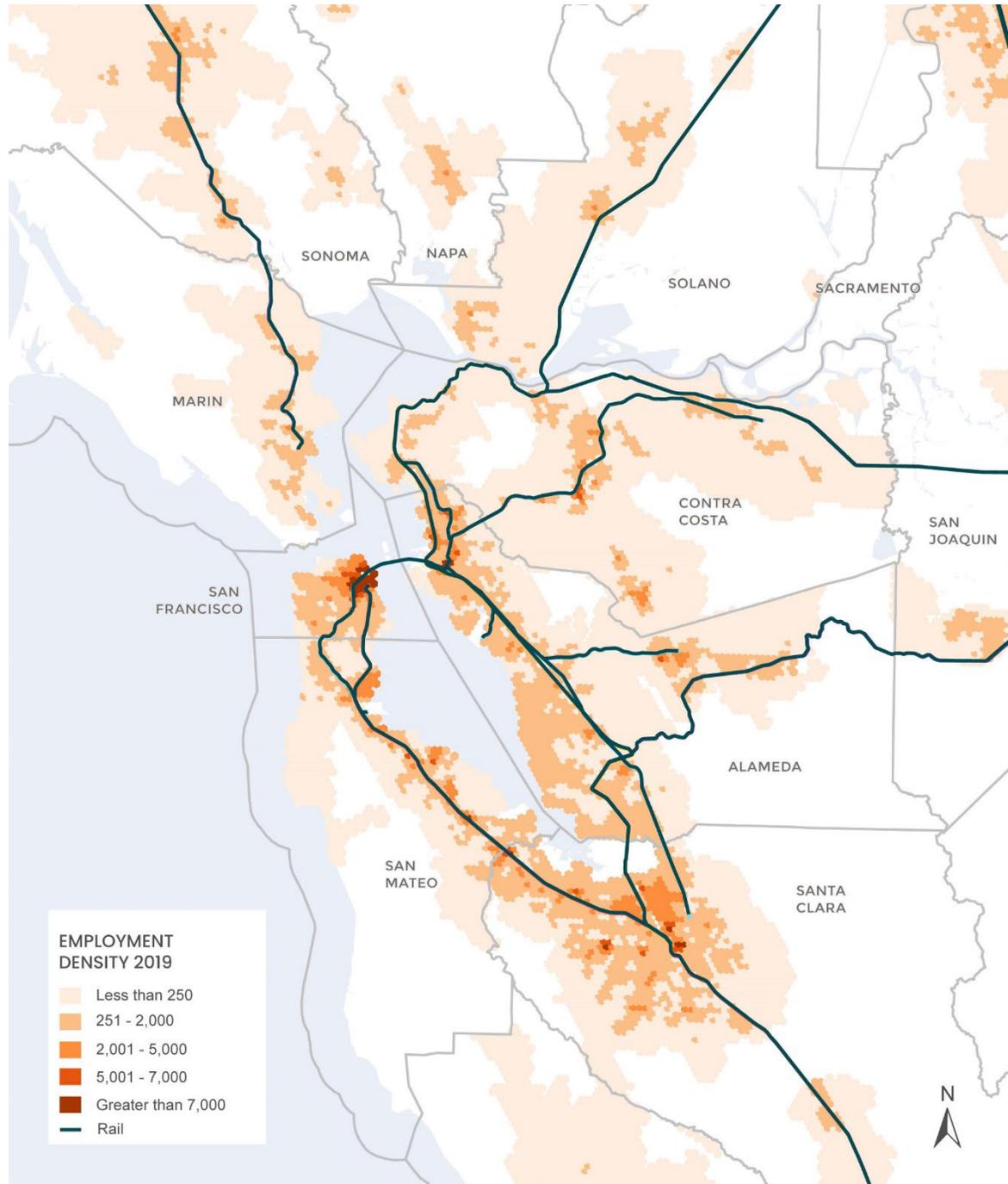
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Source: PMC analysis of data from the U.S. Census Bureau American Community Survey



Figure 2-5. 2019 Employment Density: San Francisco Bay Area

Within the Bay Area, there are dense employment centers located within downtown San Francisco and certain areas of Alameda, San Mateo, and Santa Clara counties.



Source: PMC analysis of data from the U.S. Census Bureau American Community Survey

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2.1.5. Employment Sectors

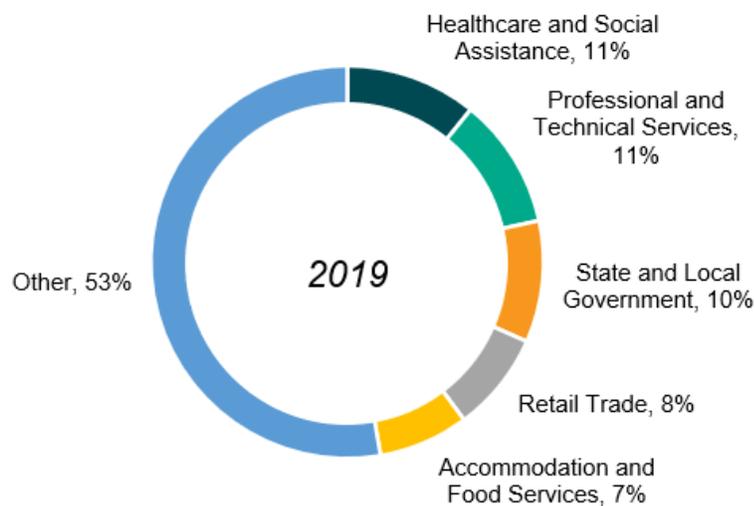
There is diversity of employment sectors across the Megaregion.

There was a diversity in employment sectors across the Megaregion in 2019. As illustrated in **Figure 2-6**, the largest sectors include Health and Social Assistance and Professional and

Technical Services, each with an estimated 11% of total regional employment. These are followed by State and Local Government (10%), Retail Trade (8%), and Accommodation and Food Services (7%). Various other industries account for over 53% of the remaining employment.

Figure 2-6. Percent Employment Share 2019

Healthcare and Social Assistance is the Megaregion’s largest industry by employment.



Source: PMC analysis of data from the U.S. Bureau of Economic Analysis (BEA) via Woods and Poole

Note: This figure measures employment from the U.S. BEA whereas previous employment figures were from the California Department of Finance to align with MPO data, which is derived from employment data from the U.S. BLS and U.S. Internal Revenue Service (IRS). However, this does not capture all occupations, including (but not limited to) unincorporated self-employed, certain farm and domestic workers, and railroad workers covered by the railroad unemployment system. U.S. BEA data provides estimates and adjustments to account for the aforementioned occupations.

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2.2. Historical Population and Employment Growth

The Sacramento Area and the Northern San Joaquin Valley have observed the highest growth rates, while the Bay Area has observed the highest growth in absolute terms.

2.2.1. Population

The total population in the Megaregion was 12.7 million in 2019, up from 9.3 million in 1990, as illustrated in **Figure 2-7**. This represents an overall increase of 3.4 million or a CAGR of 1.1% (**Figure 2-8**).

As discussed in Section 2.1, the Bay Area is the most populous region with 7.7 million residents in 2019, up from 6.0 million in 1990, which is equivalent to a CAGR of 0.9%. The Sacramento Area and the Northern San Joaquin Valley are the second and third most populous regions with over 2.5 million and 1.6 million residents respectively in 2019. In 1990, these regions were home to 1.6 million and 1.0 million residents, respectively.

Both these regions experienced above average growth rates of 1.6% and 1.5% compounded annually during this period. However, population growth in the Sacramento Area and the Northern San Joaquin Valley between 2010 and 2019 slowed from historical highs to 1.0% and 1.1%, respectively.

The population within San Francisco and San Mateo counties increased at a CAGR of 0.7% and 0.6% respectively from 1990 to 2019, lower than all other subregions.

2.2.2. Employment

According to the MTC, the strong growth in the Megaregion's economy can attract migration leading to population growth.⁴

Total megaregional employment was 6.2 million jobs in 2019, which is up from 4.7 million in 1990, as illustrated in **Figure 2-9**. This represents a total increase of 1.5 million jobs during this period with a CAGR of 1.0% (**Figure 2-10**).

At a CAGR of 1.4% between 1990 and 2019, the Sacramento Area and Northern San Joaquin Valley experienced the fastest growth in employment, which was in line with population growth rates. Employment continued to grow in these areas even during economic shocks, including the Dot-Com Bust in the early 2000s and the Great Recession and Global Financial Crisis between late 2007 and 2009.

Meanwhile, the Bay Area experienced an increase in employment from 3.4 to 4.1 million at a CAGR of 0.9% from 1990 to 2019. Due to the technology industry's dot-com bust in the early 2000s, employment growth within the Bay Area reduced to a CAGR of 0.3% between 2000 and 2010. However, between 2010 and 2019, employment growth in the Bay Area accelerated to a CAGR of 2.2% or an absolute growth of 0.7 million jobs. San Francisco experienced even higher increases in employment at a CAGR of 2.9% during this period.

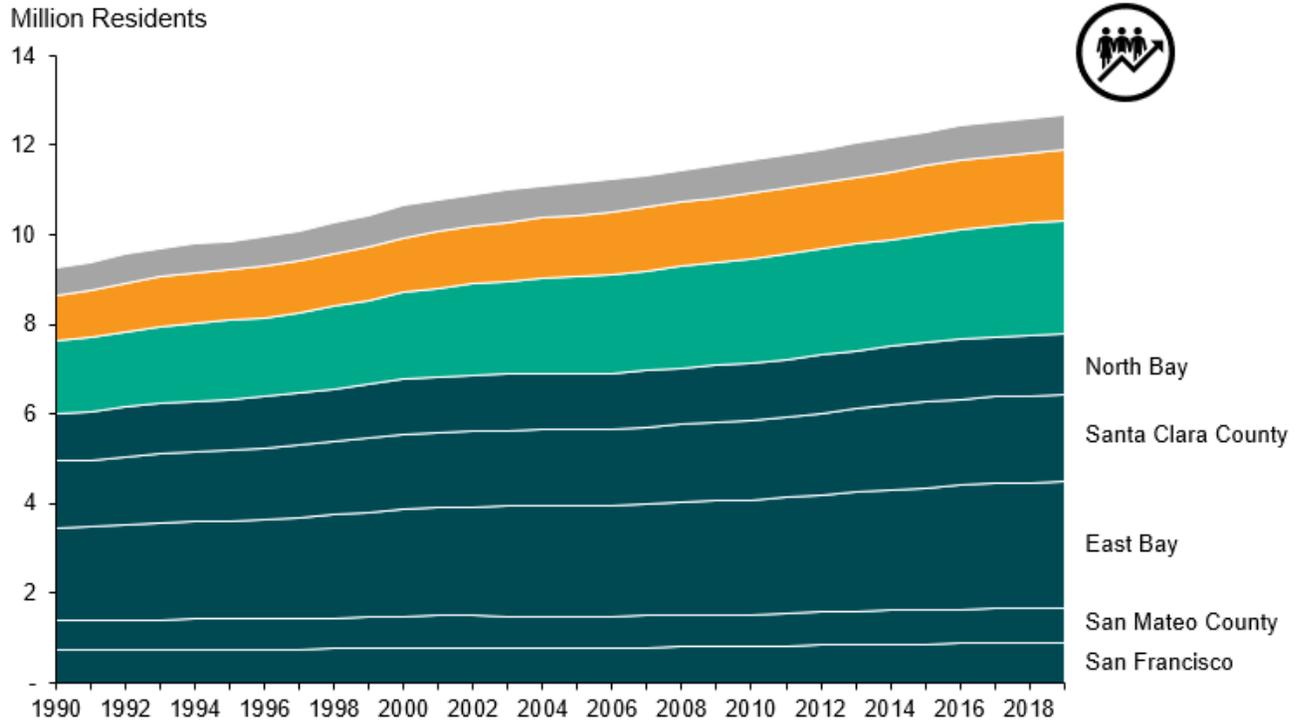
⁴ MTC PBA 2040, Projections 2040, p. 13-14



Figure 2-7. Annual Population Growth Rate of the Megaregion Over Time, 1990-2019

The Sacramento Area and the Northern San Joaquin Valley have been the Megaregion’s fastest growing regions by population rate since 1990, but the rate of growth has been increasing in San Francisco, East Bay, and Santa Clara counties in the last nine years.

■ San Francisco Bay Area ■ Sacramento Area ■ Northern San Joaquin Valley ■ Monterey Bay Area



Source: PMC analysis of data from the California Department of Finance

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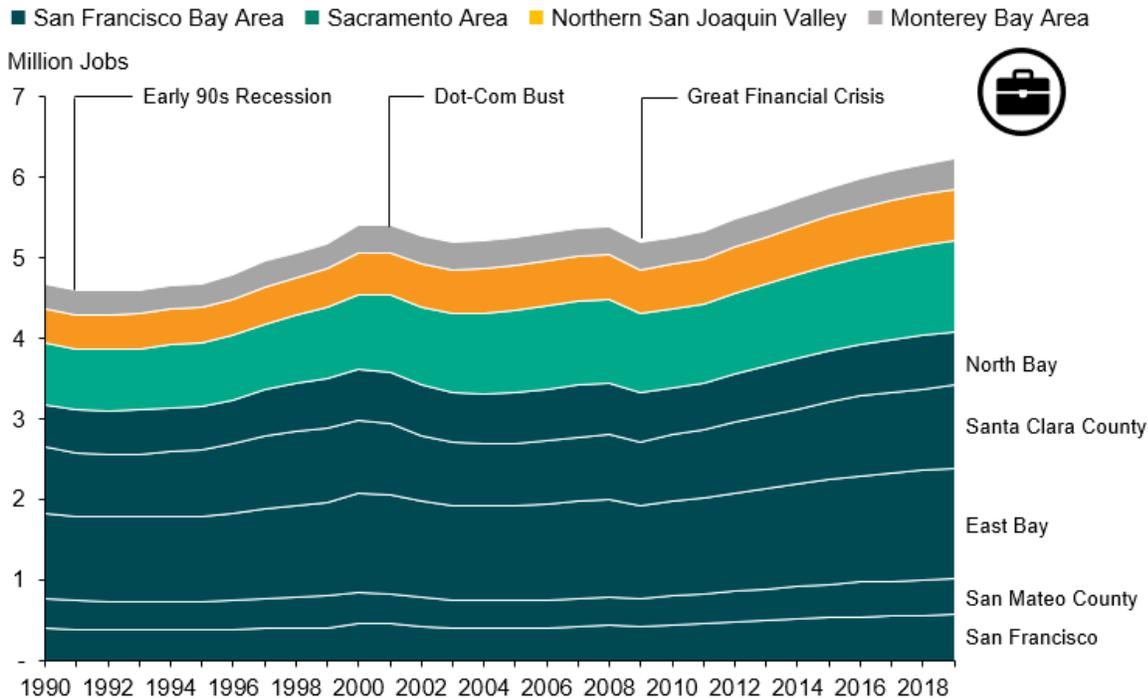
Figure 2-8. Compound Annual Population Growth Rate of the Megaregion

Region/Bay Area Sub-Region	% Compound Annual Growth Rate			
	1990-2000	2000-2010	2010-2019	1990-2019
San Francisco Bay Area	+1.2%	+0.5%	+0.9%	+0.9%
San Francisco	+0.7%	+0.4%	+1.1%	+0.7%
San Mateo County	+0.9%	+0.2%	+0.8%	+0.6%
East Bay	+1.4%	+0.7%	+1.1%	+1.0%
Santa Clara County	+1.2%	+0.6%	+1.0%	+0.9%
North Bay	+1.4%	+0.5%	+0.4%	+0.8%
Sacramento Area	+1.9%	+1.8%	+1.0%	+1.6%
Northern San Joaquin Valley	+1.7%	+1.8%	+1.1%	+1.5%
Monterey Bay Area	+1.3%	+0.3%	+0.6%	+0.8%
Megaregion	+1.4%	+0.9%	+0.9%	+1.1%

Source: PMC analysis of data from the California Department of Finance

Figure 2-9. Annual Employment Growth Rate of the Megaregion, Over Time, 1990-2019

The Sacramento Area, the Northern San Joaquin Valley, and the Sacramento Area have been the Megaregion’s fastest growing regions by employment, but average growth in San Francisco, San Mateo, and Santa Clara counties has been above Megaregion averages in the last nine years.



Source: PMC analysis of data from the California Employment Development Department

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Figure 2-10. Percent Compound Annual Employment Growth Rate of the Megaregion

Region/Bay Area Sub-Region	% Compound Annual Growth Rate			
	1990-2000	2000-2010	2010-2019	1990-2019
San Francisco Bay Area	+1.3%	-0.7%	+2.1%	+0.9%
San Francisco	+1.5%	-0.3%	+2.9%	+1.3%
San Mateo County	+0.7%	-0.7%	+2.5%	+0.8%
East Bay	+1.4%	-0.5%	+1.8%	+0.8%
Santa Clara County	+1.1%	-0.9%	+2.4%	+0.8%
North Bay	+1.6%	-0.8%	+1.5%	+0.7%
Sacramento Area	+2.0%	+0.6%	+1.6%	+1.4%
Northern San Joaquin Valley	+1.8%	+0.8%	+1.7%	+1.4%
Monterey Bay Area	+1.7%	-0.6%	+1.2%	+0.8%
Megaregion	+1.5%	-0.3%	+1.9%	+1.1%

Source: PMC analysis of data from the California Employment Development Department

The majority of the Megaregion’s population and employment growth is still concentrated within the Bay Area.

As discussed in the preceding section, the Megaregion experienced an increase of 3.4 million residents and 2.6 million jobs between 1990 and 2019. However, as illustrated in **Figure 2-12**, this growth was not evenly distributed across the Megaregion.

2.2.3. Historical Growth 1990-2019

Between 1990 and 2019, over 1.7 million residents or a 52% share of the Megaregion’s population growth was within the Bay Area. However, for employment, this was higher at over a 58% share or 0.9 million jobs.

The higher concentration of employment growth within the Bay Area is one potential factor that can increase interregional travel as residents outside of the Bay Area need to travel into jobs in the Bay Area. In addition, increasing unaffordability of housing pushes lower-

income households towards peripheral areas of urban regions. This impact is discussed in the context of the Megaregion in Chapter 3.

Even within the Bay Area, the distribution of population and employment growth also appears uneven. Between 1990 and 2019, at over 22% share, the East Bay had the highest share of Megaregion population growth among the subregions while San Francisco had just a 5% share. However, employment in San Francisco had a proportionally higher share of Megaregion employment growth, measured in absolute terms, during this period (over 11% employment share or 117,000 jobs versus 5% population share).

For residents traveling into the West Bay for work from the east, this would necessitate travel across the bay, either via a transbay crossing or across another Bay Area bridge.

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2.2.4. Recent Growth 2010-2019

With the significant growth in population and employment in the Bay Area, especially in the West Bay counties of San Francisco and San Mateo between 2010 and 2019, the historical uneven distribution of population and employment growth has been magnified further. As shown in Figure 2-12, the Bay Area had even higher (61% and 71%) shares of total Megaregion population and employment growth respectively during this period. This uneven distribution continues at a subregional level: San Francisco's share of total Megaregion population growth from 2010 to 2019 was just 5% while its share of employment growth was 13%.

In addition, high employment growth rates in the last nine years in San Mateo County appear to have resulted in a further widening of the gap between

population and employment growth: CAGRs of 4% and 9%, respectively, between 2010 and 2019 compared to CAGRs of 4% and 6%, respectively, from 1990 to 2019.

KEY TAKEAWAYS

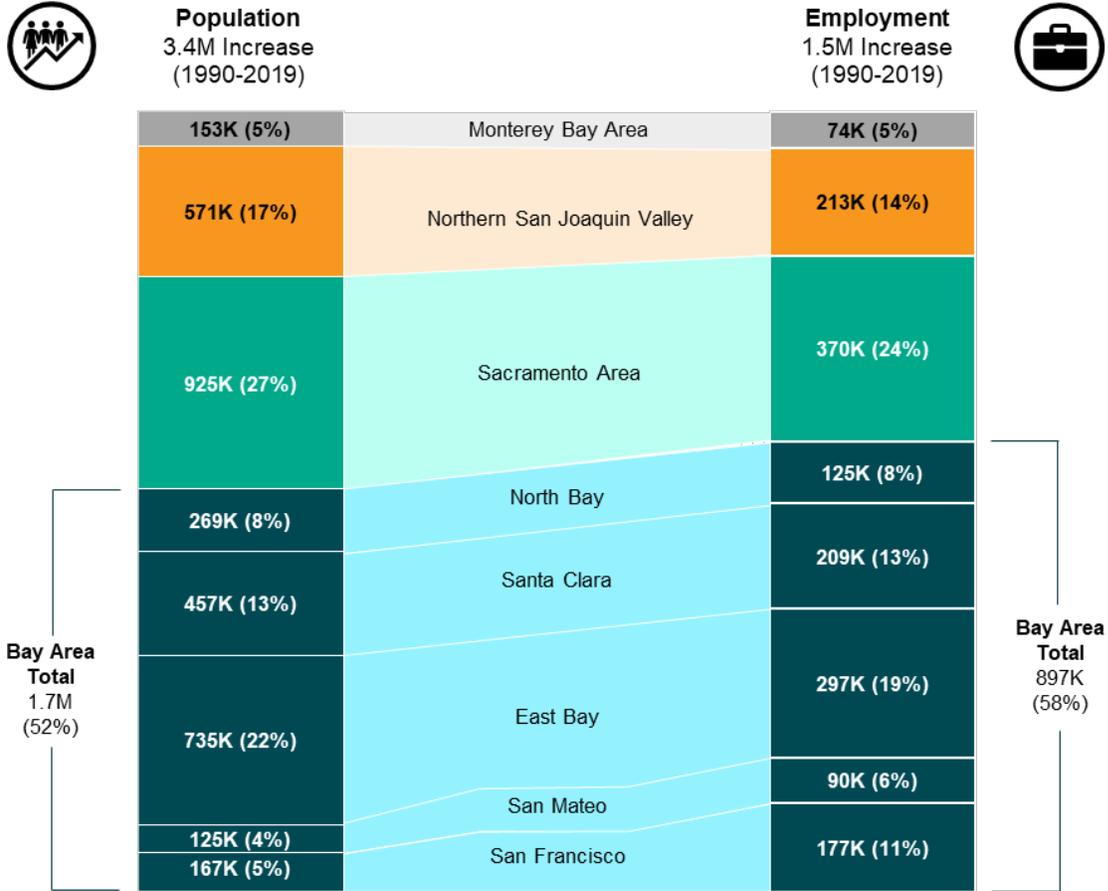
While the Sacramento Area and Northern San Joaquin Valley are the Megaregion's fastest growing regions by population and employment, most of the Megaregion's growth is still concentrated within the Bay Area, meaning increased demand for interregional travel.

Within the Bay Area, the West Bay has a much higher share of employment growth than of population growth, leading to increased travel demand across the bay.



Figure 2-11. Megaregion Population and Employment Growth

While the Sacramento Area and the Northern San Joaquin Valley experienced above average population and employment growth, most of the Megaregion’s population and employment growth was still concentrated within the Bay Area.



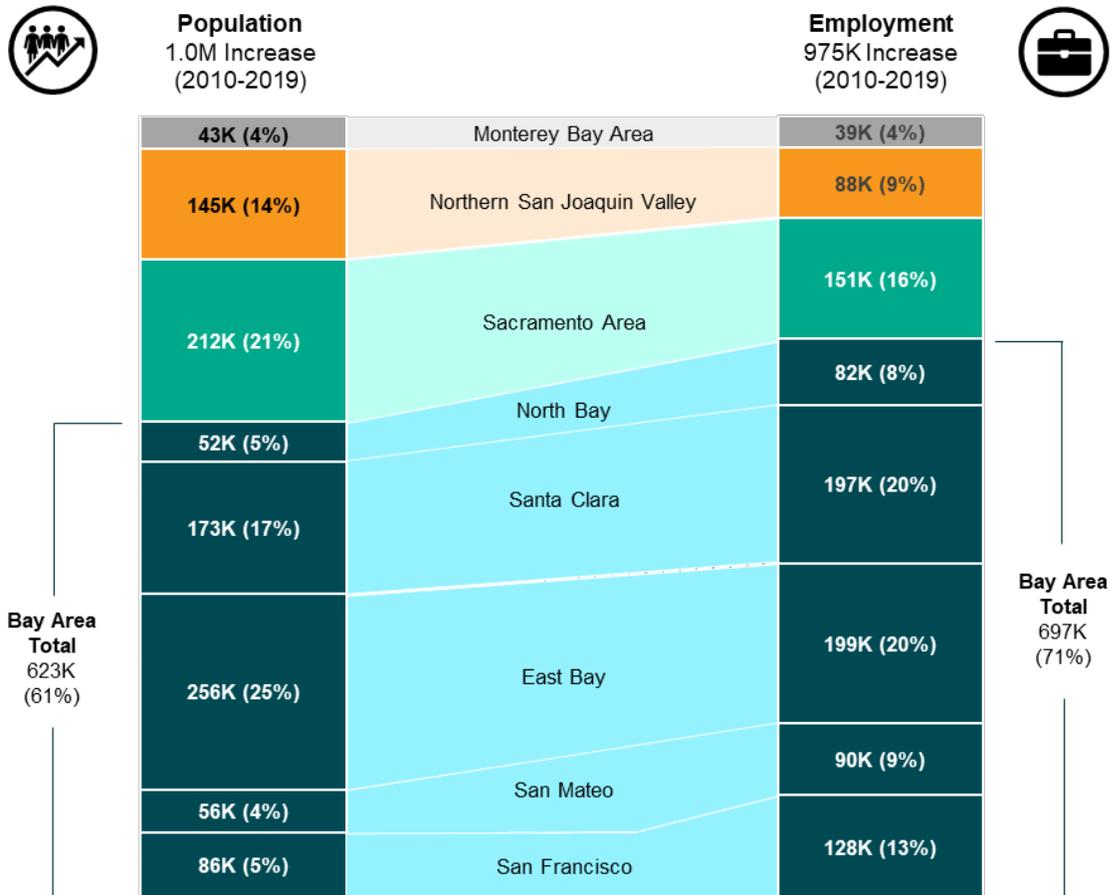
Source: PMC analysis of data from the California Department of Finance and the California Employment Development Department

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Figure 2-12. Megaregion Population and Employment Growth: Uneven Distribution

The uneven distribution of population and employment growth across the Megaregion has been further magnified in the last nine years, especially in San Francisco County.



Source: PMC analysis of data from the California Department of Finance and the California Employment Development Department

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The Megaregion has experienced high economic growth despite three economic crises.

As discussed earlier in Section 2.2, a strong megaregional economy can be an important factor driving migration and population growth. In 2019, the Megaregion is estimated to have generated a GRP of over \$1.1 trillion (\$2012) as illustrated in **Figure 2-13**. This represents over 40% of California’s state-wide gross domestic product (GDP) or 6% of the overall U.S. GDP.

Between 1990 and 2019, the Bay Area generated between 73% and 79% of the overall Megaregion’s GRP. Among the regions within the Megaregion, GRP in the Bay Area increased at a CAGR of 3.9% from 1990 to 2019 outpacing the overall Megaregion GRP CAGR of 3.6% during the same period.

This is in part due to the number of high revenue companies located within the Bay Area. Thirty-eight Fortune 500 companies are based within the Bay Area with revenues ranging from \$5.7 billion to over \$260 billion. Nine of these companies are located in San Francisco County, while eight companies are headquartered in Santa Clara County. The top 20 Fortune 500 companies are shown in **Figure 2-14**.

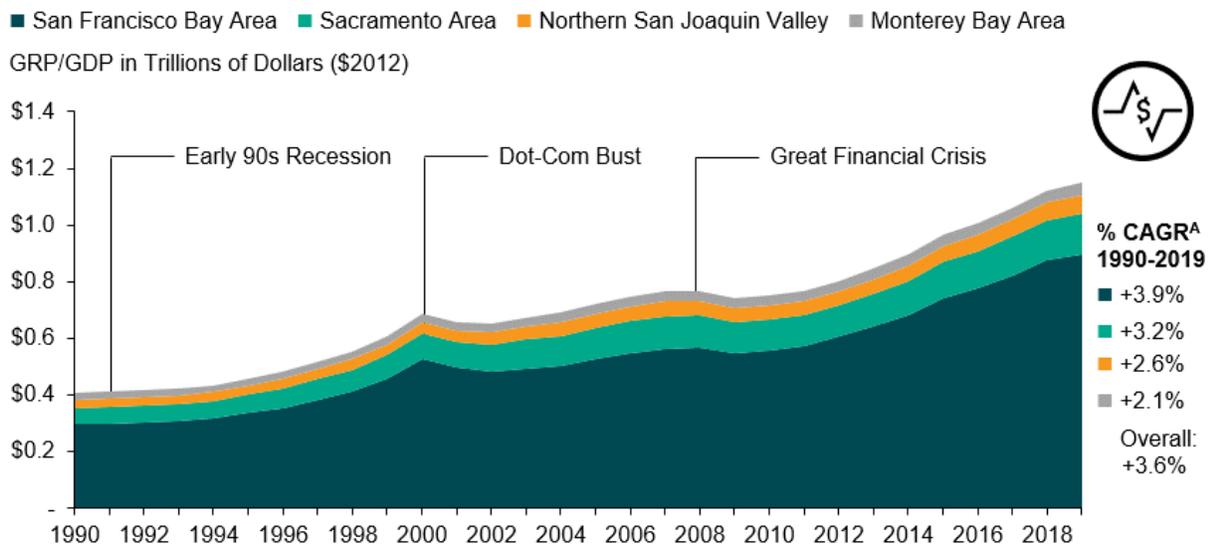
KEY TAKEAWAYS

Overall Megaregion GRP increased at a CAGR of 3.6% between 1990 and 2019.

Over 73% of the Megaregion’s GRP was generated from the Bay Area.

Figure 2-13. Estimated Megaregion GRP/GDP

The Bay Area experienced the highest growth in GRP at a CAGR of 3.9% between 1990 and 2019.



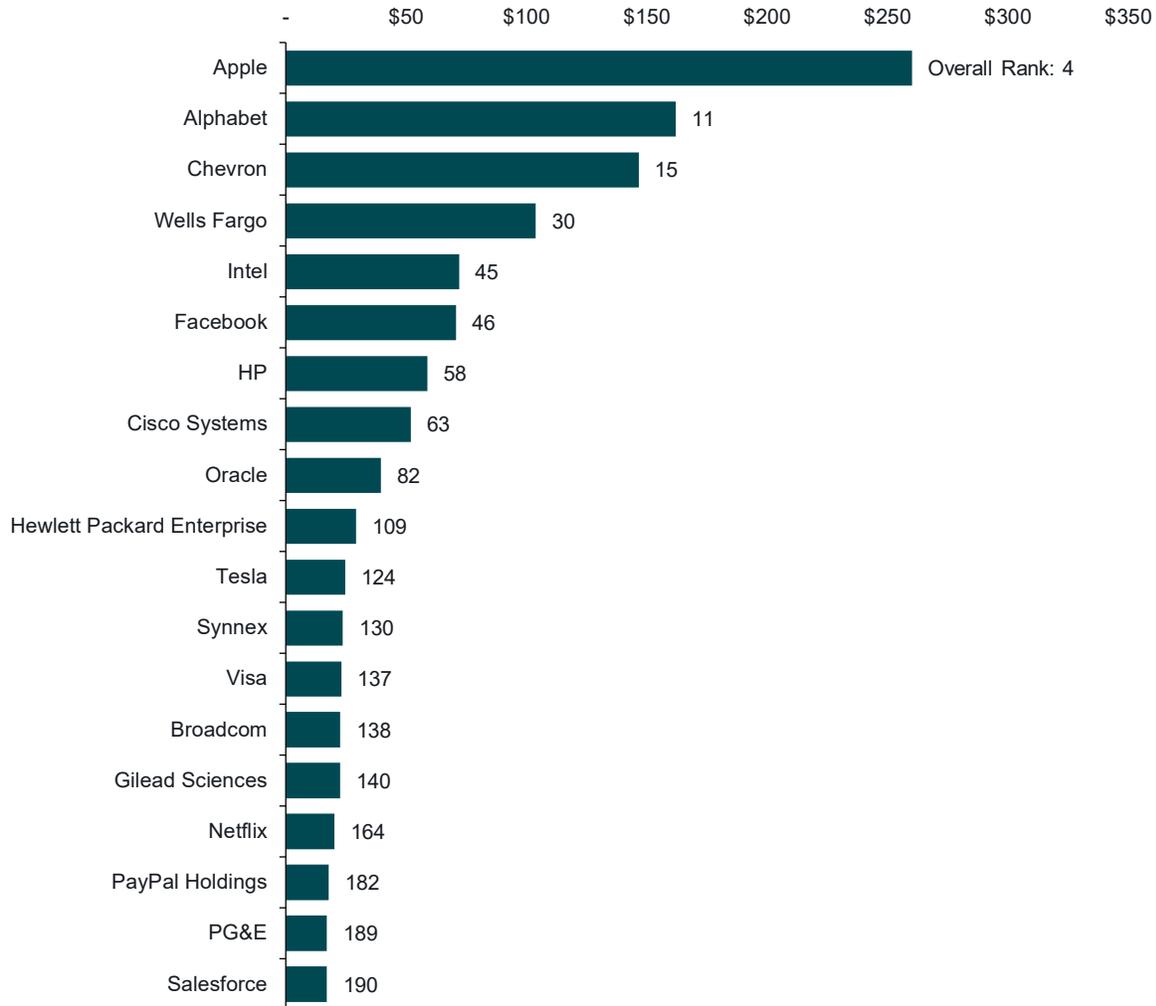
Source: PMC analysis of data from the U.S. BEA via Woods and Poole

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Figure 2-14. Top 20 Fortune 500 Companies in the Megaregion by Billion Dollar Revenues (2020)

The Bay Area is home to 38 of the top Fortune 500 companies, which is dominated by companies in the technology sector.



Source: PMC analysis of data from Fortune 500

Note: Oracle and Hewlett Packard Enterprise were formally based in the Bay Area, but they relocated their headquarters to Austin, Texas and Houston, Texas, respectively.

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Growth in the Megaregion has outperformed that of the U.S. and California.

2.2.5. Population Growth

Figure 2-15 highlights the strong Megaregion population growth.

From 1990 to 2019, the Megaregion population increased by 37% compared to 1990 levels, while across the U.S. that figure was 32%.

Since 2000, Megaregion population has increased at a rate slightly higher than the overall U.S. and Californian population growth (compared to 1990 levels).

2.2.6. Employment Growth

Megaregion employment growth from 1990 to 2019 was around 33%, as illustrated in **Figure 2-16**, compared to 38% across the U.S. Employment within the Megaregion was affected by the Dot-Com Bust in the early 2000s, but it recovered over the following years before falling again significantly during the Great Financial Crisis (2007 to 2009). However, between 2010 and 2019, Megaregion employment growth increased at a CAGR of 1.9%, higher than the national- and state-wide growth at 1.6% per annum.

2.2.7. Economic Growth

As illustrated in **Figure 2-17**, the Megaregion has been strong compared to overall U.S. and state averages.

The overall Megaregion GRP in 2019 increased 180% compared to 1990 levels. This growth outperformed statewide and overall national GRP and GDP growth of 125% and 112%, respectively.

KEY TAKEAWAYS

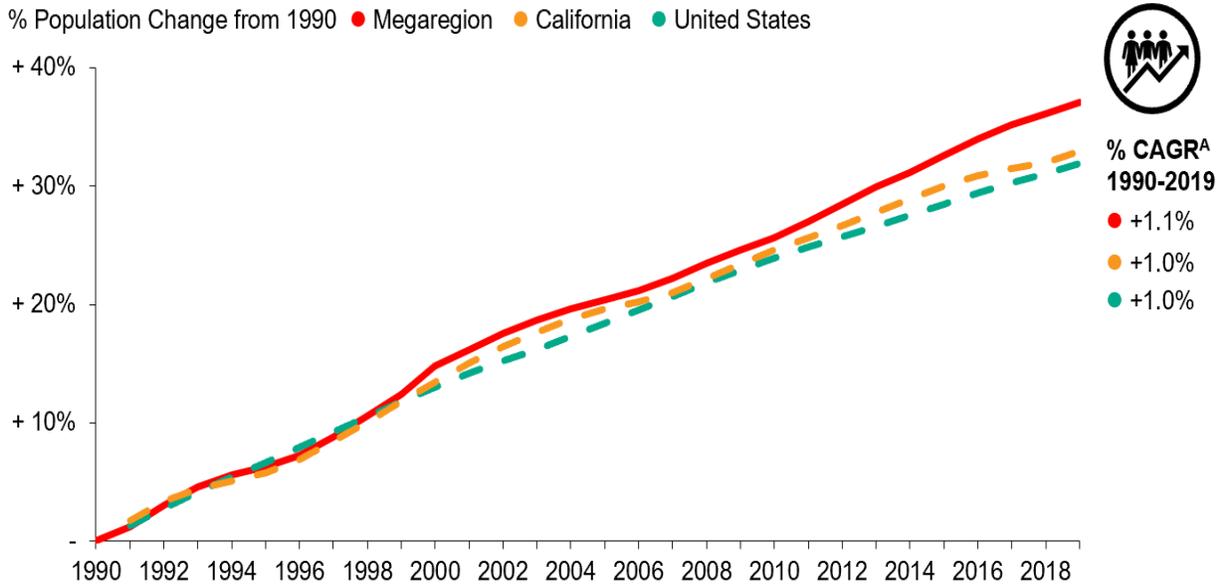
The Megaregion observed strong historical population and employment growth.

Economic growth in the Megaregion, as measured by GRP, has outperformed national and statewide GDP and GRP growth, respectively.



Figure 2-15. Megaregion Population Changes Since 1990

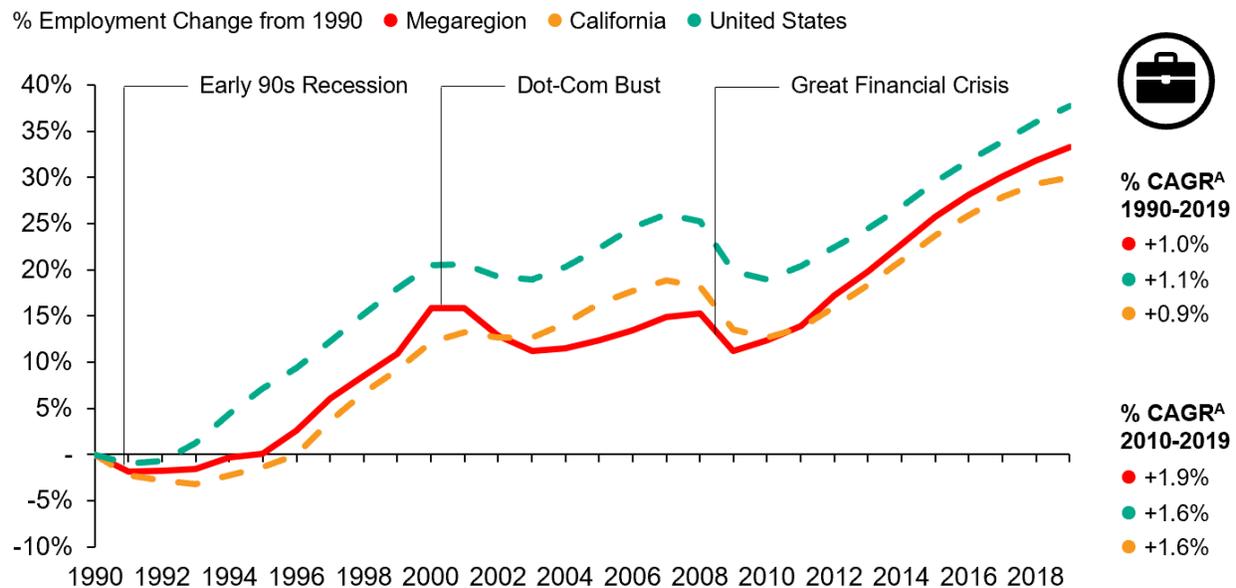
Since 2000, population has increased at a rate slightly higher than overall U.S. and Californian population growth (compared to 1990 levels).



Source: PMC analysis of data from the California Department of Finance and the U.S. Census Bureau via Woods and Poole

Figure 2-16. Megaregion Employment Changes Since 1990

From 1990, Megaregion employment growth lagged the U.S. average, but recent growth has been higher than national- and state-wide averages since 2010.



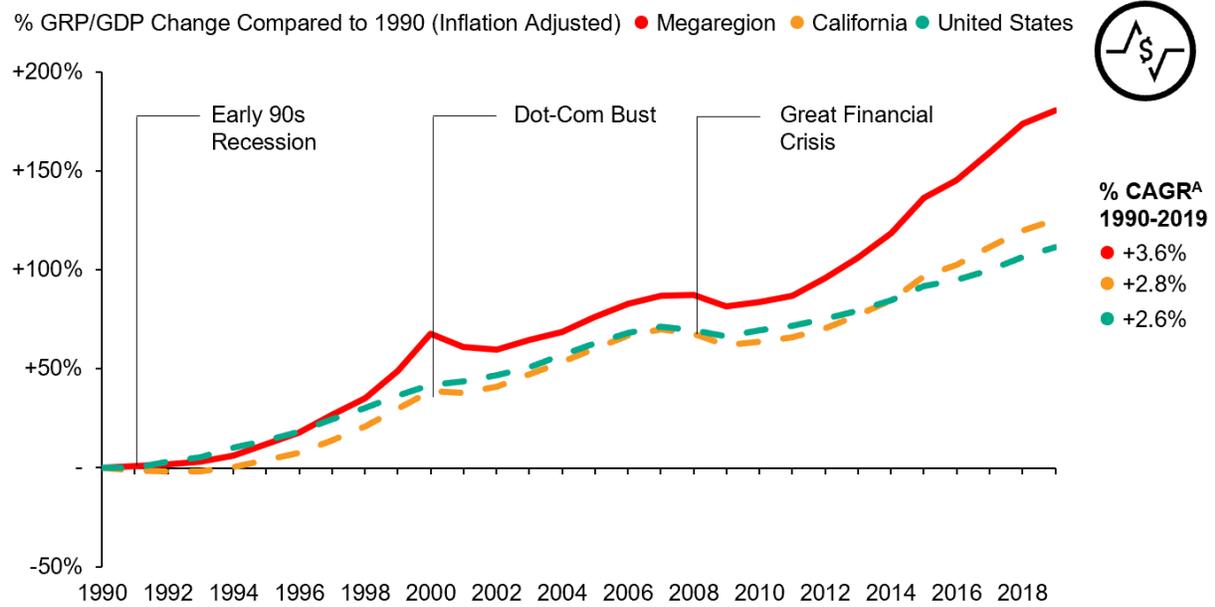
Source: PMC analysis of data from the Californian Employment Development Department and the U.S. BLS

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Figure 2-17. Megaregion GRP/GDP Changes Since 1990

Economic growth in the Megaregion has been strong compared to overall U.S. and state averages.



Source: PMC analysis of data from the U.S. BEA via Woods and Poole

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2.3. Market Segmentation

Different population groups have different propensities to use rail in the Megaregion. **Table 2-1** provides the 12 market segments found across the Megaregion. Each of these segments reflects different behaviors and characteristics. This segmentation has been based on Experian Mosaic 2019 data, which combines publicly available data sources like the census with survey and detailed consumer data, and it provides hundreds of data points on different behaviors or attitudes, grouping this to individuals and households.

The analysis includes an index value for propensity to use transit, (e.g., the Young Starters segment has an index value of 160), which means they are twice as likely to use transit than the Nonurban Mid-Life Singletons with a value of 80.

Mosaic is a means of classifying and summarizing the population and provides an additional layer of detail to understanding potential Link21 riders. It is used to help explain outcomes in the context of potential users. Pen Portraits were developed for each market segment and are presented in Appendix E.

Table 2-1. Megaregion Market Segments

The segments with the greatest propensity to use transit are Multi-Modal Urbanites and Lower-Income Transit Riders.

MARKET SEGMENT		% MEGAREGION POPULATION	PROPENSITY TO USE TRANSIT INDEX ^A
1	Multi-Modal Urbanites	9.5%	480
2	Lower-Income Transit Riders	5.6%	390
3	Middle Income Metro Families	11.6%	210
4	Young Starters	6.9%	160
5	Higher-Income Empty Nesters	5.8%	120
6	Middle-Aged and Middle Income	7.3%	105
7	Comfortable Retirement	9.9%	105
8	Nonurban Mid-Life Singletons	7.9%	80
9	Blue Collar Suburban Families	7.3%	65
10	Young Suburban Families	7.7%	40
11	Lower Income Suburban Retirees	16.1%	35
12	Lower Income Rural Retirees	4.4%	25

Source: PMC analysis of data from Experian Mosaic

^A The propensity to commute by public transportation and for households in the group to have no vehicle based on an index where 100 is the national average (therefore, an index of 200 is twice the average and 50 is half).



2.4. Summary

The Megaregion has experienced above average growth.

The Megaregion is home to over 12.7 million residents and 6.2 million jobs in 2019. Between 1990 and 2019:

- Population increased 3.4 million or at a CAGR of 1.1%.

- Employment increased 1.5 million or at a CAGR of 1.0%.
- GRP across the Megaregion increased at a CAGR of 3.6%.

As illustrated in **Figure 2-18**, Megaregion population, employment, and GRP growth rates were higher than U.S. and California growth rates, particularly GRP.

Figure 2-18. Megaregion CAGR

Historical socioeconomic growth in the Megaregion appears strong compared to national and statewide benchmarks.

% CAGR 1990-2019

Region	Population	Employment	GDP/GRP
Megaregion	+1.1%	+1.0%	+3.6%
California	+1.0%	+0.9%	+2.8%
United States	+1.0%	+1.1%	+2.6%

Source: PMC analysis of the California Department of Finance, California Employment Development Department, and U.S. BLS

However, the distribution of this growth has been uneven.

While the Megaregion has experienced strong historical growth in the last three decades, this growth has not been evenly distributed across the Megaregion. The Sacramento Area and the Northern San Joaquin Valley were the fastest growing regions in the Megaregion with population and employment between 1990 and 2019 increasing at a CAGR of at least 1.5% and 1.4%, respectively.

While population and employment in the Bay Area grew at a slower CAGR of 0.9% and 0.8%, respectively, during this period, the majority of the Megaregion's population and employment growth in absolute terms was concentrated in the Bay Area, especially between 2010 and 2019, as illustrated in **Figure 2-19**.



Figure 2-19. Megaregion Share of Growth

The Bay Area experienced a higher share of employment growth than population growth from 1990 to 2019, especially over the last nine years.

% Megaregion Share of Growth

Bay Area	1990-2019	2010-2019
Population	1.8M - 52%	0.6M - 61%
Employment	0.9M - 57%	0.7M - 71%

Source: PMC analysis of data from the California Department of Finance and the California Employment Development Department

The Bay Area’s share of Megaregion employment growth, particularly within San Francisco and San Mateo counties, has been higher than its share of population growth.

Between 1990 and 2019, the Bay Area’s share of megaregional employment growth was higher than its corresponding share of megaregional population growth. Even within the Bay Area, the West Bay counties of San Francisco and San Mateo experienced different distributions of growth. In San Francisco, the share of Bay Area population growth between 1990 and 2019 was 10% compared to 20% for employment growth as highlighted in **Figure 2-20**. The corresponding figures for San Mateo County are 7% and 10%, respectively.

From 2010-2019, the growth differential has only become greater in those two counties. In San Francisco, the share of Bay Area population growth was 14% compared to 28% for employment growth

with San Mateo County having Bay Area growth share rates of 9% and 14%, respectively.

As residents need to travel for work, these uneven geographic distributions of population and employment growth are important considerations to understand megaregional travel demand and Transbay Corridor capacity.

This theme of uneven distribution will be further explored in Chapter 3. The impacts to travel demand and on Transbay Corridor capacity due to the uneven geographic distributions of residential and employment growth is discussed in Chapter 4.

The existing population and employment by geography is a key input into the regression models that have been developed to estimate rail ridership potential (as described in Chapters 7 and 8).

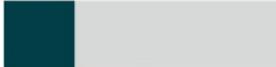
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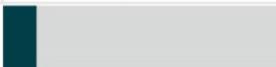
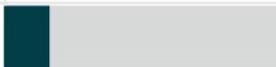
Figure 2-20. Percent Share of Bay Area Growth

San Francisco and San Mateo County population and employment shares of Bay Area growth have increased over the last decade.

% Share of Bay Area Growth - San Francisco

	1990-2019	2010-2019
Population	 167K - 10%	 86K - 14%
Employment	 167K - 20%	 128K - 28%

% Share of Bay Area Growth - San Mateo County

Bay Area	1990-2019	2010-2019
Population	 125K - 7%	 56K - 9%
Employment	 90K - 10%	 90K - 13%

Source: PMC analysis of data from the California Department of Finance and California Employment Development Department

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3. EQUITY

Advancing equity is as an important goal of Link21. This chapter examines equity within the Megaregion and looks to identify opportunities for Link21 to advance equity.

While the Megaregion's GRP increased at a rate well above statewide and national averages, the distribution of this growth, as examined in this chapter, suggests this has been inequitable across the Megaregion, leading to disparities and disadvantages for specific population groups.

- According to U.S. Census data, over 67% of the Megaregion's households with incomes between \$100,000 and \$200,000 live within the Bay Area; for households with incomes exceeding \$200,000, this is even higher at an estimated 82%.
- The Megaregion has seen the greatest growth from 1990-2019 in the highest income bracket, households earning over \$150,000. In halo counties, every income bracket has experienced growth from 1990-2019, but in the Bay Area, only the highest income brackets (over \$100,000) and the lowest income brackets (less than \$30,000) have experienced growth.
- Based on an analysis of U.S. Census data, an estimated 43% of the Megaregion's priority populations households are housing-cost burdened, meaning they spend 30% or more of their income on housing costs, leaving less disposable income for other necessities.
- While 64% of priority populations residents live within 5 miles of a rail station, this accessibility to rail is not universal throughout the Megaregion, particularly in the outer halo counties.
- Improving transit access is particularly important for the 12% of priority populations who do not have access to a vehicle at home.



3.1. Equity Overview

As discussed in Chapter 1, promoting equity is a core goal of Link21, and it is analyzed across the metrics that underpin other goals and objectives.

To facilitate the evaluation of Link21's benefits and impacts on equity, a program-specific geographic designation of equity has been defined. The priority populations designation was developed to make sure that Link21 addresses inequities across the Megaregion by identifying those areas that are currently experiencing disproportionate burdens related to transportation, livability, and accessibility; all other Megaregion areas are referred to as general populations. This designation will be used in the business case evaluation to review the distribution of program benefits and negative impacts. In the market analysis, it is used to explore disparities and disadvantages experienced by priority populations in livability, affordability, and accessibility compared to general populations. An initial definition of priority populations based on state and regional geographic metrics related to equity was used for the market analysis. This

definition is being updated to better reflect the equity priorities of the program and to incorporate community input for future work, but it will remain consistent throughout this deliverable.

Link21's equity commitment includes partnering with community members most impacted by past transportation projects to identify and avoid, mitigate, or minimize impacts while maximizing benefits to these priority populations.

Link21 has defined equity as "a state in which an individual's background does not predetermine or predict their opportunity." In order to assess how Link21 advances equity, the program must first understand how current socioeconomic conditions across the Megaregion are distributed both geographically and demographically. The data points used for this analysis are summarized in **Figure 3-1** and are not an exhaustive list of equity considerations for the program.

Figure 3-2 and **Figure 3-3** illustrate the priority populations in the Megaregion and in the Bay Area specifically.



Figure 3-1. Equity Metrics

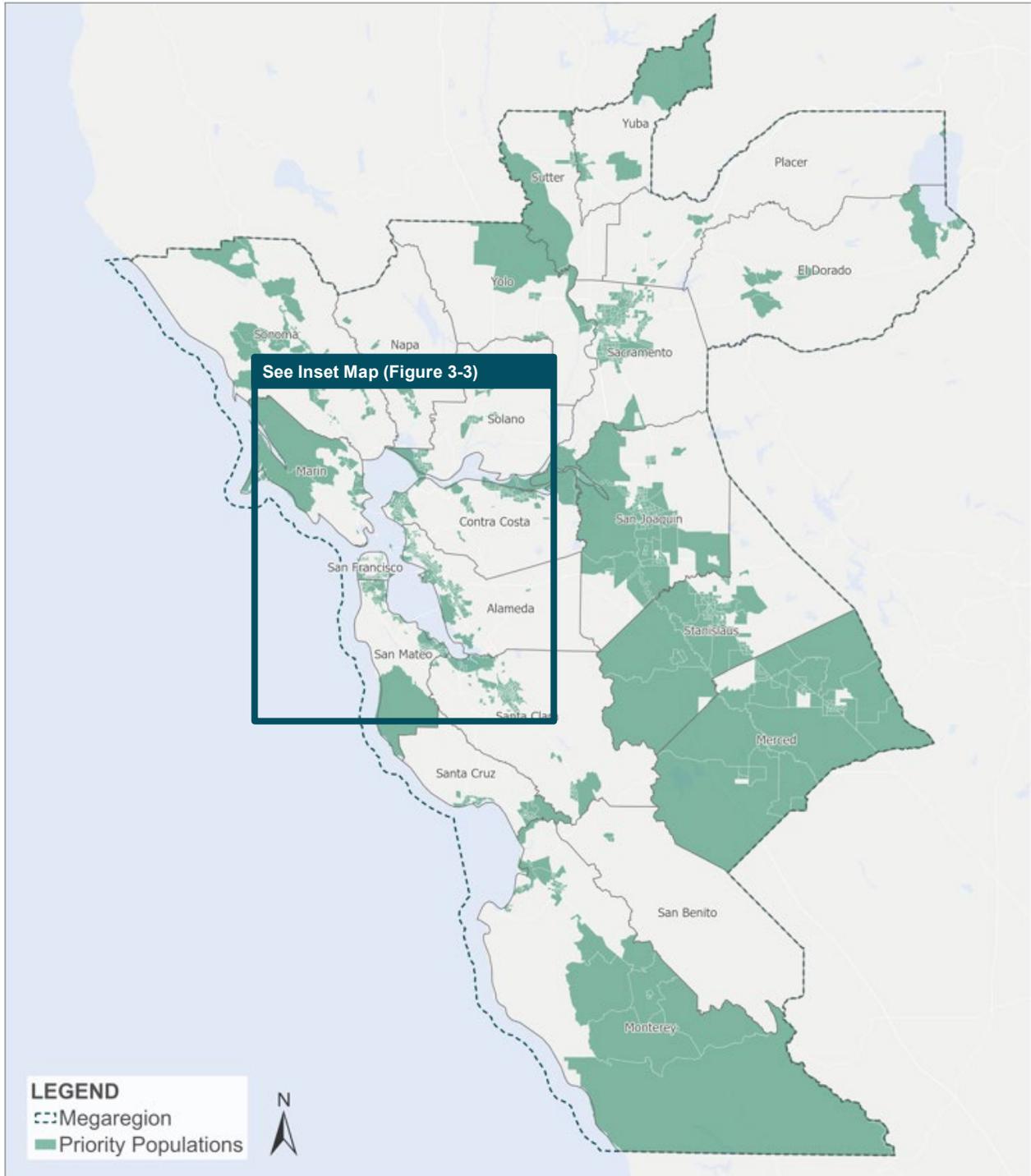
Assessing equity in the Megaregion involves many different metrics, but rail accessibility and vehicle ownership are key variables that are directly related to Link21.

Metric	Measurement	Impact to Link21	
 Household Income: How much a household earns in a year	Median household income	Income is directly related to livability and affordability and is influenced by access to jobs	Variables that have non-transportation impacts to the Link21 Program
 Housing Cost Burden: Used as a measure of affordability; aligned with definition used by HUD ^A	Households who spend over 30% of their income on housing costs	According to HUD, people who are housing cost burdened may have difficulty affording necessities, such as food, clothing, transportation, and medical care	
 Ethnicity: Related to physical traits and cultural identification	Households by ethnic group	Inequity in the Bay Area is not only related to socioeconomic status, includes racial inequity	
 Regional Rail Accessibility: The proportion of the Megaregion's population and jobs that are close to rail services	Population or jobs within 1, 5, and 10 miles of rail	Priority populations can benefit from rail proximity	Variables that have transportation impacts to the Link21 Program
 Vehicle Ownership: Households without access to a vehicle	Zero-vehicle households	These households are more likely to be transit-reliant	

^A U.S. Department of Housing and Urban Development (HUD)



Figure 3-2. Link21 Preliminary Priority Populations – Megaregion

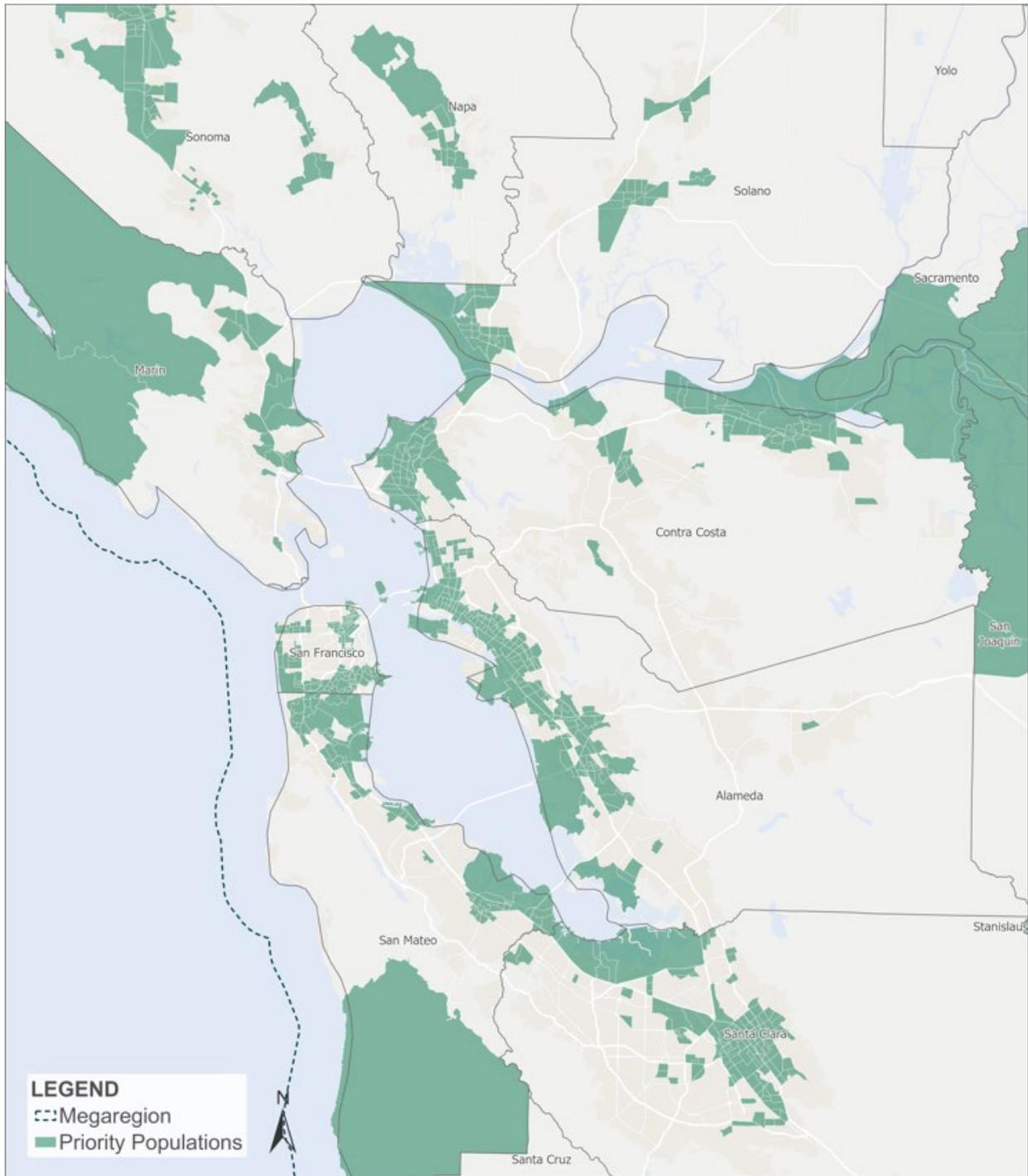


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Source: PMC analysis of data from the California State Disadvantaged Communities and Low-Income Communities, MTC Equity Priority Communities (EPC), and various congestion management agencies' adjustments to MTC's EPC



Figure 3-3. Link21 Priority Populations – Bay Area Inset



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Source: PMC analysis of data from the California State Disadvantaged Communities and Low-Income Communities, MTC EPC, and various Congestion Management Agencies' adjustments to MTC's EPC



3.2. Equity in the Megaregion

The following section provides an overview of conditions that impact equity across the Megaregion, specifically household income, housing cost, and race and ethnicity.

The Bay Area leads the Megaregion in household income and in income inequality.

3.2.1. Megaregion Trends

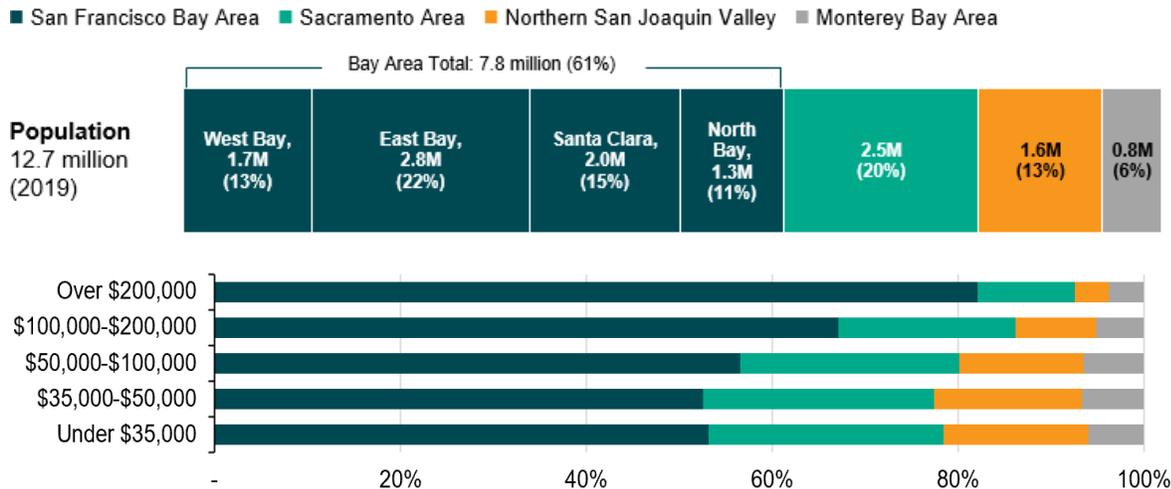
The Bay Area is home to a higher proportion of high-income households, defined as those making over \$100,000, than other regions, as illustrated in **Figure 3-4**. In 2019, an estimated 67% of

the Megaregion’s households earning between \$100,000 and \$200,000 resided in the Bay Area (82% for households earning over \$200,000).

As illustrated in **Figure 3-5**, the Bay Area has by far the highest proportion of households earning over \$100,000, double the shares in the Sacramento Area and the Northern San Joaquin Valley. An estimated 28% of households in Northern San Joaquin Valley Area, on the other hand, have incomes under \$35,000, compared to an estimated 17% within the Bay Area.

Figure 3-4. Geographic Distribution of Household Income in the Megaregion

Between 2015 and 2019, the Bay Area had a higher proportion of households with incomes over \$100,000 compared to other income brackets.



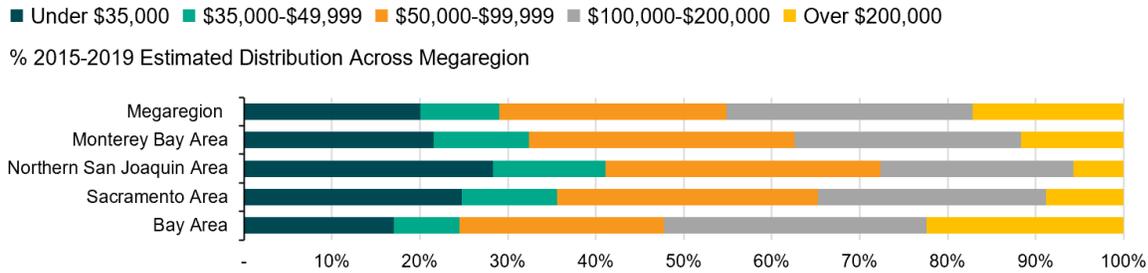
Source: PMC analysis of data from the U.S. Census American Community Survey (Table B19001 5-Year Estimates 2015-2019)

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Figure 3-5. Income Distribution by Geography

Fifty-two percent of households in the Bay Area have incomes over \$100,000, which is 14% points higher than the share of the next closest region the Monterey Bay Area at 38%.



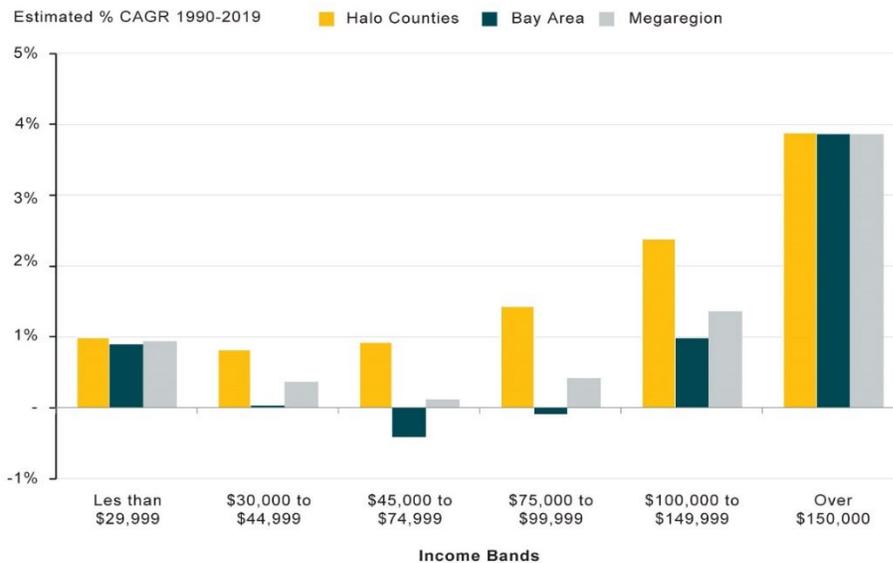
Source: PMC analysis of data from the U.S. Census American Community Survey (Table B19001 5-year Estimates 2015-2019)

3.2.2. Historical Evolution

Between 1990-2019, there was growth across all income brackets in the Megaregion. The highest growth rate was found in the highest income bracket (over \$150,000) with notable growth in the \$100,000-\$150,000 bracket and the lowest income bracket (less than \$30,000).

Halo counties' growth matched that of the Megaregion in the lowest and highest income brackets but had higher growth across all income categories in comparison to the Megaregion. The Bay Area also experienced growth on par with the Megaregion for the highest and lowest income brackets, but in contrast had much lower growth (and in some cases negative growth) in the middle-income brackets.

Figure 3-6. Megaregion Growth by Income



Source: PMC analysis of data from the U.S. Census American Community Survey (Table B19001 5-year Estimates 2015-2019)

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As illustrated in **Figure 3-7**, the highest earning households have high concentrations within the Bay Area, particularly in Marin, San Francisco, and along the Peninsula into Santa Clara County. Parts of Contra Costa and Alameda counties in the East Bay also have a high concentration of households earning over \$200,000.

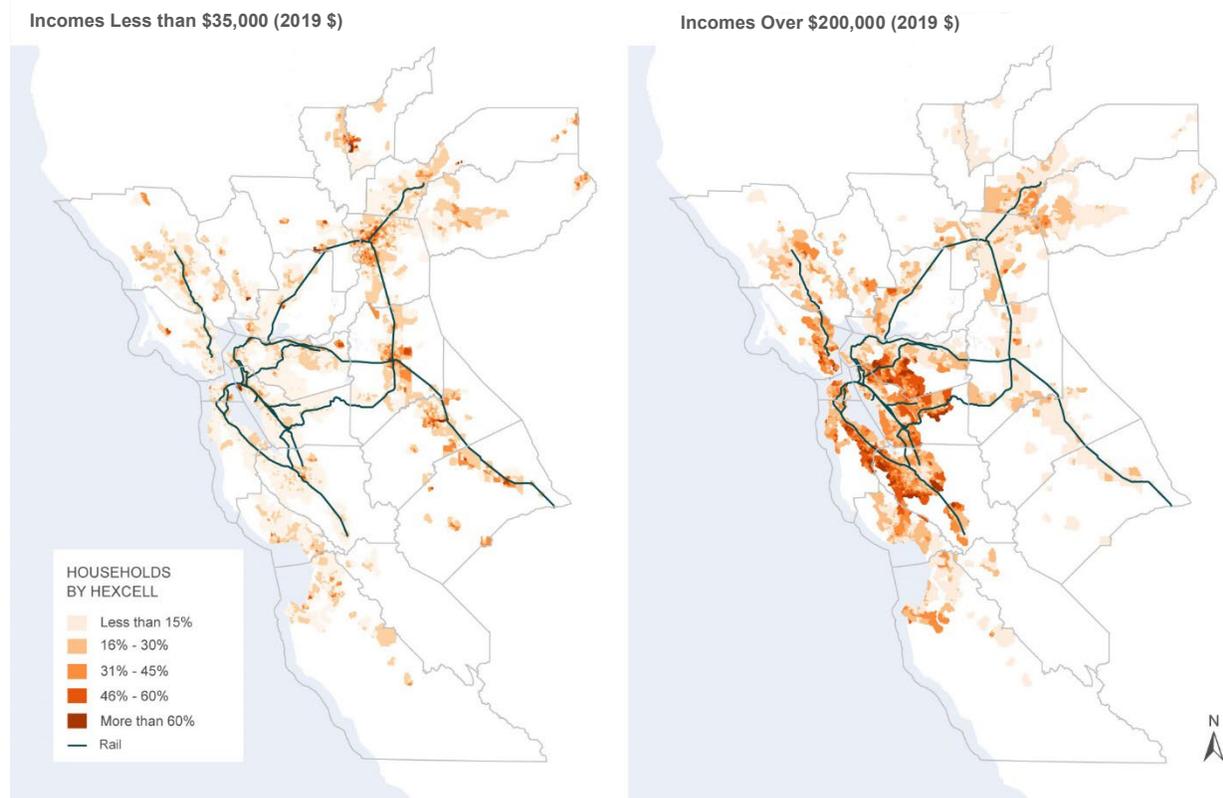
This contrasts with the high concentrations of lower income households making less than \$35,000 in

the halo counties, particularly in the Sacramento Area and Northern San Joaquin Valley, along with areas of lower income households in the San Francisco Bay Area in areas like Oakland.

In 2019, Marin, San Francisco, and San Mateo counties were among the Megaregion leaders in income inequality with Gini Indices⁵ exceeding California and national averages, as illustrated in **Figure 3-8**.

Figure 3-7. Household Incomes by Census Tract

The Sacramento Area and the Northern San Joaquin Valley have higher proportions of households making less than \$35,000 compared to the Bay Area, which has the most households earning above \$200,000 annually (2015-2019).

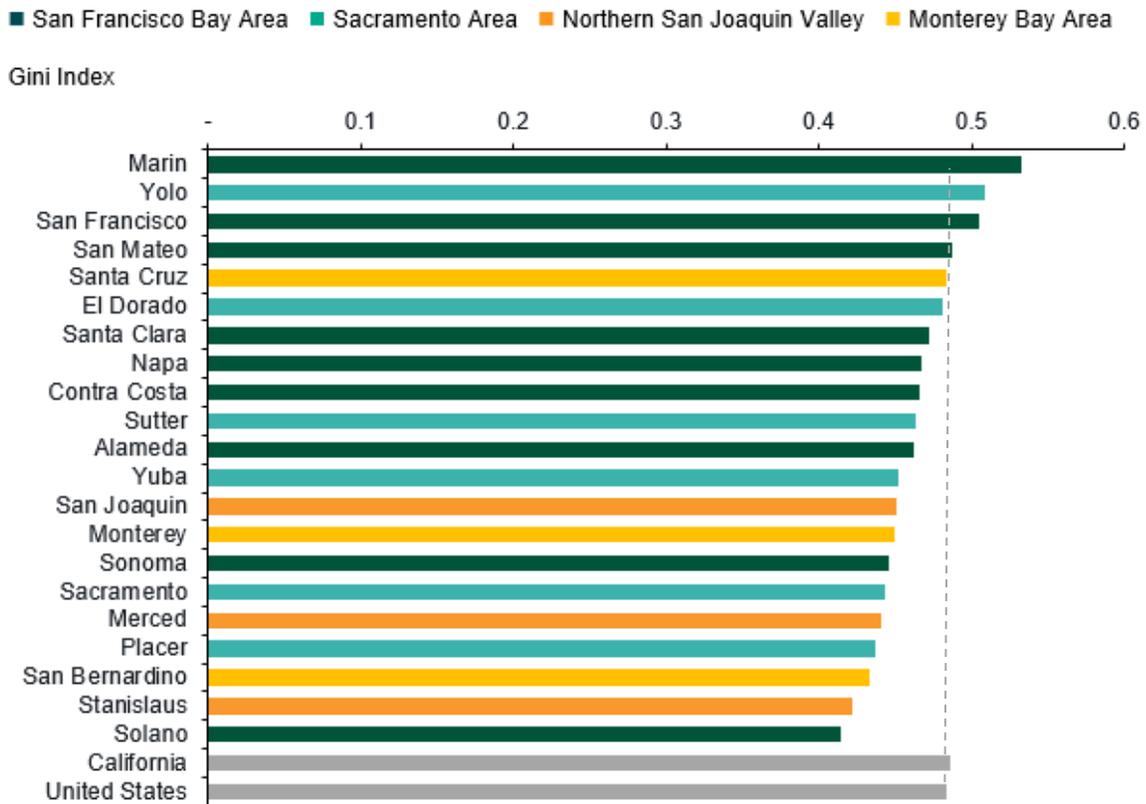


⁵ Measures degree of income inequality in an area with higher indices that correspond to more inequality.

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Figure 3-8. Gini Indices for the Megaregion



Source: PMC analysis of data from the U.S. Census Bureau American Community Survey (Table B19083, 1-year Tables, 2010-2019) and Income and Poverty in the United States: 2019 Current Population Report

Note: The Gini Index measures the degree of income inequality, where 0 represents perfect equality while an index of 1.0 equals the maximum inequality. Thus, the higher the index, the higher the degree of income inequality.

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Housing cost burdens have increased for households with incomes under \$75k.

3.2.3. Home Values and Rent Trends

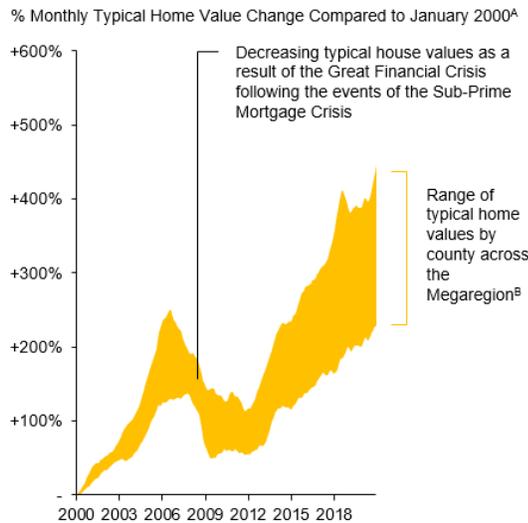
According to county-level data from Zillow, typical home values across the Megaregion in December 2020 were on average three to five times higher than the typical home values in January 2000. As illustrated in **Figure 3-9**, home values peaked in 2006 but dipped following the subprime mortgage crisis in late 2007 and continued on a downward trend as a result of the Great Financial Crisis. However, typical home values began trending upwards again in 2012. Since 2008, home values within the Bay Area, specifically in

Alameda, Santa Clara, and Napa counties, have observed the highest rate of increase compared to other counties throughout the Megaregion.

Similarly, according to Apartment List, across the U.S., the national average monthly rent was estimated to be \$1,130 in 2019. However, as illustrated in **Figure 3-10**, with the exception of Placer County in the Sacramento Area, most counties across the Megaregion had average monthly rents higher than the national average. Counties within the Bay Area are highest with average Bay Area rents 122% above the U.S. average.

Figure 3-9. Home Value Changes

By December 2020, typical home values by county range from over three to five times the typical home values in January 2000.



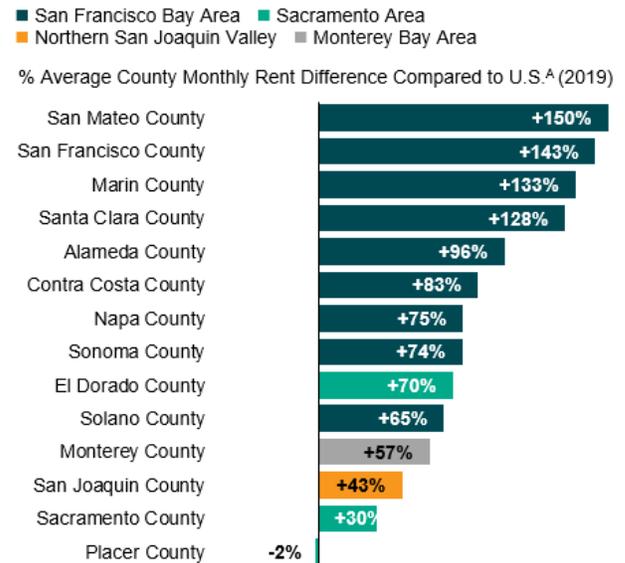
Source: PMC analysis of data from Zillow Home Value Index All Homes (Time Series, Smoothed, Seasonally Adjusted) and U.S. BLS Consumer Price Index.

^A Adjusted for inflation

^B Excludes the following counties due to lack of data availability in January 2000: Stanislaus, Sutter, and Yuba

Figure 3-10. Percent Average Megaregion County Monthly Rent Difference Compared to the U.S.

Average rent in the Bay Area is at least 65% higher than national average – San Francisco and San Mateo rents are on average almost 2.5 times the U.S. average.



Source: PMC analysis of data from Apartment List

^A Unweighted average across the calendar year

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3.2.4. Housing Cost Burden Trends

Figure 3-11 illustrates the shares of households who spend more than 30% of their household income on housing. The 30% threshold is based on the HUD definition of housing cost burden that it leads to difficulty affording necessities like food, clothing, transportation, and medical care.

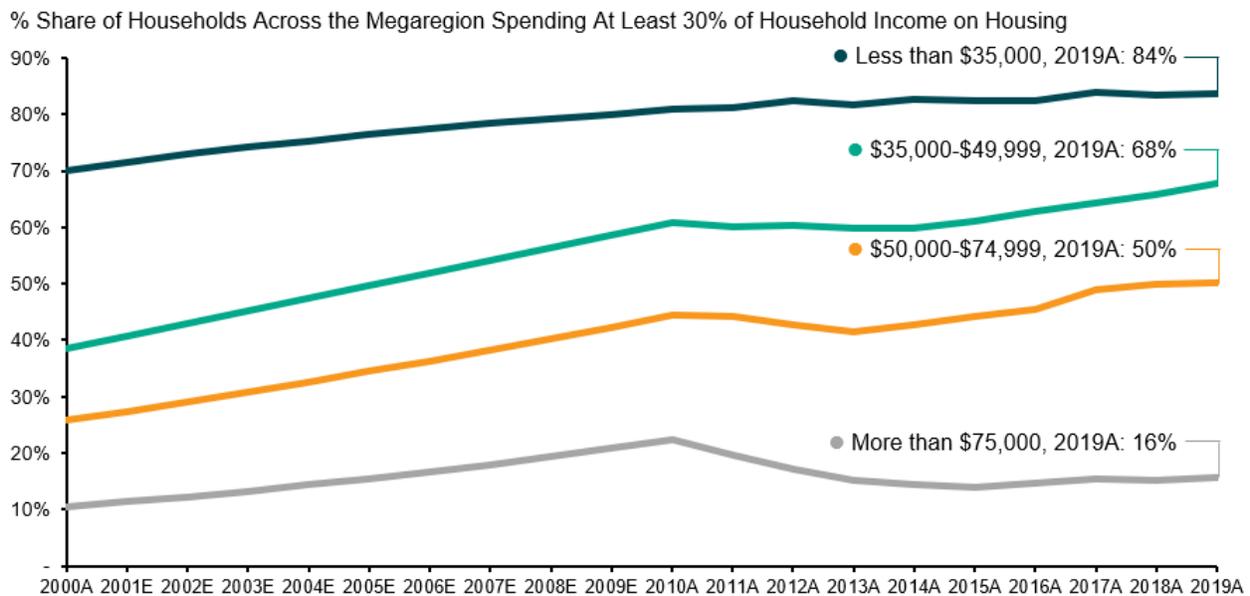
Since 2000, the proportion of households that spend at least 30% of their income on housing has increased across all income brackets. Recently, this proportion has been trending downwards for households with incomes

over \$75,000, whereas it continues to rise for households making less than \$75,000.

This suggests a growing proportion of households are burdened by the high cost of living across the Megaregion, particularly households making less than \$75,000 annually. The impact of spending a high proportion of income on housing costs for lower income households puts them at even greater disadvantage with even less income remaining to put towards other necessities.

Figure 3-11. Percent Share of Megaregion Households Spending At Least 30% of Household Income on Housing

Since 2010, the proportion of households spending 30% or more of their household income on housing has increased for all households making less than \$75,000.



Source: PMC analysis of data from the U.S. Census Decennial Census (2000) and American Community Survey (Table B25106, 1-year Table, 2011-2019)

^A For the years, the A designation stands for actual data from the U.S. Census Decennial Census for the years 2000 and 2010. For the years following 2010, data comes from the 1-year Tables from the U.S. Census American Community Survey.

^B For data between 2001 and 2009 (inclusive), the E designation stands for estimates as this was based on extrapolated estimates between actual years of 2000 and 2010.

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3.2.5. Cost Burden for General Populations

As illustrated in **Figure 3-12**, an estimated 32% of general population households were cost burdened in 2019, spending over 30% of their income on housing costs.

3.2.6. Cost Burden for Priority Populations

An estimated 43% of priority populations households were cost burdened in 2019, which is 11 percentage points higher than the proportion of cost burdened households in general populations. The biggest difference in cost burden between priority and general populations is in Alameda County, where the

proportion of cost-burdened households in priority populations is 14 percentage points higher than in general populations.

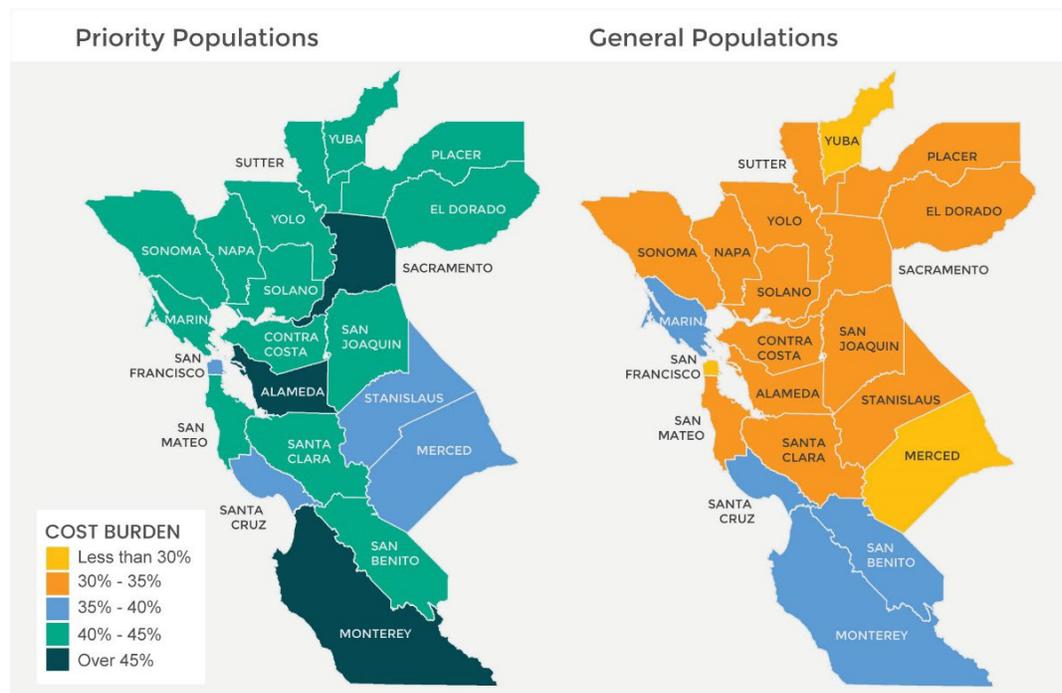
KEY TAKEAWAYS

Since 2010, the megaregional share of cost-burdened households has increased among households making less than \$75,000, and it shrunk among those making over \$75,000.

Cost burdened households comprise 37% of the Megaregion. An estimated 43% of priority populations compared to 32% of general population households (2015-2019) are cost burdened.

Figure 3-12. Priority and General Populations Cost-burdened Households

Thirty-seven percent of Megaregion households are cost burdened, meaning they spend over 30% of their income on housing, and 32% of general population households are cost burdened, compared to 43% of priority populations households (2015-2019).



Source: PMC analysis of data from the U.S. Census American Community Survey (Table B25106, 5-Year Table, 2019)

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BIPOC make up a large, growing proportion of the Megaregion's population.

3.2.7. Megaregion Trends

Figure 3-13 and **Figure 3-14** provide an overview of the population race and ethnicity patterns in 2019.

The only subregion not a minority-majority was Sacramento where the BIPOC population accounts for 47% of the population. The Northern San Joaquin Valley has the highest proportion of BIPOC residents with 65%.

The Bay Area has an estimated 63% of the Megaregion's white, non-Hispanic population (who make up 40% of the Bay Area's population), while the highest regional share of white, non-Hispanic population of 53% is in the Sacramento Area.

The highest concentrations of Hispanic/Latino population groups were found in the Northern San Joaquin Valley and the Monterey Bay Area at 48% and 51%, respectively.

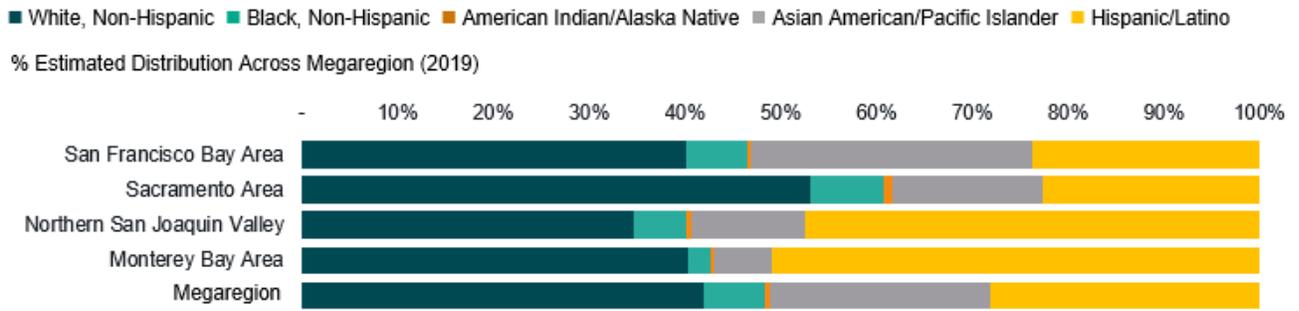
Over 81% of the Megaregion's 2.4 million Asian American/Pacific Islander population groups are concentrated within the Bay Area.

Meanwhile, the Bay Area is home to 67% of the Megaregion's Black, non-Hispanic population, while the highest share of Black, non-Hispanic population was found in the Sacramento Area at 8%.

As illustrated in **Figure 3-15**, the racial and ethnic composition of the Megaregion population varies between subregions. In 2019, BIPOC population groups represented an estimated 58% of the Megaregion's population making it a minority-majority region.

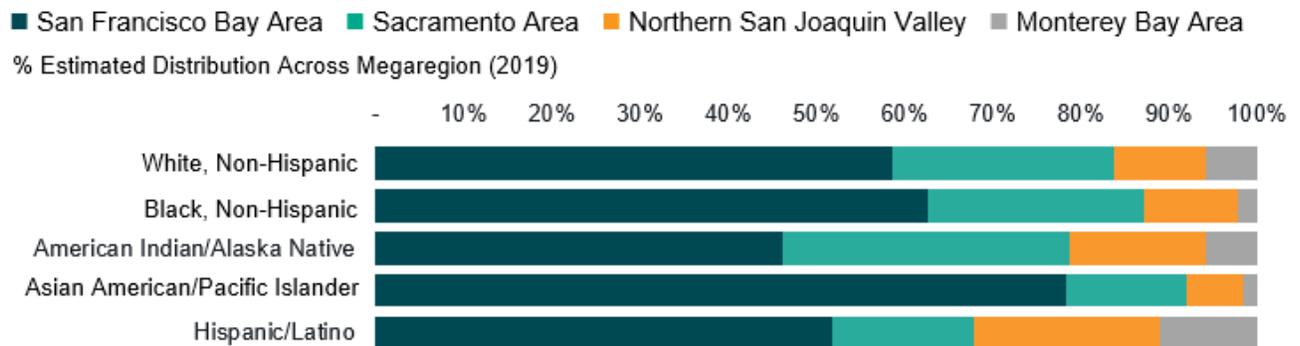


Figure 3-13. Racial/Ethnic Distribution of Megaregion Residents by Geography



Source: PMC analysis of data from the U.S. Census via Woods and Poole

Figure 3-14. Geographic Distribution of Racial/Ethnic Groups



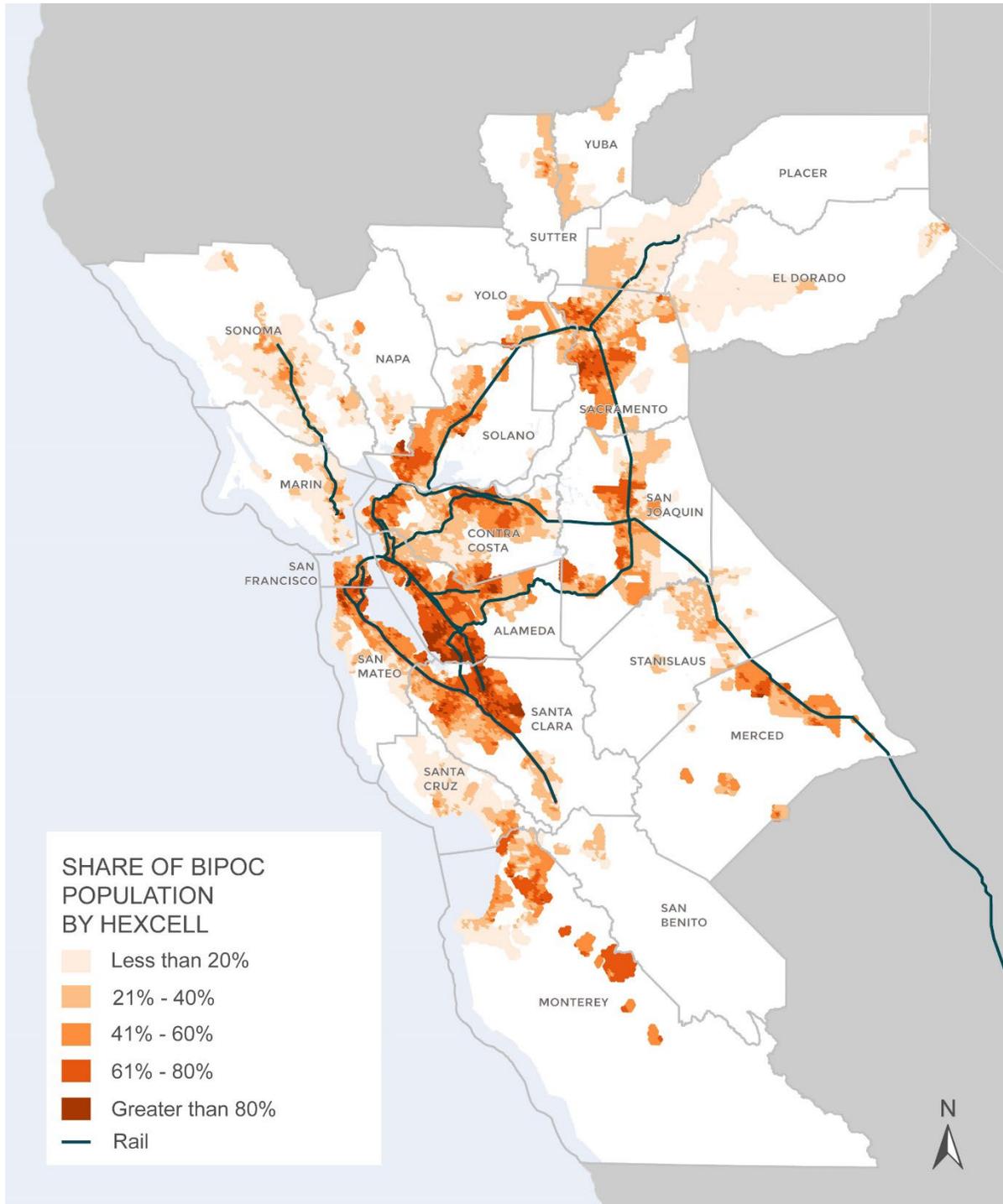
Source: PMC analysis of data from the U.S. Census via Woods and Poole

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Figure 3-15. BIPOC Population Share by Hexcell

Some of the highest concentrations of minority populations are in western and southern San Francisco, the East Bay, northeastern parts of Santa Clara County, southern Sacramento Area, and in the Northern San Joaquin Valley.



Source: PMC analysis of data from the U.S. Census American Community Survey (Table B02001 5-year Estimates 2015-2019)

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Between 1990 and 2019, the number of white, non-Hispanic households is estimated to have declined at a CAGR of 0.3%, as illustrated in **Figure 3-16**. Similar declines were observed in all subregions with the exception of the Sacramento Area where the number of white, non-Hispanic households is estimated to have increased at a CAGR of 0.5% during this period, as shown in **Figure 3-17**.

Meanwhile, the number of BIPOC households across the Megaregion has increased at a CAGR of 2.6% during this period. At CAGRs of 3.4%, the Sacramento Area and Northern San Joaquin Valley observed the highest growth rates in the Megaregion.

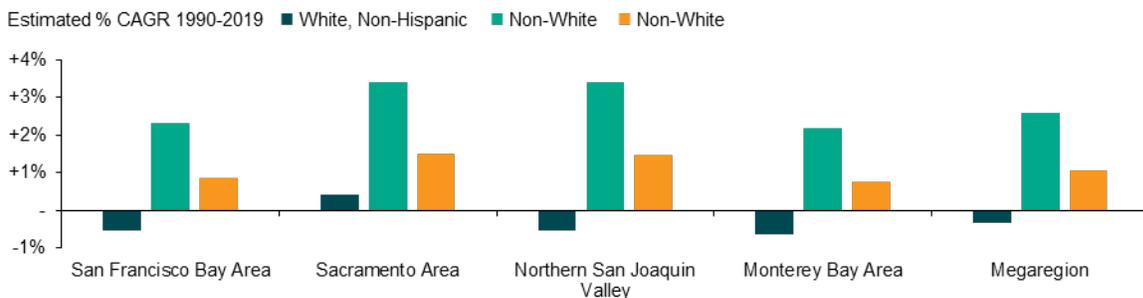
Changes in affordability may be correlated to the changes in the race/ethnic makeup of different parts of the Megaregion. In a travel survey

conducted for Link21,⁶ 23% of survey respondents indicated they moved as a result of increased housing costs, as shown in **Figure 3-18**. In addition, **Figure 3-19** shows that Black, non-Hispanic, and Hispanic/Latino respondents were more likely to state they had moved due to rising housing costs, compared to white, non-Hispanic, and Asian American/Pacific Islander respondents. These trends could increase intercounty travel across the Megaregion as examined further in Chapter 4.

Figure 3-20 shows that across the Megaregion between 2015 and 2019, a higher proportion of Black, non-Hispanic residents earned less than \$30,000/year compared to residents of other races/ethnicities. The lowest proportion was for White, Non-Hispanic and Asian American/Pacific Islander residents.

Figure 3-16. Non-Hispanic White and BIPOC Population Growth by Geography, 1990-2019

The BIPOC population has grown across all areas of the Megaregion – apart from the Sacramento Area – all regions across the Megaregion have experienced a decrease in white population groups.



Source: PMC analysis of data from the U.S. Census via Woods and Poole

⁶ More details on this survey are in Appendix C.



Figure 3-17. Population Growth by Race/Ethnicity and Geography, 1990-2019

Between 1990 and 2019, the Sacramento Area and Northern San Joaquin Valley were the fastest growing regions for BIPOC populations, especially for the Hispanic/Latino population group.

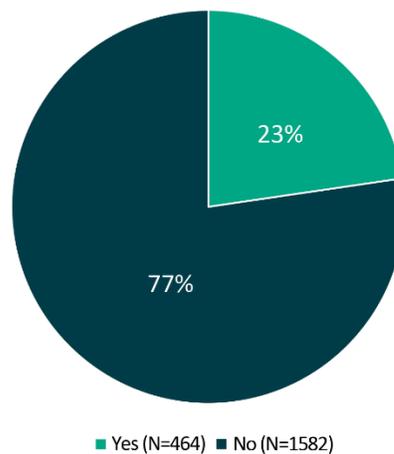
% CAGR 1990-2019	San Francisco Bay Area	Sacramento Area	Northern San Joaquin Valley	Monterey Bay Area	Megaregion
Black, Non-Hispanic	-0.2%	+2.1%	+2.8%	-1.1%	+0.5%
American Indian/Alaska Native	-0.3%	-0.3%	+0.3%	-0.2%	-0.0%
Asian American/Pacific Islander	+3.2%	+4.0%	+2.6%	+1.1%	+3.2%
Hispanic/Latino	+2.4%	+3.7%	+3.8%	+2.6%	+2.9%
All Non-White	+2.3%	+3.4%	+3.4%	+2.2%	+2.6%

Source: PMC analysis of data from the U.S. Census via Woods and Poole

Figure 3-18. Link21 Mobility Survey Question About Moving Due to Housing Costs

According to the Link21 Mobility Survey’s questions on “moving as a result of rising housing costs,” 23% of respondents had moved in the past three years because of increasing cost of housing.

Question: Have you had to move in the past 3 years because of increasing housing costs?



Source: PMC analysis of responses from the Link21 Mobility Survey

Note: The Link21 Mobility Survey is described in Appendix C. It is not statistically valid and should not be taken as representative of the megaregional population.

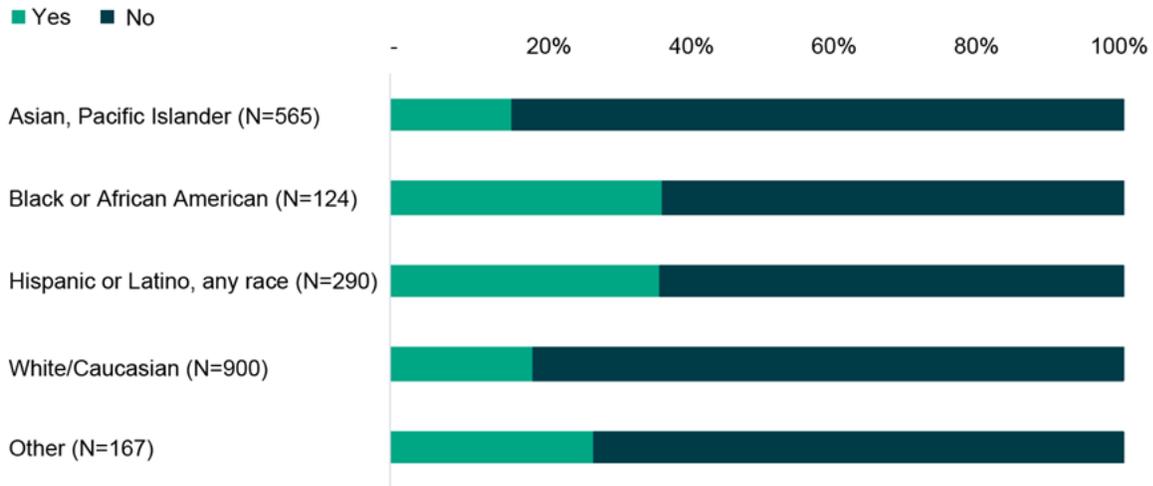
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Figure 3-19. Link21 Mobility Survey Question About Moving Due to Housing Costs by Race/Ethnicity

When the Link21 Mobility Survey’s question on if the respondents had moved in the past three years because of increasing housing costs was broken down by race/ethnicity, a higher proportion of those who responded “Yes” were Black or Latino.

Question 1: Have you had to move in the past 3 years because of increasing housing costs?
Question 2: What is your race or ethnic identification?

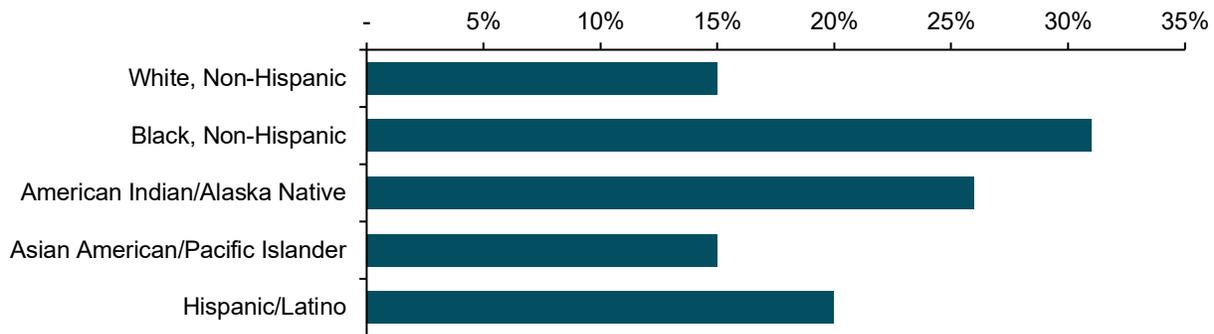


Source: PMC analysis of responses from the Link21 Mobility Survey

Note: The Link21 Mobility Survey is not statistically valid and should not be taken as representative of the megaregional population.

Figure 3-20. Percent of Megaregion Residents Share Earning Less than \$30,000 by Race/Ethnicity

Across the Megaregion between 2015 and 2019, a higher proportion of Black, non-Hispanic residents earned less than \$30,000 a year compared to residents of other races/ethnicities.



Source: PMC analysis of data from the U.S. Census American Community Survey (Tables B19001B-I, 5-year Tables, 2019)

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3.3. Equity and Transportation

As discussed in Sections 3.1 and 3.2, the growth in wealth and prosperity has not been shared equally throughout the Megaregion. Growth in the highest and lowest income brackets has led to increasing income inequality and housing burdens for low-income populations. High housing costs are pushing low-income households, including many BIPOC households, to more peripheral areas in the Megaregion, potentially further away from employment opportunities and areas with more frequent rail service.

For priority populations, the challenges created by this displacement mean that access to transportation is an even more critical issue. Priority populations were already more than twice as likely as general populations to lack access to a personal vehicle.

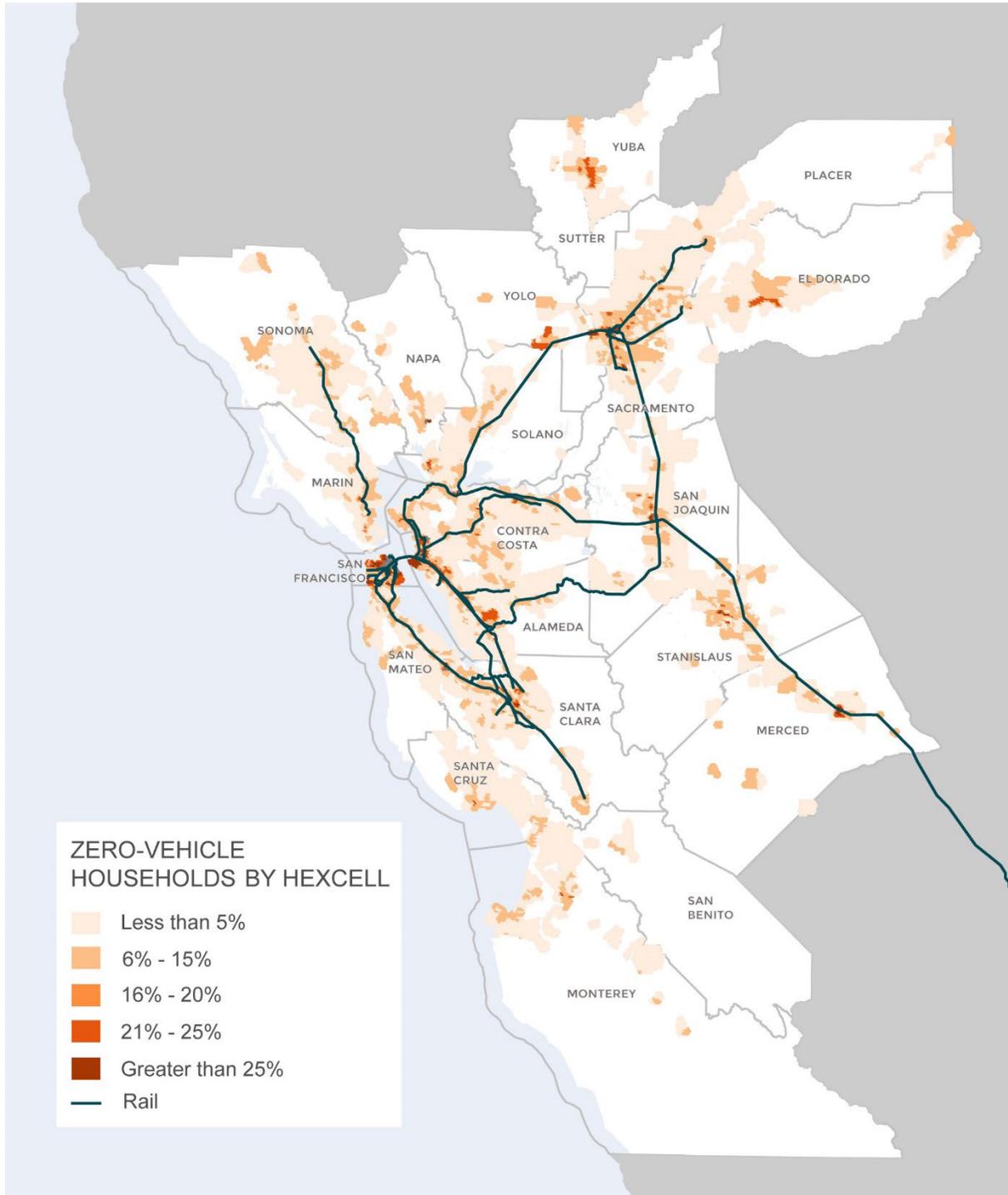
3.3.1. Megaregion Trends

As shown in **Figure 3-21**, the highest proportions of households without a vehicle are concentrated in San Francisco, the East Bay, and other pockets of households along megaregional rail lines. This could reflect a combination of factors including households without means to own a vehicle, as well as those who choose to live without an automobile due to high-quality transit access. However, there are also a number of areas in halo counties far away from rail that show a higher proportion of zero-vehicle households.

Across the Megaregion, an estimated 8% of households do not have access to a vehicle. However, the proportion of priority populations without access to a vehicle is even higher at 12% compared to general populations at 5%. The differences are illustrated by county in **Figure 3-22**.

Figure 3-21. Zero-vehicle Households by Census Tract (2015-2019)

The three primary areas where over 25% of households do not own an automobile are the urban areas of San Francisco, Oakland, and Sacramento (2015-2019).



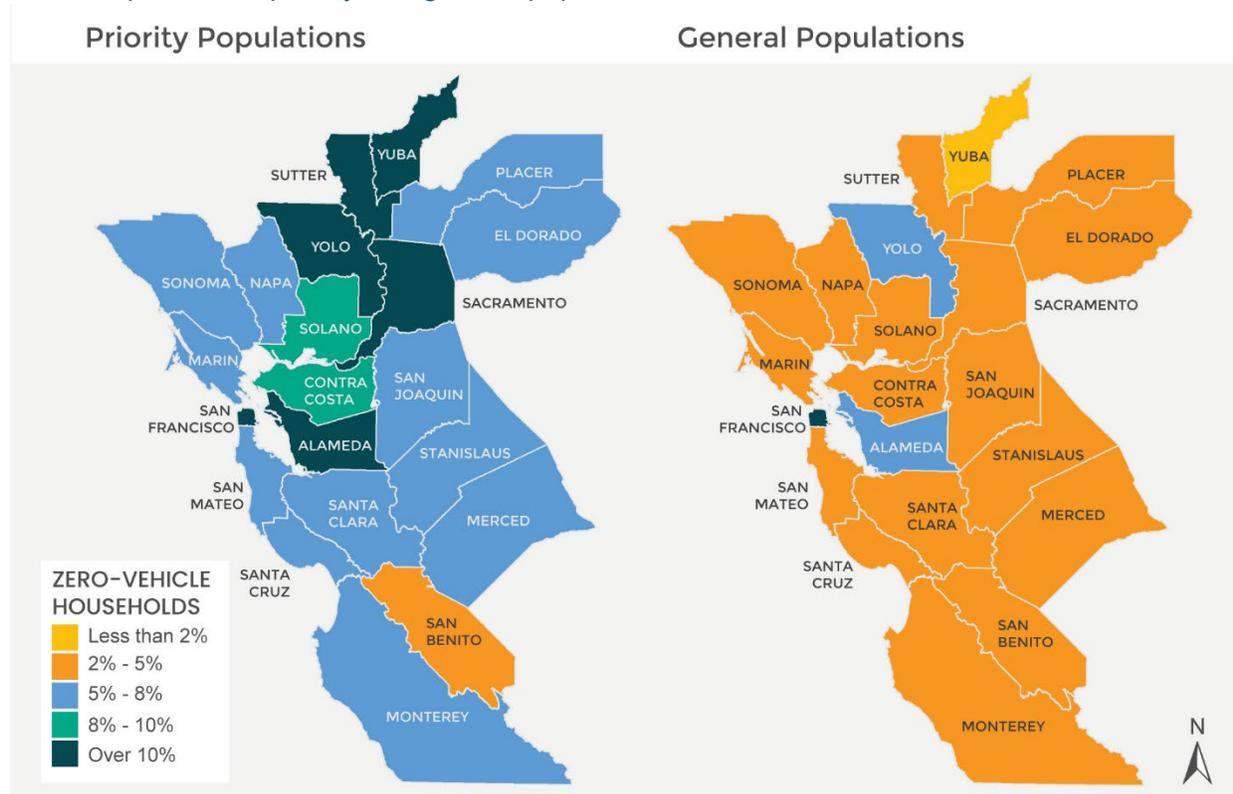
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Source: PMC analysis of data from the U.S. Census American Community Survey (Table S2504 5-year Estimates, 2015-2019)



Figure 3-22. Zero-vehicle Households by Priority and General Populations

In both urban and rural areas, the proportion of households without access to a personal vehicle was higher in priority populations households compared to general population households (2015-2019). San Francisco, Alameda, and Yuba counties have the greatest difference in auto ownership between priority and general populations.



Source: PMC analysis of data from the U.S. Census American Community Survey (Table S2504, Five Year Table, 2019)

Transportation costs account for a significant share of many households' monthly income.

3.3.2. Transportation Cost Burden

Cost burden is measured by HUD as spending 30% or more of the household salary on housing costs. While this is an important indicator of affordability, it does not take into account high transportation costs that may be

associated with living in areas where housing is more affordable.

The Center for Neighborhood Technology's (CNT) Housing and Transportation (H+T[®]) Affordability Index⁷ provides a combined housing and transportation cost burden, and it estimates transportation costs as a percentage of income for the regional typical household at the tract level. The CNT sets a combined threshold for housing and transportation cost burden

⁷ CNT's H+T[®] Affordability Index was provided to the PMC by BART.

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at 45% of income. With a housing affordability threshold of 30%, the assumed transportation affordability for this analysis is 15% of income.

As shown in **Figure 3-23**, the majority of Megaregion tracts had transportation costs that were more than 15% of the household income with 95% of tracts paying an unaffordable amount towards transportation costs. Counties in peripheral areas of the Megaregion were most cost burdened, and 12 counties⁸ had 100% of tracts that were transportation-cost burdened. San

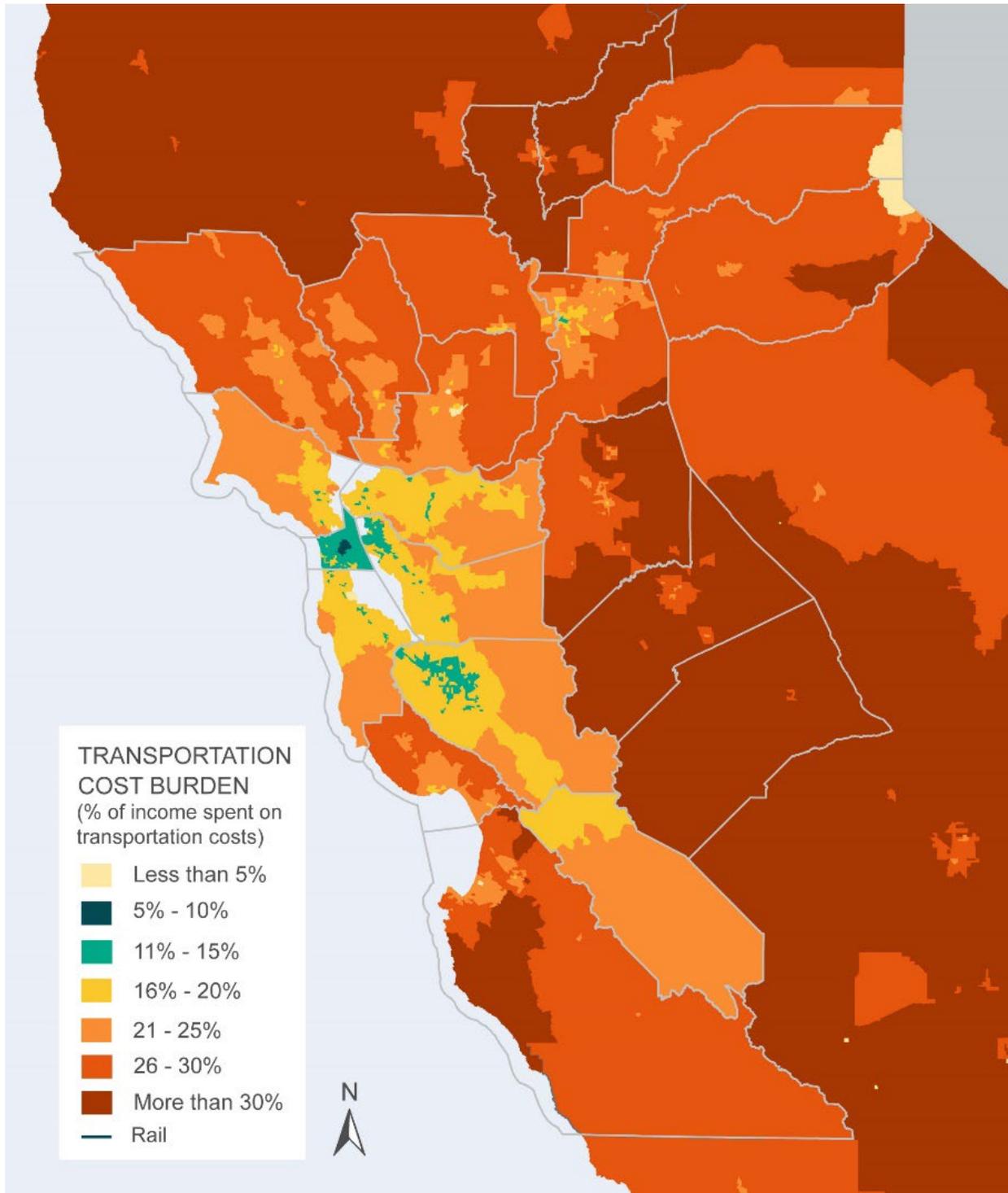
Francisco had the lowest transportation cost burden with 30% of priority populations tracts transportation-cost burdened and 18% of general population tracts transportation-cost burdened.

While the vast majority of the Megaregion is transportation-cost burdened, the contrast between areas with better public transportation options and those without suggests that high quality transit can meaningfully reduce cost burden for households.

⁸ El Dorado, Merced, Napa, Placer, San Benito, San Joaquin, Santa Cruz, Sonoma, Stanislaus, Sutter, Yolo, Yuba



Figure 3-23. Megaregion Transportation Cost Burdens



Source: PMC analysis of CNT'S H+T® Affordability Index data

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Priority populations in parts of the Megaregion are located in close proximity to rail (within 5 miles).

3.3.3. General Population Trends

An estimated 70% of the Megaregion's general population residents live within 5 miles of rail, while 21% live within 1 mile of rail.

3.3.4. Priority Population Trends

As illustrated in **Figure 3-24**, an estimated 32% of priority populations residents live within 1 mile of a rail station, and 74% live within 5 miles of rail. For general populations, 21% live within 1 mile of a rail station, and 70% live within 5 miles of rail. First/last mile-connections, such as walking, cycling, or local bus service connections, are especially important for the 42% of priority populations living between 1 and 5 miles from rail since they are less likely to have access to a vehicle compared to general populations.

For priority populations households already residing within close proximity to rail, Link21 has the potential to deliver benefits by providing improved service

levels and improved connectivity to key destinations. Measures that mitigate or reduce the potential for displacement of priority populations as a result of rail improvements will be important to ensuring Link21 benefits reach those households.

For priority populations located further from stations, access will be a key issue, especially for households without vehicle access. This is particularly true in more rural parts (e.g., Monterey County) of the Megaregion that may have fewer transit options to connect riders from their homes to stations.

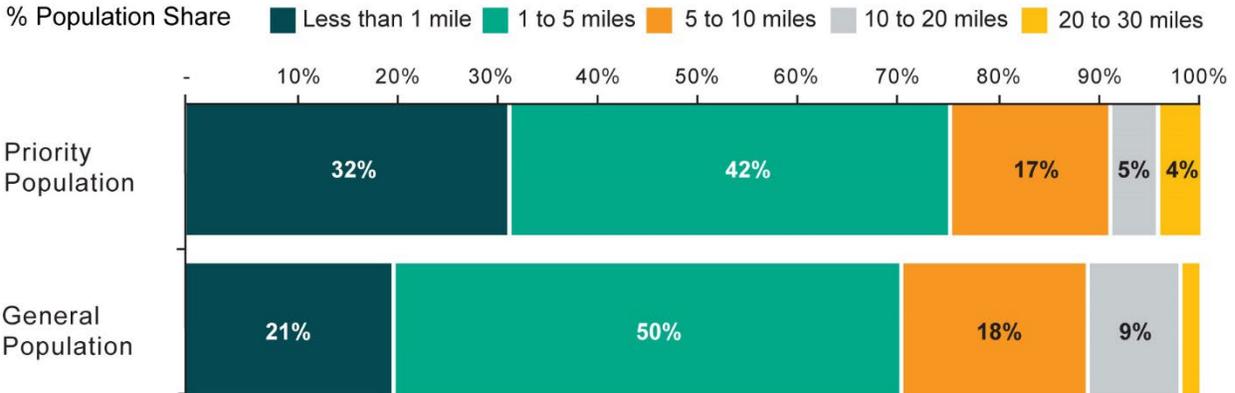
KEY TAKEAWAYS

- Areas within a reasonable walking, cycling, or local bus distance to rail will benefit more from improvements to rail service.
- More priority populations (32%) live within 1 mile of a rail station than general populations (21%), aligning with a greater dependence or reliance on rail for the former.



Figure 3-24. Priority and General Populations' Proximity to a Rail Station

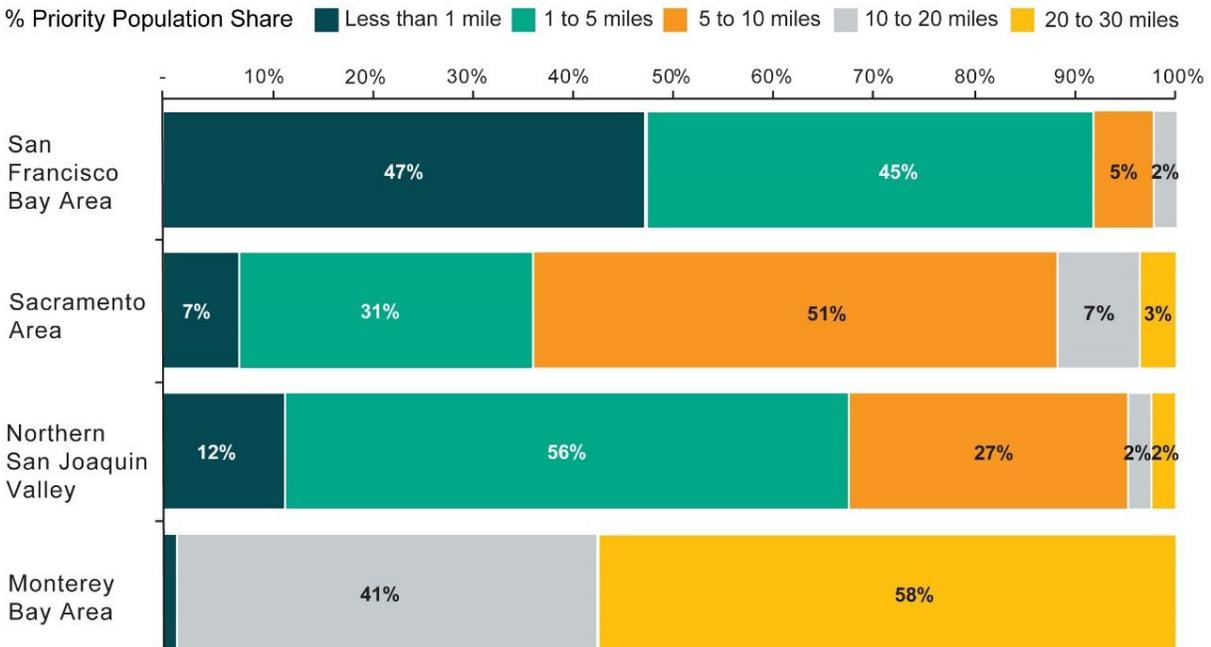
A higher proportion of priority populations live less than 1 mile from a rail station than general populations.



Source: PMC analysis of California Department of Finance and American Community Survey data

Figure 3-25. Priority Populations' Proximity to a Rail Station by Megaregional Area

Geographic proximity of priority populations to rail varies widely within the Megaregion. In the Bay Area, 47% of the population live within 1 mile from a rail station, and in the halo counties, priority populations tend to live further away, especially in the Monterey Bay Area.



Source: PMC analysis of California Department of Finance and American Community Survey data

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3.4. Market Segmentation for Priority Populations

While the preceding sections have provided comparisons between priority and general populations, **it is important to understand that these population groups are not homogenous**. This section applies the market segmentation (Section 2.3) to priority populations to provide a deeper understanding of the range of users and households that comprise this group.

These groups comprise many types of people with varying needs and motivations associated with the way they travel and their propensity to use transit.

Market segments that overlap geographically with priority populations show a higher propensity to be lower income, and they are more likely to work in blue collar jobs. Some already take transit, but those in more rural areas are not as likely to use it. Vehicle ownership is low in a few of these segments, indicating that transit access is even more important for accessing daily needs. In more rural areas of the Megaregion, the compounded impact of lower average auto ownership and low transit access identifies a concern specific to those priority populations.

The five priority populations market segments, described in **Figure 3-26**, provide considerations for planners and decision-makers when working to identify how Link21 can benefit priority populations, including:

- Priority populations in urban and rural areas will have different needs and priorities.
- Vehicle access is a common issue, underlining the need to focus on those who rely on transit.
- Zero-vehicle riders or residents with lower access to a vehicle also use transit for daily needs, not just commuting.

Some priority populations segments are more likely to work in blue collar jobs and/or jobs not requiring a degree, which has implications for job location and working hours and hence transportation needs.

When looking at Link21 benefits like newly accessible jobs by transit, it will be important to analyze a breakdown of jobs to make sure they include a range of job types for different types of skills and levels/types of education and with a range of wages. Expanding access to living-wage jobs for priority populations will be important for advancing equity, but it will not be as simple as connecting priority populations home destinations to living-wage job centers.



Figure 3-26. Top Market Segments for Priority Populations

LOW-INCOME TRANSIT RIDERS	BLUE COLLAR SUBURBAN FAMILIES	NON-URBAN MID-LIFE SINGLETONS	YOUNG STARTERS	LOWER INCOME RURAL RETIREES
<ul style="list-style-type: none"> ▫ More likely to take transit and less likely to own a car ▫ Low-income, less likely to have a degree; likely to be employed in a blue collar job ▫ More likely to be Hispanic/Latino or Black 	<ul style="list-style-type: none"> ▫ Members of this segment are very likely to be Hispanic/Latino; reside in families with younger children ▫ Lower household incomes; less likely to have a degree; likely to work in blue collar jobs ▫ Likely to commute by auto because they live in suburban areas 	<ul style="list-style-type: none"> ▫ Middle aged singles without kids ▫ Car ownership is low, and transit usage is low as well due to living in the suburbs 	<ul style="list-style-type: none"> ▫ Young singles without kids, likely to be white ▫ Lower incomes, likely to be a student or have a blue collar job ▫ Less likely to own an automobile and higher than average transit use 	<ul style="list-style-type: none"> ▫ Retired couples in rural areas ▫ Low income ▫ Low rates of public transit usage due to rural location but also only average rates of auto ownership

Source: PMC analysis of data from Experian Mosaic

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3.5. Summary

The benefits of strong economic growth in the Megaregion have not been shared equally.

The historic growth in the highest and lowest income brackets and the racial/ethnic demographic changes of different subregions demonstrate the impacts of economic and racial inequity in the Megaregion. Housing unaffordability serves as a push factor out of urban areas that disproportionately affects Black and Hispanic/Latino residents, and it is tied to racial disparities in wealth.

The increasing cost of housing in the Megaregion disproportionately impacts lower income households as illustrated in **Figure 3-27**, where 84% of

households making less than \$35,000 per annum are cost burdened, whereas 16%, a significantly smaller share, of households making over \$75,000 are considered cost burdened.

Access to transit is critical to Megaregion residents, particularly for the 12% of priority populations residents who do not have access to a vehicle in their household. High transportation costs are an additional burden on low-income and cost-burdened households. Having access to more affordable, high quality transit has the potential to improve livability by allowing households to reduce transportation costs and improve access to affordable housing and living-wage jobs.

Figure 3-27. Percentage of Cost Burdened Households

The lower the household income, the higher the proportion of cost burdened households.



Source: PMC analysis of data from the American Community Survey (Table B25106, 1-Year Table, 2019)

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Future transportation projects, including under Link21, have the opportunity to advance equity by providing direct benefits to priority populations.

Link21 aims to advance equity, and to do so it must consider conditions as they are today and identify how rail can realistically influence equitable outcomes.

The Government Alliance on Race and Equity (GARE) found that it is likely that projects not actively managing equity impacts will exacerbate inequity further. Link21 should actively identify opportunities to improve livability and provide equitable outcomes for people living in the Megaregion's priority populations, while mitigating program impacts that will likely exacerbate existing inequity.

As summarized in Section 3.3, because some priority populations are already located in proximity (less than 5 miles) to rail, there is an opportunity for priority populations to share in the benefits from service and connectivity improvements that a megaregional rail program, such as Link21, will deliver. However, in order for the program to deliver benefits to priority populations in proximity to existing stations, it will be important to consider how any program-associated displacement can be avoided or mitigated and what fare policy would enable these populations to ride.

When targeting Link21 benefits for priority populations, it is important to acknowledge that priority populations are not a homogeneous group and are made up of users with a range of needs and priorities. The Link21 market segments can preliminarily provide more insight on the needs of different users. For priority populations, these segments underscore the importance of transit for users without vehicle access, highlight the need for different approaches to urban and non-urban priority populations, and reinforce the need to review new access to jobs by job type. For later phases of program development, priority populations will be reviewed and amended to capture equity needs with these considerations.



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4. MEGAREGIONAL TRAVEL

The following chapter provides an overview of the current state of travel across the Megaregion and identifies key opportunities for Link21 to address various travel challenges by adding rail capacity and improving the rail passenger experience.

Growing demand for travel across the Megaregion, driven by sustained population and employment growth, has led to a number of travel-related challenges:

- Based on analysis of StreetLight OD data, trips have been heavily concentrated in certain geographies:
 - Over two-thirds of megaregional trips in 2015 took place in the Bay Area.
 - Over 70% of trips crossing the bay used the two crossings in the Transbay Corridor.
- Capacity of existing infrastructure cannot keep up with growing demand on key links. In particular, peak-period demand for both Transbay Corridor crossings has exceeded capacity since 2015, leading to crowded trains and congested highways.
- Other elements of the travel experience have suffered, including long travel times for rail passengers compared to auto users, an inaccessible rail network for a large share of trips, and uncoordinated transfers between infrequent rail services.



4.1. Existing Travel Demand

Chapter 2 identified the uneven distribution of historical population and employment growth across the Megaregion, specifically San Francisco and San Mateo counties' disproportionately high proportion of the Megaregion's employment growth compared to population growth.

Given that Link21 will include a new transbay passenger rail crossing between Oakland and San Francisco, this section examines travel demand across the Megaregion and in the Transbay Corridor, which is directly impacted by these uneven distribution patterns. This travel demand is analyzed in terms of trips made by auto, rail, and other non-rail public transit between pairs of unique traffic analysis zones (TAZ), as defined in regional travel demand models. Trips made on foot or by bicycle, as well as trips taking place entirely within the same TAZ, are not covered in this section.⁹ Trips are aggregated to eight summary regions for the purpose of description and visualization in Chapters 4 and 6 only:

1. San Francisco (City and County)
2. San Mateo County
3. East Bay: Alameda, Contra Costa, and Solano counties

4. South Bay: Santa Clara County
5. North Bay: Marin, Napa, and Sonoma counties
6. Sacramento Area: El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba counties
7. Northern San Joaquin Valley: Merced, San Joaquin, and Stanislaus counties
8. Monterey Bay Area: Monterey, San Benito, and Santa Cruz counties

Most of the Megaregion's travel demand is concentrated in the Bay Area.

4.1.1. Megaregion Overview

As illustrated in **Figure 4-1**, in 2015 travelers within the Megaregion made a combined total of 32.2 million trips on an average weekday. Of these trips, 3.0 million (9%) were made between regions and 19.9 million (62%) took place within the Bay Area.

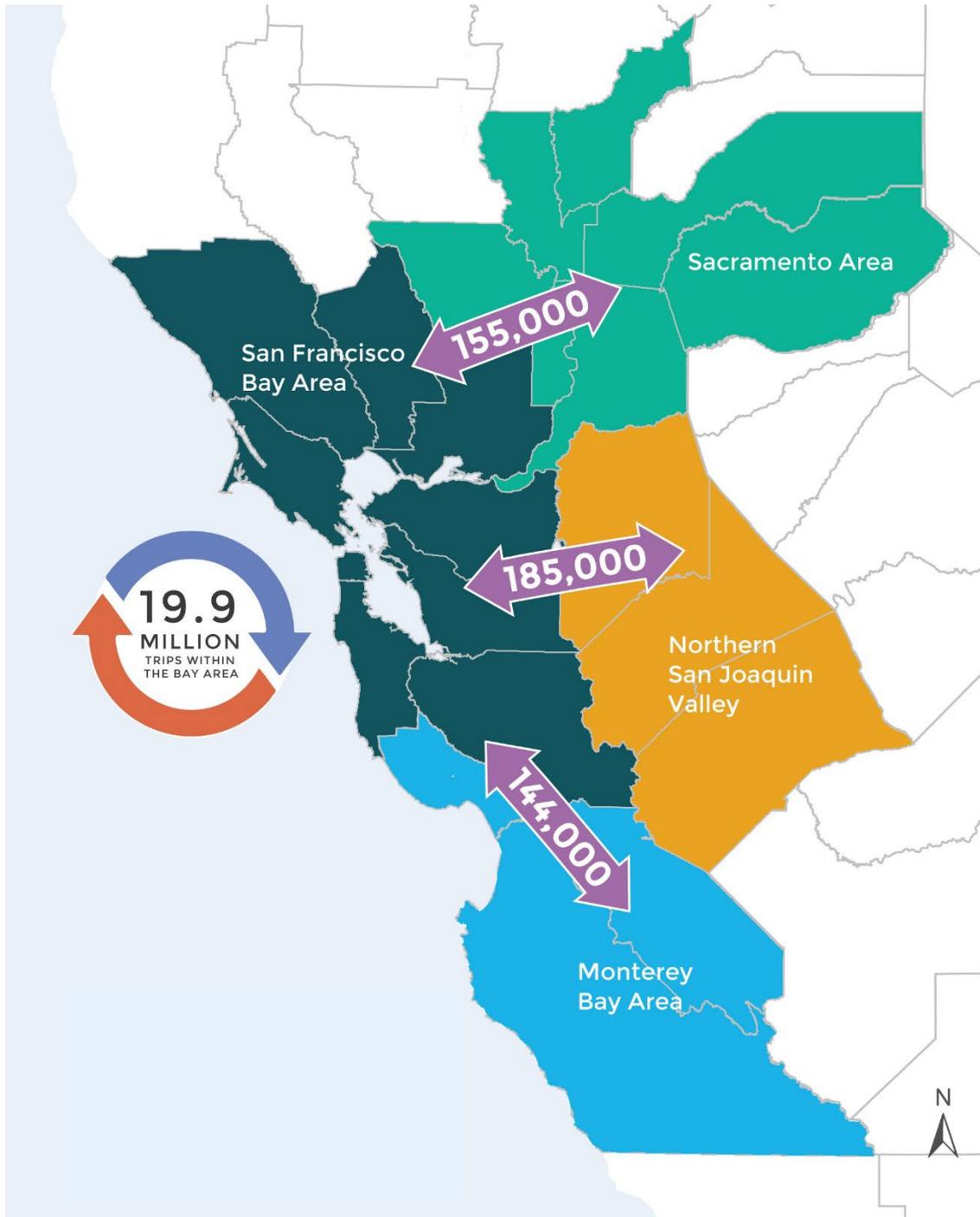
Table 4-1 details the distribution of average weekday trips by origin and destination. The largest flows were found within and between the East Bay, San Francisco, San Mateo County, and Santa Clara County. These regions accounted for 55% of all trips and 69% of interregional trips in 2015.

⁹ More details on the methodology used to analyze current travel patterns are provided in Appendix D.



Figure 4-1. Trips within the Megaregion (2015)

Almost two-thirds of all trips in the Megaregion in 2015 were made within the Bay Area.



Source: PMC analysis of StreetLight and other travel pattern data

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Table 4-1. Average Weekday Megaregional Trips (Thousands) 2015, Both Directions

The majority of interregional trips in the Megaregion in 2015 (2.1 million, which is equivalent to a 69% share) involved travel between the East Bay, San Francisco, San Mateo County, and Santa Clara County.

ORIGIN	DESTINATION							
	EAST BAY	SAN FRANCISCO	SAN MATEO COUNTY	SANTA CLARA COUNTY	NORTH BAY	SACRAMENTO AREA	MONTEREY BAY AREA	NORTHERN SAN JOAQUIN VALLEY
EAST BAY	7,069							
SAN FRANCISCO	440	2,177						
SAN MATEO COUNTY	235	541	1,647					
SANTA CLARA COUNTY	399	67	414	4,790				
NORTH BAY	201	106	21	7	1,760			
SACRAMENTO AREA	123	8	5	7	12	7,202		
MONTEREY BAY AREA	11	3	8	121	1	1	1,949	
NORTHERN SAN JOAQUIN VALLEY	136	6	10	29	4	100	6	2,622

Source: PMC analysis of StreetLight and other travel pattern data

Note: Region pairs with higher trip volumes have darker shading in the above and subsequent tables; intraregional pairs (e.g., San Francisco – San Francisco) are not shaded.

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Figure 4-2 details the mode share of megaregional trips in 2015. Over 95% of daily trips were made by auto. The share of auto trips drops slightly during the morning (AM) and afternoon (PM) peak periods¹⁰ to 94%. Of the non-auto trips, only 28% of daily trips and 27% of peak trips were made by rail (consisting of heavy/regional rail and subway/metro services, such as BART and Muni Metro subway), with the remainder made by some other form of transit (bus, ferry, or street-running light rail).

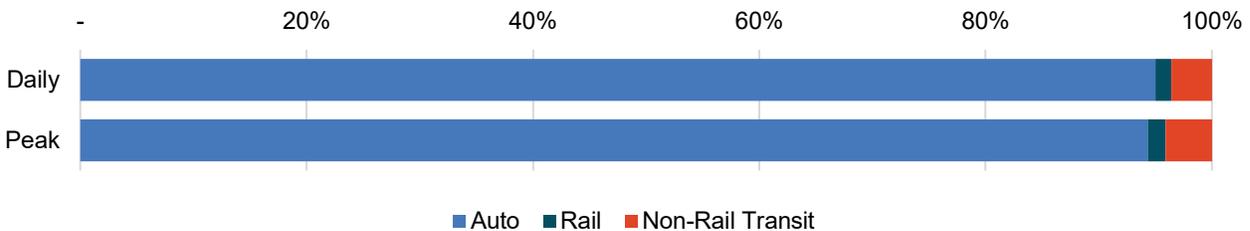
In addition, **Table 4-2** highlights region pairs with high shares of rail trips in 2015 that correspond to the geographic extent of megaregional rail service. The

Transbay Corridor between the East Bay and San Francisco had the highest rail share at just over 45% across an entire day, rising to over 50% during the peak periods. This aligns with the core market of the BART system.

Figure 4-3 provides a breakdown of the megaregional trips by trip purpose in 2015. Work and school trips combined made up just under 40% of daily trips, with other trips (e.g., leisure, shopping, personal business) making up the remaining 60%. During the AM and PM peak periods, there is an approximate 4% point shift away from other trips in favor of work and school trips compared to the entire day.

Figure 4-2. Percent of Megaregional Average Weekday Mode Shares (2015)

In 2015, auto was the dominant mode of travel across the Megaregion at all times of day. Rail trips only accounted for a small share of non-auto trips (approximately 25%).



Source: PMC analysis of StreetLight and other travel pattern data

¹⁰ The AM peak period is defined as 6 am to 10 am, and the PM peak period is defined as 3 pm to 7 pm.



Table 4-2. Percent of Megaregional Average Weekday Rail Mode Shares by Region Pair, Both Directions (2015)

On an average weekday, almost half of all San Francisco-East Bay trips, which comprise the majority of trips in the Transbay Corridor, were made by rail.

ORIGIN	DESTINATION							
	EAST BAY	SAN FRANCISCO	SAN MATEO COUNTY	SANTA CLARA COUNTY	NORTH BAY	SACRAMENTO AREA	MONTEREY BAY AREA	NORTHERN SAN JOAQUIN VALLEY
EAST BAY	1.0%							
SAN FRANCISCO	46.3%	1.4%						
SAN MATEO COUNTY	6.9%	11.9%	0.6%					
SANTA CLARA COUNTY	0.4%	26.8%	2.8%	0.1%				
NORTH BAY	0.6%	1.0%	0.7%	0.0%	0.0%			
SACRAMENTO AREA	1.6%	7.6%	0.9%	1.0%	0.2%	0.1%		
MONTEREY BAY AREA	0.2%	1.1%	0.2%	0.2%	0.0%	0.0%	0.0%	
NORTHERN SAN JOAQUIN VALLEY	0.8%	23.7%	0.7%	0.3%	0.0%	0.0%	0.0%	0.0%

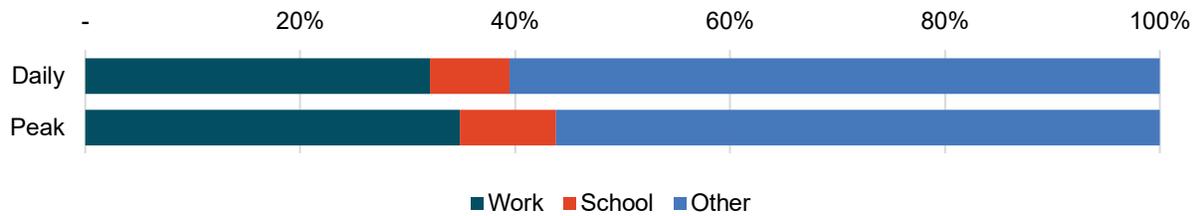
Source: PMC analysis of StreetLight and other travel pattern data

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Figure 4-3. Percent of Megaregional Average Weekday Trip Purpose Shares (2015)

Work and school trips combined accounted for just under 40% of daily trips and just under 45% of peak period trips in 2015.



Source: PMC analysis of StreetLight and other travel pattern data

4.1.2. Bay Crossing Focus

Approximately 675,000 trips on an average weekday in 2015 involved crossing the bay using one of four auto or rail crossings:

1. Bay Bridge
2. Transbay Tube
3. San Mateo–Hayward Bridge
4. Dumbarton Bridge

Figure 4-4 illustrates the major trip flows in the Megaregion that cross the bay using one of the four crossings listed.

In the East Bay, Alameda, Contra Costa, and Solano counties were the primary origin or destination, accounting for over 95% of trip ends. On the western side of the bay, a majority of trips started or ended in San Francisco (63% of trip

ends), followed by San Mateo County (33% of trip ends).

Of these East Bay to San Francisco and San Mateo County trips, over 73% traveled in the Transbay Corridor, defined as the Bay Bridge (39%) and Transbay Tube (34%), which are the only crossing routes into San Francisco from most of the East Bay that do not involve a significant detour. Most of the remaining 27% of trips were heading to or from San Mateo County and used the San Mateo–Hayward Bridge, which is over 15 miles south of the Bay Bridge.

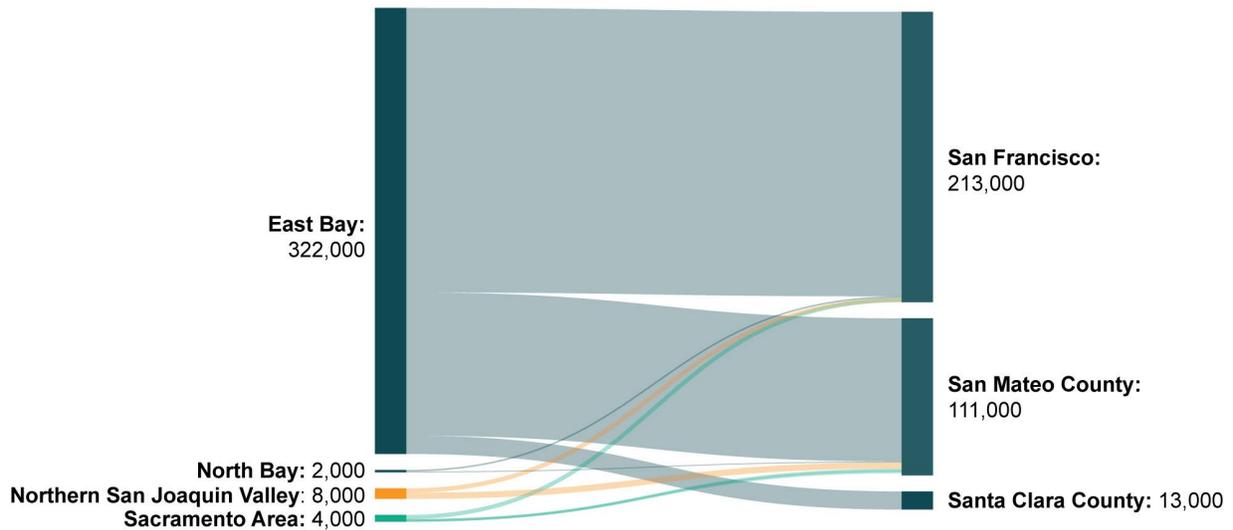
Beyond the East Bay, the Sacramento Area and Northern San Joaquin Valley had approximately 4,700 and 7,000 daily trips, respectively, to or from San Francisco and San Mateo counties.

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Figure 4-4. Average Weekday Bay Crossing Roundtrips (2015)

San Francisco – East Bay is the dominant market for trips crossing the bay.



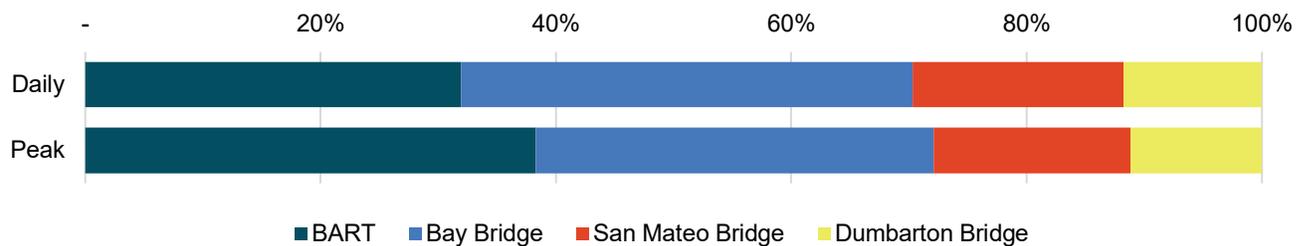
Source: PMC analysis of StreetLight and other travel pattern data

Figure 4-5 illustrates the distribution of daily and peak period trips traversing the bay by crossing in 2015, which largely mirrors the distribution of East Bay to San Francisco and San Mateo County trips described previously. The Transbay Corridor accounted for 70% of trips crossing the bay throughout the day, increasing to 72% during the peak

period. In particular, BART accounted for 32% of daily trips and 38% of peak period transbay trips, suggesting that it caters slightly more to work and school trips that cross the bay. Meanwhile, the Bay Bridge was the most heavily traveled auto crossing, followed by the San Mateo–Hayward and Dumbarton bridges, respectively.

Figure 4-5. Percent of Daily and Peak Period Bay Crossing Trips (2015)

Over 70% of 2015 daily and peak period trips crossing the bay used the two transbay crossings reflecting the large share of trips between the East Bay and San Francisco.



Source: PMC analysis of StreetLight and other travel pattern data

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Figure 4-6 illustrates the varied travel markets served by each of the four bay crossings as of 2015. As discussed previously, the Transbay Corridor crossings were geographically positioned to serve the majority of trips between San Francisco and the inner East Bay (comprising northern Alameda and western Contra Costa counties), which are the largest sources of demand on their respective sides of the bay. Given their location at the northern end of the bay, the Bay Bridge and BART were also located to serve a large share of bay crossing trips involving northern San Mateo County (north of San

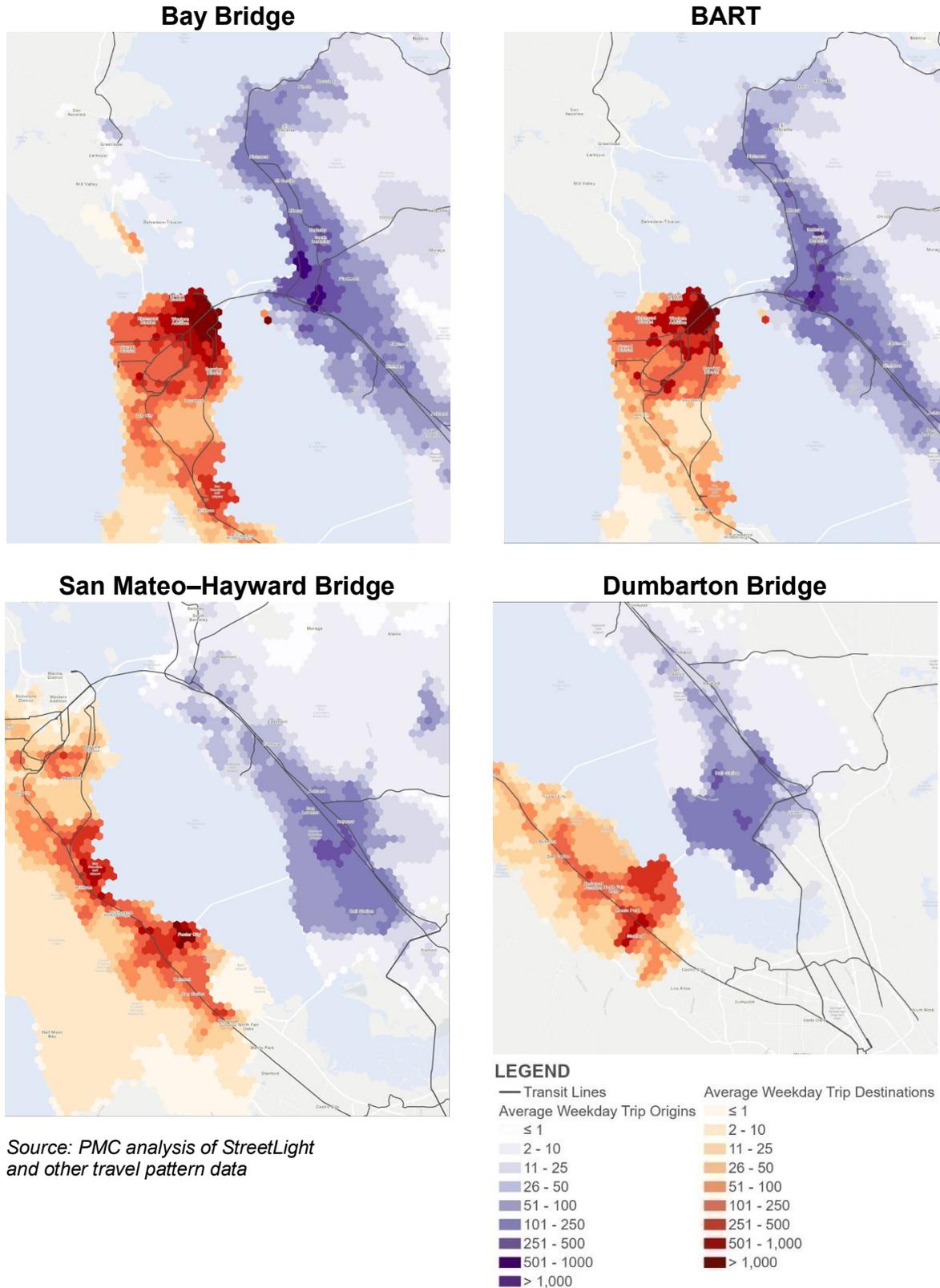
Francisco International Airport [SFO]) and/or the North Bay, Sacramento Region, and Northern San Joaquin Valley.

On the other hand, the San Mateo-Hayward and Dumbarton bridges catered to smaller and more local markets. Again, this may be at least partially attributed to geography. The crossings are more closely spaced at the southern end of the bay, and trips between points south of the Dumbarton Bridge typically use routes that skirt the bay's southern edge rather than cross it at all.



Figure 4-6. OD Volume of Westbound Bay Crossing Trips by Crossing (2015)

The Bay Bridge and BART crossings serve the largest bay crossing markets in terms of volume and geographic area.



Source: PMC analysis of StreetLight and other travel pattern data

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4.1.3. Transbay Corridor Focus

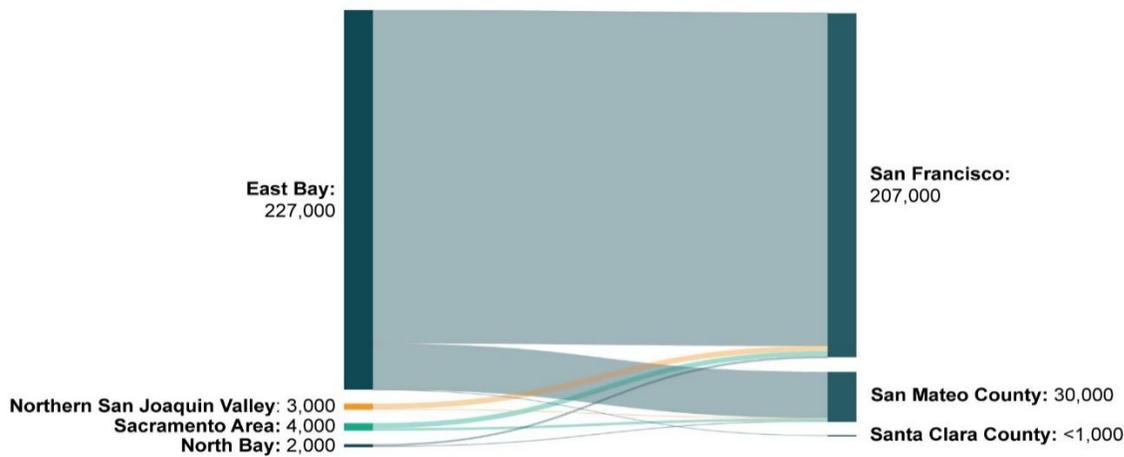
As discussed in the previous subsections, the Transbay Corridor accounted for over 70% of daily trips crossing the bay in 2015.

Travel in the Transbay Corridor is dominated by East Bay to San Francisco trips and vice versa.

Figure 4-7 illustrates that almost 85% of average weekday transbay roundtrips (197,000 out of 237,000) are made between these two regions. Beyond this core market, East Bay-San Mateo County accounts for 12% of average weekday trips with the remaining markets each accounting for less than 1.5%.

Figure 4-7. Average Weekday Transbay Roundtrips 2015

San Francisco-East Bay is the dominant market for trips using the Transbay Corridor.



Source: PMC analysis of StreetLight and other travel pattern data

Figure 4-8 displays by region pair the share of trips crossing the bay made by BART. It shows that BART’s highest mode share was in the busy East Bay-San Francisco market at 49% of daily trips and 56% of peak period trips. It also commands a 23% share of the Northern San Joaquin Valley to/from San Francisco trips and 9% of the Sacramento Area to/from San Francisco trips (increasing to 39% and 16%, respectively, during the peak period). These trips likely involve a transfer between a partner rail operator and BART (e.g., the Capitol Corridor-BART transfer at Richmond serves travelers between the Sacramento Area and San Francisco).

KEY TAKEAWAYS

In 2015, most interregional travel within the Megaregion took place between San Francisco, San Mateo County, Santa Clara County, and the East Bay.

Trips between the East Bay and San Francisco accounted for the largest share of trips crossing the bay.

The Transbay Corridor served over 70% of daily bay crossing trips, largely attributable to the high volume of East Bay-San Francisco trips.



Figure 4-8. BART Mode Share by Bay Crossing Region Pairs (2015)

In 2015, BART’s highest mode share was in the East Bay-San Francisco market at almost 50% throughout the day and just over 55% during the peak period.

Average Weekdays

ORIGIN	DESTINATION	
	SAN FRANCISCO	SAN MATEO COUNTY
EAST BAY	49.0%	4.3%
NORTHERN SAN JOAQUIN VALLEY	23.0%	0.9%
SACRAMENTO AREA	8.5%	1.7%
NORTH BAY	3.7%	N/A

Average Peak Hours

ORIGIN	DESTINATION	
	SAN FRANCISCO	SAN MATEO COUNTY
EAST BAY	56.4%	4.7%
NORTHERN SAN JOAQUIN VALLEY	38.6%	2.9%
SACRAMENTO AREA	15.8%	3.6%
NORTH BAY	6.2%	N/A

Source: PMC analysis of StreetLight and other travel pattern data

Demand for rail travel in the Megaregion has grown steadily in the last nine years since 2010.

4.1.4. Megaregion Overview

Figure 4-9 illustrates the growth in megaregional rail ridership between 2010 and 2019 for five interregional services: BART, Capitol Corridor, Caltrain, Altamont Corridor Express (ACE), and San Joaquins. While year-to-year growth trends varied by service, all five recorded at least 10% total growth between 2010 and 2019, which reflects the Megaregion’s sustained population and employment growth during that period.

ACE and Caltrain observed the largest ridership growth over the past decade with ACE ridership more than doubling. Along with Capitol Corridor, these three

operations increased their services during that period to meet consistent year-over-year growth.

Also illustrated in Figure 4-9, between 2013 and 2019 regional rail services in the Northern San Joaquin Valley, specifically ACE and the San Joaquins, recorded absolute growth in annual ridership of 370,000 and 470,000, respectively, the highest of the analyzed transit agencies. This partly reflects the population growth in the Northern San Joaquin Valley.

TRANSBAY CORRIDOR FOCUS

In the Transbay Corridor, BART ridership grew fairly consistently between 2010 and 2016 before dropping slightly between 2017 and 2019. This peak and subsequent decline could be attributed to changing distributions of

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population and employment throughout the Megaregion (as discussed in Section 2.2), increasingly crowded trains, and/or other factors affecting the competitiveness of BART against other travel modes. That said, BART still carries a dominant majority of megaregional rail trips: 118 million out of 123 million in 2019. Between 2011 and 2019, as illustrated in **Figure 4-10**, westbound transbay peak hour volumes have increased at a CAGR of 2.9% from over 17,700 passengers/hour in the peak AM direction (westbound) in 2011 to over 24,400 in 2019.

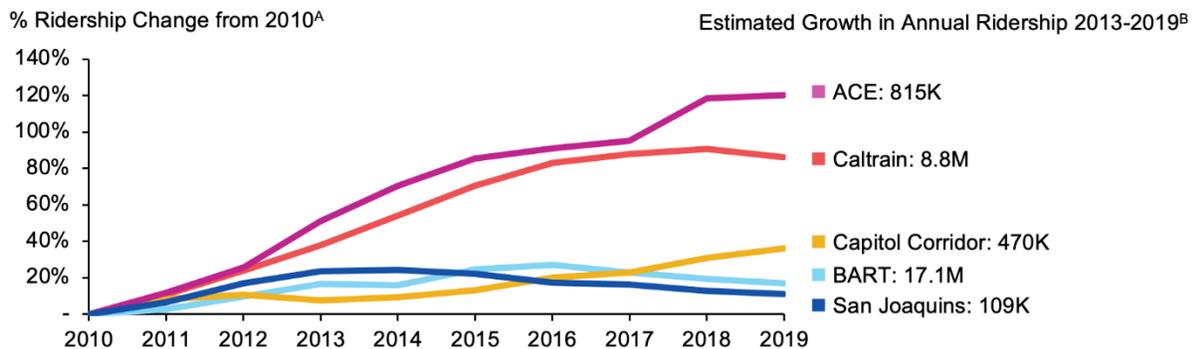
KEY TAKEAWAYS

Ridership grew across all megaregional rail services over the past decade, including an approximate doubling of ACE and Caltrain ridership.

In the Transbay Corridor, while BART has observed more modest ridership growth percentage-wise and even a slight decline between 2017 and 2019, it still carries a large majority of megaregional rail demand.

Figure 4-9. Megaregional Rail Ridership Growth Between 2010 and 2019

Interregional rail operators in the Megaregion have seen consistent ridership growth over the past decade.



Source: PMC analysis of rail operator and FTA data

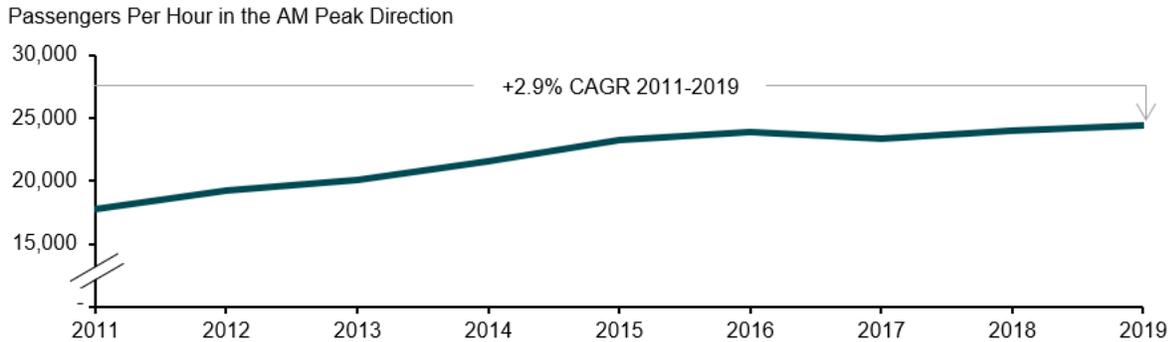
^A Ridership for all agencies is annual except for Caltrain, which is based on average weekday due to data availability.

^B Absolute growth figures are between 2013 and 2019 due to data availability (Caltrain data was only available from 2013).

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**Figure 4-10. Transbay Tube Passengers Per Hour in the AM Peak Direction (2011-2019)**

Peak hour volumes have steadily increased in the Transbay Tube.



Source: PMC analysis of BART data

A large share of megaregional trips start or end in locations that are inaccessible by rail.

Figure 4-11 illustrates the starting locations of megaregional trips in relation to rail stations. Only 30% of trips in 2015 started within 1 mile of a rail station (corresponds to a reasonable walking distance), whereas 73% of trips started within 5 miles of a rail station (corresponds to a reasonable auto access distance).

The inaccessibility of rail stations is particularly noticeable in areas of the Megaregion that are associated with high trip volumes, such as western San Francisco, parts of Santa Clara County, most of the Monterey Bay Area, and most of the Sacramento Area. The long access distance to a rail station from these areas likely means that most travelers chose to drive or, in some cases, use other forms of public transit to make their trip.

Among the high-travel areas listed above, non-rail transit is most widely available in western San Francisco,

northern Santa Clara County, and metropolitan Sacramento, and it can be a viable alternative to rail for shorter urban and intraregional trips. As regular long-distance, interregional bus service within the Megaregion is rare and rail remains the primary means of non-driving interregional travel, poor access to rail stations is likely a major barrier to rail travel to/from these areas.

KEY TAKEAWAYS

Only 30% of megaregional trips in 2015 originated within 1 mile (a reasonable walk access distance) of a rail station.

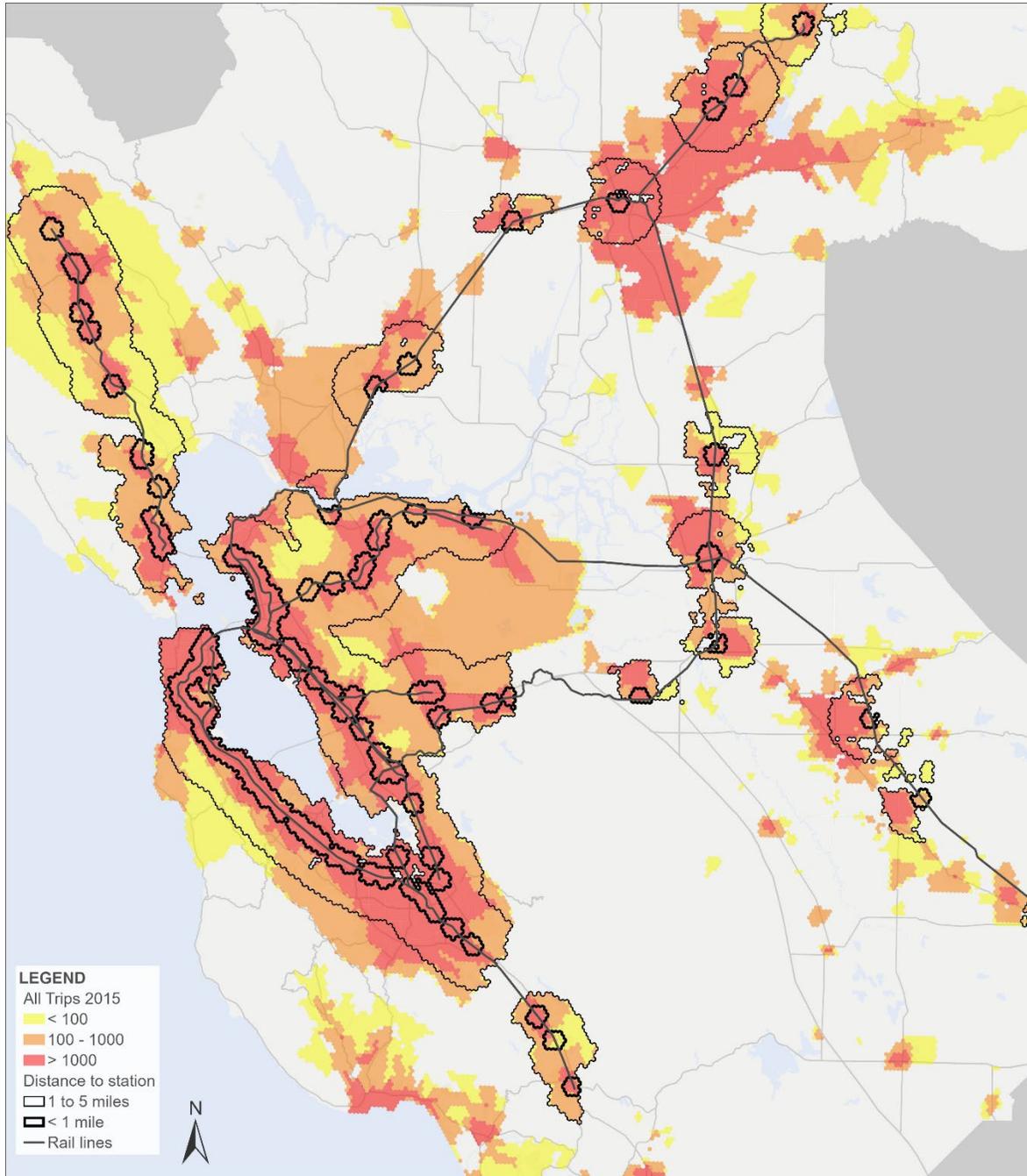
Seventy-three percent of trips originated within 5 miles (a reasonable drive access distance) of a rail station.

The inaccessibility of rail stations, particularly by foot, combined with limited parking supply at rail stations, likely serves as a deterrent to rail usage.



Figure 4-11. Average Weekday Trip Origins by Distance from Nearest Rail Station (2015)

Only 30% of megaregional trips in 2015 started within a 1-mile walking distance from a rail station.



Source: PMC analysis of StreetLight and other travel pattern data

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4.2. Existing Infrastructure and Capacity in the Megaregion

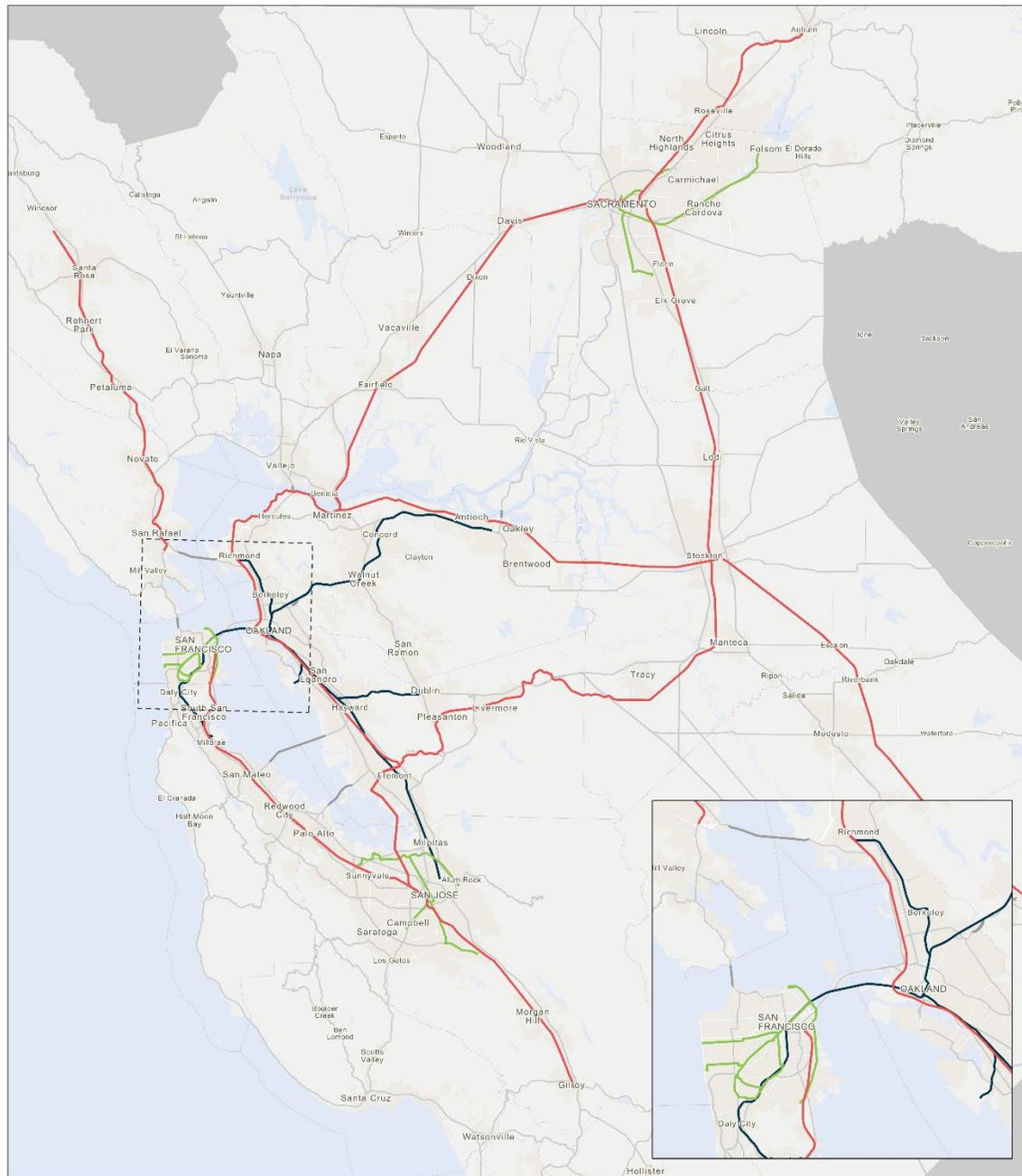
This section introduces key existing infrastructure and rail services within the Megaregion and compares their capacity against the growing demand for travel described in Section 4.1.

4.2.1. Overview of Key Megaregional Infrastructure and Rail Service

Figure 4-12 provides an overview of key existing infrastructure and rail service within the Megaregion. Summary descriptions of the existing transbay, other regional and local infrastructure, and rail services can be found in the following subsections.



Figure 4-12. Overview of Key Existing Megaregional Infrastructure and Rail Service



LEGEND

Layer

- BART
- Other Megaregional Rail
- Other Local Rail
- Other Megaregional bridges and tunnels
- Other Highways



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TRANSBAY CORRIDOR INFRASTRUCTURE



Source: MTC

Bay Bridge

The Bay Bridge connects San Francisco and Oakland, carrying five lanes of Interstate 80 (I-80) in each direction, equivalent to an approximate capacity of 10,000 vehicles/direction/hour.

With an average of 265,000 vehicle trips/day in both directions in 2019 (17,800/peak hour), the Bay Bridge is by far the busiest vehicle crossing of the bay, reflecting its central location at the core of the Bay Area and Megaregion.

The Bay Bridge also serves several bus routes from various transit operators across the Megaregion, primarily AC Transit.

Given the high demand for travel, the bridge and freeway approaches on both ends (I-80, I-580, and I-880 in the East Bay and U.S. 101 in the West Bay) frequently experience heavy congestion at all times of day.



Source: BART

BART

BART provides hybrid suburban-metro rail service in the Bay Area counties of San Francisco, San Mateo, Alameda, Contra Costa, and Santa Clara.

Four transbay lines serve the system's core from Daly City through downtown San Francisco, across the bay via the Transbay Tube and diverge at the Oakland Wye near downtown Oakland to serve different parts of the East Bay and Santa Clara County with termini at Richmond, Antioch, Dublin/Pleasanton, and Berryessa/North San Jose. A fifth line runs exclusively in the East Bay between Richmond and Berryessa.

Under normal conditions, each line operates at base 15-minute headways throughout the service day with



additional trains where necessary during peak periods and less frequent service on weekends.¹¹

In total, the Transbay Tube accommodates as many as 23 scheduled peak hour trains/direction, providing a total capacity of 26,450 passengers/direction (assuming a planning capacity of 115 passengers/car and 10 cars/train).

Connections to Capitol Corridor are available at Richmond and Oakland Coliseum stations, to ACE via a bus transfer at West Dublin/Pleasanton, to Caltrain at Millbrae, and to San Joaquins at Richmond.

In its fiscal year ending April 2019, BART served more than 410,000 riders/day on average with more than half (227,000) crossing the bay via the Transbay Tube. This high demand has resulted in trains crowded well beyond an average 115 passengers/car, particularly during peak periods in the peak direction of travel.

OTHER MEGAREGIONAL INFRASTRUCTURE – RAIL SERVICES



Source: CCJPA

Capitol Corridor

Capitol Corridor provides all-day Regional Rail service between San Jose, Oakland, and Sacramento, as well as markets in between such as Fairfield and Davis. Fifteen roundtrips/weekday operate between Sacramento and the Oakland-Jack London Station with seven of these round trips continuing south to San Jose and one round trip continuing past Sacramento to Auburn.

Average journey times are 1 hour and 50-55 minutes between Sacramento and Oakland and 1 hour and 15-25 minutes between Oakland and San Jose.

Each train has a capacity of 366 seated passengers. Capitol Corridor served a total of 1.8 million trips during the 2019 fiscal year, making it the fourth busiest Amtrak route nationwide.

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¹¹ Before March 2020 (pre-pandemic)



Source: Caltrain

Caltrain

Caltrain is a single-line heavy rail service connecting San Francisco, the Peninsula, and Santa Clara County/Silicon Valley.

It operates three main service types: local stopping at all stations, limited stopping at fewer stations, and Baby Bullet stopping at select major stations.

Travel times between San Francisco and San Jose range from approximately 66 to 100 minutes depending on the service. There are 104 trains/weekday that currently run between San Francisco and San Jose with a varying mix of service types and stopping patterns, while up to three peak period services (AM northbound, PM southbound) travel past San Jose to Gilroy.

In 2019, Caltrain served an average of 63,500 riders/day. Per train planning capacity varies depending on train length and configuration. Five-car gallery trains average 612 seats, while six-car bi-level trains average 771 seats.



Source: San Joaquin Regional Rail Commission (SJRRC)

Altamont Corridor Express

ACE serves commuters traveling between Stockton and Lathrop in the Northern San Joaquin Valley, the Tri-Valley communities of Livermore and Pleasanton, southern Alameda County (Fremont), and Silicon Valley (Santa Clara County and San Jose).

Four roundtrips, each with a capacity of 804 passengers, operate each weekday (westbound in the AM peak and eastbound in the PM peak) and make the trip from Stockton to San Jose in just under 2 hours and 15 minutes.

ACE recorded an average daily ridership of approximately 5,900 in 2018.



Source: Amtrak

San Joaquins

The San Joaquins connect the Bay Area, Sacramento Region, and Northern San Joaquin Valley with five roundtrips per day between Oakland and Merced (via Martinez and Stockton) and two per day between Sacramento and Merced (via Stockton). Service continues south past Merced to Bakersfield.

Travel times are one hour and 20 minutes between Merced and Stockton, 1 hour and 50 minutes between Stockton and Oakland, and 1 hour and 20 minutes between Stockton and Sacramento.

The San Joaquins served over one million riders in its 2019 fiscal year, although a large share of that ridership occurred outside the Megaregion. Its trains have a planning capacity of 460 passengers.

OTHER MEGAREGIONAL INFRASTRUCTURE – HIGHWAYS, BRIDGES, AND TUNNELS



Source: MTC

Richmond-San Rafael Bridge

The Richmond-San Rafael Bridge carries five lanes of I-580 — two westbound and two or three eastbound depending on the time of day (equivalent to an approximate capacity of 4,000-6,000 vehicles/hour/direction) — over the bay, connecting northern Alameda and Contra Costa counties with Marin County.

In 2019, the bridge served a combined average of 76,400 vehicle trips/day in both directions and 6,600 vehicles/hour during the peak period.



Source: Golden Gate Bridge Highway and Transportation District

Golden Gate Bridge

The six-lane Golden Gate Bridge links San Francisco with Marin County, as well as points further north in Sonoma and Napa counties.

This joint segment of U.S. 101 and State Route (SR) 1 saw an average of 117,000 vehicle trips/day in both directions in 2019 and 10,000 vehicles during the peak hour. It has an approximate capacity of 6,000 vehicles/hour/direction.



Source: MTC

San Mateo-Hayward Bridge

The six-lane San Mateo-Hayward Bridge forms part of SR-92 and extends from Foster City to Hayward. More broadly, it links two major north-south freeway corridors on either side of San Francisco Bay: U.S. 101 in the west and I-880 in the east.

Its six lanes (three in each direction) provide a vehicle capacity of approximately 6,000/hour/direction. In 2019, it served a combined average of 120,000 vehicle trips/day in both directions and 9,000/peak hour.



Source: MTC

Dumbarton Bridge

The Dumbarton Bridge is the southernmost bridge spanning the bay. It carries six lanes of SR-84 between Menlo Park and Fremont, which is equivalent to a capacity of 6,000 vehicles/hour/direction.

It provides another connection between U.S. 101 and I-880, and it serves as a key route between Silicon Valley and points east and northeast. The bridge carried an average of 74,000 vehicles/day in both directions in 2019 and 7,500 vehicles/peak hour.



Source: MTC

Carquinez Bridge

The Carquinez Bridge is part of I-80, crossing the Carquinez Strait and straddling the border between Contra Costa and Solano counties.

It is eight lanes wide and has a capacity of approximately 8,000 vehicles/hour/direction.

It forms part of the primary route between the Bay Area and Sacramento Region. In 2019, it served 125,000 vehicle trips/day in both directions on average and 9,100 vehicles/peak hour.



Source: MTC

Benicia-Martinez Bridge

The Benicia-Martinez Bridge provides an alternate route between Contra Costa and Solano counties to the east of the Carquinez Bridge, carrying nine lanes of I-680 (four southbound and five northbound) and providing a capacity up to 8,000-10,000 vehicles/hour/direction.

An average of 63,000 vehicles/day used the bridge in both directions in 2019 and 5,200 vehicles/peak hour. An adjacent rail bridge also serves Capitol Corridor on its route between the Bay Area and Sacramento.



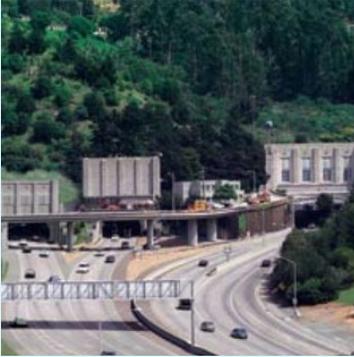
Source: MTC

Antioch Bridge

The Antioch Bridge is a two-lane bridge carrying SR-160 between Contra Costa and Sacramento counties.

In 2019, it carried 18,000 vehicle trips per day in both directions on average and 1,800 vehicles per peak hour. It has an approximate vehicle capacity of 2,000 per hour per direction.

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Source: MTC

Caldecott Tunnel

The four-bore, eight-lane Caldecott Tunnel is part of SR-24, the primary connection between central Alameda and Contra Costa counties.

In 2019, the tunnel served a combined average of 169,200 vehicle trips/day in both directions, which is 12,900 vehicles/peak hour. It has an approximate vehicle capacity of 8,000/hour/direction.



Source: SF Gate

I-80

I-80 travels east from downtown San Francisco across the Bay Bridge to Emeryville/Oakland before turning northeast and passing through Berkeley, Richmond, Hercules, Vallejo (via the Carquinez Bridge), Fairfield, Davis, and Sacramento.

The Bay Bridge, a key part of the Transbay Corridor, and its eastern and western approaches are five lanes wide, and I-80 maintains that width for much of its span in the East Bay. The Bay Bridge is the busiest stretch of I-80 and served an average of 265,000 vehicle trips/day in both directions in 2019 (17,800/peak hour).



Source: East Bay Times

I-580

I-580 is a spur of I-80, running between San Rafael and Tracy. In between, it serves major communities, such as Richmond, Oakland, San Leandro, Dublin/Pleasanton, and Livermore. It travels along the Richmond–San Rafael Bridge, runs concurrently with I-80 in Berkeley, and meets the eastern end of the Bay Bridge in Emeryville.



At its busiest point between Pleasanton and Livermore, I-580 served an average of 236,700 vehicle trips/day per direction, which corresponds to 19,700 trips/peak hour, in 2019.



Source: SF Gate

I-880

I-880 is another spur of I-80, connecting Oakland and San Jose via Hayward and Fremont. Its northern terminus is the eastern end of the Bay Bridge in Emeryville/Oakland.

At its busiest point in Hayward, I-880 served an average of 290,000 vehicle trips/day per direction, which corresponds to 24,600 trips/peak hour, in 2019.



Source: MTC

U.S. 101

U.S. 101 is the primary freeway in the West Bay, running between San Francisco and San Jose before continuing south through the Monterey Bay Area. In San Francisco, it intersects the western terminus of I-80, 3 miles west of the Bay Bridge's western end. As such, it forms a key part of the Bay Bridge's western approach in San Francisco. North of San Francisco, it travels across the Golden Gate Bridge into Marin and Sonoma counties before exiting the Megaregion.

In 2019, the continuous stretch of U.S. 101 between Mountain View and San Francisco saw an average of over 200,000 vehicles/day in each direction in 2019, and the busiest stretch, in San Mateo County just south of SFO, served 272,000 trips/day and 17,900 trips/peak hour.

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OTHER LOCAL RAIL SERVICES



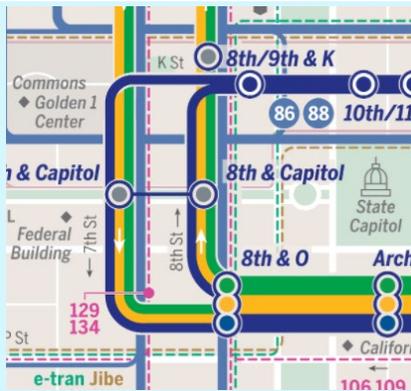
Source: SFMTA

Muni Metro

Muni Metro, operated by the San Francisco Municipal Transportation Agency (SFMTA), serves the City of San Francisco with six lines.

It connects with Caltrain at the 4th and King Street Station and with BART at several shared stations in downtown San Francisco as well as elsewhere in the city.

With an average weekday ridership of 173,500 in 2019, it is the nation's second busiest light rail system.



Source: Sacramento Regional Transit District

Sacramento Regional Transit Light Rail

Sacramento Regional Transit is a three-line light rail system operated by the Sacramento Regional Transit District that links downtown Sacramento with suburbs to the northeast, east, and southeast.

It connects with Capitol Corridor and San Joaquins rail services at the main Sacramento Valley Station.

In 2019, it served an average of 36,000 riders/weekday.



Source: SJRRC

Santa Clara Valley Transportation Authority Light Rail

The Santa Clara Valley Transportation Authority (VTA) operates three light rail lines in San Jose and the Silicon Valley suburbs of Santa Clara County.

Connections to megaregional rail services are available in San Jose (Caltrain, ACE, and Capitol Corridor), Mountain View (Caltrain), and Berryessa (BART).

The system served 8.33 million riders in 2019, an average of 26,700/weekday.

There is insufficient capacity to accommodate growing travel demand across the Megaregion, particularly in the Transbay Corridor.

4.2.2. Megaregion Overview

In 2015, 32.2 million trips were made on an average weekday across the Megaregion. Despite the extensive network of rail services and highway infrastructure, it is insufficient to serve this growing demand for travel, and rail users encounter crowded trains during peak periods while auto users experience congestion.

Figure 4-13 illustrates the top 10 most delayed highway corridors in the Megaregion in 2017 based on MTC Vital Signs vehicle hours of delay data. It shows that high-delay corridors are scattered throughout the Megaregion.

The corridors with the highest delays were centered on the Bay Bridge (the bridge itself), as well as multiple

approach highways on both ends, including I-80 westbound in Berkeley, I-80 eastbound in San Francisco, and I-580 westbound in Oakland.

Furthermore, both approaches to the San Mateo-Hayward Bridge experienced high vehicle delay, reflecting the high volume of trips and limited highway capacity crossing the bay.

According to MTC's TM 1.5, approximately 90% of auto trips that require a bridge crossing in the Bay Area have only one logical crossing point leaving travelers with no viable alternative, particularly in cases of severe congestion. In particular, as the only bridge connecting the high-population and employment areas of the East Bay and San Francisco, **the Bay Bridge was the most congested link in the network** with demand surpassing capacity by about 10% in the AM peak period.

Figure 4-13. Top Ten Congested Highway Delays

Table 4-3. Top Ten Congested Highway Rankings

RANK	CORRIDOR
1	Eastbound U.S. 101 and I-80: San Francisco to Treasure Island (includes western span of the Bay Bridge)
2	Westbound I-80: Hercules to Treasure Island (includes eastern span of the Bay Bridge)
3	Southbound U.S. 101: Sunnydale to San Jose
4	Northbound I-680: Fremont to Sunol
5	Eastbound SR-4: Martinez to Concord
6	Eastbound I-80: Emeryville (Bay Bridge eastern end toll plaza) to Albany
7	Southbound I-880: West Oakland to East Oakland
8	Southbound I-280: Cupertino to San Jose
9	Eastbound SR-24: Oakland to Orinda (includes Caldecott Tunnel)
10	Northbound I-680: Danville to Walnut Creek

Source: PMC analysis of data from MTC Vital Signs



Figure 4-14 illustrates the ratio of rail passenger demand to capacity observed during the peak hour across the Megaregion in 2019. It shows that rail services throughout San Francisco, San Mateo, and Alameda counties operated close to or above capacity during the morning peak hour. As a result, trains were frequently crowded, negatively impacting the overall passenger experience.

Demand exceeded available planning capacity in the Transbay Tube and the westbound segments leading up to it beginning at the Fruitvale and MacArthur stations. Analogous to the Bay Bridge, BART is the only rail service connecting the East Bay to San Francisco and San Mateo counties, which contributes to especially high demand for travel through the Transbay Tube and correspondingly crowded trains.

Beyond BART, northbound Caltrain services also operated at close to 100% capacity for most of the San Jose to San

Francisco corridor, particularly through San Mateo and northern Santa Clara counties. Southbound Capitol Corridor services experienced their highest crowding levels, nearly reaching 75% of capacity leading up to Richmond, which serves as one of two main transfer locations for passengers traveling from the North Bay and Sacramento Region to San Francisco and the Peninsula. Again, Caltrain and Capitol Corridor are the only rail services operating within their respective corridors,¹² leaving passengers with little choice other than to board crowded trains during peak periods.

Figure 4-15 illustrates a BART train-car at 100% of its planning capacity of 115 passengers. In 2019, the average AM peak train through the Transbay Tube exceeded this capacity by 8%, as shown in Figure 4-14. Crowding on trains is exacerbated when there is a system delay, and there is spill over onto the platforms at heavily used stations if the delay is significant.

¹² The San Joaquins run alongside the Capitol Corridor for a short segment between Martinez and Richmond.

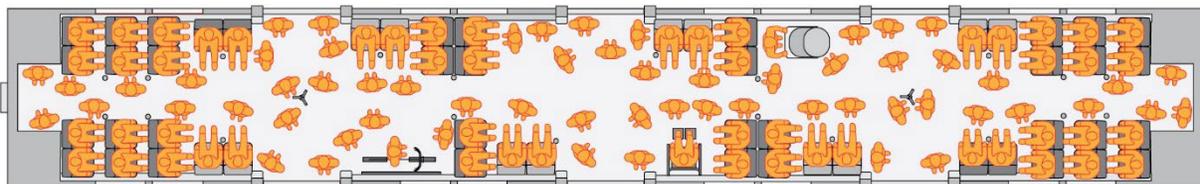
Figure 4-14. Rail Peak Hour Crowding Levels

The Transbay Tube experiences passenger loads over 108% of capacity in the AM peak hour.¹³



Source: PMC analysis of 2019 data from BART, CCJPA, San Mateo County Transit District, and SJRRC

Figure 4-15. Typical Conditions During Peak Hours of a Standing Room Only Transbay Train Car with Minimal Room for Movement



Note: Figure is for illustrative purposes only using the Next Generation Class E cars.

¹³ AM peak hour refers to 8-9 am. The map shows demand-to-capacity ratio on segments heading toward downtown San Francisco, and it uses planning capacity values provided by each operator.



4.2.3. Transbay Corridor Focus

In recent years, demand for travel in the Transbay Corridor has grown beyond the combined capacity of the two main crossings. As a result, during peak hours the Bay Bridge and its approaches, including freeways and local streets, on both ends of the bay are congested, and BART trains operate over planning capacity.

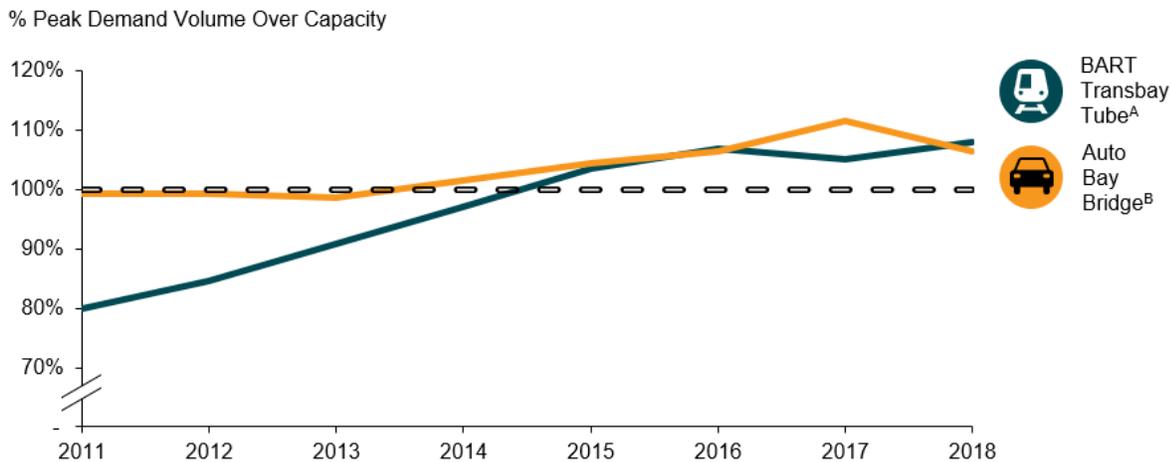
Figure 4-16 illustrates historical westbound BART and Bay Bridge volume-to-capacity ratios during the average weekday AM peak hour. After 2011, auto demand on the Bay Bridge was consistently near capacity until 2014 when demand surpassed the peak

hour planned capacity of 9,250 vehicles/hour, ultimately surging to over 110% of its capacity in 2017. Meanwhile, BART experienced steady growth in the volume-to-capacity ratio (increased crowding on trains) over the first half of the past decade, surpassing 100% in 2015 and reaching a peak of 108% in 2018.¹⁴

The relatively static capacity of both facilities, at least in the short term, coupled with the growing demand for transbay travel and the lack of alternative crossings, suggests that both transbay crossings will continue to struggle to adequately serve the entirety of pre-COVID-19 demand.

Figure 4-16. Percent Peak Demand Volume Over Capacity

Both transbay crossings have been operating above their planned capacities since 2015.



Source: PMC analysis of BART peak loadings and Caltrans traffic census program

^A BART capacity assumed to be 25,300 passengers/hour/direction.

^B Bay Bridge historical capacity assumed to be at 9,250 vehicles/hour/direction. This capacity subsequently increased to 10,000 vehicles/hour/direction in 2021 with the implementation of all-electronic tolling.

¹⁴ The capacity values used in this and following subsections refer to planning/planned capacities, which are set to allow a facility to operate at some minimum level of service. It is physically possible for demand to exceed planning capacity, albeit with a significant degradation of service levels (i.e., more crowded trains or increased congestion leading to longer travel times).



In addition to crowded trains, demand for parking at BART stations exceeds available supply. The 2015 BART Station Profile Study showed that 46% of BART passengers drove alone or carpooled to their origin station. This high share of auto access to BART stations has put a strain on their parking facilities.

Figure 4-17 compares parking usage at BART parking facilities in January 2015 and January 2019. On a typical weekday in 2015, by 9 am 79% of parking facilities (26 out of 33) reached maximum occupancy; this share increased to 89% (32 out of 36) by 2019. Parking demand increased with facilities filling up quicker despite capacity improvements with three additional parking facilities built between 2015 and 2019.

Parking facilities in the East Bay, particularly at stations in Oakland and along the Antioch-SFO/Millbrae Line along SR-24 were particularly busy with several filling up before 8 or 9 am.

KEY TAKEAWAYS

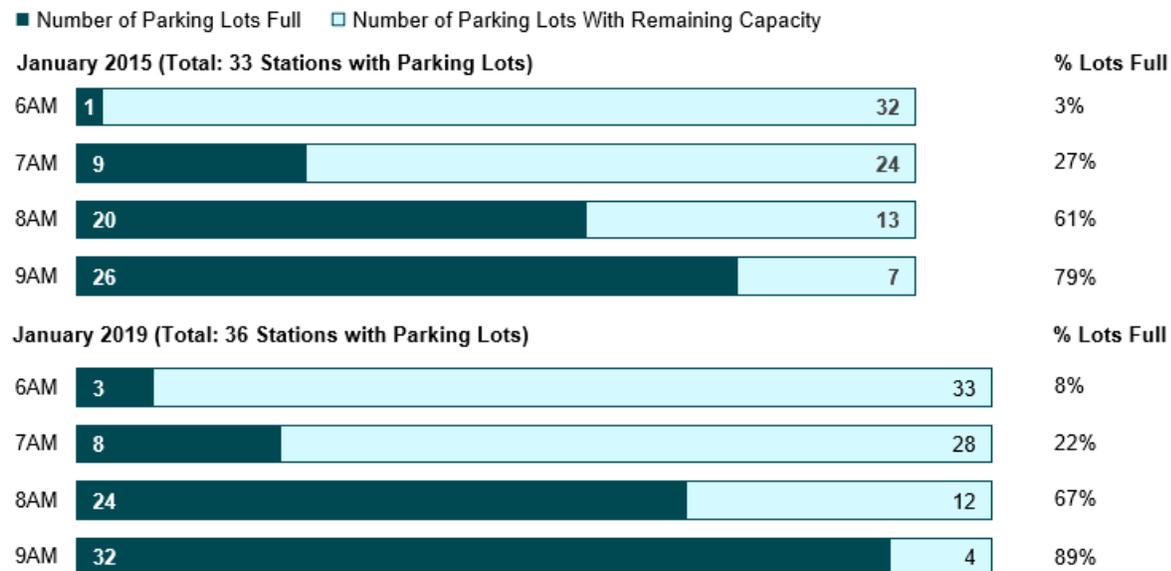
Existing rail and highway capacity are insufficient to meet pre-Covid demand for travel during peak periods.

Both the Bay Bridge and BART trains through the Transbay Tube have operated at roughly 108% of their planned capacity during peak hours (pre-COVID).

While the majority of BART travelers currently drive to access stations, demand for BART parking facilities exceeds available capacity.

Figure 4-17. BART Parking Capacity Comparison (January 2015 and 2019)

Since 2015, there has been higher demand for parking at BART despite more capacity.



Source: PMC analysis of BART parking capacity

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4.3. Travel Experience

There is an increasing proportion of commutes over one hour, particularly to and from San Francisco and San Mateo counties.

Survey responses from the American Community Survey suggest a trend of increasing commute times across the Megaregion, as illustrated in **Figure 4-18**. In particular, long commutes have become increasingly prevalent over the past decade; 14% of workers in the Megaregion traveled more than 60 minutes one way to get to/from work in 2019, compared to 10% in 2010. In addition, the share of workers traveling more than 90 minutes in each direction to get to/from work (super commuters), also increased to 5% in 2019, which is up from 3% in 2010.

This upward shift in commute time distribution may be partially attributed to the capacity issues described in Section 4.2. Insufficient rail and highway capacity has led to more crowded trains and congested roads and highways, which in turn contribute to longer travel times (the latter more so than the former). Another likely contributing factor is rising housing costs and housing cost burdens causing certain segments of the population, notably priority populations, to live further from their workplaces.

Figure 4-19 compares 2010 and 2019 commute time distributions for workers in San Francisco and San Mateo counties (i.e., those with a large share of commuters crossing the bay), showing that these workers experience comparatively longer commutes than those elsewhere in the Megaregion.

From 2010 to 2019, the share of super commuters grew from 4% to 8% in San Francisco and from 5% to 7% in San Mateo County. These high super commuting shares reflect the particularly crowded and congested conditions in the Transbay Corridor.

KEY TAKEAWAYS

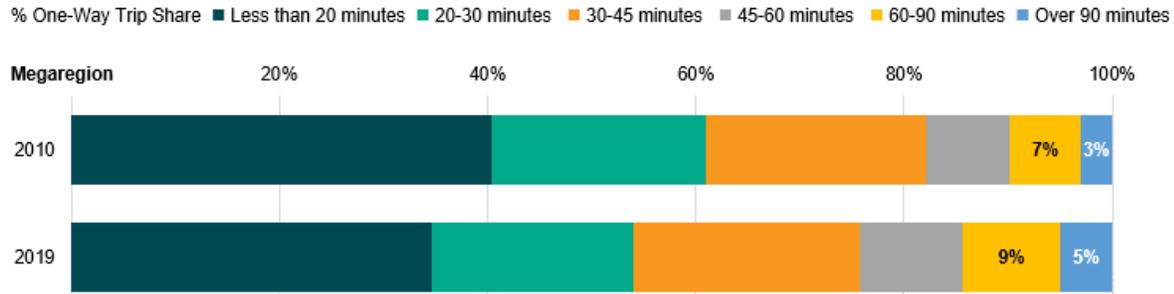
A growing share of the Megaregion's workers face a long (60 minutes or more) trip to get to/from work.

This trend is particularly noticeable in San Francisco and San Mateo counties where a large share of workers are forced to use crowded trains or congested bridges to cross the bay.



Figure 4-18. Commute Times in the Megaregion

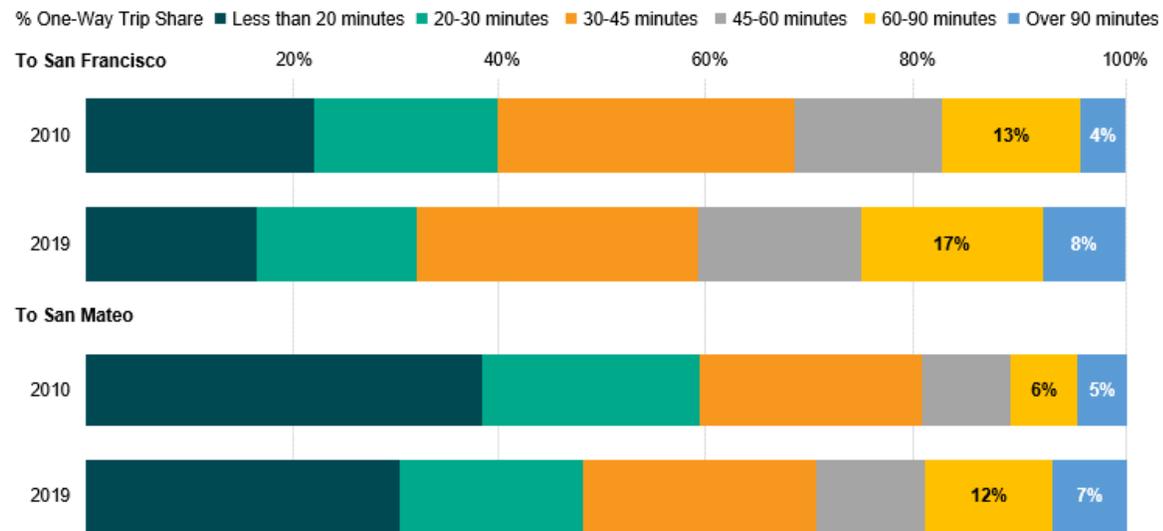
In 2019, an estimated 14% of trips were longer than one hour, which is up from 10% in 2010.



Source: PMC analysis of U.S. Census Bureau American Community Survey (2010 and 2019, 1-Year Estimates, Table B08603)

Figure 4-19. Commute Times to San Francisco and San Mateo Counties

In 2019, the proportion of super commuters was even higher for work trips to San Francisco and San Mateo than for all work trips across the Megaregion.



Source: PMC analysis of U.S. Census Bureau American Community Survey (2010 and 2019, 1-Year Estimates, Table B08603).

A variety of barriers prevented Megaregion residents from using rail.

In 2020, Link21 conducted the Link21 Mobility Survey (as described in Appendix C) among 2,046 Transbay Corridor users (i.e., users of the Bay Bridge, Transbay Tube, or ferry services) to understand the barriers and incentives for using rail across the Megaregion. The results of this survey helped inform the factors contributing to unmet rail demand potential as part of the market analysis.

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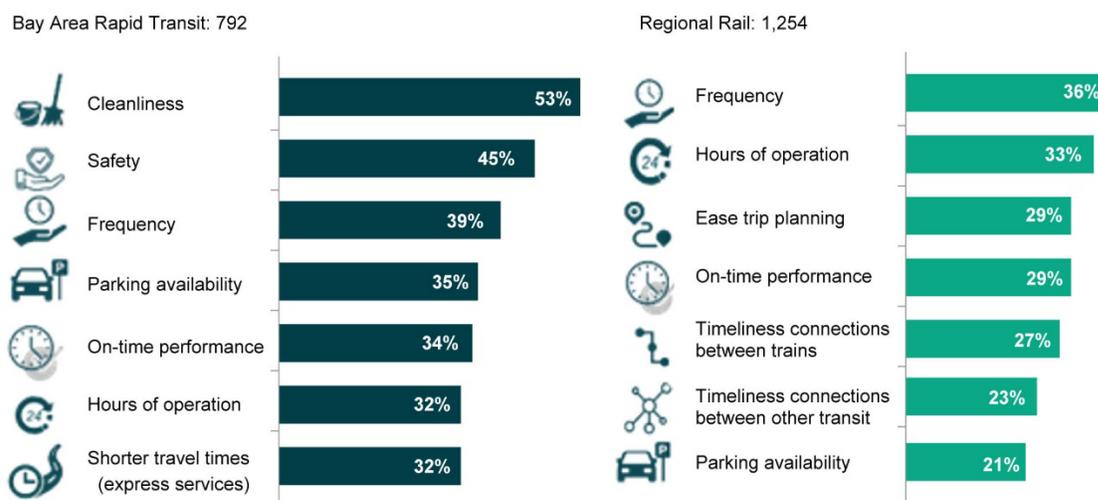


MEGAREGION OVERVIEW

As illustrated in **Figure 4-20**, the attributes that users identified as needing improvement vary considerably depending on the existing level of service provided. While the areas of improvement for BART are related to cleanliness and safety, for Regional Rail services (Caltrain, Capitol Corridor, San Joaquins, and ACE) key concerns include frequency and hours of operation.

Figure 4-20. Areas of Improvement for BART and Regional Rail

Different areas of improvement needs were identified depending on the rail service.



Source: PMC analysis of transbay travel survey data

4.3.1. Transbay Corridor Focus

For transbay trips, as illustrated in **Figure 4-21**, five of the top eight reasons why Megaregion residents are using BART to cross the bay were related to cost and travel time compared to using a vehicle. Meanwhile, among the participants who did not use BART to make regular trips traversing the bay, service accessibility (related to Reasons 1 and 2), long travel times (Reason 3 and 5), and crowded conditions (Reason 4) were among the top indicated reasons preventing people from using BART transbay services.

As shown in **Figure 4-22**, for both rail and non-rail users, travel time, cost, frequency, and reliability were perceived

as the most important service attributes for rail. For non-rail users, safety was an important factor, which was also the eighth-most indicated reason preventing non-rail users from using BART.

KEY TAKEAWAYS

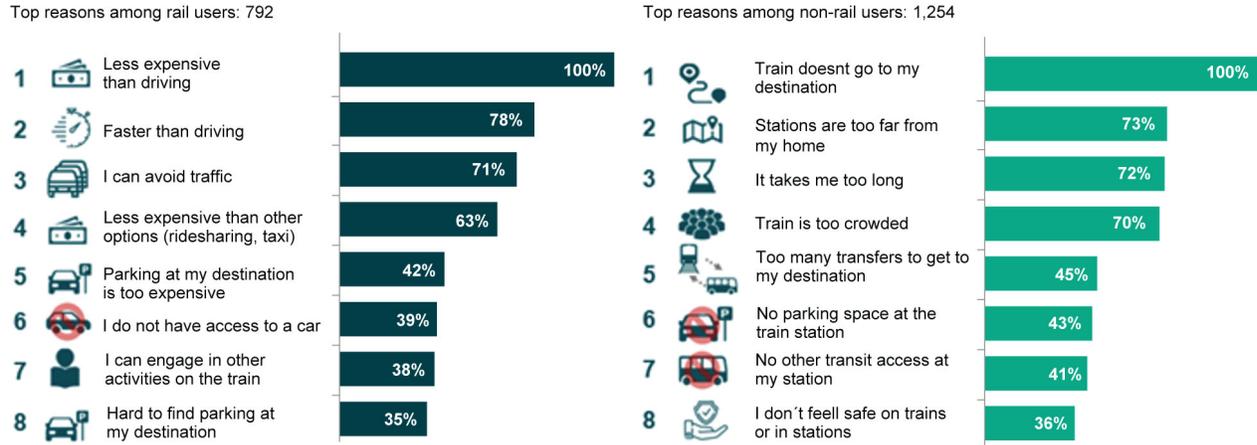
Service accessibility, long travel times, and crowded conditions were barriers preventing Megaregion residents from using BART for transbay trips (pre-COVID-19).

Frequency, hours of operation, and on-time performance (OTP) are the key barriers to using Regional Rail services.

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Figure 4-21. Top 8 Reasons for Transbay Travel Mode Choice

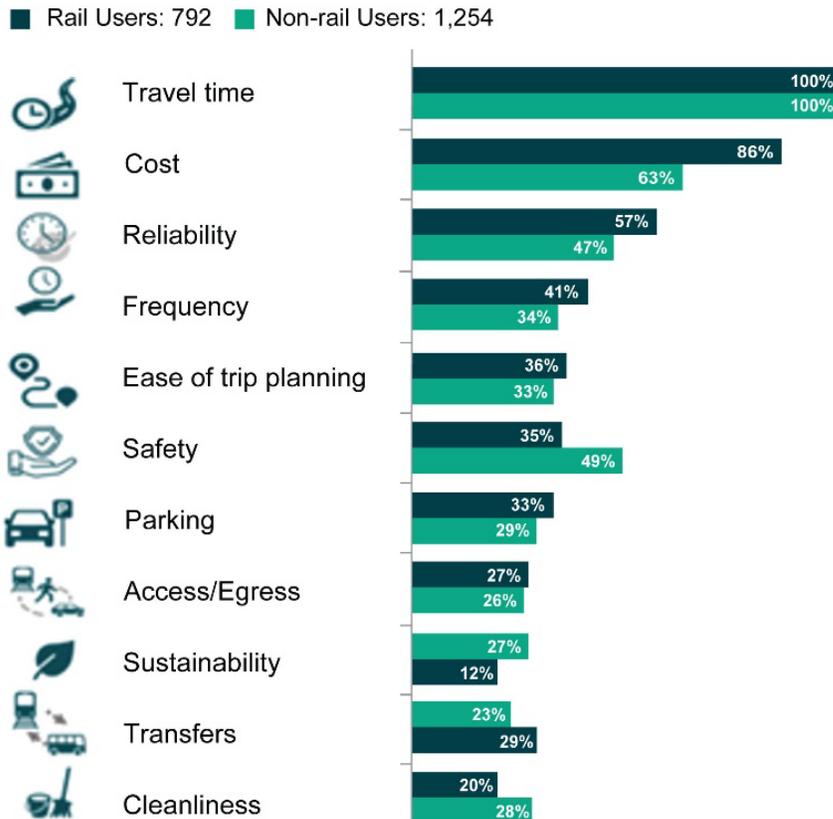
Trip length and trip duration are key factors in bay crossing mode choice for both rail and non-rail users.



Source: PMC analysis of transbay travel survey data

Figure 4-22. Top Rail Service Characteristics

Travel time and cost are top rail service characteristics among rail and non-rail users.



Source: PMC analysis of transbay travel survey data



Rail trips across the Megaregion often take longer than the corresponding auto trip.

4.3.2. Megaregion Overview

Figure 4-23 illustrates the distribution of peak period rail travel time minus auto travel time for all 8,900 OD pairs evaluated for Link21 in the Megaregion that have rail service (out of over 40,000 total pairs).¹⁵ Over 99% of OD pairs have a positive differential, meaning that it takes longer to travel by rail between the two clusters than it does by auto.

This disparity in travel times may be partially attributed to limited Regional Rail coverage and accessibility to rail stations. As noted in Section 4.1, over a quarter of trips in the Megaregion begin more than 5 miles away from a rail station, leading to long access and egress times for rail travelers. As suggested in Section 4.3.1, it is likely that long travel times contribute to the high megaregional auto mode share observed in Section 4.1.

4.3.3. Transbay Corridor Focus

Among cluster pairs that use the Transbay Corridor, 66% had a rail trip that was longer than the corresponding

auto trip by 30 minutes or more. Additionally, 48% fell within the 15 to 45 minutes range — these cluster pairs correspond to the core Transbay Corridor market served by BART: East Bay to San Francisco and northern San Mateo County.

Larger travel time disparities were observed for longer distance trips involving connections beyond the BART network, such as downtown San Francisco to downtown Sacramento. These long travel times were driven by additional factors, including long transfer times between infrequent services.

KEY TAKEAWAYS

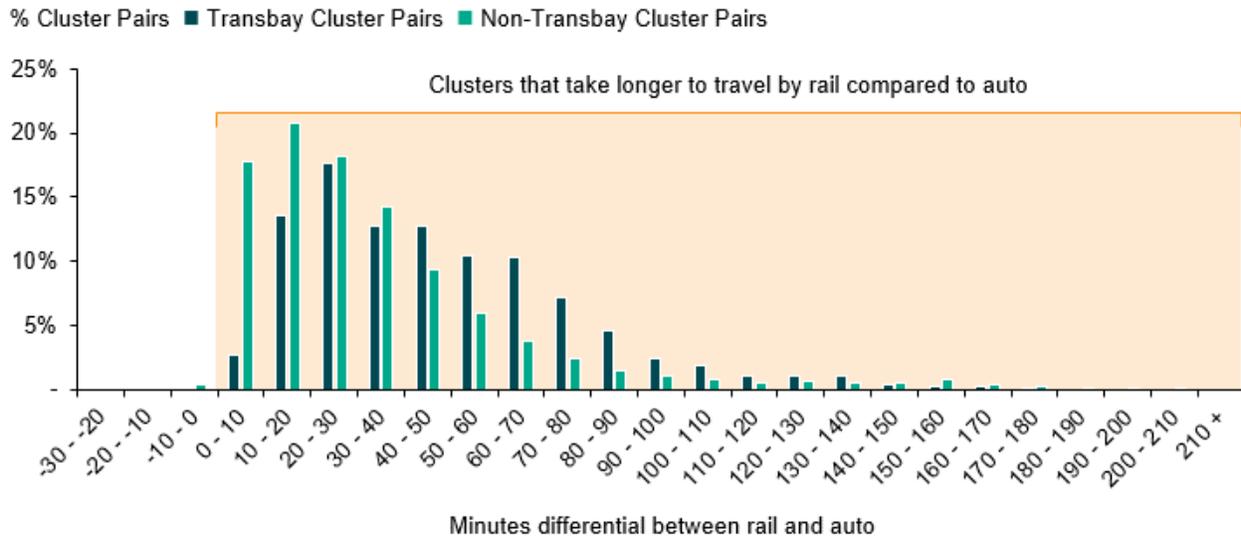
Rail travel times in the Megaregion do not compare favorably to auto travel times with over 99% of OD pairs having a longer rail trip than auto trip.

Most core Transbay Corridor BART trips between the East Bay and San Francisco/San Mateo took up to 60 minutes longer than the corresponding auto trip. Higher disparities were observed for longer trips.

¹⁵ The OD pairs used in this analysis are defined by clusters, which are catchment areas around existing, planned, and potential future rail stations. More information about clusters can be found in Chapter 7 and Appendix B of this Report.

Figure 4-23. Rail vs Auto Travel Time Comparison by OD Pair

An estimated 66% of transbay clusters had a rail trip that was at least 30 minutes longer (including average access to and egress from rail stations) than the corresponding auto trip.



Source: PMC analysis of MTC Travel Model skims (auto travel times) and General Transit Feed Specification (GTFS) data (rail travel times)

Trip time length and costs for existing rail service across the Megaregion makes rail uncompetitive to auto.

In addition to comparatively long travel times due to limited accessibility to stations, other aspects of the passenger experience make rail uncompetitive against auto for many trips.

Long travel times are compounded by limited accessibility to rail stations, leading to long access and egress times at both the origin and destination ends of a trip and, for travelers with access to a car, it makes rail an impractical choice for many trips (see Section 4.1). For travelers without access to a car, travel could be infeasible altogether.

Frequency and service hours are uncompetitive for many trips, particularly those requiring Regional Rail travel. Capitol Corridor, ACE, and San Joaquins operate with headways greater

than one hour, and ACE is limited to peak period travel in the peak direction only.

Many trips, particularly those crossing the bay, require long transfers between operators, which are perceived to be more onerous than in-vehicle travel time or waiting time at the origin station.

Crowded trains and parking facilities are another key barrier, particularly for passengers wanting to cross the bay using BART at peak hours (as described in Section 4.2).

Service unreliability is also an increasing concern for rail users. Trains have encountered more frequent and/or longer delays in recent years, which may be partially attributed to crowded trains and an overall congested rail network.

Delivering a high quality passenger experience for rail travelers is critical to increasing ridership, encouraging mode



shift away from auto, and providing options for travelers without car access.

Figure 4-24 compares individual components of travel times and costs between auto and rail for specific transbay trips across the Megaregion, reflecting a variety of trip distances and purposes (e.g., commute, business, and non-work). Many rail trips between key destinations in the Megaregion rely on infrequent service (headways of one hour or longer particularly during the off-peak period). Such infrequent service results in long schedule delays for travelers who have departure and/or arrival time requirements (i.e., someone who needs to arrive at a destination at a certain time may need to depart their origin much earlier than would be necessary if more frequent service was available).

Figure 4-24 also shows that many rail trips between key destinations, particularly long-distance ones spanning multiple regions, require one or more transfers between rail operators. These transfers are often uncoordinated and introduce long transfer times that are perceived more negatively than in-vehicle travel time or waiting time at the origin station. Furthermore, as there are over 30 different transit operators across the Megaregion, each with its individual fare structure, this contributes to high per unit trip costs in some cases.

Additionally, **Figure 4-25** illustrates that rail operators in the Megaregion often fail to meet their stated reliability standards, as measured by train OTP. In 2019, the three largest rail operators all fell short of their target. Contributing factors include aging infrastructure, vehicles, and

systems; crowding affecting station dwell times; passenger incidents and behavior; and, in the case of Caltrain and Capitol Corridor, right-of-way intrusion. Such unreliable service (or at least perceived unreliable service) creates a further barrier to using rail for long interregional trips: a delay on the first leg of a rail journey may be especially costly when transferring to an infrequent service for the second leg (note that the reliability of auto travel times is similarly impacted by increasing congestion).

These findings reinforce the findings from the Link21 Mobility Survey: long travel times (including long transfer waits) and infrequent service were key barriers to people traveling by rail. Additionally, crowded trains due to lack of capacity to accommodate demand is a significant detriment to the overall passenger experience, further driving away would be rail travelers.

KEY TAKEAWAYS

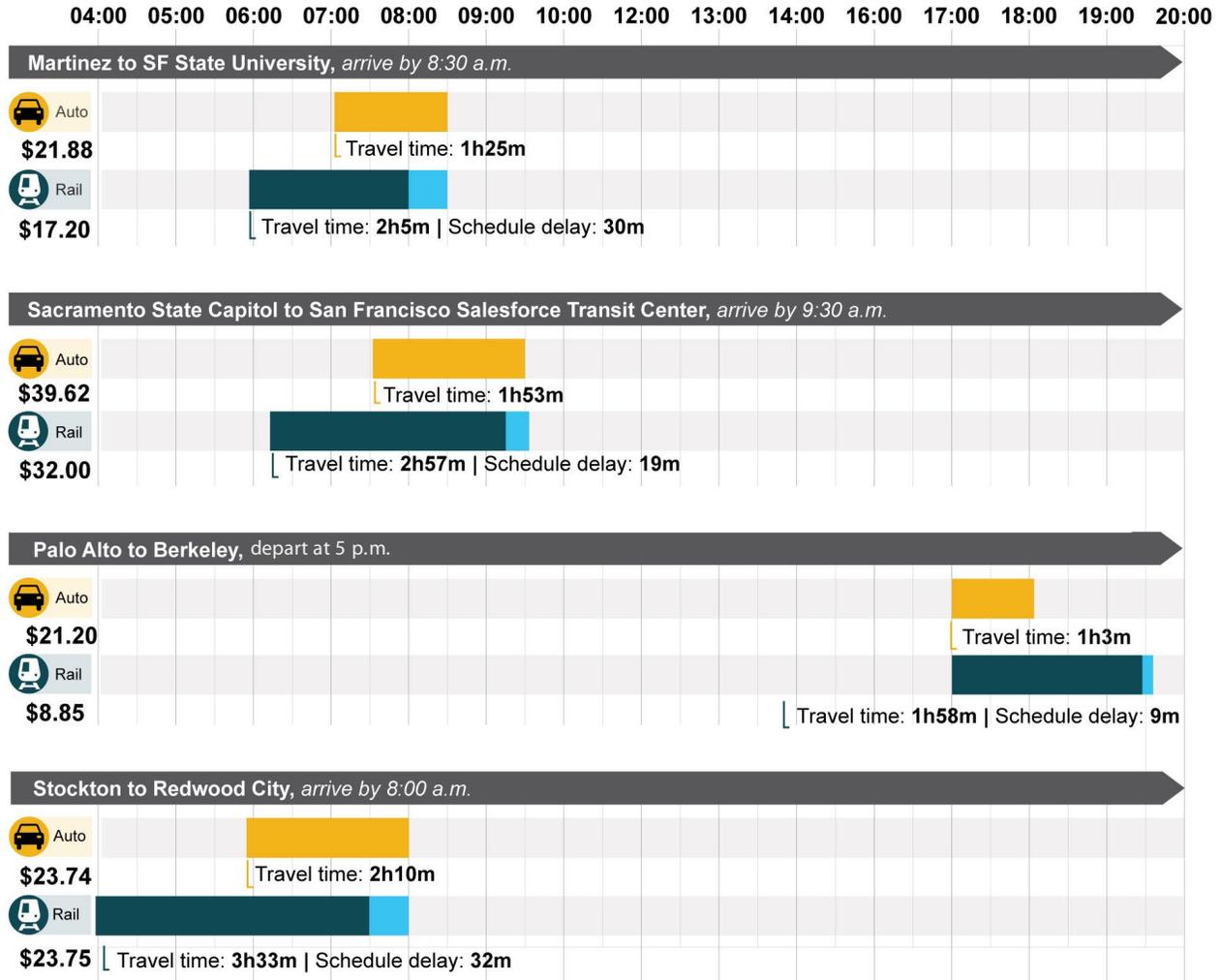
Comparatively long rail travel times are driven by a variety of factors, including long access and egress times to/from rail stations, slow and infrequent trains, and long transfers — all combining to create an uncompetitive passenger experience that serves as a barrier to rail travel.

Long-distance rail trips spanning different regions typically require transfers between different operators, each with uncoordinated schedules and/or infrequent service, further degrading the passenger experience.



Figure 4-24. Auto vs Rail Level of Service for Key Trips Across the Megaregion

Rail trips, particularly when involving multiple operators, can take significantly longer than auto trips and can sometimes be more costly.¹⁶



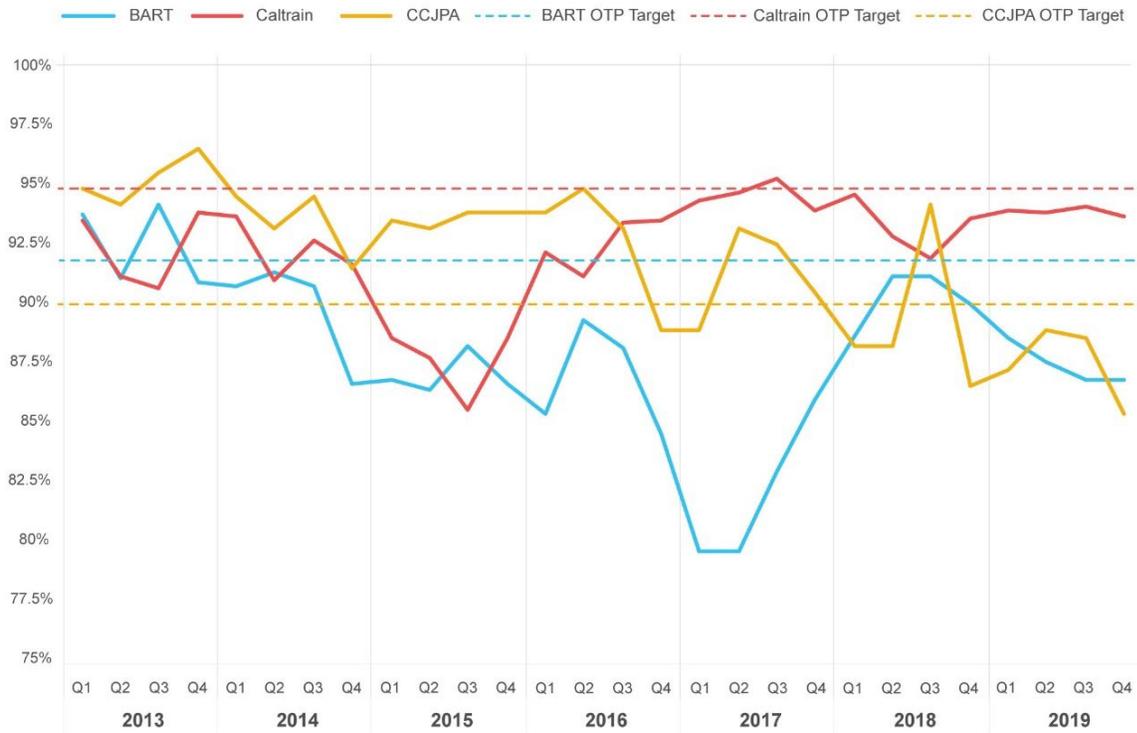
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¹⁶ Auto costs include tolls and average parking costs and exclude ownership costs. Schedule delay is the difference between a traveler's desired time of arrival or departure and the actual arrival or departure time of the earliest or latest feasible rail service.



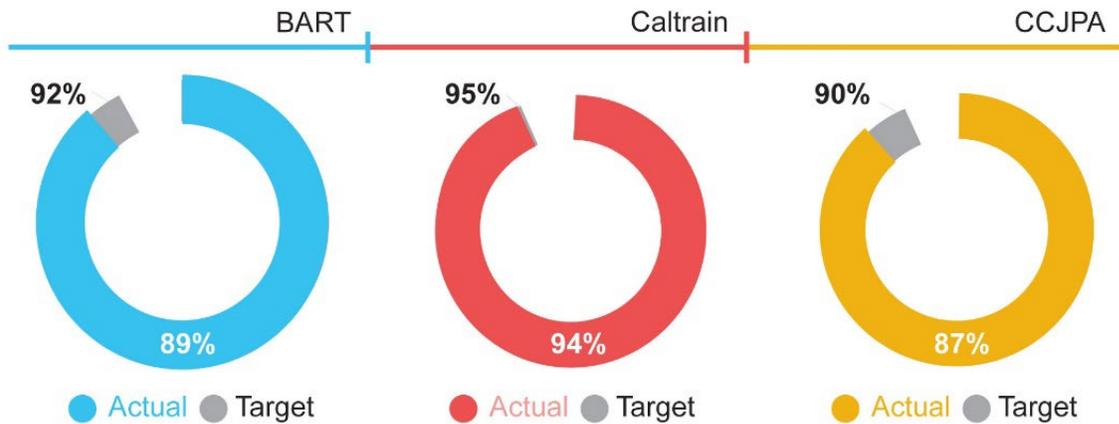
Figure 4-25. Quarterly OTP by Rail Operator (2013-2019)

Rail operators in the Megaregion often fail to meet their OTP targets.



Source: PMC analysis of rail operator OTP data

Figure 4-26. Annual OTP by Rail Operator (2019)



Source: PMC analysis of rail operator OTP data

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4.4. Summary

The majority of megaregional travel occurs in the Bay Area.

In 2015, 32.2 million trips were made on an average weekday in the Megaregion, two thirds of which occurred within the Bay Area, particularly to/from the East Bay and San Francisco, San Mateo, and Santa Clara counties. Three million trips crossed regional boundaries, and 675,000 crossed the bay using one of four crossings (three bridges and the Transbay Tube).

The two main Transbay Corridor crossings — the Transbay Tube and the Bay Bridge — are located in the core of the Bay Area and the wider Megaregion. The Bay Bridge is the most direct highway link between much of San Francisco and the East Bay, while BART is the only rail service crossing the bay. As a result, the two combined handled over 70% of trips crossing the bay in 2015.

There is insufficient capacity to accommodate pre-COVID-19 travel demand.

The growing demand for travel throughout the Megaregion, fueled by sustained population and employment growth and changing geographic patterns of said growth, has approached or exceeded the capacity of key links and infrastructure in the Megaregion, particularly in the Transbay Corridor. Since 2015, both the Bay Bridge and the Transbay Tube have been operating consistently above their planned capacities during peak periods, as summarized in Figure 4-16.

Elsewhere in the Megaregion, key highways and rail links are also operating close to or above their planned capacity, including highway approaches to the various bay crossings and Caltrain links along the Peninsula.

Long travel times and other factors impact the Megaregion's travel experience.

In addition to congested highways and crowded trains, other factors have impacted the travel experience across the Megaregion, particularly for rail users.

For the majority of trips, rail travel times are not competitive with auto travel times, in some cases taking 60 minutes longer. This disparity may be attributed to a variety of factors, including long access and egress times to/from rail stations, slow and infrequent trains, and long transfers. In addition, long distance rail trips spanning different regions within the Megaregion typically require transfers between different operators, each with uncoordinated schedules and/or infrequent service.

Link21 represents a clear opportunity to add additional rail capacity to relieve the bottlenecks in the Transbay Corridor and beyond, while also improving other elements of the rail passenger experience, such as travel time, frequency, less transfers, and coordination between rail operators. As such, improving the passenger experience is one of Link21's foundational goals, which will enable the achievement of the three other program goals: promote equity and livability,



support economic opportunity and global competitiveness, and advance environmental stewardship and protection.

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SECTION III: FUTURE CONDITIONS

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5. FUTURE POPULATION AND EMPLOYMENT GROWTH

The uneven distribution of historical population and employment growth has contributed to increasing transbay travel demand (since people do not always live near where they work), future variations in population and employment growth distribution could have further impacts on transbay travel demand. This chapter examines these different population and employment forecasts.

- The adopted regional transportation plans of the Megaregion's various MPOs project growth in population to over 15.3 million in 2040 at a CAGR of 1.0% with employment growing to 7.2 million over the same time frame at a CAGR of 0.9%.
- Since the adoption of PBA 2040, MTC has developed three alternative Horizon Futures 2050 forecasts, each with a different growth scenario. These planning scenarios have varying growth rates in terms of both overall Bay Area growth and growth of the different counties that form the Bay Area.¹⁷
- The MPOs' adopted plans serve as the baseline scenario for Link21 while the Horizon Futures 2050 forecasts are used to inform the Link21 uncertainty analysis described in Chapter 10.

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¹⁷ MTC also adopted PBA 2050, an update to PBA 2040 (in fall 2021), while this report and accompanying analysis were being finalized. As such, the majority of forecasts in this report are based on PBA 2040.



5.1. Population and Employment Forecasts

Link21 considered different forecasts to drive its market analysis assessment of future rail potential.

The population and employment analysis in Chapter 2 is based on historical values from the California Department of Finance and California Employment Development Department, respectively.

A base year of 2015 was selected for Link21 to align with most of the adopted MPO plans including those from the MTC, AMBAG, SACOG, Stanislaus Council of Governments (StanCOG), San Joaquin Council of Governments (SJCOG), and Merced County Association of Governments (MCAG). The forecasts presented in this section begin from the base year of 2015 and end in 2040 (referred to herein as forecasted growth).

5.1.1. Baseline Forecasts

- For the nine-county Bay Area, PBA 2040 is used in this Report as the Baseline Forecast.¹⁸
- PBA 2040 is the long-range Regional Transportation Plan and Sustainable Communities Strategy for the Bay Area.
- PBA 2040 was adopted in 2017 by the Association of Bay Area Governments (ABAG) and MTC for a coordinated land use and transportation planning process.

- For AMBAG, SACOG, StanCOG, and MCAG, the 2040 adopted MPO plans are used as the Baseline Forecast.

5.1.2. Other Forecasts

After the adoption of PBA 2040, MTC undertook the Horizon initiative, which attempted to incorporate the uncertainty of external forces into the early stages of its 2050 regional planning process. These Horizon Futures 2050 forecasts apply to the Bay Area counties only.

There are three different forecast scenarios: Back to the Future, Clean and Green, and Rising Tides, Falling Fortunes. These scenarios have divergent population and employment growth rates based on various political, technological, economic, and environmental assumptions and challenges that impact the lives of Bay Area residents and are a means to manage the forecasting uncertainty. The external forces underpinning the different futures are described in **Table 5-1**.

This Report uses these three forecast scenarios to inform the transbay capacity analysis and uncertainty analysis for Link21.

In addition to comparing the different population and employment forecasts for the Megaregion and the Bay Area, this section also compares these forecasts to historical growth from 1990 to 2019 as examined in Chapter 2.

¹⁸ As previously mentioned, MTC has recently published a draft for PBA 2050 that was later adopted

in fall 2021 (after the completion of the market analysis).



Table 5-1. Three Forecast Scenarios from Horizon Futures 2050

SCENARIO	DESCRIPTION
<p>Back to the Future</p>	<ul style="list-style-type: none"> ▫ Defined by a thriving national economy supported by increased public investment in infrastructure, as well as immigration reform that increases the national population and workforce growth rate significantly. ▫ In the Bay Area, the technology sector thrives, leading to broad adoption of low-cost driverless vehicles. ▫ As a result, coastal metropolitan areas see a new wave of growth as technologies enable residents to commute longer distances to thriving urban job centers. ▫ Silicon Valley technologies remain dominant worldwide in everything from cars to e-commerce, yet booming growth poses challenges for communities and their aging infrastructure that are absorbing that growth.
<p>Clean and Green</p>	<ul style="list-style-type: none"> ▫ Defined by an aggressive federal carbon tax to curb carbon dioxide emissions. ▫ Assumes the policy is implemented in the early 2020s and results in similar commitments worldwide. Consequently, clean technologies thrive. ▫ Driverless electric vehicles become nearly universal with consumers preferring to share rides more frequently. Virtual reality enables more telecommuting and distributed workplace locations, particularly for higher income individuals. ▫ Federal infrastructure investment allows for the completion of high-speed rail lines across the country, including California High-Speed Rail. ▫ Yet with high taxes and new regulations, jobs are assumed to be increasingly automated, which boosts productivity but results in fewer openings for workers without college degrees.
<p>Rising Tides, Falling Fortunes</p>	<ul style="list-style-type: none"> ▫ Defined by relaxed federal regulations and the elimination of federal programs from social services to infrastructure. ▫ The federal government implements costly tariff policies as well as tight immigration restrictions. ▫ As a result, an era of slow growth begins across the United States, with particularly significant impacts in areas like the Bay Area. ▫ Labor constraints mean that innovation rates slow and driverless electric vehicles fail to live up to the hype. Finally, a lack of international leadership means that worst-case sea level rise predictions come true, resulting in three feet of sea level rise by 2050.

Source: PMC of Horizon Futures Final Report

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Actual population and employment figures differ from previous MPO forecasts.

As these MPO forecasts were developed before 2015, actual population and employment figures between 2015 and 2019 do not exactly reflect the forecast figures from the MPOs. Appendix A provides a further discussion on these differences.

To account for the differences in actual growth between 2015 and 2019, the following section references historical population and employment growth between 1990 and 2019 consistent with the findings in Chapter 2 and comparing this to forecasts between 2015 to 2040.

NOTE ON COVID-19

The forecasts shown in this section are based on MPO forecasts that were developed well before the COVID-19 pandemic. Since the introduction of public health measures, including lockdowns discouraging unessential trips, there has been an unprecedented decrease in travel demand across the Megaregion and in cities around the world.

How the COVID-19 pandemic will impact population and employment growth that underpin travel demand forecasts for Link21 is uncertain but will be examined as part of the program. An Uncertainty Analysis providing further discussion on this topic is included in Chapter 10 and Appendix I.



5.2. Baseline Forecast

The Bay Area is forecast to have the highest megaregional population and employment growth in absolute terms.

The population and employment values within this section are based on MPO adopted plans (including PBA 2040).

5.2.1. Population Forecasts

Population in the Megaregion is forecast to increase at a CAGR of 1.0% from 2015 to 2040, as illustrated in **Figure 5-1** and **Figure 5-2**. By 2040, the Megaregion population is projected to reach 15.3 million, an overall increase of 3.3 million.

The Bay Area is forecast to remain the largest region with 9.6 million residents in 2040, up from 7.6 million in 2015. This represents an increase of over 2.0 million or a CAGR of 1.0%. Within the East Bay, slightly lower growth of 0.9% is forecast from 2015-2040, compared to historical growth of 1.0%. However, in San Francisco, there is higher forecast growth of 1.2% per annum from 2015 to 2040, compared to 0.7% historically.

The Northern San Joaquin Valley is forecast to have almost 1.8 million residents by 2040, up from almost 1.3 million residents in 2015. This represents a CAGR of 1.4% and is projected to be the fastest growing region. Meanwhile, the Sacramento and Monterey Bay areas are forecast to grow at 0.9% and 0.6%, respectively.

5.2.2. Employment Forecasts

The MPO data forecasts that Megaregion employment will grow at a CAGR of 0.9% from 2015 to 2040, as illustrated in **Figure 5-3** and **Figure 5-4**. Total Megaregion employment is forecast to reach 7.1 million jobs by 2040, up from 5.6 million in 2015, for a total increase of 1.5 million jobs.

The Northern San Joaquin Valley is forecast to have total employment of 0.7 million by 2040, representing an increase of 0.2 million from 2015 at a CAGR of 1.2%, the fastest growing employment center over the period.

Employment across the Bay Area is projected to reach 4.7 million jobs by 2040, up from 3.7 million in 2015 at a CAGR of 0.9%, which is in line with average Megaregion growth. Within the East Bay, higher growth at a CAGR of 1.2% is forecast between 2015 and 2040, compared to historical growth of 0.8% between 2019 and 2040. In San Francisco, growth is forecast at a CAGR of 0.9% from 2015 to 2040 compared with 1.3% between 1990 and 2019.

Similarly, jobs in the Sacramento Area are forecast to grow at a CAGR of 0.9% and by 2040 the region is forecast to have up to 1.3 million jobs, an increase from 1.1 million in 2015. In the Monterey Bay Area, employment is forecast to grow up to 0.395 million jobs, up from 0.338 million jobs in 2015. This growth is equivalent to a CAGR of 0.6%, which is below the average of 0.9% CAGR across the Megaregion.



KEY TAKEAWAYS

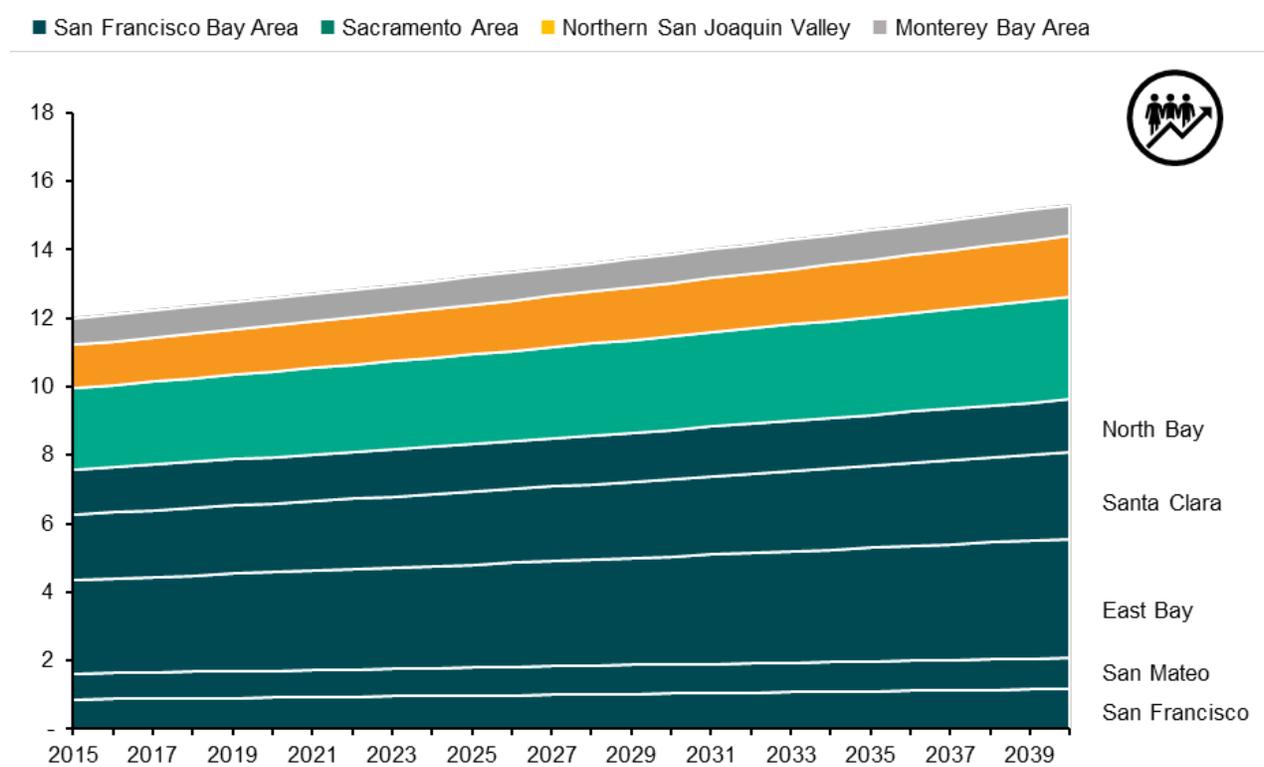
- Megaregion forecast population and employment growth from 2015 to 2040 is projected to increase at a rate of 1.0% and 0.9% per annum, respectively.
- The Northern San Joaquin Valley is forecast to remain the fastest growing area by both population

(CAGR 1.4%) and employment (CAGR 1.2%) of the Megaregion over the 2015 to 2040 period.

- The Bay Area has the largest share of expected population growth from 2015 to 2040 of 2.0 million and the largest employment growth of 1.0 million jobs.

Figure 5-1. Baseline Forecast: Population Growth

The Baseline Forecast implies continued population growth of 1.4% per annum in the Northern San Joaquin Valley in addition to accelerated growth (compared to historical growth) in the Bay Area, especially in San Mateo and Santa Clara counties.



Source: PMC analysis of data from the California Department of Finance, Employment Development Department, State of California, and MPOs (MTC, AMBAG, SACOG, StanCOG, and MCAG)

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Figure 5-2. Percent Compound Annual Population Growth Rate

Region/Bay Area Sub-Region	Historical ^A	Forecast ^B
San Francisco Bay Area	+0.9%	+1.0%
San Francisco	+0.7%	+1.2%
San Mateo	+0.6%	+0.8%
East Bay	+1.0%	+0.9%
Santa Clara	+0.9%	+1.2%
North Bay	+0.8%	+0.6%
Sacramento Area	+1.6%	+0.9%
Northern San Joaquin Valley	+1.5%	+1.4%
Monterey Bay Area	+0.8%	+0.6%
Megaregion	+1.1%	+1.0%

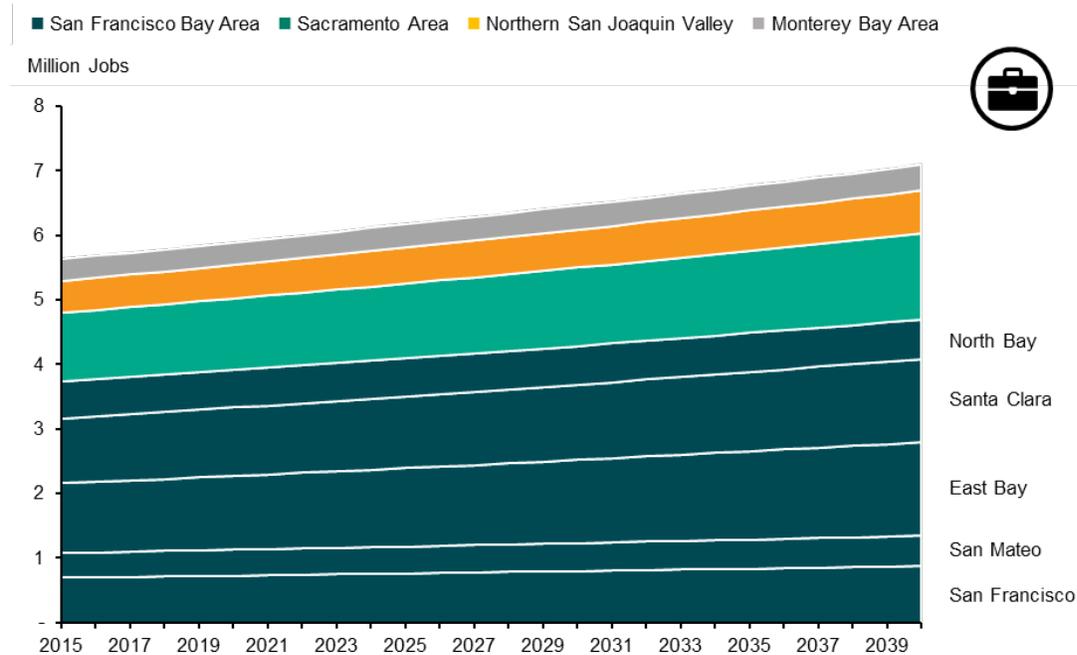
Source: PMC analysis of data from the California Department of Finance, Employment Development Department, State of California, and MPOs (MTC, AMBAG, SACOG, StanCOG, and MCAG)

^A Historical growth rates are from 1990 to 2019.

^B Future forecast growth rates are from 2015 to 2040.

Figure 5-3. Baseline Forecast: Employment Growth

The Baseline Forecast implies slowing employment growth over time in Sacramento and the Northern San Joaquin Valley and continued steady growth in the Bay Area.



Source: PMC analysis of data from the California Department of Finance, Employment Development Department, State of California, and MPOs (MTC, AMBAG, SACOG, StanCOG, and MCAG)

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**Figure 5-4. Percent Compound Annual Employment Growth Rate**

Region/Bay Area Sub-Region	Historical ^A	Forecast ^B
San Francisco Bay Area	+0.9%	+0.9%
San Francisco	+1.3%	+0.9%
San Mateo	+0.8%	+0.8%
East Bay	+0.8%	+1.2%
Santa Clara	+0.8%	+1.0%
North Bay	+0.7%	+0.3%
Sacramento Area	+1.4%	+0.9%
Northern San Joaquin Valley	+1.4%	+1.2%
Monterey Bay Area	+0.8%	+0.6%
Megaregion	+1.0%	+0.9%

Source: PMC analysis of data from the California Department of Finance, Employment Development Department, State of California, and MPOs (MTC, AMBAG, SACOG, StanCOG, and MCAJ).

^A Historical growth rates are from 1990 to 2019.

^B Future forecast growth rates are from 2015 to 2040.

Historical uneven distribution of total population and employment growth trends is expected to continue in the Megaregion.

As discussed in the preceding sections, the Megaregion forecasts project an increase of 3.3 million residents and 1.5 million jobs between 2015 and 2040. However, as illustrated in **Figure 5-5**, this growth is not forecast to be distributed evenly across the Megaregion.

Between 2015 and 2040, more than 2.0 million residents or 62% of the Megaregion’s forecast population growth is expected to be within the Bay Area. However, the Bay Area is forecast to have a higher share of employment growth, almost 66% of the expected megaregional growth or 1.0 million jobs.

The higher concentration of growth forecast within the Bay Area is one potential factor that could increase interregional travel as residents outside of the Bay Area will need to travel into jobs located within the Bay Area.

The projected shares of total population and employment growth over the 2015 to 2040 period are forecast to be even within the Sacramento Area (at 19%) and also in the Monterey Bay Area (at 4%). However, in the Northern San Joaquin Valley, the expected share of population growth, at 16%, exceeds the projected share of employment growth at 12% over the same period.

Within the Bay Area, shares of Megaregion population and employment growth also appear uneven. Between 2015 and 2040, the East Bay is forecast to have a 22% share of absolute



population growth while the share of absolute employment growth is forecast at 26%. Similarly, San Francisco and San Mateo County are forecast to have a combined 14% share of absolute population growth but an 18% share of absolute employment growth.

The historical share of Megaregion population growth within the Bay Area from 1990 and 2019 was 52%; however, this is forecast to increase to 62% over the 2015 to 2040 period. There is a similar trend for employment growth, where the share increases from 58% to 66% over the same time frame.

In all other areas, there are reverse trends. In the Sacramento Area, the historical share of Megaregion population growth from 1990 to 2019 was 27% and is expected to decrease to 19% over the 2015 to 2040 period. The employment growth share decreases from 24% to 19% over the same period.

There are more modest declines in growth share within the Northern San Joaquin Valley and the Monterey Bay Area.

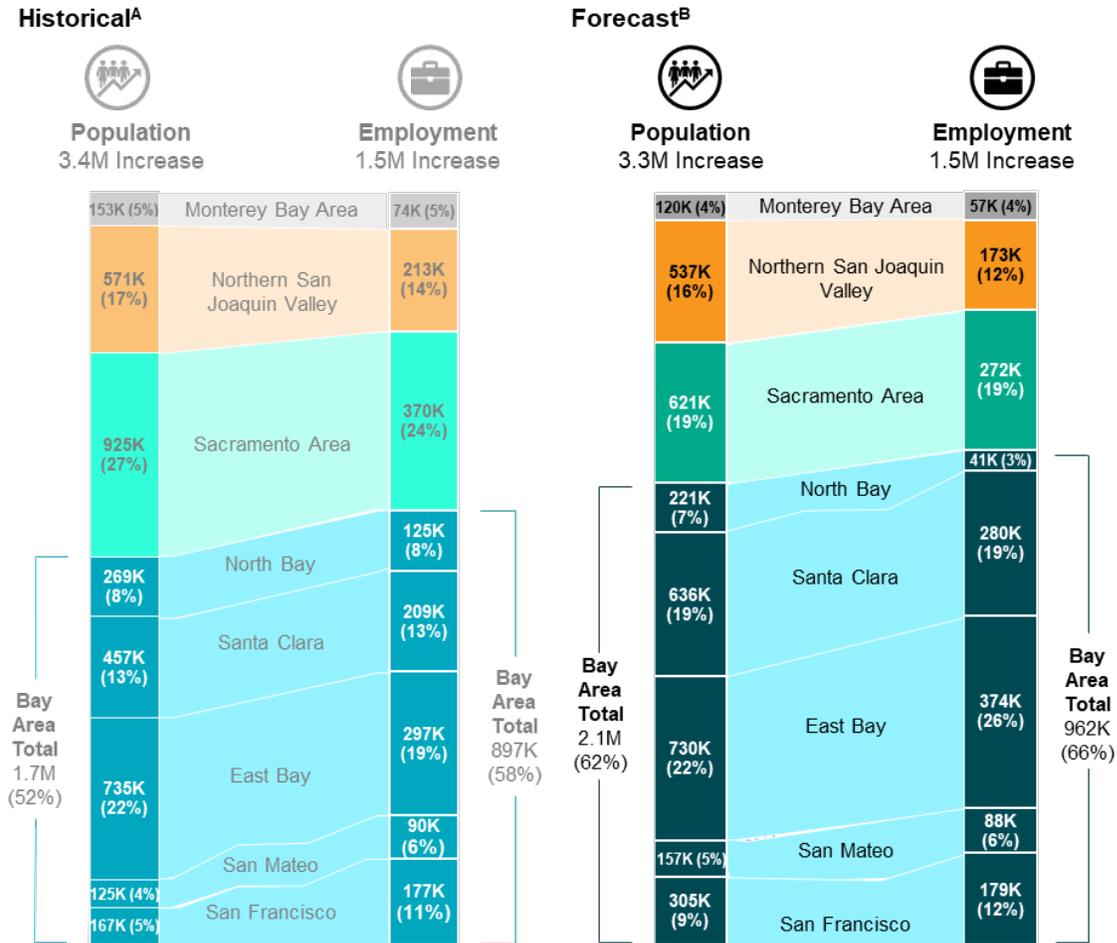
KEY TAKEAWAYS

- Historically, the uneven distributions of population and employment growth in the west and east subregions of the Bay Area have contributed to increased transbay travel demand.
- In the future, continued uneven distributions of population and employment growth are forecast in the Megaregion, which may lead to further increased travel demand on congested transbay infrastructure.



Figure 5-5. Historical and Baseline Forecasts

The Baseline Forecast for the Bay Area has a large proportion of the growth in the Megaregion, continuing the uneven distribution of population and employment growth trends particularly in San Francisco.



Source: PMC analysis of data from the California Department of Finance, Employment Development Department, State of California, and MPOs (MTC, AMBAG, SACOG, StanCOG, and MCAG)

^A Historical growth rates are from 1990 to 2019.

^B Future forecast growth rates are from 2015 to 2040.

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5.3. Other Future Forecasts

Population and employment growth projections vary significantly between the Baseline Forecast and the Horizon Futures scenarios.

Given that the Baseline Forecast is based on plans developed and adopted by the various Megaregion MPOs as far back as 2017 and that newer Horizon Futures 2050 for the Bay Area have been developed since, Link21 also considers these latest forecasts for the market analysis and future travel demand assessment.¹⁹ In particular, the analysis examines the sensitivity of rail ridership potential to changes in land use patterns. This section provides a comparative summary between the three forecast scenarios and the Baseline Forecast.

The three Horizon Futures present divergent patterns of change impacting the lives of Bay Area residents based on various political, technological, economic, and environmental challenges and the responses to these challenges. The different scenarios have led to a range of population and employment growth projections in the Bay Area, as shown in

Figure 5-6 and **Figure 5-7**. This section compares the growth associated with each of the three Horizon Futures through 2040 to the Baseline Forecast as detailed in Section 5.2.

For population, both the Back to the Future and Clean and Green scenarios project growth rates for San Mateo and Santa Clara counties higher than the Baseline Forecast, and higher than other Bay Area subregions, whereas the Baseline Forecast projects the highest growth in San Francisco and Santa Clara County.

Meanwhile, for employment, all three Horizon Futures forecasts project employment growth in San Francisco ranging from a CAGR of 1.6% to 2.7%, significantly higher than the PBA 2040 forecast of 0.9%.

For the Rising Tides, Falling Fortunes scenario, population is projected to decrease in the East Bay while employment is projected to decrease in San Mateo County and the North Bay from 2015 base year estimates.

¹⁹ The scenarios used here are from Horizon Futures 2050 Round 2, which considers the impact of external forces and a

set of projects and strategies that might be implemented in response.



Figure 5-6. Percent Population Compound Annual Growth Rate

The population growth rate projections in the different Horizon Futures emphasize growth in different counties within the Bay Area.

Bay Area Subregion	Historical ^B	Future Forecasts ^A				Rising Tides, Falling Fortunes
		Baseline (PBA 2040)	Back to the Future	Clean and Green		
San Francisco	+0.7%	+1.2%	+1.4%	+1.2%	+0.7%	
San Mateo County	+0.6%	+0.8%	+2.2%	+1.4%	+0.5%	
East Bay	+1.0%	+0.9%	+1.3%	+0.6%	-0.3%	
Santa Clara County	+0.9%	+1.2%	+2.6%	+1.6%	+0.3%	
North Bay	+0.8%	+0.6%	+1.0%	+0.5%	+0.2%	
San Francisco Bay Area	+0.9%	+1.0%	+1.7%	+1.0%	+0.1%	

Source: PMC analysis of data from the California Department of Finance and MTC

^A Future forecast growth rates are from 2015 to 2040.

^B Historical growth rates are from 1990 to 2019.

Figure 5-7. Percent Employment Compound Annual Growth Rate

Horizon Futures project higher than average employment growth rates in San Francisco, whereas faster growth was projected in the East Bay for the Baseline Forecast.

Bay Area Subregion	Historical ^B	Future Forecasts ^A				Rising Tides, Falling Fortunes
		Baseline (PBA 2040)	Back to the Future	Clean and Green		
San Francisco	+1.3%	+0.9%	+2.7%	+2.2%	+1.6%	
San Mateo County	+0.8%	+0.8%	+0.9%	+0.4%	-0.1%	
East Bay	+0.8%	+1.2%	+1.7%	+0.9%	+0.0%	
Santa Clara County	+0.8%	+1.0%	+2.0%	+0.8%	+0.3%	
North Bay	+0.7%	+0.3%	+0.9%	+0.4%	-0.5%	
San Francisco Bay Area	+0.9%	+0.9%	+1.8%	+1.1%	+0.4%	

Source: PMC analysis of data from the California Department of Finance and MTC

^A Future forecast growth rates are from 2015 to 2040.

^B Historical growth rates are from 1990 to 2019.

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The changes in population and employment growth have a subsequent impact on the distribution of growth within the Bay Area. These varying growth rates between the Baseline Forecast and the Horizon Futures forecasts mean that the distribution of population and employment growth within the Bay Area also varies depending on the scenario. Given that transbay travel demand growth has historically been driven by the uneven distribution of historical population and employment growth, the wide variation in growth projections would likely impact future transbay travel demand.

As illustrated in **Figure 5-8**, the PBA 2040 baseline implies that 23% of population growth and 28% of employment growth in the Bay Area between 2015 and 2040 occurs in San Francisco and San Mateo counties combined.

The gap between the proportions of population and employment growth in these counties is much greater in the Back to the Future and Clean and Green scenarios. The proportions of absolute population and employment growth during the same period are 22% and 35% for the Back to the Future scenario and, more starkly still, 28% and 49% for the Clean and Green scenario.

The Rising Tides, Falling Fortunes scenario is the conservative growth scenario among the Horizon Futures. As illustrated in Figure 5-8, this scenario projects a decrease in population for the East Bay counties of Alameda and Contra Costa from 2015 to 2040, as well as a reduction in employment for San Mateo County and the North Bay during

the same period. As this would result in some negative growth values, **Figure 5-9** illustrates the absolute figures only, rather than the proportion shares illustrated for the other scenarios that are shown in Figure 5-8.

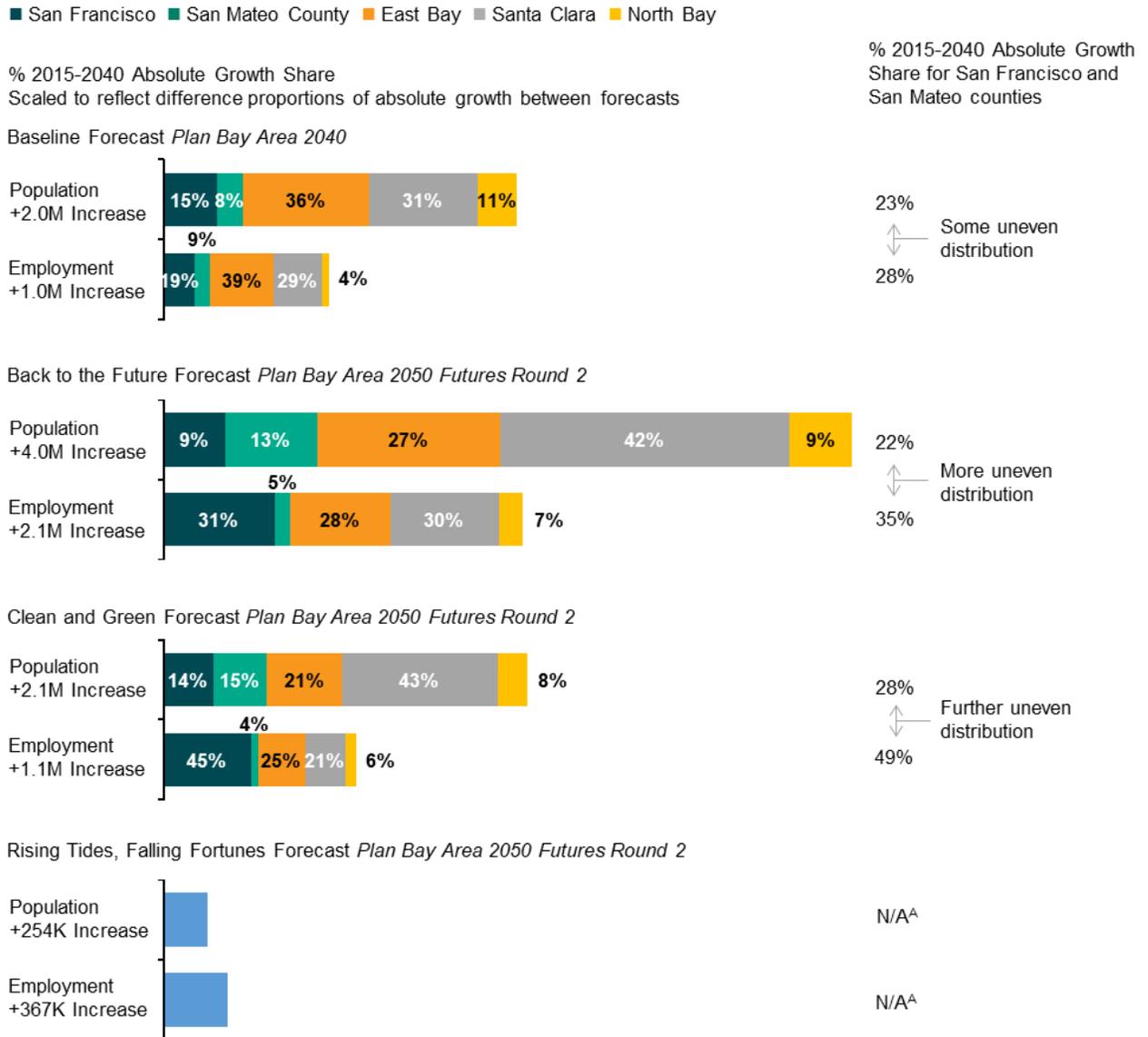
KEY TAKEAWAYS

- The different forecasts between the Baseline Forecast and Horizon Futures have population and employment growth projections that vary widely between the forecasts.
- These variations result in different distributions of population and employment among the Bay Area counties, (e.g., the imbalance between population and employment growth is much more pronounced in two of the Horizon Futures scenarios than in the Baseline Forecast).
- Given that transbay travel demand growth has historically been driven by the uneven distribution of historical population and employment growth, it is likely the wide variation in growth projections will further impact future transbay travel demand.



Figure 5-8. Geographical Distribution of Population and Employment Growth Forecasts

The different forecasts have varying proportions of population and employment growth and distributions of the growth across the Bay Area, which will have implications for transbay travel demand forecasts.



Source: PMC analysis of data from MTC

^A As the *Rising Tides, Falling Fortunes* forecast projects a decrease in population and/or employment in certain counties, this would result in negative absolute growth rates. Thus, only total Bay Area population and employment growth is shown in this forecast, rather than the county-by-county growth shown as per the other forecasts.

Note: Values are rounded and may not add up to 100%.

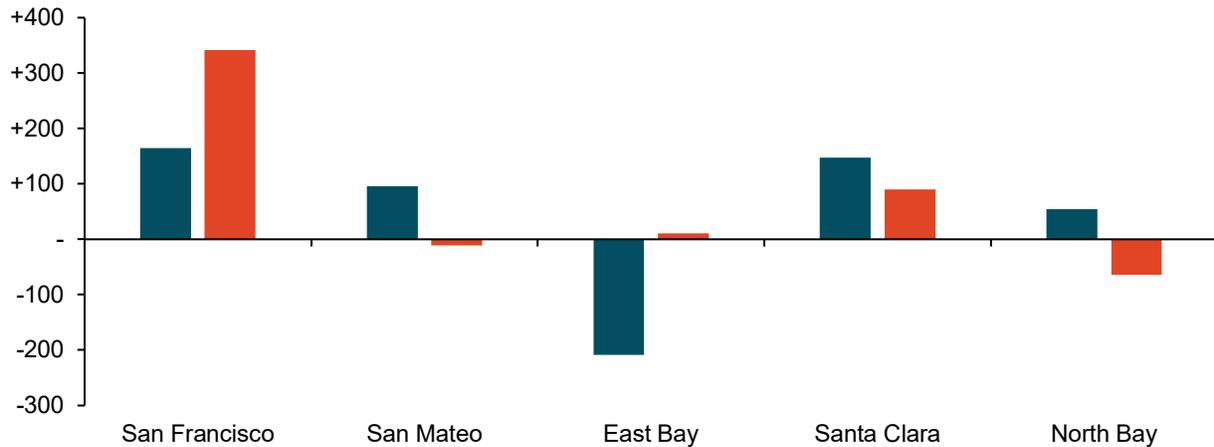
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Figure 5-9. Population and Employment Growth Forecasts for Rising Tides, Falling Fortunes Growth Scenario

Rising Tides, Falling Fortunes is the conservative growth scenario among the Horizon Futures forecasts and projects a decrease in population in the East Bay as well as a reduction in employment in San Mateo County and the North Bay.

Thousand Net Change in Residents (■) or Jobs (■)



Source: PMC analysis of data from MTC

5.4. Summary

Continued strong growth is projected for the Megaregion for the Baseline Forecast and two of the three Horizon Futures scenarios.

The Baseline Forecast shows that Megaregion population and employment will increase at a CAGR of 1.0% for population and 0.9% for employment, similar to historical growth rates of 1.1% and 1.0%, respectively, between 1990 and 2019.

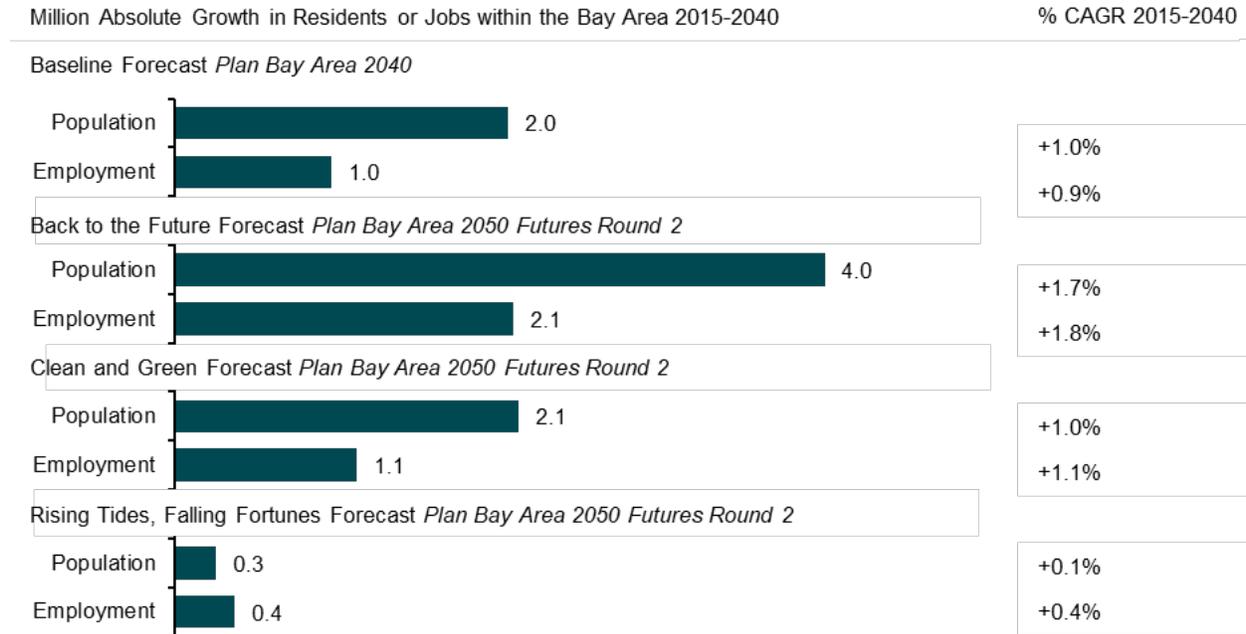
Within the Bay Area, the Baseline scenario (PBA 2040) forecasts growth of 1.0% and 0.9% for population and employment respectively. Meanwhile, Horizon Futures projects higher growth for population and employment in the Back to the Future and Clean and Green forecasts with conservative growth assumptions for the Rising Tides, Falling Fortunes scenario. These growth variations are illustrated in **Figure 5-10**.

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Figure 5-10. Absolute Growth in Residents or Jobs in the Bay Area (2015-2040)

Strong population and employment growth in the Bay Area is projected in the Baseline Forecast, whereas varying growth is projected in the three sensitivity scenarios from even stronger growth to more conservative growth for the Bay Area.



Source: PMC analysis of data from MTC

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Variations in the distribution of population and employment growth between scenarios can impact transbay travel demand.

The variations in growth rates between the various forecasts are seen not only for the overall Bay Area forecasts, but also in variations between specific counties. For instance, in the Baseline Forecast, San Francisco employment is forecast to grow at a CAGR of 0.9% between 2015 and 2040, which is in line with the 0.9% average growth across the Bay Area during this period. Meanwhile, in the three Horizon Futures scenarios, employment growth in San Francisco is forecast to increase at a CAGR of 2.7%, 2.2%, or 1.6% (depending on the scenario), which is significantly higher than the Bay Area averages of 1.8%, 1.1%, and 0.4%, respectively. The

variations in population growth between San Francisco and the Bay Area average do not vary as widely in comparison.

Figure 5-11 illustrates the absolute population and employment growth between 2015 and 2040 in San Francisco as well as the proportion of absolute growth within the Bay Area. The total forecast growth for the Back to the Future Forecast is highest among the four scenarios with a significantly more uneven distribution of population and employment growth during this period.

Given that the uneven distribution of historical population and employment growth have in part contributed to the increase in transbay travel demand, the further widening of population and employment growth could have impacts on transbay travel demand, as discussed in the next chapter of this Report.

Figure 5-11. Percent San Francisco Bay Area Share of Absolute Growth (2015-2040)

The Back to the Future Forecast not only forecasts higher population and employment growth for San Francisco, but also it forecasts a higher proportion of absolute employment growth compared to population.

Forecast	Population	Employment
Baseline	305k – 15%	179k – 19%
Back to the Future	355k – 9%	641k – 31%
Clean and Green	288k – 14%	505k – 45%
Rising Tides, Falling Fortunes ^A	164k – N/A ^A	342k – N/A ^A

Source: PMC analysis of data from MTC

^A As the Rising Tides, Falling Fortunes Forecast projects a decrease in population and/or employment in certain counties, this would result in negative absolute growth rates. Thus, only total Bay Area population and employment growth is shown in this forecast, rather than the county-by-county growth shown as per the other forecasts.



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6. FUTURE MEGAREGIONAL TRAVEL

As described in the previous chapter, the geographic variations in population and employment growth are expected to impact future travel demand and conditions across the Megaregion.

- The Megaregion as a whole will continue to experience growing travel demand, which is projected to be fastest in the halo counties but largest in the core Bay Area counties. The imbalance may be attributed to strong projected population growth in the former and strong projected employment growth in the latter.
- The Transbay Corridor, which has been operating above planned capacity since 2015, is projected to serve 35% more average weekday trips in 2040 than in 2015, underscoring its strategic location and important role in the megaregional transportation network.
- While incremental capacity increases are already planned for both transbay crossings, these will likely be insufficient to meet the forecast growth for transbay travel demand, highlighting the need for substantial investment in a new crossing to serve the projected demand in 2050 and beyond.

This chapter further explores these growth trends and the challenges they may introduce on capacity constrained infrastructure in the Megaregion.



6.1. Future Travel Demand

This section examines travel demand across the Megaregion until 2040 and compares this demand against existing demand, as presented in Section 4.1. As with the existing demand, this future demand comprises trips made by auto, rail, and other non-rail public transit between pairs of unique TAZs, as defined in regional travel demand models. Trips made on foot or by bicycle, trips taking place entirely within the same TAZ, and trips under 3 miles in length are not covered in this section. Trips are aggregated to eight summary regions, listed in Section 4.1, only for the purpose of visualization in this chapter.

Travel demand forecasts, as described in this section, are based on the same land use assumptions as the baseline population and employment forecasts, as described in Section 5.2.

6.1.1. Forecasting Methodology Summary

Future travel demand estimates were developed by using StreetLight location-based services data, trip tables from existing travel models (with future year tables corresponding to adopted plan scenarios), and other data sources to develop a base year trip table. This base year (2015) trip table generally reflects total travel volumes, mode shares, and trip purpose shares consistent with the existing travel models and temporal and spatial distribution of trips consistent with StreetLight observations. Once the base year trip table was developed, trips between each zone-pair were scaled separately by mode by the growth rate for the corresponding county pair

between the relevant base and future year MPO model trip tables.

Additional details on trip table development are in Appendix D.

The rate and amount of travel demand growth is projected to vary geographically.

6.1.2. Megaregion Overview

Table 6-1 details the distribution of projected average weekday trips by origin and destination. As with existing travel demand, in the future the largest flows are expected to occur within and between the East Bay, San Francisco, San Mateo County, and Santa Clara County. These regions are projected to account for 56% of all trips and 64% of interregional trips by 2040.



Table 6-1. Average Weekday Megaregional Trips in 2040 (Thousands), Both Directions

The majority (64%) of predicted 2040 interregional trips in the Megaregion continue to involve travel between the East Bay, San Francisco, San Mateo County, and Santa Clara County.

ORIGIN	DESTINATION							
	EAST BAY	SAN FRANCISCO	SAN MATEO COUNTY	SANTA CLARA COUNTY	NORTH BAY	SACRAMENTO AREA	MONTEREY BAY AREA	NORTHERN SAN JOAQUIN VALLEY
EAST BAY	8,901							
SAN FRANCISCO	538	2,791						
SAN MATEO COUNTY	409	691	1,885					
SANTA CLARA COUNTY	672	43	592	6,283				
NORTH BAY	376	146	58	65	2,029			
SACRAMENTO AREA	192	17	8	16	19	9,031		
MONTEREY BAY AREA	15	5	10	188	1	2	2,255	
NORTHERN SAN JOAQUIN VALLEY	226	16	16	57	5	179	8	3,248

Source: PMC analysis of StreetLight and other travel pattern data

Note: Region pairs with higher trip volumes have darker shading in the above and subsequent tables; intraregional pairs (e.g., San Francisco – San Francisco) are not shaded.

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The 41 million average weekday trips across the Megaregion in 2040 represents significant projected growth from 2015: an overall increase of 27%, or 8.8 million trips. **Tables 6-2** and **6-3** break down the distribution of this projected travel growth across the Megaregion, revealing a distinction between fast-growing travel markets and those with large absolute growth.

Within the Bay Area, travel to and from the North Bay is forecast to increase at high rates between 2015 and 2040. In particular, North Bay-Santa Clara County trips are forecast to grow by over 800%, and North Bay-San Mateo County trips are projected to grow by over 150%, although the forecast volumes are relatively low compared to the larger travel flows in the Megaregion. Outside the Bay Area, travel from the Sacramento Area and Northern San Joaquin Valley to San Francisco, San Mateo, and Santa Clara counties is forecast to increase at over 75% for each region pair in each direction.

These high growth rates reflect the disparate population and employment growth rates throughout the Megaregion. While regions, such as the Sacramento Area and the Northern San Joaquin Valley, are projected to record relatively strong population growth, other regions such as San Francisco and Santa Clara County are projected to record relatively strong employment growth, leading to an increased need for travel between the two areas.

On the other hand, the largest absolute growth in travel is expected to occur entirely within the Bay Area. The East

Bay and San Mateo and Santa Clara counties lead this projected growth with an increase of 174,000 daily trips (75% growth over 2015) between the East Bay and San Mateo County in both directions, and 273,000 daily trips (68% growth over 2015) between the East Bay and Santa Clara County. Other region pairs observing notable absolute growth in trips include East Bay–North Bay (175,000 trips in both directions), San Francisco–San Mateo County (150,000 trips), and San Francisco–East Bay (98,000 trips).



Table 6-2. Percent Growth in Average Weekday Megaregional Trips 2015-2040, Both Directions

Halo counties are projected to experience the fastest trip growth rates, but the Bay Area is expected to accommodate the largest absolute growth in travel, particularly in the East Bay and San Mateo and Santa Clara counties.

ORIGIN	DESTINATION							
	EAST BAY	SAN FRANCISCO	SAN MATEO COUNTY	SANTA CLARA COUNTY	NORTH BAY	SACRAMENTO AREA	MONTEREY BAY AREA	NORTHERN SAN JOAQUIN VALLEY
EAST BAY	26%							
SAN FRANCISCO	22%	28%						
SAN MATEO COUNTY	74%	28%	14%					
SANTA CLARA COUNTY	68%	-36%	43%	31%				
NORTH BAY	87%	39%	172%	879%	15%			
SACRAMENTO AREA	57%	117%	75%	135%	55%	25%		
MONTEREY BAY AREA	38%	64%	32%	55%	6%	51%	16%	
NORTHERN SAN JOAQUIN VALLEY	66%	152%	60%	99%	26%	79%	33%	24%

Source: PMC analysis of StreetLight and other travel pattern data

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Table 6-3. Absolute Growth in Average Weekday Megaregional Trips (Thousands) 2015-2040, Both Directions

ORIGIN	DESTINATION							
	EAST BAY	SAN FRANCISCO	SAN MATEO COUNTY	SANTA CLARA COUNTY	NORTH BAY	SACRAMENTO AREA	MONTEREY BAY AREA	NORTHERN SAN JOAQUIN VALLEY
EAST BAY	1,832							
SAN FRANCISCO	98	614						
SAN MATEO COUNTY	174	150	238					
SANTA CLARA COUNTY	273	-24	178	1,493				
NORTH BAY	175	41	37	58	269			
SACRAMENTO AREA	69	9	3	9	7	1,829		
MONTEREY BAY AREA	4	2	3	67	0	1	306	
NORTHERN SAN JOAQUIN VALLEY	90	10	6	29	1	79	2	626

Source: PMC analysis of StreetLight and other travel pattern data

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The projected growth in megaregional travel is accompanied by changes in residents' mode choice. **Tables 6-4 and 6-5** detail the share of trips by region pair that are projected to be made by rail in 2040, reflecting some notable changes between 2015 and 2040.

The rail mode share in the San Francisco to East Bay market is projected to decrease slightly from an average of 46% in both directions in 2015 to 44% in 2040. Nevertheless, given the expected increase in overall trip volumes between the two regions, the absolute number of rail trips is still projected to grow by approximately 16% or 34,000 daily trips. As BART trains continue to fill up with more riders, some potential riders switch to other, less

crowded modes, whether by choice or out of necessity.

On the other hand, other region pairs are forecast to have high increases in rail mode share, including San Francisco to Santa Clara County and the Northern San Joaquin Valley to San Francisco. This increased usage of rail is likely driven by new or enhanced rail service in these corridors, such as enhanced Caltrain service between San Francisco and Santa Clara County and Valley Link service providing improved connectivity between the Northern San Joaquin Valley and much of the Bay Area through more direct service. These projects are described in greater detail in Section 6.2.



Table 6-4. Percent Megaregional Average Weekday Rail Mode Shares by Region Pair (2040), Both Directions

The share of rail trips is projected to decrease slightly for San Francisco-East Bay trips, while increasing substantially in other markets.

ORIGIN	DESTINATION							
	EAST BAY	SAN FRANCISCO	SAN MATEO COUNTY	SANTA CLARA COUNTY	NORTH BAY	SACRAMENTO AREA	MONTEREY BAY AREA	NORTHERN SAN JOAQUIN VALLEY
EAST BAY	1.7%							
SAN FRANCISCO	44.1%	1.0%						
SAN MATEO COUNTY	13.0%	10.8%	0.4%					
SANTA CLARA COUNTY	5.0%	45.6%	2.0%	0.4%				
NORTH BAY	0.8%	1.2%	1.0%	0.0%	0.0%			
SACRAMENTO AREA	2.5%	11.3%	1.3%	2.8%	0.3%	0.1%		
MONTEREY BAY AREA	0.2%	3.1%	0.4%	0.2%	0.0%	0.1%	0.0%	
NORTHERN SAN JOAQUIN VALLEY	1.5%	43.9%	2.5%	0.4%	0.0%	0.1%	0.0%	0.0%

Source: PMC analysis of StreetLight and other travel pattern data

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Table 6-5. Percent Point Change in Average Weekday Rail Mode Shares by Region Pair 2015-2040, Both Directions

ORIGIN	DESTINATION							
	EAST BAY	SAN FRANCISCO	SAN MATEO COUNTY	SANTA CLARA COUNTY	NORTH BAY	SACRAMENTO AREA	MONTEREY BAY AREA	NORTHERN SAN JOAQUIN VALLEY
EAST BAY	0.7%							
SAN FRANCISCO	-2.2%	-0.4%						
SAN MATEO COUNTY	6.1%	-1.1%	-0.2%					
SANTA CLARA COUNTY	4.6%	18.8%	-0.8%	0.3%				
NORTH BAY	0.1%	0.2%	0.2%	0.0%	0.0%			
SACRAMENTO AREA	0.9%	3.7%	0.4%	1.8%	0.1%	0.1%		
MONTEREY BAY AREA	0.0%	2.0%	0.2%	0.0%	0.0%	0.1%	0.0%	
NORTHERN SAN JOAQUIN VALLEY	0.7%	20.2%	1.8%	0.1%	0.0%	0.1%	0.0%	0.0%

Source: PMC analysis of StreetLight and other travel pattern data

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6.1.3. Bay Crossing Focus

In 2015, over one in five interregional trips across the Megaregion involved crossing the San Francisco Bay using one of four crossings (three bridges and the Transbay Tube). This share is projected to hold constant in the coming decades. However, with overall interregional travel increasing, the number of trips crossing the bay is also projected to grow from 675,000 to 949,000 on an average weekday in 2040.

Other current trends observed are also projected to continue through 2040. As illustrated in **Figure 6-1**, the majority of trip ends (93%) on the eastern side of the bay are projected to be associated with the East Bay while San Francisco and San Mateo County account for the majority of western trip ends (95%).

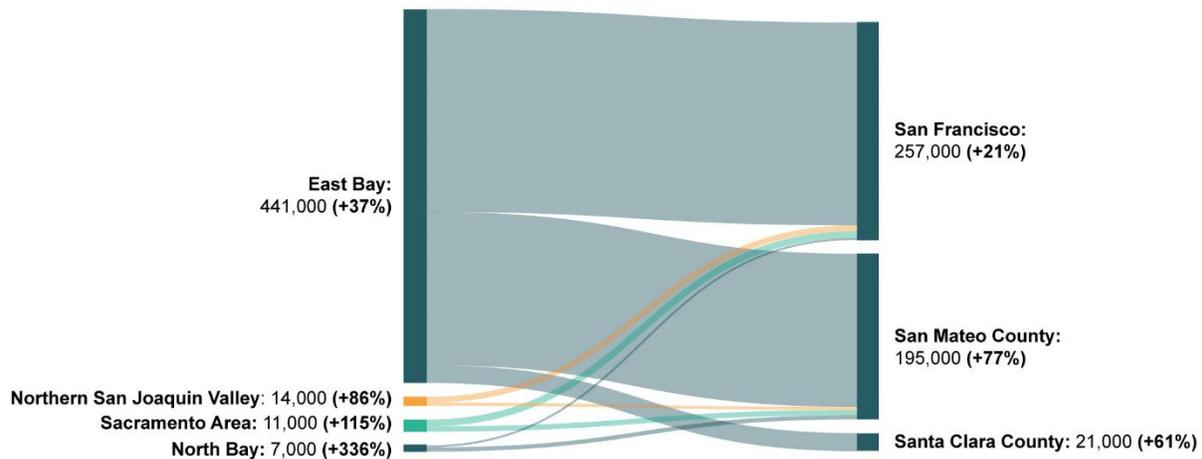
Similarly, the Transbay Corridor is forecast to carry the highest share and volume of bay crossing trips. This

forecast crossing share is at 67% of all bay crossing trips and 70% of trips between the East Bay and San Francisco and San Mateo County. Approximately 638,000 trips in both directions are forecast to use the Transbay Corridor on an average weekday in 2040, representing a 35% increase from 2015 volumes.

Examining individual region pairs reveals growth trends similar to those noted in the previous subsection. San Francisco to/from the North Bay, the Sacramento Area, and the Northern San Joaquin Valley are forecast to be among the fastest growing region pairs with trips growing by 125% to 150% between 2015 and 2040. On the other hand, trips within the Bay Area’s core are forecast to grow by the largest absolute amounts. East Bay-San Mateo County is forecast for an increase of 77,000 daily trips (75% increase), while East Bay-San Francisco is forecast to see an increase of 33,000 daily trips (16% increase).

Figure 6-1. Average Weekday Bay Crossing Roundtrips (2040) and Percent Growth from 2015 (in parentheses)

San Francisco-East Bay is projected to remain the dominant market for trips crossing the bay.



Source: PMC analysis of StreetLight and other travel pattern data

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6.1.4. Transbay Corridor Focus

As noted in the previous subsection, the Transbay Corridor is projected to remain the primary bay crossing in the Megaregion and serve 35% more average weekday trips in 2040 than in 2015, which underscores its strategic location and important role in the megaregional transportation network. By 2040, it is projected to serve a combined 638,000 average weekday trips in both directions.

Note that the forecasts discussed herein are the Baseline Forecasts – forecasts using Horizon Futures PBA 2050 anticipate higher demand levels as a result of the uneven distribution of population and employment in the Bay Area. The impacts of these forecasts to transbay infrastructure are discussed further in Section 6.2.

Figure 6-2 illustrates the origin and destination breakdown of Transbay Corridor trips. Seventy-three percent of trips are forecast to take place between San Francisco and the East Bay (463,000 in both directions) with another 19% between San Mateo County and the East Bay (123,000 in both directions).

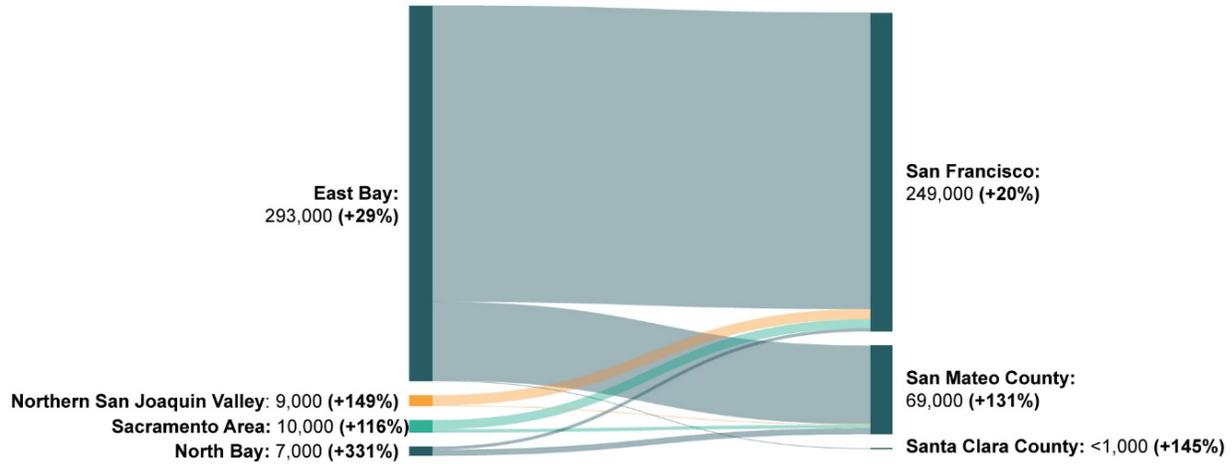
As with travel across the Megaregion as a whole, transbay trip growth between 2015 and 2040 is projected to be fastest for trips between outer regions and the Bay Area and largest by volume for trips within the Bay Area. One exception is the East Bay–San Mateo County region pair, which is projected to grow at a very fast rate (122%) and add a large volume (34,000 average daily trips).

KEY TAKEAWAYS

- The OD distribution of trips across the Megaregion among the various bay crossings and within the Transbay Corridor is expected to remain broadly similar between 2015 and 2040.
- The projected growth in megaregional travel, 8.8 million additional average weekday trips by 2040, represents a 27% increase over 2015.
- In general, interregional travel growth is projected to be fastest for trips between outer regions (such as the Sacramento Area and the Northern San Joaquin Valley) and the Bay Area and largest for trips within the core Bay Area.

Figure 6-2. Average Weekday Transbay Roundtrips (2040) and Percent Growth from 2015 (in parentheses)

San Francisco-East Bay remains the dominant market for trips using the Transbay Corridor.



Source: PMC analysis of StreetLight and other travel pattern data

A large share of forecast megaregional trips start or end in locations that are inaccessible to rail.

Figure 6-3 illustrates the origins of forecast 2040 megaregional trips in relation to rail stations. Even with planned investments to the rail network, only 31% of trips originate within 1 mile of a rail station (corresponding to a reasonable walking access distance), while 74% of trips originate within 5 miles of a rail station (corresponding to a reasonable auto access distance). Both shares represent modest one-point improvements over their respective 2015 shares.

As with 2015, the inaccessibility of rail stations is particularly noticeable in certain areas of the Megaregion that are also associated with high trip volumes,

such as western San Francisco, parts of Santa Clara County, and most of the Sacramento Area.

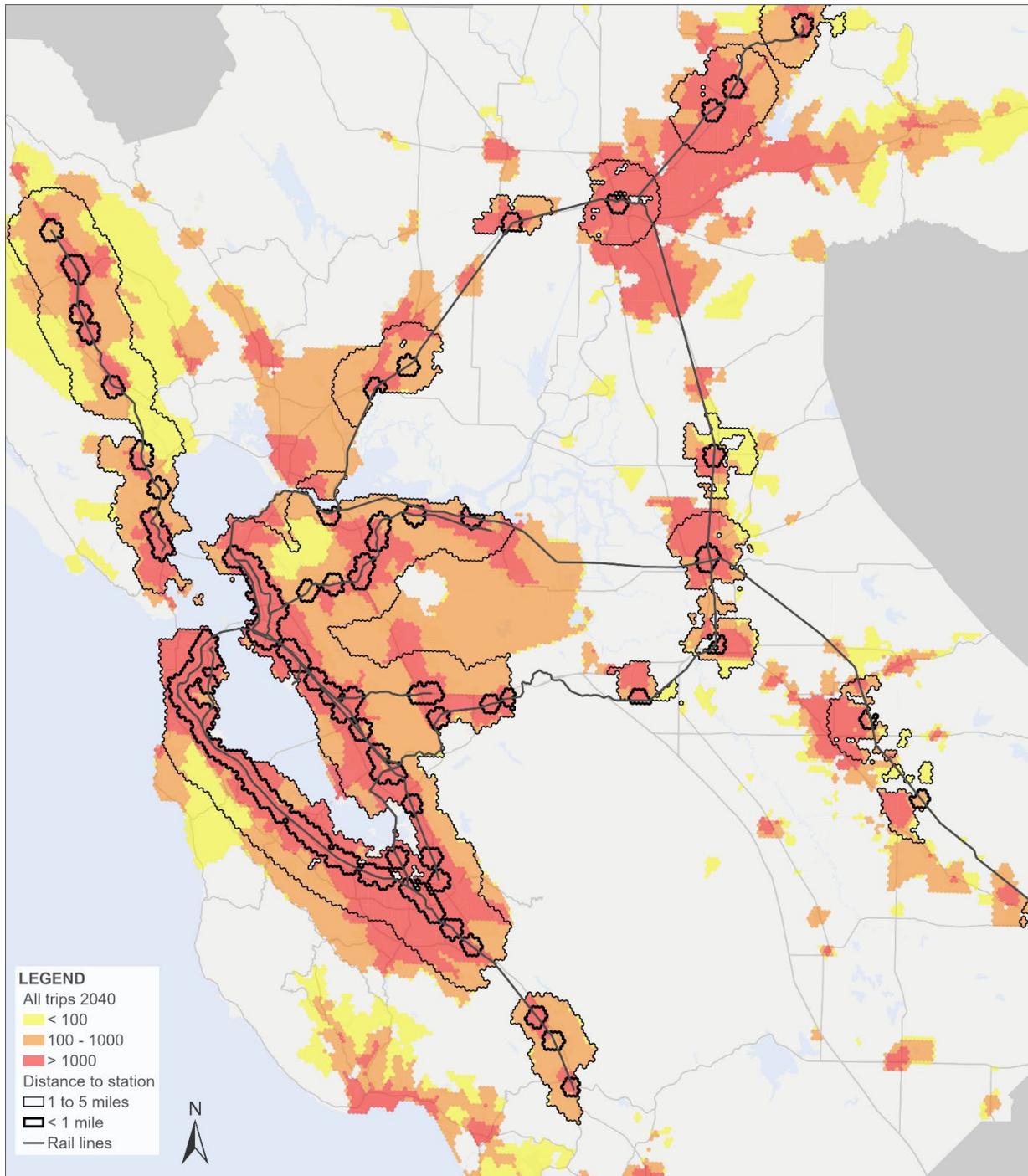
KEY TAKEAWAYS

- As with 2015, less than one-third of megaregional trips in 2040 are forecast to start within reasonable walking distance of a rail station (1 mile), though in reality this reasonable walking distance may be reduced due to poor walking conditions, further reducing the one-third share of trips.
- Similarly, just under three quarters of trips are forecast to start within a reasonable driving distance (5 miles) of a rail station.



Figure 6-3. Average Weekday Trip Origins by Distance from Nearest Rail Station (2040)

Only 31% of megaregional trips in 2040 are forecast to originate within walking distance (1 mile or less) from a rail station.



Source: PMC analysis of StreetLight and other travel pattern data

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6.2. Future Infrastructure and Capacity

This section introduces future investments in the megaregional transportation network, focusing on new and enhanced rail services and comparing their capacity against the projected growing demand for travel described in Section 6.1.

New rail projects and enhanced rail service target certain corridors.

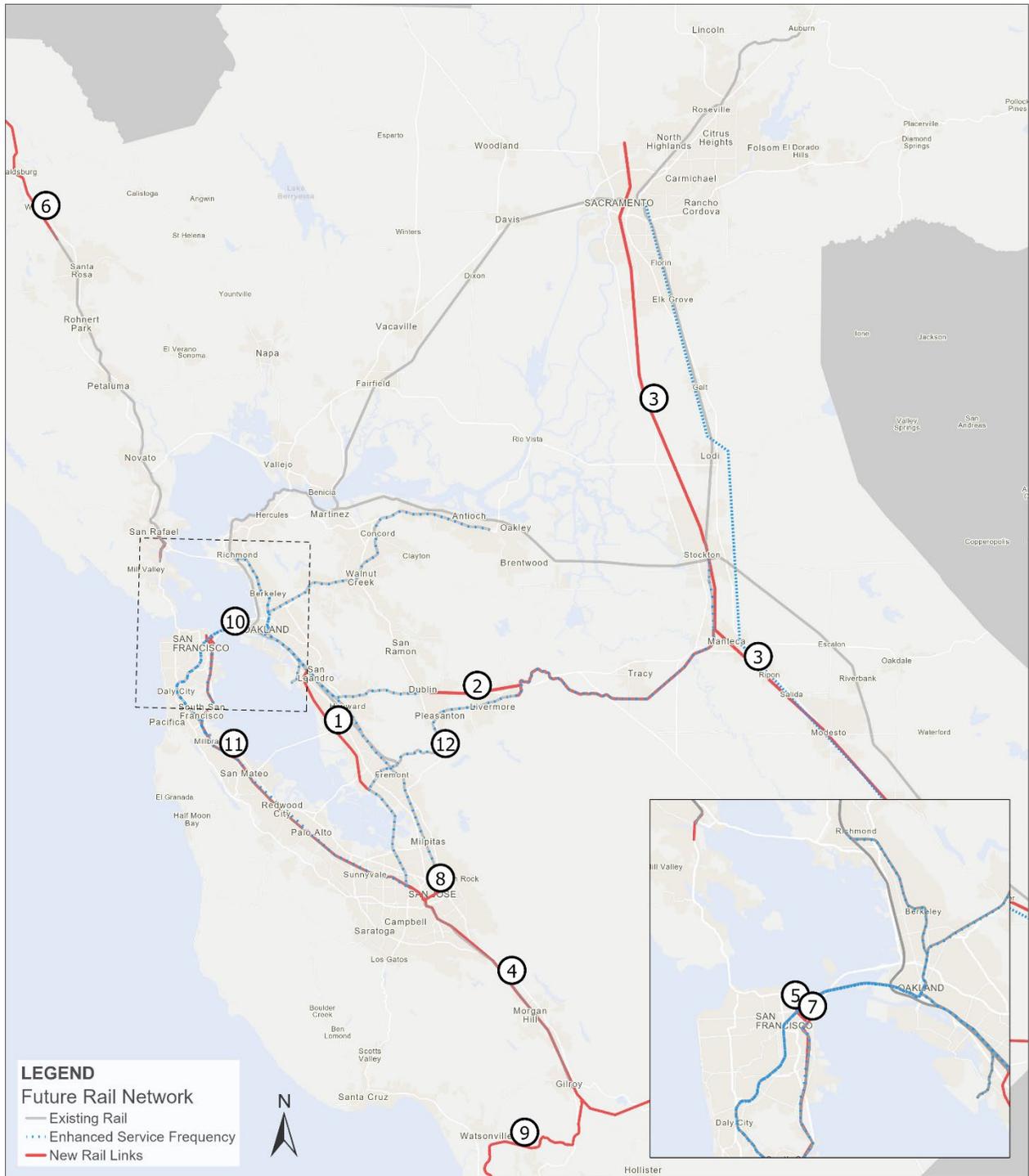
Figure 6-4 illustrates the extent of new and enhanced rail services planned for

the Megaregion by 2040 as recorded by various rail operators in PBA 2050,²⁰ followed by a brief description of each investment. These investments, coupled with existing rail services and infrastructure, collectively make up the future baseline megaregional rail network that various Link21 concepts and alternatives will be screened and evaluated against.

²⁰ At the time of analysis and writing, the PBA 2050 Blueprint was available and represented the latest source of future investments.



Figure 6-4. Overview of the Future Baseline Megaregional Rail Network



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ID	INVESTMENT	DESCRIPTION
NEW RAIL LINKS		
1	South Bay Connect	Reroutes Capitol Corridor between the Oakland Coliseum and Fremont, adding a new station at Ardenwood and reducing travel time between Oakland and San Jose
2	Valley Link	New rail line between North Lathrop and Dublin/Pleasanton BART station, running up to five trains per peak hour and offering a seamless connection between the Northern San Joaquin Valley and the BART network
3	Valley Rail	New rail service between the Northern San Joaquin Valley and the Sacramento Area: five daily trains (operated by ACE) from Merced to Sacramento/Natomas via a new alignment and two additional San Joaquins services between the Merced and Sacramento Valley stations
4	California High-speed Rail	High-speed rail connecting Northern and Southern California with various service patterns connecting stops at San Francisco, Millbrae, San Jose, Gilroy, and Merced within the Megaregion
5	Central Subway	Underground extension of T Third Street light rail line in San Francisco between 4th/King and Chinatown, providing up to 20 trains per hour (tph)
6	Sonoma-Marín Area Rail Transit (SMART) Expansion to Windsor	Northern extension of SMART service to Cloverdale and Windsor, maintaining current frequencies
7	Caltrain Downtown Extension (DTX)	Extension of Caltrain alignment in San Francisco from 4th/King to Salesforce Transit Center; will ultimately serve high-speed rail trains as well
8	BART to Silicon Valley Phase II	Extension of BART Richmond – Berryessa and Daly City – Berryessa service from Berryessa to Santa Clara via San Jose with rail connections at San Jose Diridon, maintaining baseline BART frequencies
9	BART Irvington Station	Infill station at Irvington between Fremont and Warm Springs
10	Monterey County Rail Extension	Extension of Caltrain or Capitol Corridor to Salinas with up to two hourly services
ENHANCEMENTS TO EXISTING RAIL SERVICES		
11	BART Core Capacity	Series of Transbay Tube and associated infrastructure upgrades, enabling frequency increases on all lines and increasing total capacity in the Transbay Tube to 30 tph
12	Caltrain Electrification and 2040 Business Plan	Caltrain corridor electrification from San Francisco and San Jose, enabling higher frequencies (up to 8 tph during the peak) and preparing right-of-way for high-speed rail service
13	ACE Frequency Increase	Increases ACE frequency from four to eight trains per day with four operating in the peak period and direction (westbound AM and eastbound PM) and the remainder distributed throughout the day

Source: PMC analysis of data from various project sponsors

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Capacity investments in the Transbay Corridor are insufficient to serve projected demand growth.

As described in Section 4.2, both crossings in the Transbay Corridor have been operating above their respective planned capacities since 2015 due to constrained infrastructure capacity and growing travel demand.

The Transbay Corridor forecasts shown in this section use scenarios from the Horizon Futures 2050 initiative. The scenarios used here are based on population and employment forecasts in absence of any future interventions without additional transbay rail capacity beyond that provided by BART Core Capacity investments.²¹

6.2.1. Bay Bridge Forecasts

Auto demand already exceeds capacity on the Bay Bridge. As illustrated in **Figure 6-5**, the unconstrained auto demand for the AM peak hour Bay Bridge is forecast to grow, further exceeding capacity. This is despite an expected small increase in Bay Bridge capacity due to the implementation of all-electronic tolling in 2021.

However, unconstrained demand in the most conservative Rising Tides, Falling Fortunes forecast is anticipated to exceed available capacity by 23% in 2050 while the Back to the Future forecast projects unconstrained demand to reach as high as 97% above available capacity. Given that there is a maximum capacity limit for the Bay Bridge, much of this unconstrained transbay demand

will likely not be accommodated by the Bay Bridge.

6.2.2. Transbay Tube Forecasts

Like the Bay Bridge, BART transbay demand has exceeded available capacity since 2015, as described in Section 4.2. While the Transbay Tube planned capacity improvements will provide some relief, most notably the BART Core Capacity project increasing Transbay Tube capacity from 22 to 28 tph per direction, demand for travel through the Transbay Corridor is still forecast to grow over the next several decades, reaching 53,000 trips per average weekday peak hour by 2050 (under the Baseline Forecast), which is an 85% increase over 2015 volumes.

Figure 6-6 illustrates that the planned capacity increases in the Transbay Tube will be insufficient to accommodate projected travel growth according to several future scenarios estimated by the MTC. Under the most aggressive growth Clean and Green Forecast, 2050 demand for westbound BART travel during the AM peak hour could exceed the Transbay Tube's planned capacity, inclusive of Core Capacity upgrades, by 107% by 2050. Conversely, even under a more conservative Baseline Forecast, 2050 demand is likely to exceed capacity by 54%.

²¹ Scenarios used here are from the Horizon Futures 2050 *Project Performance Runs* that consider the

impact of external forces but no new projects or strategies.



KEY TAKEAWAYS

- Even with planned capacity improvements, both Transbay Corridor crossings are projected to be operating well above capacity in 2050 and beyond.
- Under the most aggressive demand growth scenario, by 2050 the BART Transbay Tube could be operating at 107% above and

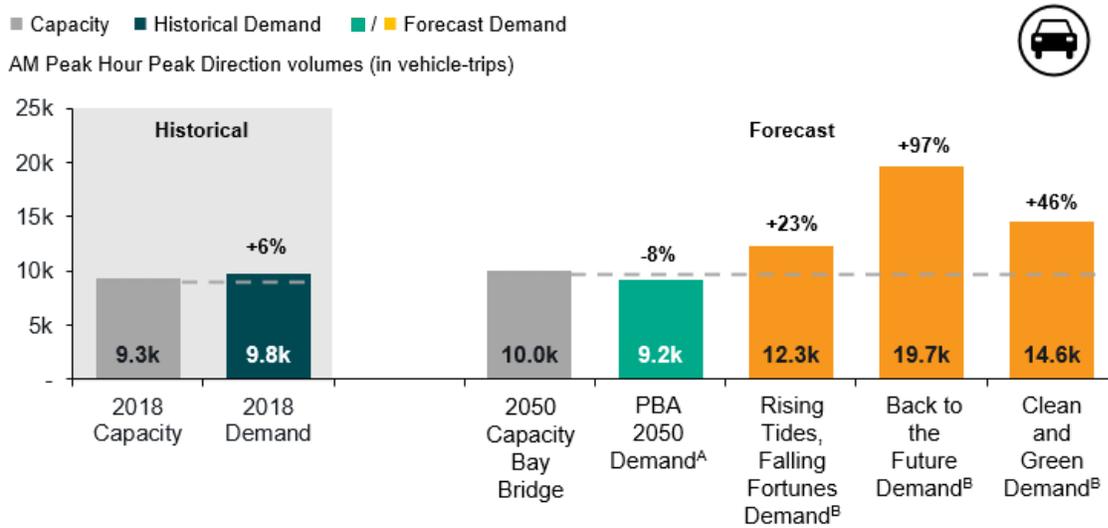
the Bay Bridge at 97% above their respective planned capacities.

- The large disparity between unconstrained demand and planned available capacity underscores the need for substantial investment in a new crossing to serve all projected demand.



Figure 6-5. AM Peak Hour Peak Direction Volumes vs Capacity for Bay Bridge (in vehicle trips)

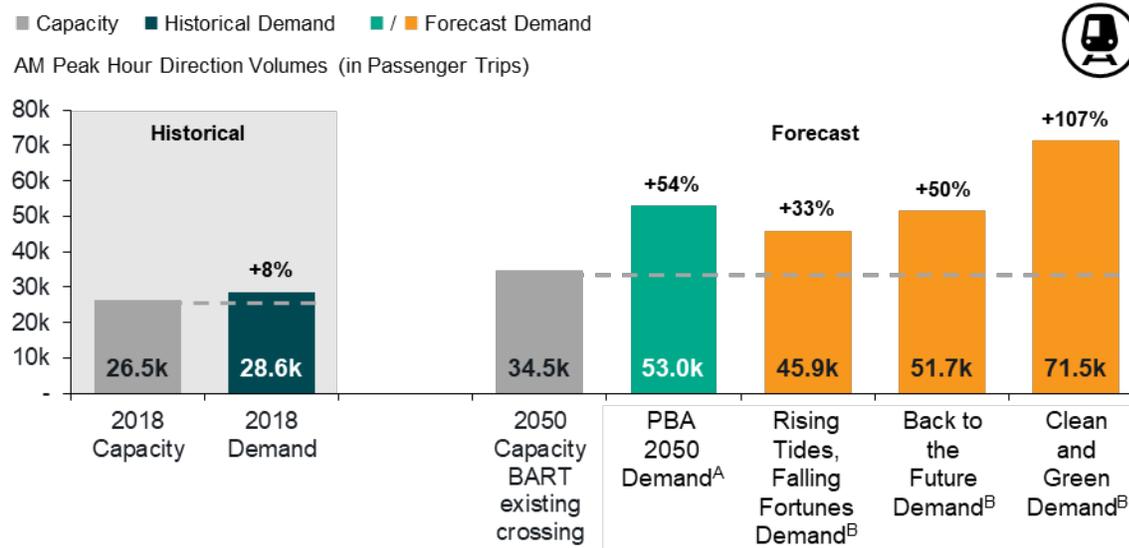
With demand already exceeding capacity, transbay auto demand is expected to continue to grow, putting further strain on the Bay Bridge.



Source: PMC analysis of MTC travel model data

Figure 6-6. AM Peak Hour Direction Volumes vs Capacity for Transbay Tube (in passenger trips)

While the Core Capacity project will increase capacity on the Transbay Tube, unconstrained demand is forecast to exceed available capacity, even in the most conservative Baseline Forecast.



Source: PMC analysis of MTC travel model data

^A Includes the Link21 Program as in the recently adopted PBA 2050.

^B Excludes PBA 2050 projects.

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6.3. Summary

There is continued growth in travel demand, albeit unevenly distributed.

The Megaregion is projected to experience substantial growth in travel. By 2040, 8.8 million additional average weekday trips are forecast, representing a 27% increase over 2015 volumes. This growing demand for travel can be attributed to the projected size and distribution of population and employment growth across the Megaregion.

While the OD distribution of trips across the Megaregion is expected to remain broadly similar between 2015 and 2040, the distribution of projected travel demand growth is more uneven. Among interregional trips, growth is projected to be fastest for trips between outer regions (such as the Sacramento Area and the Northern San Joaquin Valley) and the Bay Area with some region pairs recording growth rates above 150% over the 25-year span. Such fast growth is likely driven, at least in part, by imbalanced population and employment growth. The outer regions are projected to accommodate a relatively large share of population growth, while the Bay Area is projected to accommodate a similarly large share of employment growth, leading to an increased need for travel between them.

Conversely, travel within the Bay Area, particularly its core regions of San Francisco, San Mateo County, Santa Clara County, and the East Bay, is projected to grow by large absolute amounts. In particular, demand for travel through the Transbay Corridor is

projected to grow 35% from 474,000 average weekday trips in both directions in 2015 to 638,000 by 2040, which is driven by an increasing geographic imbalance of population and employment growth across the Megaregion.

Planned Transbay Corridor capacity improvements will likely be insufficient to serve growing demand.

The significant growth in Transbay Corridor travel is likely to further strain the already overcrowded and congested crossings, even when accounting for planned capacity increases to the Transbay Tube and the Bay Bridge. The BART Core Capacity project will enable an additional 6 tph to travel through the Transbay Tube (from 22 to 28 tph in each direction), whereas the implementation of all-electronic tolling has provided a slight boost to the Bay Bridge's vehicle capacity.

Despite these investments, travel demand is projected to exceed planned capacity by the early 2030s at the latest, as illustrated in Figures 6-5 and 6-6. Of the range of demand growth scenarios analyzed, the most aggressive one could result in the Transbay Tube operating at 120% above its planned capacity by 2050 and the Bay Bridge at 97% above its planned capacity. Conversely, the most conservative growth scenario could result in the planned Transbay Tube and Bay Bridge capacities exceeded by 18% and 23%, respectively.

The disparity between forecast demand growth and planned capacity increases indicates that incremental capacity investments will likely be insufficient to meet travel demand within the next decade, and network constraints will



likely continue to degrade the rail passenger experience. It underscores the need for substantial investment in a new crossing to serve the entirety of projected demand growth and deliver a high-quality passenger experience for decades to come.

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SECTION IV: RAIL POTENTIAL ANALYSIS

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7. MARKET ANALYSIS APPROACH

The market analysis seeks to inform the development of program concepts by identifying entire markets and individual corridors with the greatest unmet ridership potential for new or improved rail service in the Megaregion. It does so by deploying a regression model and a custom spreadsheet tool to estimate the unmet rail potential for a given market or corridor.

Two additional themes informed the overall approach to the market analysis:

1. **Equity** is central to all aspects of Link21 work. Trips made by priority populations are double counted when estimating unmet rail potential (equity-weighted), reflecting the importance of serving areas with high priority populations shares and totals.
2. Given the central role the Transbay Corridor plays in Link21, the market analysis focused on enabling **transbay trips** that use the Transbay Corridor to cross the bay between San Francisco and Oakland. However, non-transbay trips could also realize meaningful benefits from Link21-related investments and network/service improvements.

This chapter provides an overview of the market analysis approach. Additional details on this approach are provided in subsequent chapters.



7.1. Purpose of the Market Analysis

The market analysis informs the development of program concepts by identifying high potential markets and corridors.

As introduced in Chapter 1, Link21 aims to transform the passenger rail experience in the Megaregion. In doing so, it would enable wider goals to enhance the Megaregion's equity, livability, economic opportunity, and environmental quality, and to deliver benefits to residents and workers across the Megaregion.

The market analysis seeks to inform the development of program concepts by identifying entire markets and individual corridors with the greatest unmet ridership potential for new or improved rail service in the Megaregion. It does so by asking two main questions:

1. Where do people want to travel?
2. Which locations have the greatest potential to support new or additional/improved rail service?

7.2. Overall Approach

Figure 7-1 provides an overview of the market analysis approach. Chapters 1-6 described existing and future socioeconomic and travel conditions. The remaining steps are described in subsequent subsections and include:

1. Identifying high potential market opportunities: locations and location pairs that may be served by rail.

The development of program concepts builds upon the planned rail network, included in the MPO adopted regional transportation plans (the Link21 Baseline is described in Appendix G).

In addition to the market analysis, other sources inform the development of program concepts, including other plans (such as the *2018 California State Rail Plan* and individual rail operators' plans or visions, stakeholder engagement, co-creation workshops, and public outreach).

Note that **the Market Analysis is not a demand forecasting exercise**. It aims to identify travel markets and corridors with large numbers of potential rail passengers, whereas a demand forecast aims to estimate the ridership for a specific rail service.

2. Identifying high potential corridor opportunities: geographically proximate bundles of markets that may be served by rail.
3. Testing corridor performance under several future scenarios as part of an uncertainty analysis.



Figure 7-1. Overview of Market Analysis Components

The market analysis first assesses existing and future socioeconomic and travel conditions, then it provides insight into markets and corridors with high unmet ridership potential, which informs the development of program concepts.



The market rail potential analysis focuses on identifying specific markets with high ridership potential.

The market analysis identifies individual neighborhoods or entire municipalities that could generate sufficient ridership potential to support future new or additional rail service. The entire Megaregion is covered by hexcells that are uniform hexagonal areas, 0.5 miles in diameter. Clusters are a group of multiple hexcells. They are the main geographic unit of analysis for the market analysis, and they represent neighborhoods or municipalities. Clusters are comprised of a hub at the center of a cluster and its surrounding area. Additional details on the geographic definitions used in the market analysis are provided in Appendix B.

The market rail potential analysis identifies clusters and cluster pairs with the greatest unmet potential with an emphasis on equity in the outputs. Unmet potential is defined as follows:

- **Baseline ridership** represents rail demand assuming land use and

projects included in adopted MPO plans.²²

- **Good service rail potential** (or total rail potential) represents rail demand under an 'idealized network' with (potentially unrealistic) good rail service and no crowding between all cluster pairs in the Megaregion.
- **Unmet rail potential** is the difference between good service rail potential and baseline ridership. It measures the number of additional riders that could be captured with new or additional/improved rail service.

Unmet rail potential outputs may then be further analyzed as follows:

- **Equity-weighted:** potential trips made by priority populations living in the origin or destination clusters are counted twice, which is consistent with FTA guidance on equity analysis. Current priority populations' usage of rail may be particularly detached from overall demand for rail due to historic underinvestment that makes rail harder to access and/or less convenient. As such, serving communities with high shares of

²² Additional details on future projects included in adopted MPO plans under the baseline are provided in Appendix G.



priority populations and delivering benefits to them is a point of emphasis for Link21.

- **Miles-weighted** demand between two clusters is weighted by the rail distance between them, which elevates the importance of long distance trips and their impacts on key program objectives, such as environmental stewardship and public health and safety.
- **Transbay trips** associated with a given cluster, crossing the bay using the Transbay Corridor between San Francisco and Oakland versus total trips to or from that cluster.

Unmet potential is estimated using a regression model that is custom specified to identify conditions that enable high rail ridership in the Megaregion. This model estimates rail potential as a function of key factors, including socioeconomic characteristics of clusters (such as population and employment density) and rail level of service characteristics (such as travel time, cost, frequency, and transfers).

The regression model is then applied in a spreadsheet (Market Analysis Spreadsheet Tool or MAST) to calculate the good service rail potential and unmet rail potential for all cluster pairs in the Megaregion. The tool also incorporates crowding constraints and future population and employment growth in estimating the future unmet rail potential.

Additional details on the analysis and tools used to inform the market (and subsequent corridor) rail potential analysis are provided in Chapter 8 and Appendix B.

The main output of this step is a series of markets with high unmet rail potential, which serves as an input to the next step, the corridor rail potential analysis.

The corridor rail potential analysis bundles markets into corridors that could be served by rail.

Once high potential individual markets have been identified, a second step is to identify corridors that could be served by rail. Corridors are defined as geographically proximate and bundled sets of high potential markets (clusters), and, at this point, they do not take into account engineering, operational, or cost considerations. They may consist of multiple segments, which are shorter components of a longer corridor.

The methodology and dimensions of the corridor rail potential analysis are similar to those of the market rail potential analysis described in the prior subsection. Unmet rail potential is estimated using the regression model and MAST. It is then weighted by priority populations share, and transbay trips are broken out separately.

The main output of this step is a list of corridors and segments with high unmet rail potential. These corridors and segments directly inform the development of program concepts alongside other sources.



The uncertainty analysis considers several future scenarios in testing the robustness of the outputs from the market and corridor rail potential analyses.

The uncertainty analysis enables the prioritization of corridors and segments that perform well under a variety of possible future scenarios, and it ensures the analysis can be future-proof by considering how travel demand patterns could change from today's estimates as land use patterns and rail competitiveness evolve.

Within the context of the market analysis, the uncertainty analysis focused on the following five key parameters:

1. Housing growth and patterns
2. Job growth and patterns
3. Working patterns
4. Travel costs
5. Baseline projects

The goal of this analysis is to compare the relative performance of corridors, specifically changes in the ranking of corridors and segments, between each of the several uncertainty scenarios and the baseline corridor analysis.

The uncertainty analysis approach was designed to test the impacts on equity-weighted unmet rail potential of changes to the five key parameters, which were judged to have the potential to substantially affect the **relative** performance of corridors, segments, and cluster pairs.

More information about these scenarios and their outcomes is provided in Chapter 10.

Other key considerations in developing and applying the market analysis approach were examined.

Below are some other key considerations and limitations of the approach to the three steps described in preceding subsections.

- The analysis focuses primarily, but not entirely, on transbay markets.
- It focuses on trips longer than 3 miles, as shorter-distance trips are not transbay and would likely be better served by other modes in much of the Bay Area.
- The primary output of the market analysis is unmet rail potential, as it is a key informant of where to provide new or additional/improved rail service. However, total (good rail service) rail potential can also be an important consideration when evaluating and comparing markets and corridors.
- It includes induced trips but not land use impacts. Induced trips are those that are directly attributable to new or improved rail service. Land use impacts may include new development or zoning policies attracting large amounts of new housing construction, and thus travel demand, to certain areas.
- Equity is central to Link21 and the market analysis. Trips made by priority populations are double counted when analyzing unmet rail potential to reflect the importance of serving these communities.
- The market analysis estimates rail potential, which is one of several



- criteria for evaluating program concepts and alternatives. These other criteria need to be examined and analyzed alongside unmet rail potential when developing and evaluating concepts and alternatives.
- While the market analysis identifies markets with high rail potential, it does not necessarily mean rail is the best transit mode to serve those markets. It could be that some other transit modes would serve the market more effectively.
- Good service rail potential, and thus unmet rail potential, varies depending on service assumptions that define good service (speed/travel time, frequency, and fares).

7.3. Summary

The market analysis approach considers markets and corridors positioned to benefit from rail.

The Link21 market analysis goes beyond a typical market analysis, which considers existing and future travel patterns in the light of socioeconomic and demographic trends. It focuses on identifying markets and corridors that might be best served by rail, deploying a regression model and a custom spreadsheet tool to estimate the unmet rail potential for a given market or corridor. This unmet rail potential is subsequently used to inform the development and evaluation of program concepts.

Equity and transbay trips are the core themes behind the analysis.

Equity is central to all aspects of Link21 work. Trips made by priority populations are double counted when estimating unmet rail potential, reflecting the importance of serving areas with high priority populations shares and totals.

Given the central role the Transbay Corridor plays in Link21, the market analysis focuses on enabling transbay trips that use the Transbay Corridor to

cross the bay between San Francisco and Oakland. However, non-transbay trips could also realize meaningful benefits from Link21-related investments and network/service improvements.

The uncertainty analysis tests the robustness of the market analysis outputs.

Given the inherent uncertainties in the inputs and assumptions used in the market analysis (compounded by the impacts of the COVID-19 pandemic), the uncertainty analysis is an important component of the overall approach. It allows Link21 to future-proof the analysis by considering how travel demand patterns could change from today's estimates as land use patterns, mobility trends, and competitiveness of rail service evolve.



8. MARKET RAIL POTENTIAL ANALYSIS

The purpose of the market rail potential analysis is to identify markets, defined by clusters and cluster pairs, with the highest ridership potential for Link21 by focusing on trips using the Transbay Corridor between San Francisco and Oakland. As mentioned in Chapter 7, the analysis emphasizes equity by doubling potential trips made by priority populations, reflecting the central role that equity plays in Link21.

The high potential markets identified in this analysis inform the next step in the market analysis — the corridor rail potential analysis where markets are grouped into corridors and segments that may directly inform program concept development.

This chapter examines the approach and tools behind the market (and corridor) rail potential analysis, that were introduced in the previous chapter, in greater detail. It also presents key insights and takeaways from the market rail potential analysis.



8.1. Rail Potential Model and Application Approach

The rail potential model is a regression model that determines the factors driving high rail ridership.

The core purpose of this model is to determine the factors driving high rail ridership. This provides a basis for identifying corridors with high rail potential, though not for forecasting ridership in these corridors. Therefore, a regression model was developed to identify the conditions that enable high rail ridership in the Megaregion. The model parameters were estimated using observed data by fitting a regression to 2015 observed ridership data by cluster pairs.

This model estimates rail potential as a function of key factors, including:

- Hub and cluster socioeconomic characteristics
- Travel characteristics

The regression model contains socioeconomic characteristics of clusters, such as population and employment density, propensity to use rail, and parking costs, as well as rail level of service characteristics, such as travel time, cost, frequency, and transfers.

Different variable combinations were calibrated against a 2015 baseline of observed rail ridership for cluster pairs with existing rail service (i.e., only

clusters for hubs that represent existing rail stations).

There are 202 clusters throughout the Megaregion of which 122 have existing rail service. The key drivers of the rail market potential of a cluster pair are:

- Socioeconomic data (population and employment at both ends of the cluster pair)
- Propensity to use rail/transit depending on market segmentation (explained further in Appendix E)
- Rail level of service characteristics (journey time, cost, frequency, and transfers)
- Whether the trip is transbay or not
- Time period (peak/off-peak) of travel
- Trip distance
- Parking costs at both ends of the cluster pair
- Whether one end of the cluster pair is an end-of-the-line BART station or a rail station that is far from any other rail station; end-of-the-line BART stations or rail stations that are far from other stations tend to have large catchment areas and higher market potential

The full list of rail demand drivers and their estimated impacts (regression coefficients) is presented in **Table 8-1**.



Table 8-1. Rail Demand Drivers and Estimated Impacts

Model coefficients show the drivers of rail demand in the Megaregion and their impacts on demand.

VARIABLE	COEFF.	NOTES
Population/employment	1.00	If population/employment increases by 10%, forecast trips should increase by broadly 10%
Rail journey time (minutes)	-0.83	If rail journey time decreases by 10%, forecast trips should increase by 8.3% – this is in line with most benchmarks
Rail cost (dollars)	-0.35	If rail cost decreases by 10%, forecast trips should increase by 3.5% – this is in line with (or slightly more sensitive than) most benchmarks
Rail frequency (trains per hour)	0.23	If rail frequency is increased by 10%, forecast trips should increase broadly by 2.3%
Rail transfers (binary indicator of rail-rail transfers)	-0.52	The impact is a flat -0.52; however, the relative impact varies by trip length It is equivalent to a penalty of approximately 25 minutes in a 35-mile trip and 50 minutes on an 85-mile trip
Transbay marker	1.25	Transbay trips have higher demand
Off-peak marker	-0.40	Off-peak trips have lower demand
Long distance marker (>=30 miles)	-0.96	Long distance trips have lower demand
Longer distance marker (>=90 miles)	-2.40	Very long-distance trips have lower demand
Short distance marker (<=3 miles)	-1.37	Short distance trips have lower demand
Shorter distance marker (<=2miles)	-1.28	Very short distance trips have lower demand
Parking cost marker (parking cost exists)	0.62	Trips with auto parking costs (e.g., downtown San Francisco) have higher demand
BART end-of-line marker	0.83	Trips that have an extended park-and-ride area have higher demand
Widely spaced stations (>=5 miles from other stations)	1.12	Stations that are far from other stations have higher demand
Constant	-15.36	No conventional interpretation; estimated only to maintain statistical validity of overall model
R²	0.51	
Total Error (%)	-8.6%	

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The rail potential model is applied in a spreadsheet tool to identify corridors with high unmet rail demand.

The MAST identifies markets and corridors with high unmet rail potential in the Megaregion by applying the rail potential model and incorporating:

- Rail vehicle crowding impacts
- Future year growth
- Good service rail potential

Future year unmet rail potential is determined by calculating the difference between the 2040 good rail service scenario and the 2040 baseline.

The underlying formula for unmet demand in the future year of 2040 is:

$$\text{Unmet Rail Potential (2040)} = \text{Good Rail Service Potential} - \text{Baseline Ridership}$$

- **Unmet rail potential** is the difference between good rail service potential and baseline ridership.

Good rail service potential

represents rail potential under an idealized network with (potentially unrealistic) good rail service and with no crowding between all cluster pairs in the Megaregion.

- **Baseline ridership** represents rail demand assuming land use, future year growth (including the impact of population and employment growth), and projects included in the adopted MPO plans (PBA 2040 in the case of the Bay Area).

A crowding curve was estimated that assumes some people choose not to use rail services when there are crowded conditions. The crowding curve in **Figure 8-1** shows that as a train gets more crowded (i.e., load factor increases), the capture rate — defined as the share of a given set of travelers who are willing to use a rail service — decreases. Note that the presence of crowding causes the capture rate to decrease just before the load factor²³ hits 100% of planning capacity.

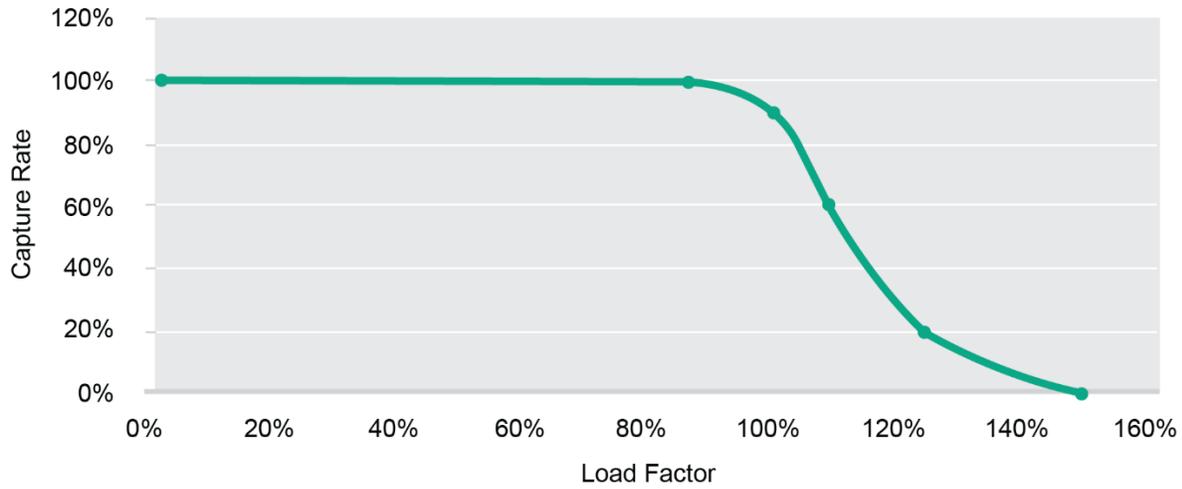
Crowding affects the transbay market more than the non-transbay market, as demonstrated in Chapters 4 and 6. Without the future baseline improvements, significant demand is lost to crowding.

²³ Load factor is defined as the ratio between the number of passengers estimated to be in a rail car and its available planning capacity.



Figure 8-1. Crowding Curve

As trains get more crowded, travelers begin to divert to other modes of travel.



Future year growth includes population and employment growth in addition to the inclusion of future baseline projects from adopted MPO plans.

The model responded positively to population and employment growth with total daily rail potential growing slightly faster than population and employment (approximately 28% for population/employment vs. 33% for rail potential). It is reasonable that rail potential grows faster than population/employment because clusters with rail service are expected to grow faster than clusters without rail service.

Good rail service is a theoretical concept of service that is fast, frequent, affordable, direct, and has plenty of available seats (whether plausible or not). For the model application, it provides a consistent basis to assess the relative ridership potential across cluster pairs.

Good rail service assumptions differ by trip distance:

- For longer distance trips, a competitive travel time, direct service, and sufficient frequency to enable reasonable flexibility regarding travel time choice are likely to be critical factors.
- For shorter distance trips, high frequency, high capacity, and direct service are likely to be critical factors.

To account for these differences, the definition of good rail service is segmented by trip length²⁴ to account for trips better served by a good level of regional rail service versus a good level of urban rail service.

The segmentation is as follows:

- Trips lower than 30 minutes → urban rail
- Trips higher than 90 minutes → regional rail

²⁴ Trip length includes both access and egress time.



- Trips between 30-90 minutes → test urban and regional rail and take the maximum unmet rail potential of the two

The definition of good service for urban and regional rail is shown in **Table 8-2**. More details on the definition of good rail service are provided in Appendix B.

Table 8-2. Good Rail Service Definitions

Good rail service assumptions vary between urban and regional rail.

RAIL SERVICE CHARACTERISTIC	URBAN RAIL	REGIONAL RAIL
Rail travel time	Whichever is lower: <ul style="list-style-type: none"> ▫ Rail travel time based on 40 mph average speed ▫ 120% of auto travel time 	Whichever is lower: <ul style="list-style-type: none"> ▫ Rail travel time based on 50 mph average speed ▫ 120% of auto travel time
Rail cost	Whichever is lower: <ul style="list-style-type: none"> ▫ \$2 + \$0.10 per mile (minimum of \$2.10) ▫ 150% of auto cost 	Whichever is lower: <ul style="list-style-type: none"> ▫ \$0.25 per mile ▫ 150% of auto cost
Peak rail frequency	Whichever is higher: <ul style="list-style-type: none"> ▫ 8 tph ▫ tph following BART Core Capacity project 	Peak: 4 tph
Off-peak rail frequency	5 tph	2 tph
Rail transfers	No transfers	No transfers
Rail crowding	No crowding	No crowding

The following charts show the gradual impacts of each of these changes summarized for all ODs. **Figure 8-2** shows future year impacts on peak trips by showing how 2040 baseline trips were developed from 2015 (base year) baseline trips. Crowding first depresses base year trips by 7%, (i.e., a certain number of potential rail trips are not accommodated because travelers are unable or unwilling to board crowded trains). Future population and employment growth and baseline service improvements then combine to account

for a 62% increase in trips between 2015 and 2040. This 2040 demand is subsequently depressed by 9% to account for future levels of crowding. **Figure 8-3** shows how good rail service impacts were applied to future year data (which is grown in Figure 8-2; the first column *Future year – baseline* in Figure 8-3 is the same as the final column in Figure 8-2). It shows that improving travel times to good rail service standards and eliminating transfers had the largest impacts on rail potential at +22% and +16%, respectively. The impacts in the

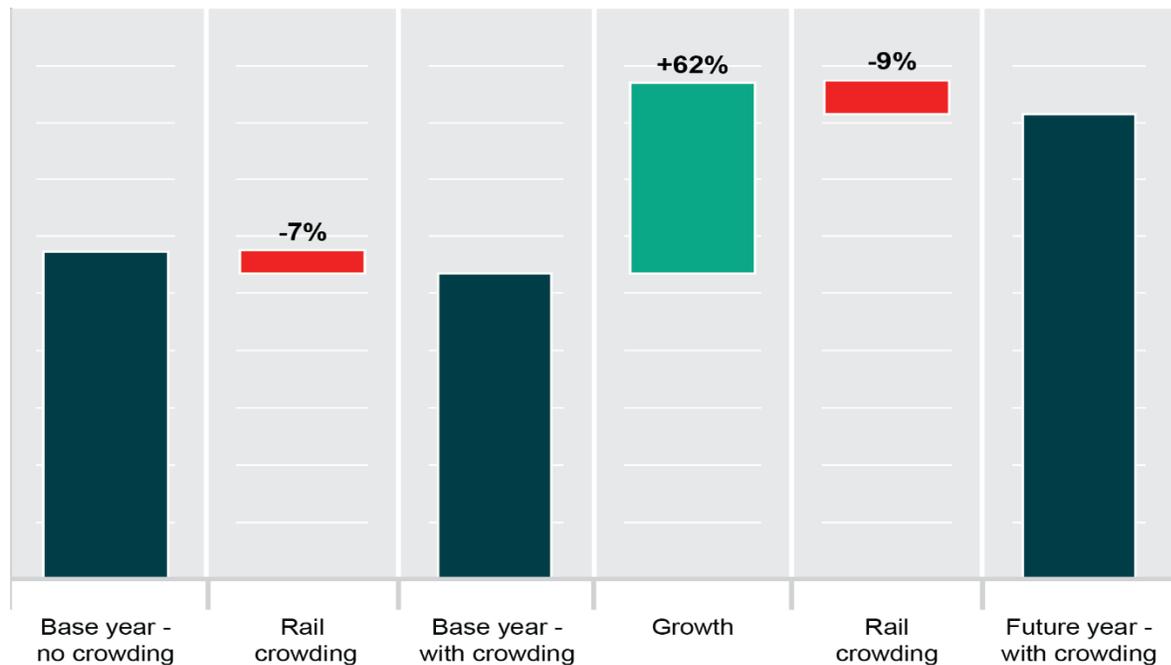


peak period and for transbay trips are higher than those for average daily megaregional trips.

The MAST produced a ranked list of cluster pairs by unmet rail potential. The ranked list of cluster pairs was then grouped into corridors that will inform the development of program concepts.

Figure 8-2. Future Year Impacts, 2040

Population and employment growth and baseline service improvements caused a 62% increase in demand from baseline ridership, while crowding reduced demand by 7% and 9% in the existing and future years, respectively.

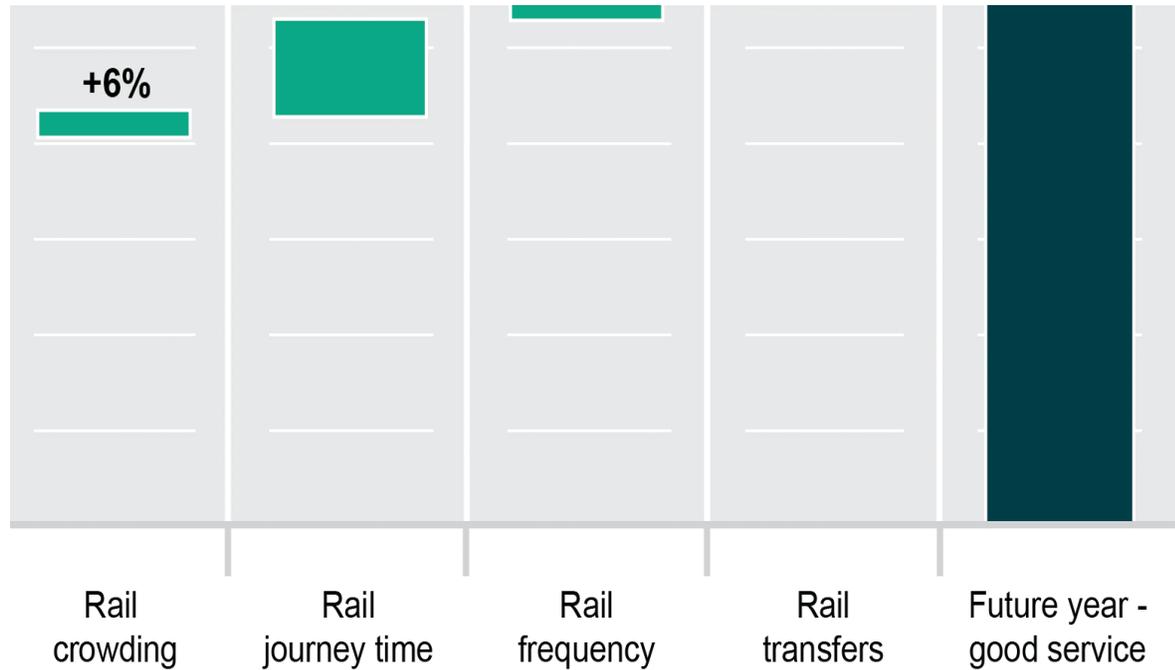


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Figure 8-3. Good Rail Service Impacts, 2040

The largest benefits came from improved journey times (+22%) and eliminating transfers (+16%).



8.2. Key Insights

Good transbay rail service benefits people across the Megaregion.

Figure 8-4 illustrates the transbay equity-weighted good rail service (or total) potential for all clusters in the Megaregion, showing that all clusters stand to benefit when good transbay rail service is provided. Of all good rail service potential for trips greater than 3 miles throughout the Megaregion,

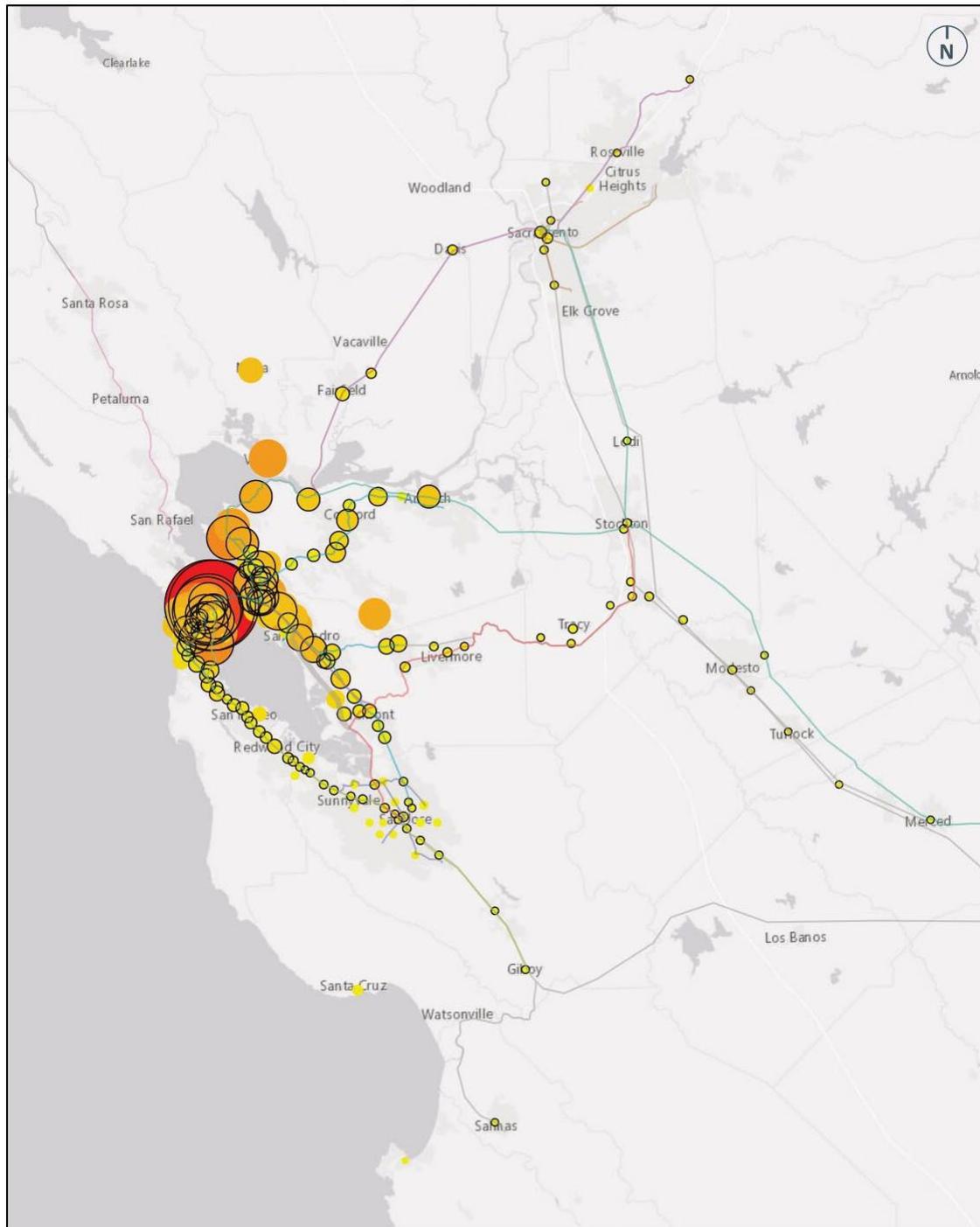
including transbay and non-transbay trips, 46% involve a trip using the Transbay Corridor. The transbay good rail service potential is particularly concentrated in clusters at the core of the Megaregion, notably San Francisco, Alameda, and Contra Costa counties. Areas with relatively high total transbay potential but without an existing or planned rail station include San Pablo, Vallejo, and San Ramon.

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Figure 8-4. Transbay Equity-weighted Good Rail Service Potential (number of potential trips), 2040

Forty-six percent of good rail service potential involves a trip in the Transbay Corridor.



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A new transbay passenger rail crossing could substantially increase transbay rail ridership across the Megaregion.

Figure 8-5 illustrates where the potential for attracting new rail riders is located (i.e., unmet rail potential) by subtracting the baseline rail ridership from the good rail service potential shown in Figure 8-4. Substantial unmet potential can be found throughout the Megaregion with a

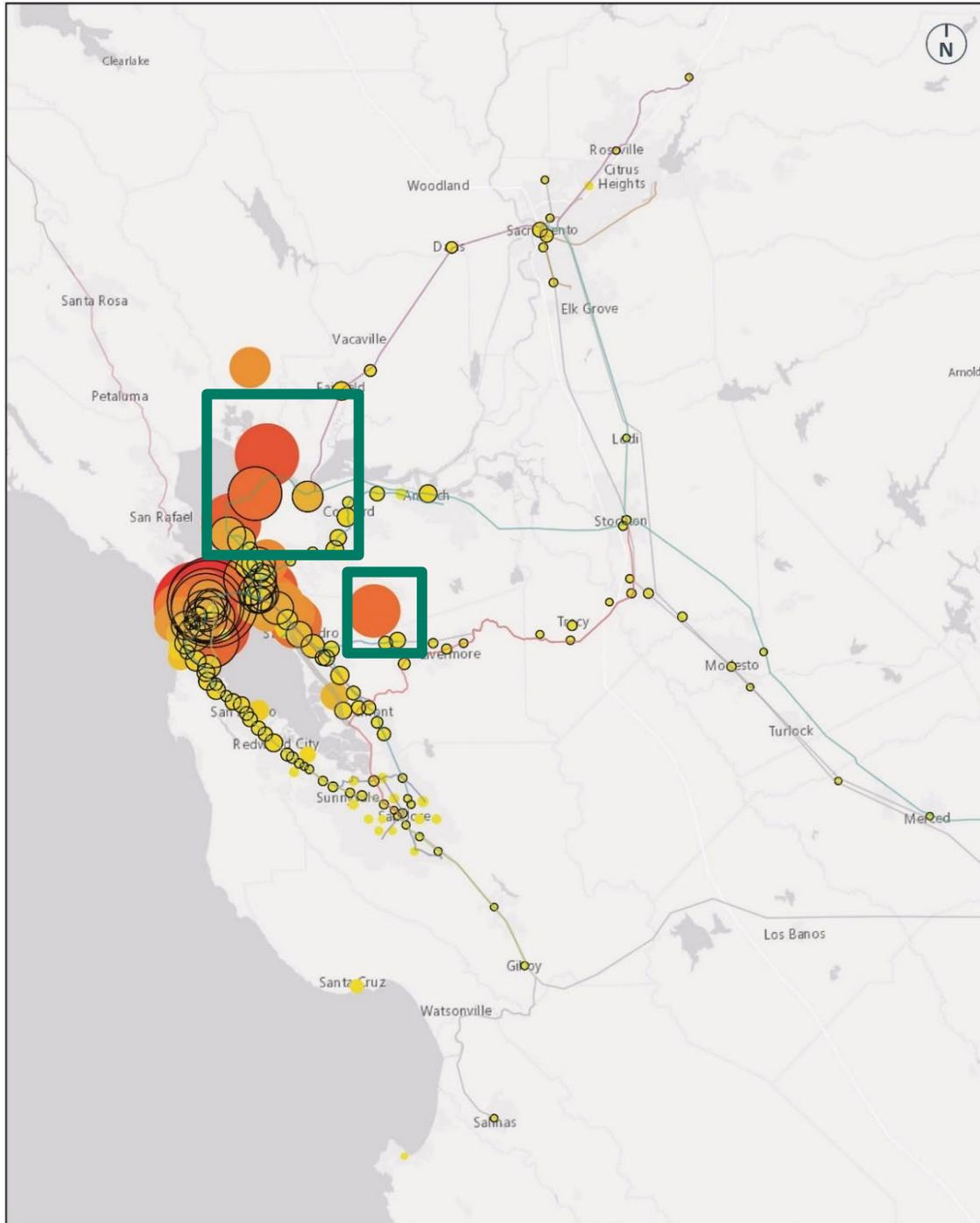
significant portion (45%) involving a trip in the Transbay Corridor. Similar to the good rail service potential, most of this unmet transbay rail potential is concentrated in San Francisco, Alameda, and Contra Costa counties.

The following subsections describe additional insights focusing on specific parts of the map in Figure 8-5.



Figure 8-5. Transbay Equity-weighted Unmet Rail Potential (number of potential trips), 2040

Forty-five percent of total unmet rail potential involves a trip in the Transbay Corridor.



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The greatest transbay unmet potential is observed in markets close to the Transbay Corridor.

Among all travel markets in the Megaregion, those close to the Transbay Corridor, on both the eastern and western ends, have the greatest unmet transbay rail potential, as **Figure 8-6** illustrates. These high potential markets cover municipalities such as San Francisco, Oakland, and Emeryville.

The highest potential markets may be categorized as follows:

- New markets without existing rail service, such as western San Francisco, Lower Pacific Heights/Japantown in San Francisco, and the Grand Lake District and MacArthur Boulevard corridor in Oakland
- Markets with poor transbay rail service, such as southeastern San Francisco and Emeryville
- Markets with significant rail crowding, such as the existing BART corridor along Market Street in San Francisco

Other travel markets close to the Transbay Corridor with relatively medium levels of potential include:

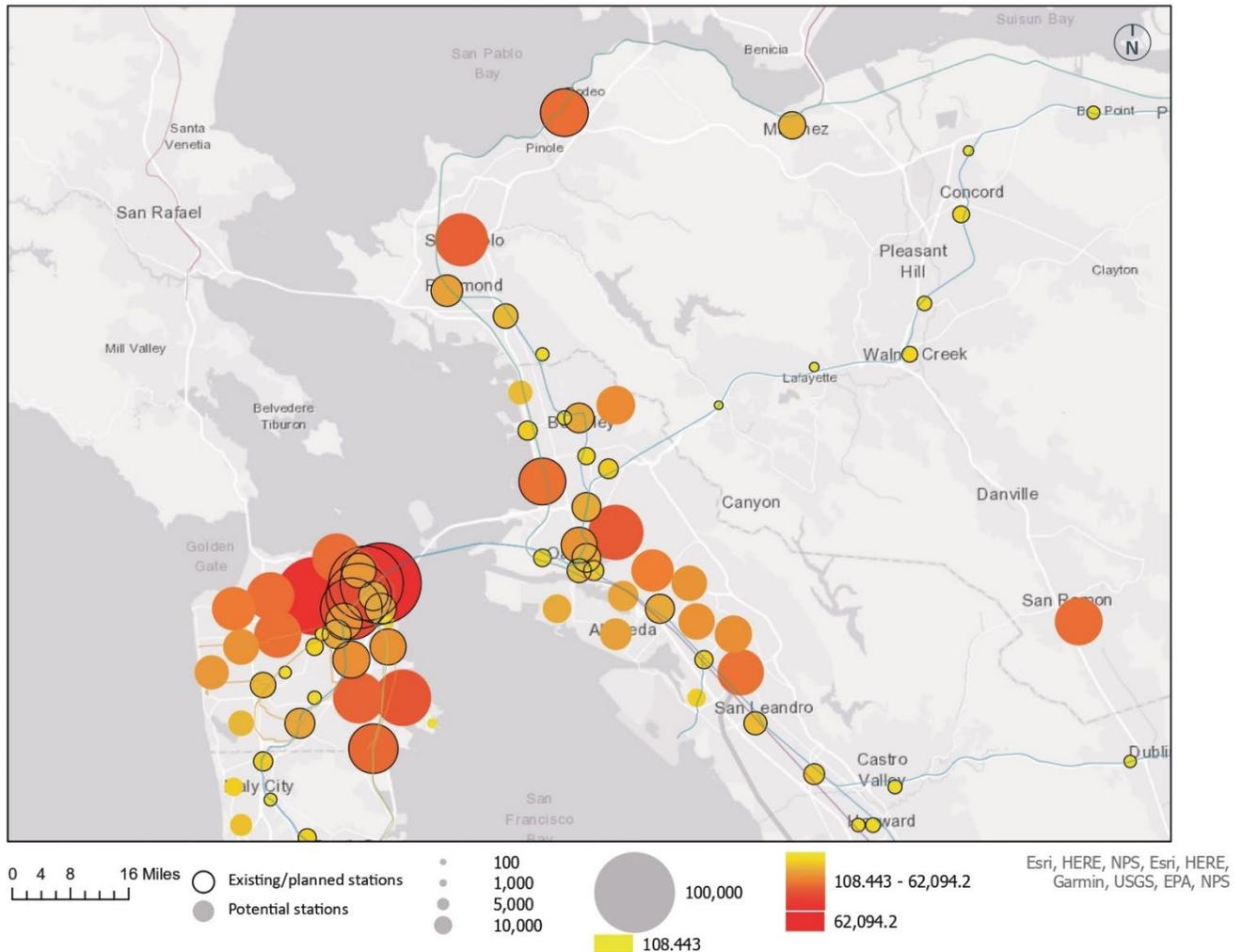
- South of Market, South Park, Dogpatch, Mission and Balboa Park neighborhoods of San Francisco
- Downtown Oakland, Jack London Square, around MacArthur BART, and the San Antonio and Fruitvale neighborhoods in Oakland
- Eastern Berkeley, and Central and Western Alameda

Investing in a new transbay passenger rail crossing in the core of the Megaregion could provide benefits and unlock unmet transbay rail potential across the Megaregion while delivering meaningful benefits to existing users, such as reducing or eliminating transfers. For example, a regional rail crossing connecting Emeryville to San Francisco and continuing south along the Peninsula could provide a one-seat ride from Sacramento or Stockton to San Francisco or San Mateo County.



Figure 8-6. Transbay Equity-weighted Unmet Rail Potential (number of potential trips), 2040

The highest transbay equity-weighted unmet rail potential can be found in San Francisco and the inner East Bay communities of Oakland and Emeryville.



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There is relatively high unmet potential for new medium-distance transbay markets to/from San Francisco.

While a large share of transbay unmet rail potential is found in the core of the Megaregion, other markets further away from the Transbay Corridor could also benefit from good transbay rail service and/or investment beyond the crossing. Such investment could unlock a relatively high amount of unmet rail potential in markets without existing transbay rail

service, such as San Pablo, Hercules, Vallejo, and San Ramon (highlighted in the green boxes in Figure 8-5, all of which are in the top 15 for equity-weighted transbay unmet potential), while also improving service for and delivering benefits to existing riders. Other markets with a relatively medium amount of unmet transbay rail potential include Richmond, Martinez, Napa, and San Mateo County.



Unmet potential for markets further from the Transbay Corridor is more limited.

Markets located a long distance from the Transbay Corridor, such as Sacramento, Stockton, Modesto, and Sonoma County, have more limited absolute unmet transbay rail potential. The good rail service potential in these markets is relatively high compared to baseline ridership; however, this large percentage/relative difference is driven mostly by low baseline ridership rather than any significant amount of unmet potential.

As mentioned in an earlier key insight, investment in a new transbay passenger rail crossing and other infrastructure in the core of the Megaregion can still deliver travel and other benefits to all parts of the Megaregion, including these long-distance markets.

Long distance transbay markets have a higher impact on transbay rail travel when measured in passenger miles.

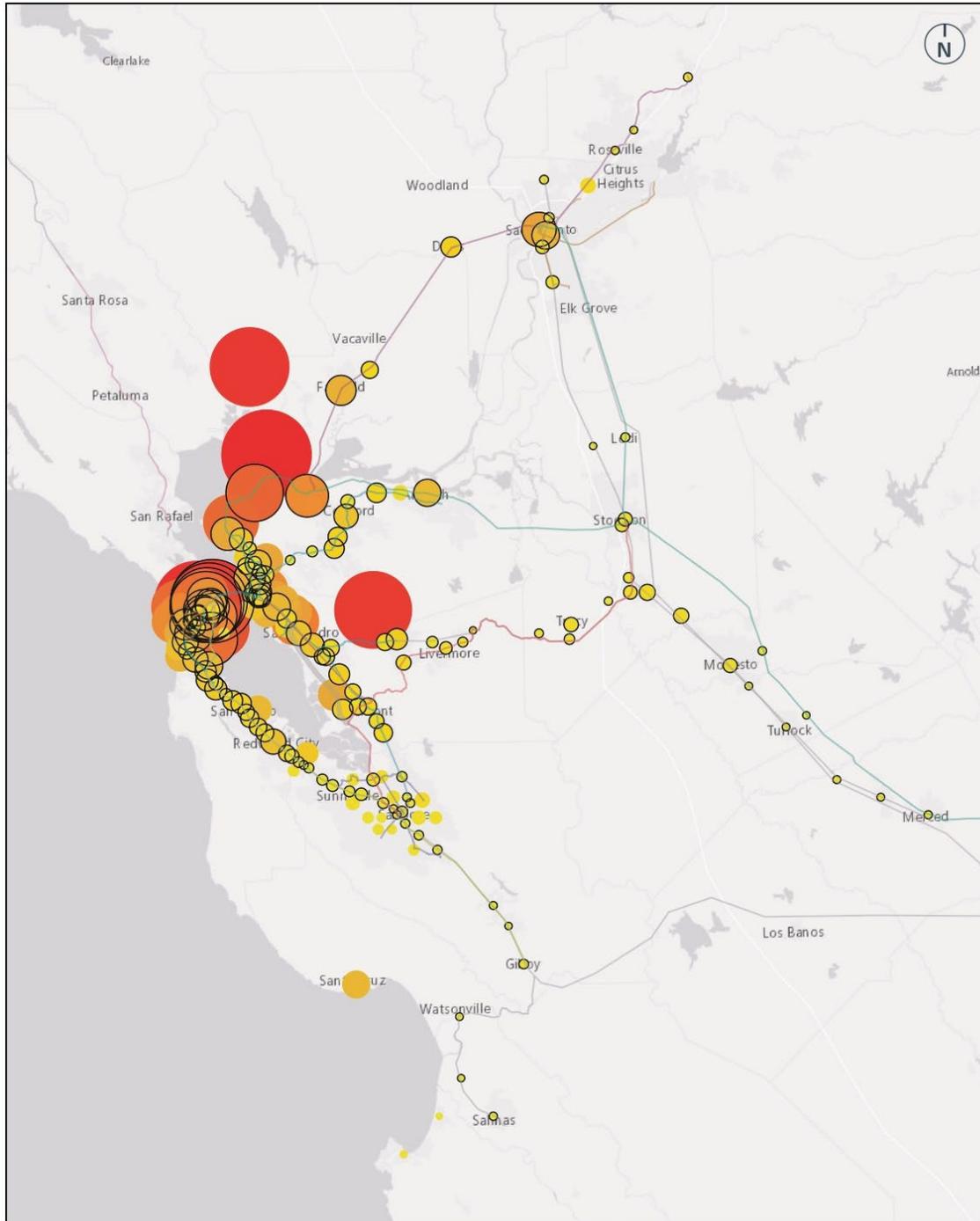
Figure 8-7 depicts the passenger miles impact of unmet transbay rail potential by cluster. Its trends broadly parallel those observed in Figure 8-5 and described in prior insights. The impacts of medium- and long-distance markets are amplified due to the higher number of passenger miles traveled. Key markets with increased impacts include Vallejo, San Ramon, Napa, and Sacramento.

The higher passenger miles traveled drive greater mileage-related benefits, such as travel time savings and greenhouse gas emission reductions.



Figure 8-7. Transbay Miles- and Equity-weighted Unmet Rail Potential (number of potential passenger miles), 2040

Weighting unmet potential by trip distance (in addition to equity) results in a slightly larger impact for long-distance transbay markets and thus potentially greater mileage-related benefits.



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Non-transbay trips could also benefit from Link21.

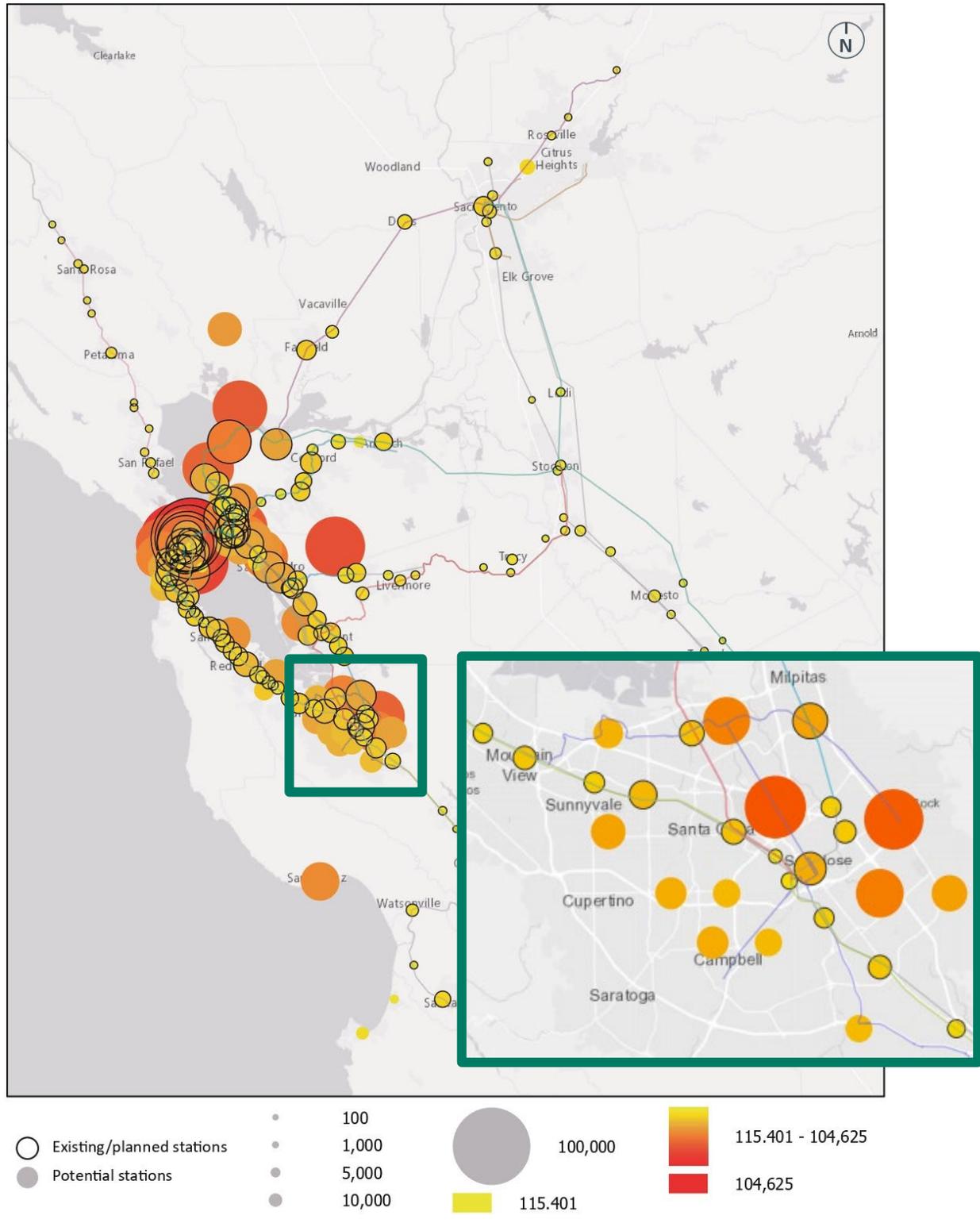
While one of the key objectives for Link21 is to improve transbay rail travel, it could also benefit non-transbay rail travel.

Figure 8-8 illustrates the unmet rail potential for all trips, not just transbay, and for all clusters in the Megaregion, revealing a substantial amount of unmet rail potential in Santa Clara County in

particular, albeit substantially lower than that in San Francisco. This concentration of unmet potential suggests that Santa Clara County could benefit from Link21-related investments that improve rail service to either the West or East Bay. For example, a new transbay passenger rail crossing that connects San Francisco to Oakland and extends south to San Jose could attract new, non-transbay rail riders between San Jose and Oakland.



Figure 8-8. Total Equity-weighted Unmet Rail Potential (number of potential trips), 2040
 Non-transbay markets could also benefit from Link21.



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8.3. Summary

The Megaregion's core (San Francisco and inner East Bay cities between Richmond and Oakland) has the highest potential for attracting new transbay rail riders.

Forty-five percent of all equity-weighted total and unmet rail potential in the Megaregion involves a trip through the Transbay Corridor. The majority of this unmet transbay rail potential can be found in the core of the Megaregion. These high potential markets exist in several categories:

- New markets without existing rail service, such as western San Francisco, Lower Pacific Heights/Japantown in San Francisco, and the Grand Lake District and MacArthur Boulevard corridor in Oakland
- Markets with poor transbay rail service, such as southeastern San Francisco and Emeryville
- Markets with significant rail crowding, such as the existing BART corridor along Market Street in San Francisco

Beyond the Megaregion's core, relatively high to medium unmet transbay rail potential exists in markets further from the Transbay Corridor. These markets include San Pablo, Hercules, Martinez, Vallejo, Napa, San Ramon, and parts of San Mateo County.

Other markets with more limited potential stand to benefit from Link21 in other ways.

Markets located a long distance from the Transbay Corridor, such as Sacramento and Stockton, have relatively modest unmet transbay rail potential. However, potential trips to and from those markets have larger passenger miles potential due to the longer trip distances involved. This higher passenger miles potential could translate into larger mileage-related benefits from a new transbay passenger rail crossing and other infrastructure at the core of the Megaregion, such as travel time savings and greenhouse gas emissions reductions, which are also important when developing and evaluating program concepts and alternatives.

The impacts of a new transbay passenger rail crossing under Link21 extend beyond transbay trips. Areas such as Santa Clara County could benefit from investments beyond the immediate crossing.



9. CORRIDOR RAIL POTENTIAL ANALYSIS

Once individual, high potential markets have been identified in the market rail potential analysis, they can be bundled and connected to form segments, which in turn can be grouped to form corridors. These corridors are an appropriate geographic unit of analysis to inform subsequent program concept development, as they are high level representations of potential rail alignments. Rail service is typically provided along a series of connected markets, rather than between individual market pairs. The corridor rail potential analysis aims to reflect this condition.

The corridor rail potential analysis seeks to identify corridors and segments with high unmet potential using similar approaches and tools to the preceding market rail potential analysis. Similarly, the analysis emphasizes equity by doubling potential trips made by priority populations, reflecting the central role that equity plays in Link21.

The high potential markets, segments, and corridors identified in this analysis subsequently informed the development of program concepts, alongside other sources, such as public studies/plans, public and stakeholder engagement, engineering and operations considerations, and others. The corridor rail potential analysis does not involve any engineering, operational, or other considerations that are central to concept development; these will be addressed by the PMC Planning and Engineering Team in subsequent phases.

This chapter introduces the corridors that were constructed and analyzed, presents the approach to evaluating each corridor and its component segments, and distills key findings from the evaluation of the various corridors.



9.1. Corridor Identification

Nine East Bay and three West Bay corridors were identified.

Most of the 202 clusters analyzed in the market rail potential analysis, particularly those with high transbay unmet potential, fall naturally into geographically organized corridors. Nine such corridors exist in the East Bay, and three more corridors exist in the West Bay (illustrated in **Figure 9-1** and **Figure 9-2**, respectively). Parts of the Megaregion with very low unmet potential have been excluded from corridors altogether.

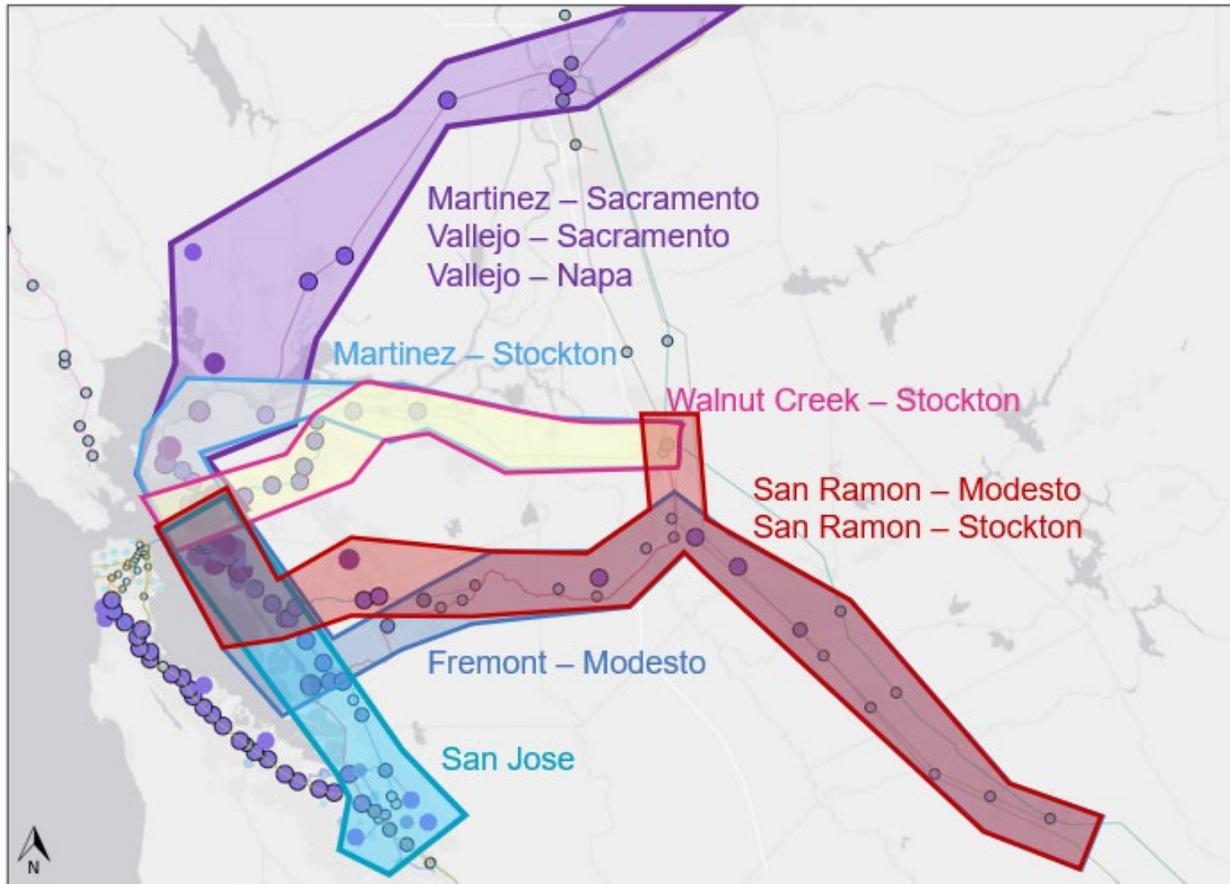
East Bay corridors originate in Alameda/Oakland and extend to Sacramento, Stockton, and Modesto. They are approximate linear groupings of markets, both with and without existing rail service, defined by natural geography and existing urbanization and development patterns.

West Bay corridors originate in San Francisco and take three different segments through the city before converging onto a common segment through San Mateo and northern Santa Clara counties and ending in San Jose. Two of the three segments through San Francisco are defined by existing rail corridors: the East Corridor approximately follows the Caltrain alignment from downtown to Millbrae via the Bayshore District, and the Central Corridor approximately follows the BART alignment from downtown San Francisco to Millbrae via Daly City. The West Corridor consists of several new markets without existing rail service. The common segment in San Mateo and northern Santa Clara counties approximately follows the existing Caltrain alignment from Millbrae to San Jose.



Figure 9-1. East Bay Corridors

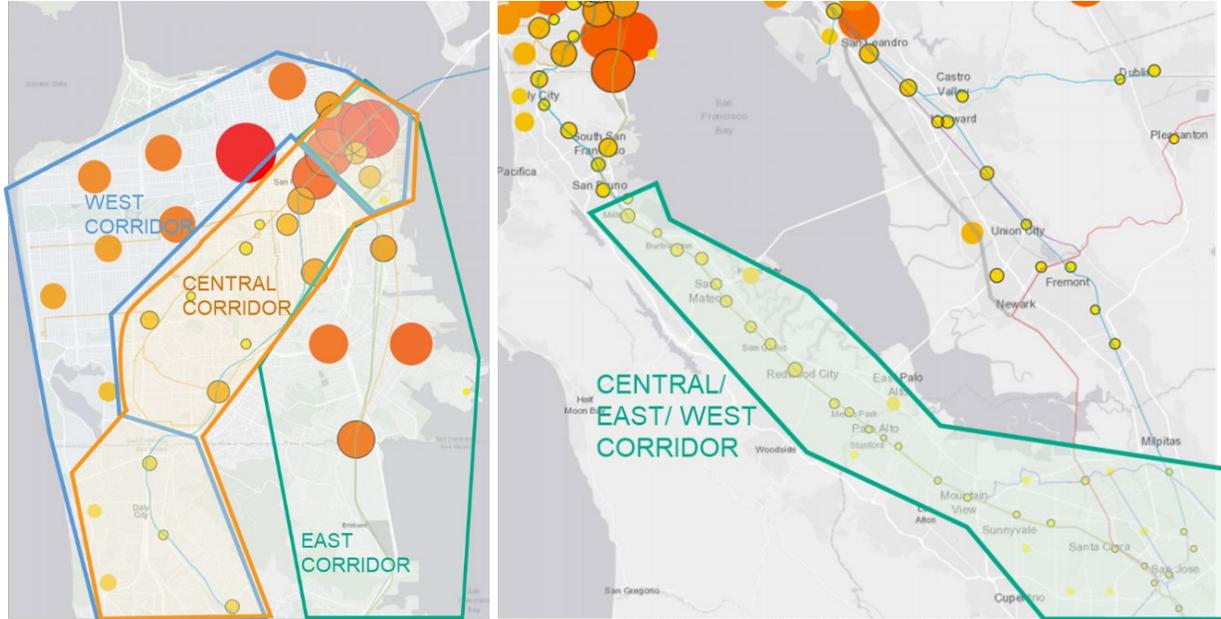
East Bay corridors are approximate linear groupings of markets that originate in Alameda/Oakland and extend to Sacramento, Stockton, and Modesto.



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Figure 9-2. West Bay Corridors

West Bay corridors are defined by existing rail service in San Francisco (east and central) or connect new markets (west) and converge on one main segment that follows existing rail service through San Mateo and Santa Clara counties.



9.2. Corridor Evaluation Approach

The unmet potential for each corridor was estimated using the following steps:

1. **Split the corridors into segments** at logical breakpoints based on large markets (e.g., Richmond) or infrastructure barriers (e.g., Carquinez or Benicia–Martinez bridges) starting from one end of the Transbay Corridor in San Francisco or Oakland.
2. For each segment, **identify a number of market concepts** by connecting high potential, geographically proximate clusters.
3. **Evaluate the transbay equity-weighted unmet potential of each market concept** by connecting it with all clusters representing all existing and planned stations on the other side of the bay, (e.g., an Oakland–Richmond market concept would be evaluated by measuring the unmet rail potential from all of its clusters to all existing and planned rail station clusters in San Francisco, San Mateo, and northern Santa Clara counties).
4. For each segment, identify the market concept with the **highest transbay equity-weighted unmet potential**.
5. For each corridor, **incrementally identify segments** that have the highest combined total transbay equity-weighted unmet potential.



9.3. Key Findings

Highest unmet potential is in the core of the Megaregion, closest to the Transbay Corridor for all corridors.

Table 9-3 breaks down the unmet and total rail potential by segment for the 12 corridors tested. For each corridor, the segment immediately adjacent to the Transbay Corridor accounts for over half of the transbay unmet and total potential. This potential is largely driven by the selected concept that involves new markets without existing transbay rail service, particularly ones in the East Bay, such as parts of East Oakland outside the existing BART corridor.

For **Sacramento-bound corridors**, most of the remaining transbay unmet and total potential in the East Bay is accounted for by the Richmond–Hercules segment. This segment consists of new markets without existing transbay service, including San Pablo and Hercules. Unmet potential beyond Hercules is fairly limited with the exception of Vallejo, which is in the top ten single markets by unmet potential.

Similarly, among **Stockton-bound corridors**, the Richmond–Hercules segment in the Martinez/Stockton corridor has the highest unmet and total potential outside of the Oakland–Richmond and

Oakland–Bay Fair corridors due to the new markets along that segment. San Ramon, a single new market east of Bay Fair, contributes a more modest amount of unmet potential compared to other segments, but on its own it is in the top five single markets by unmet potential.

Of all nine East Bay corridors, unmet potential on the **Modesto- and San Jose-bound corridors** is most heavily skewed toward the initial Oakland–Bay Fair segment. Beyond the initial segment, some outer segments in the San Jose corridor (covering Milpitas and San Jose) have relatively high amounts of non-transbay unmet potential.

By contrast, on the three **West Bay corridors**, the high unmet potential in San Francisco can be attributed to both new clusters in western San Francisco (e.g., Lower Pacific Heights/Japantown, Richmond District, and Sunset District), existing clusters with poor existing transbay rail service (e.g., southeastern San Francisco), and crowded trains on existing BART Transbay rail service through downtown San Francisco. New rail service serving the latter markets could relieve crowding on existing services, unlocking substantial potential demand that is unable or unwilling to use existing services.

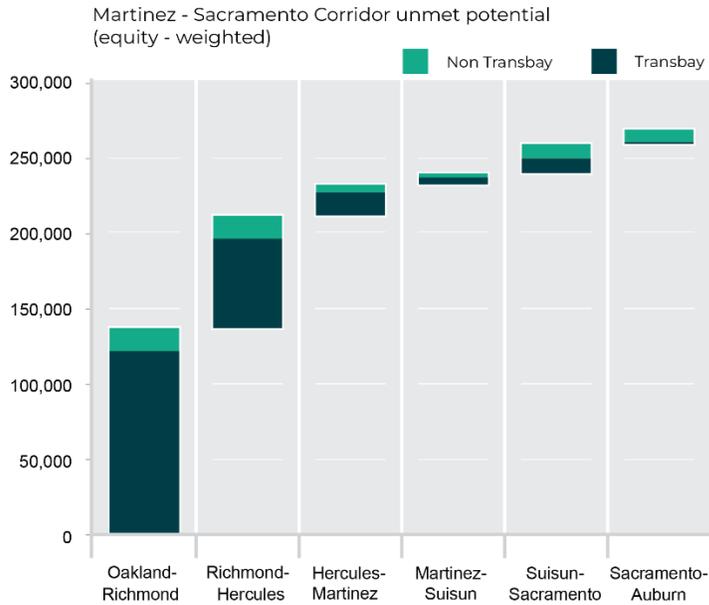


Table 9-3. Unmet and Good Service Rail Potential by Corridor

For all corridors, segments at the Megaregion’s core have the highest good service rail potential and unmet potential.

SACRAMENTO-BOUND EAST BAY CORRIDORS

Martinez–Sacramento Corridor

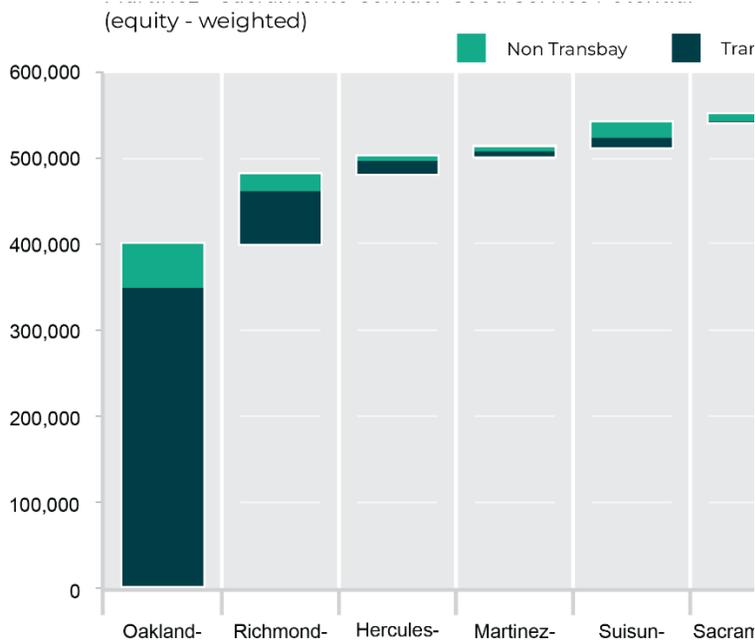


Major new transbay markets:

- Central and Western Alameda
- Grand Lake (Central Oakland)
- Eastern Berkeley
- Emeryville
- San Pablo
- Hercules

Existing markets with insufficient rail service/capacity:

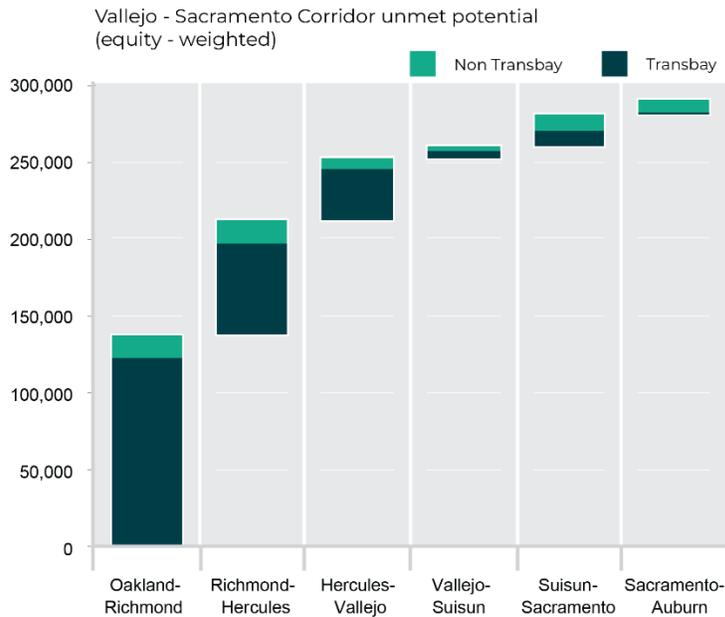
- Downtown Oakland (applies to all East Bay corridors)



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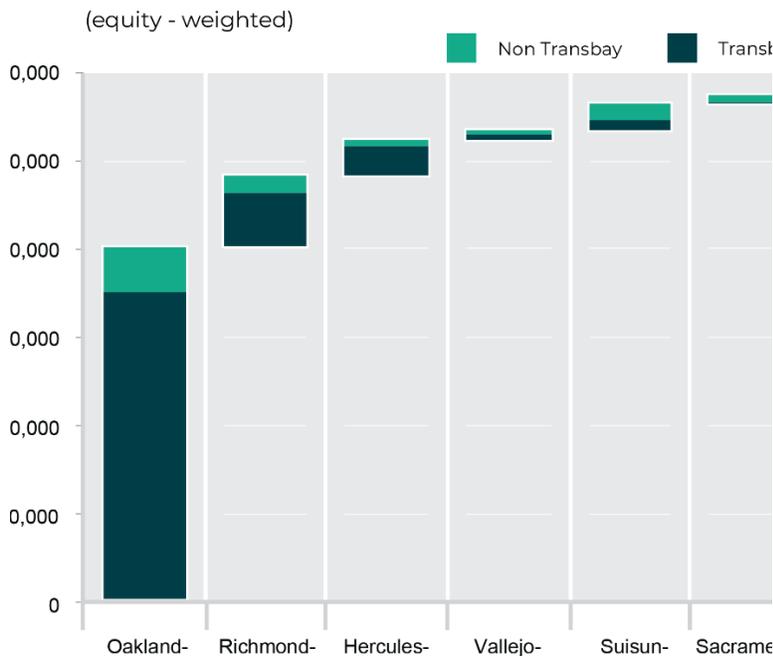


Vallejo–Sacramento Corridor



Major new transbay markets:

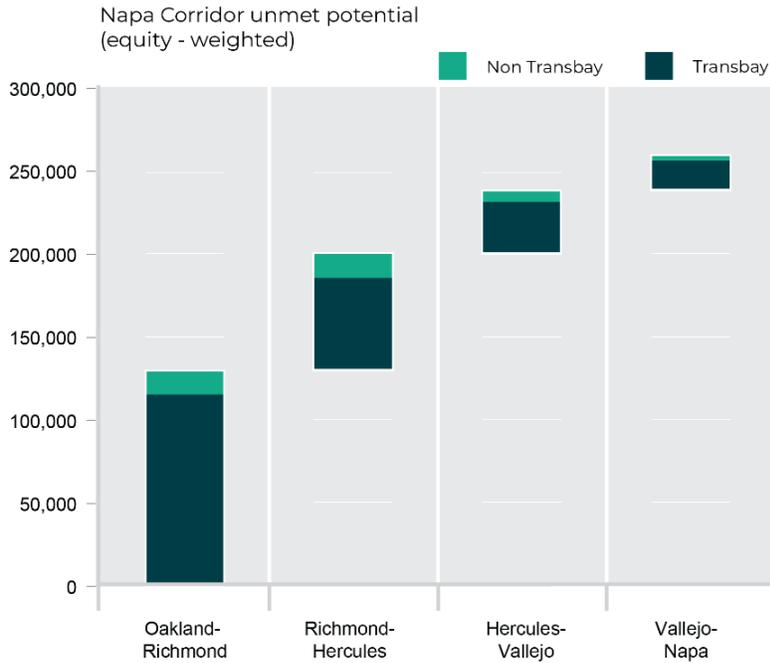
- Central and Western Alameda
- Grand Lake (Central Oakland)
- Eastern Berkeley
- Emeryville
- San Pablo
- Hercules
- Vallejo



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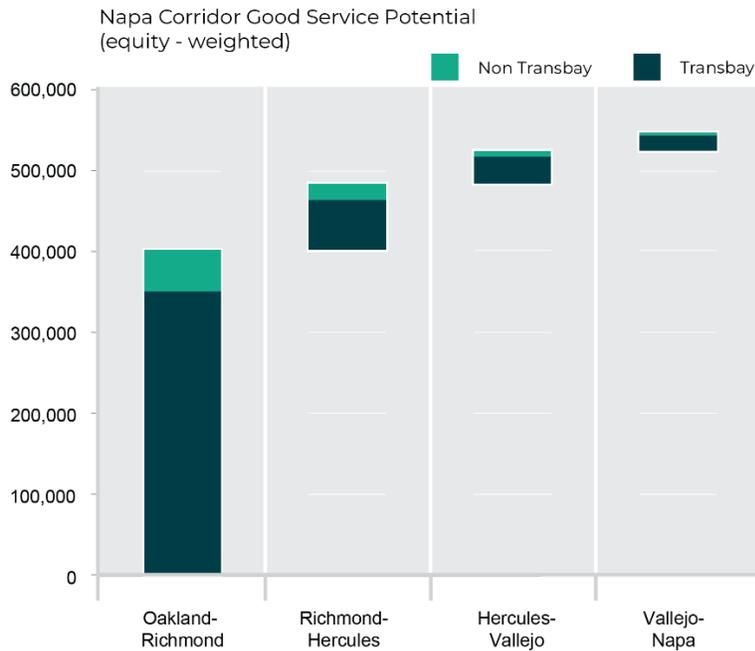


Napa Corridor



Major new transbay markets:

- Central and Western Alameda
- Grand Lake (Central Oakland)
- Eastern Berkeley
- Emeryville
- San Pablo
- Hercules
- Vallejo
- Napa

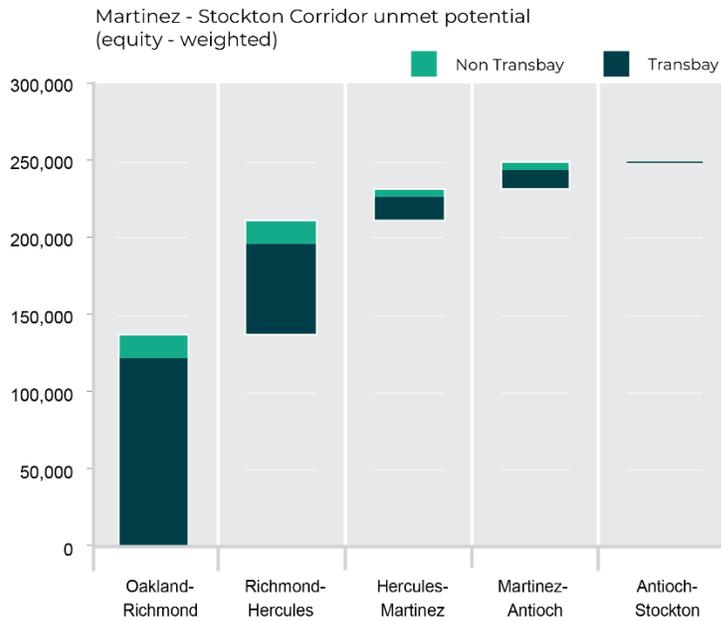


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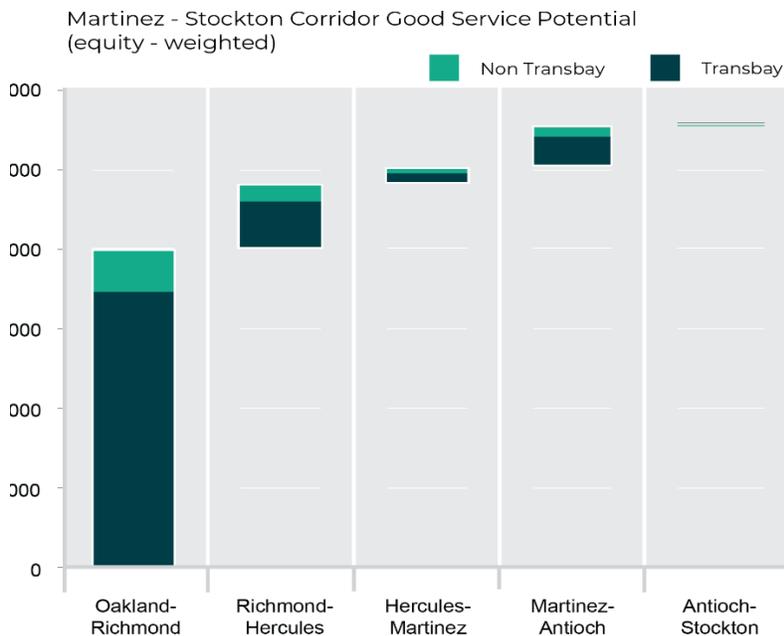
STOCKTON-BOUND EAST BAY CORRIDORS

Martinez–Stockton Corridor



Major new transbay markets:

- Central and Western Alameda
- Grand Lake (Central Oakland)
- Eastern Berkeley
- Emeryville
- San Pablo
- Hercules

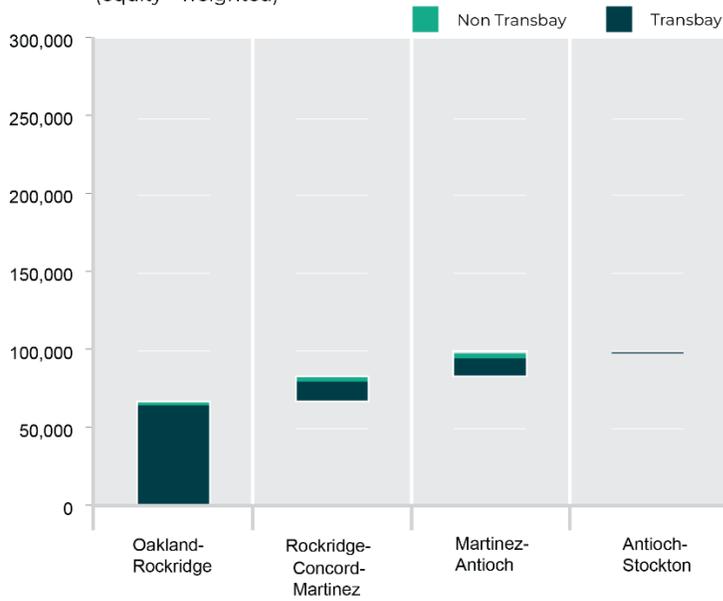


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Walnut Creek–Stockton Corridor

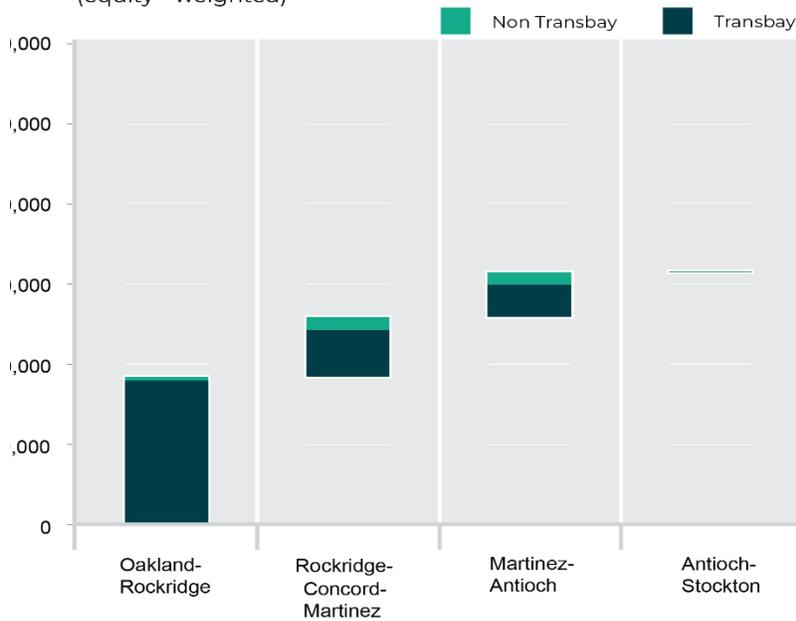
Walnut Creek - Stockton Corridor unmet potential (equity - weighted)



Major new transbay markets:

- Central and Western Alameda
- Grand Lake (Central Oakland)

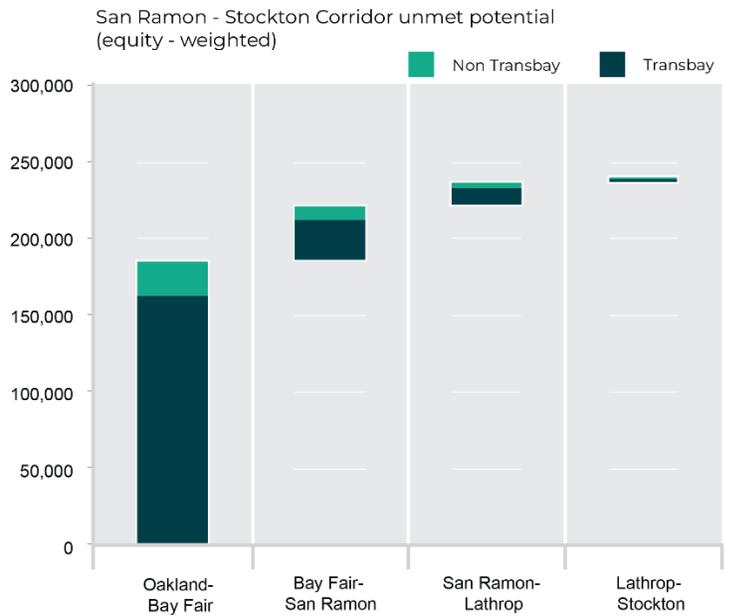
Walnut Creek - Stockton Corridor Good Service Potential (equity - weighted)



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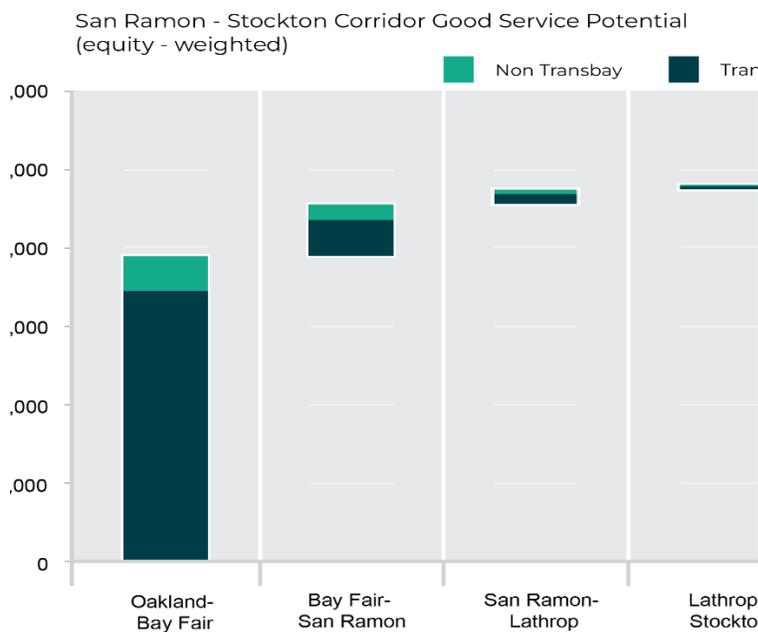


San Ramon–Stockton Corridor



Major new transbay markets:

- Central and Western Alameda
- Grand Lake (Central Oakland)
- Eastern Oakland
- San Ramon

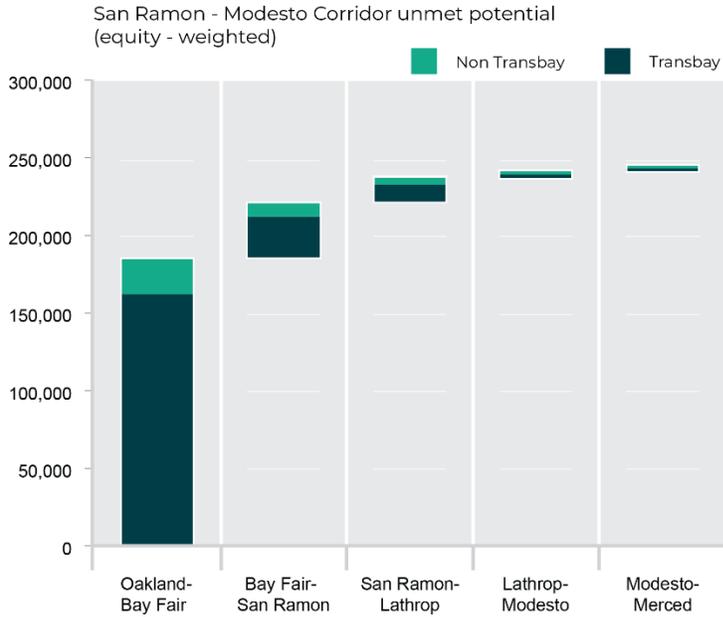


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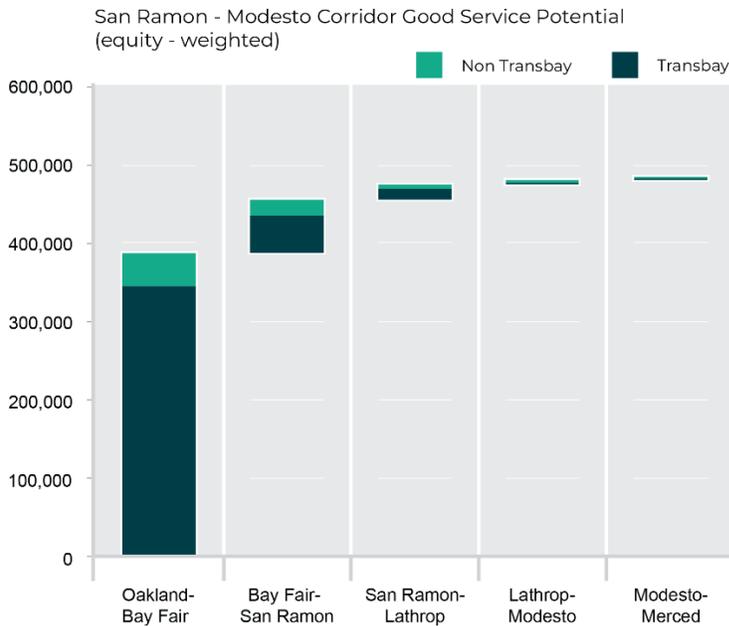
MODESTO-BOUND EAST BAY CORRIDORS

San Ramon–Modesto Corridor



Major new transbay markets:

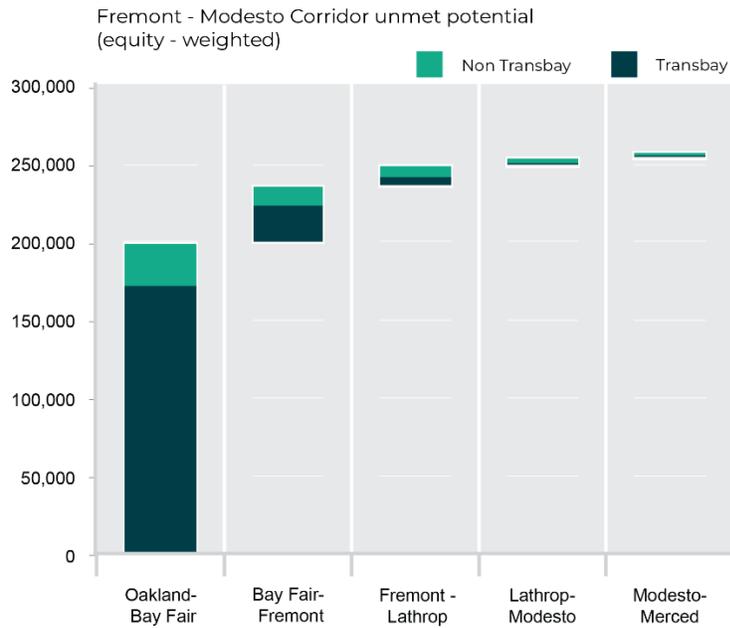
- Central and Western Alameda
- Grand Lake (Central Oakland)
- Eastern Oakland
- San Ramon



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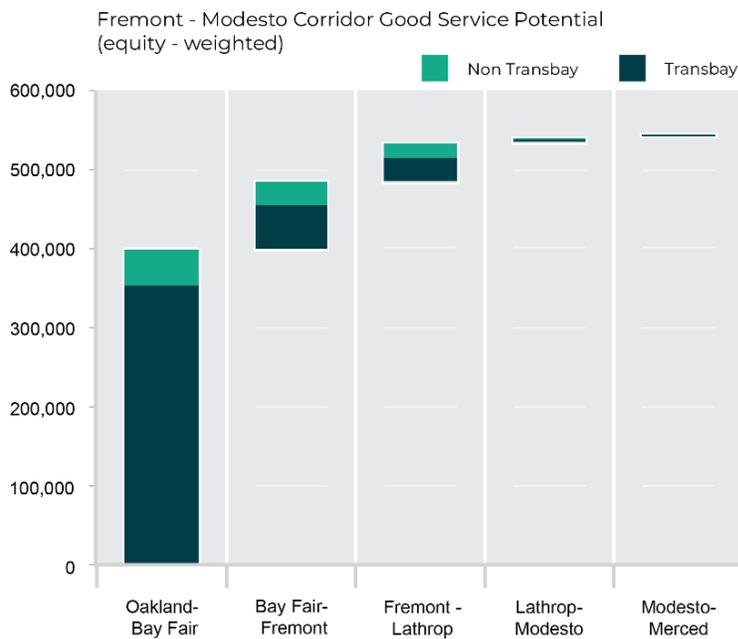


Fremont–Modesto Corridor



Major new transbay markets:

- Central and Western Alameda
- Grand Lake (Central Oakland)
- Eastern Oakland

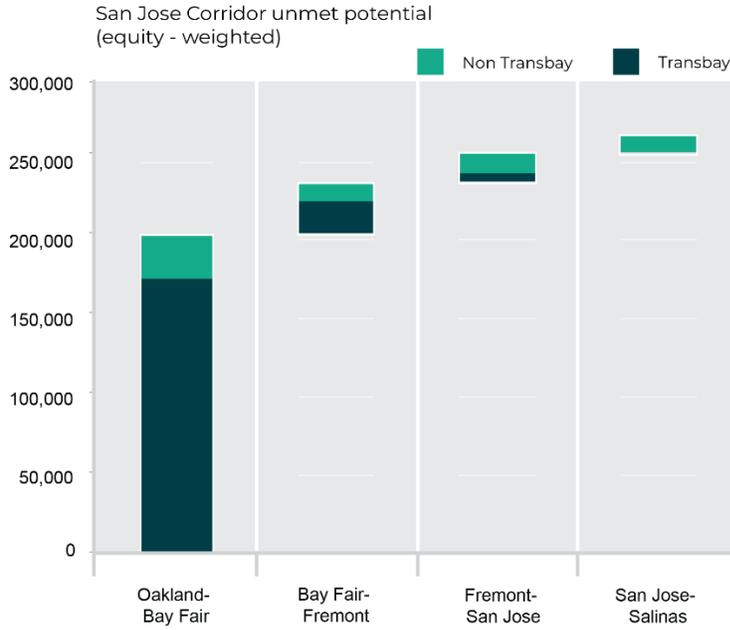


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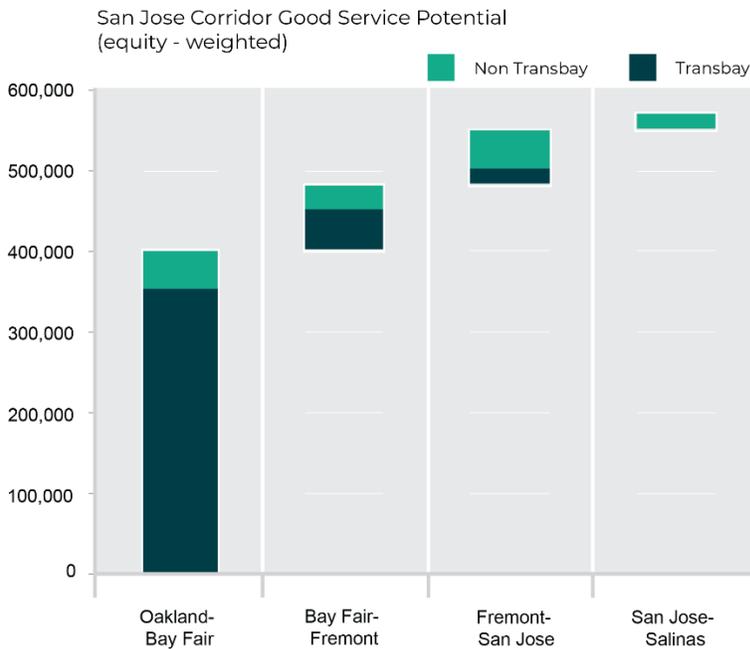
SAN JOSE-BOUND EAST BAY CORRIDORS

San Jose Corridor



Major new transbay markets:

- Central and Western Alameda
- Grand Lake (Central Oakland)
- Eastern Oakland
- San Jose (non-transbay potential)

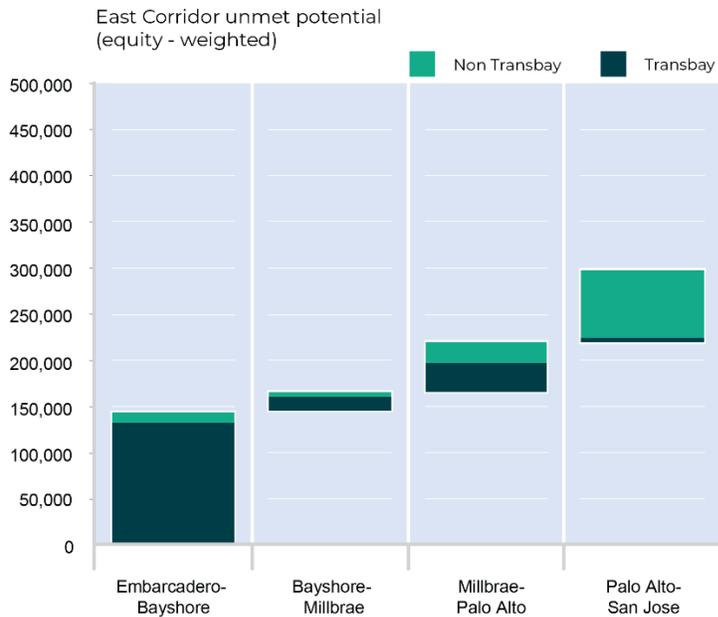


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SAN JOSE-BOUND WEST BAY CORRIDORS

East Corridor

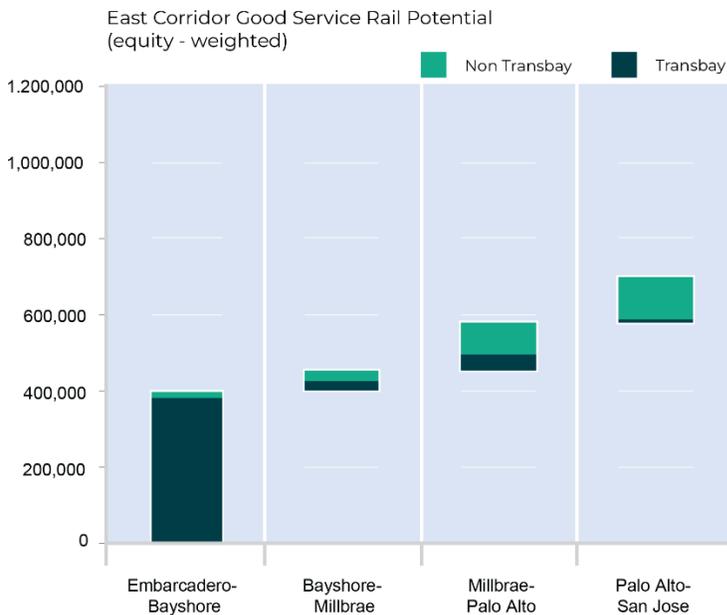


Major new transbay markets:

- Southeastern San Francisco

Existing markets with insufficient rail service/capacity:

- Downtown San Francisco
- San Mateo and Northern Santa Clara counties (mostly non-transbay)

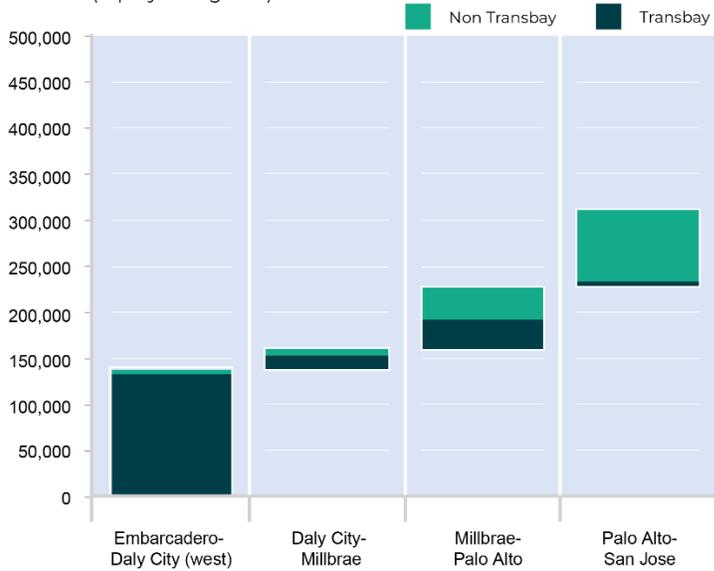


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Central Corridor

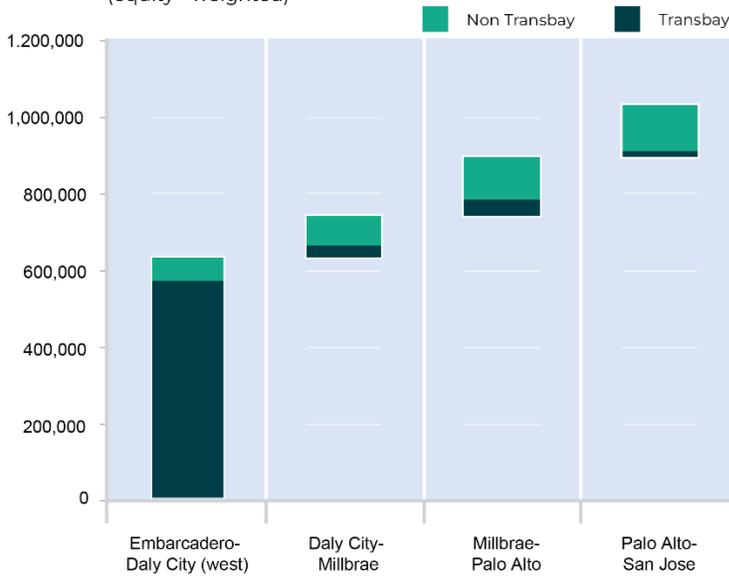
Central Corridor unmet potential (equity - weighted)



Existing markets with insufficient rail service/capacity:

- Downtown San Francisco
- Mission District and Balboa Park
- San Mateo and Northern Santa Clara counties (mostly non-transbay)

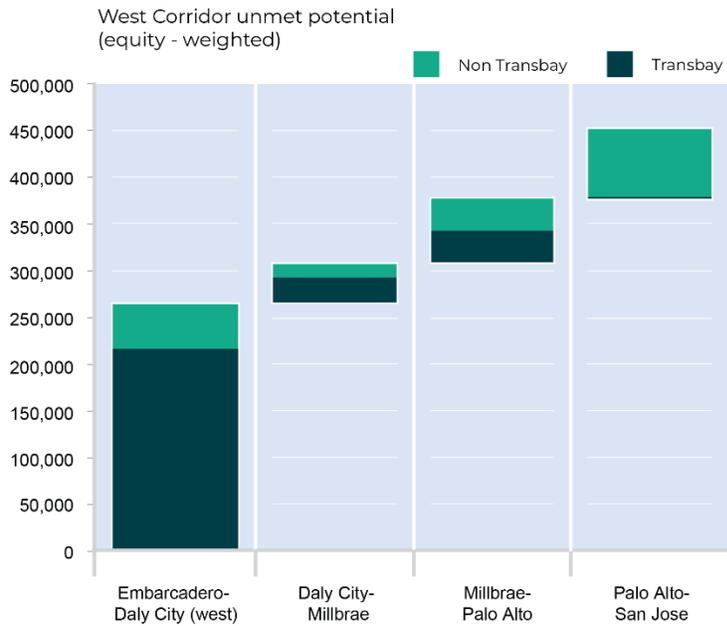
Central Corridor Good Service Rail Potential (equity - weighted)



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West Corridor

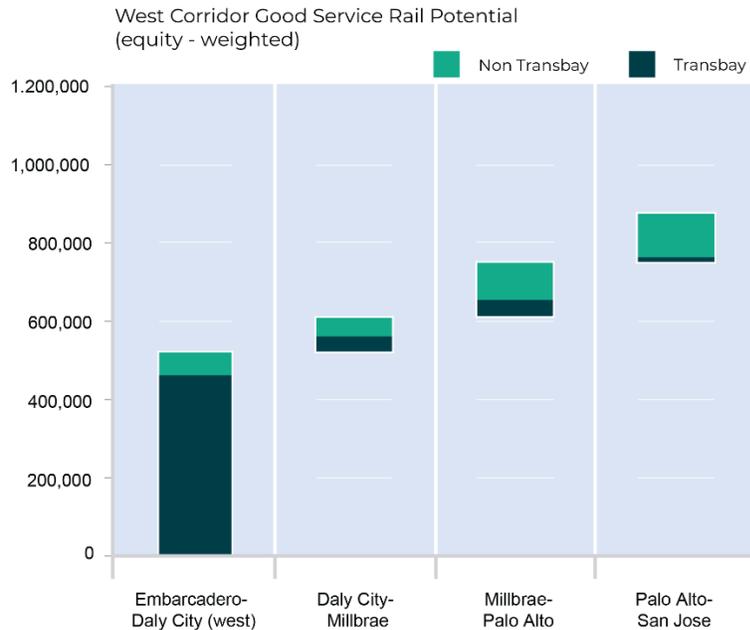


Major new markets:

- Lower Pacific Heights/Japantown
- Western San Francisco

Existing markets with insufficient rail service/capacity:

- Downtown San Francisco
- San Mateo and Northern Santa Clara counties (mostly non-transbay)



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Existing transbay rail service dampens unmet potential in certain segments and corridors.

Figure 9-4 shows the unmet rail potential by segment for a corridor between Oakland and Stockton via Rockridge, Martinez, and Antioch. Like other corridors, most of the transbay unmet potential can be found in the Oakland–Rockridge segment, close to the Transbay Corridor at the Megaregion’s core.

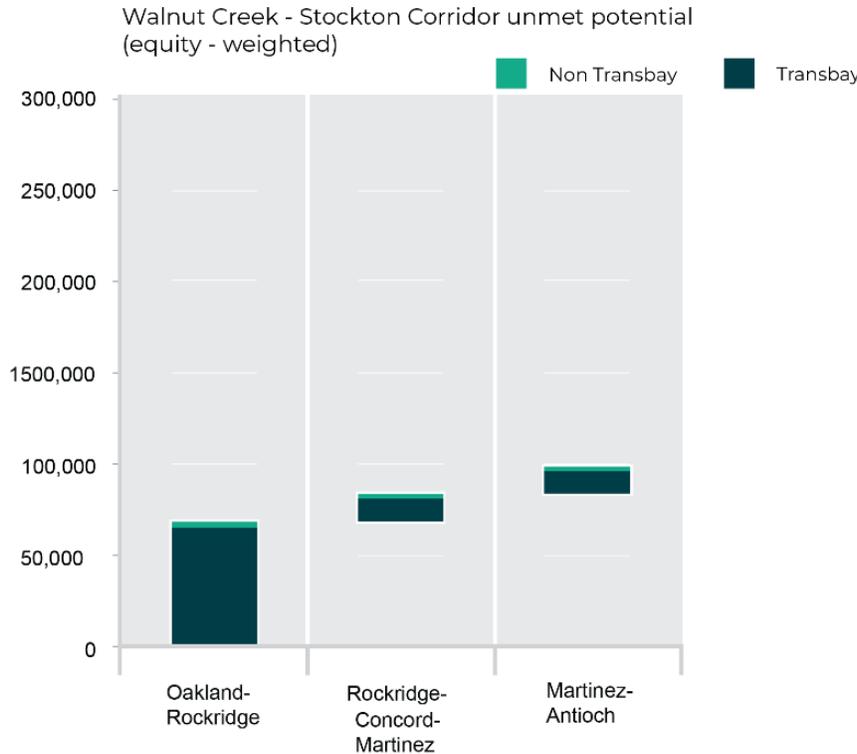
However, the total unmet rail potential, both in the entire corridor and particularly in the core Oakland–Rockridge segment, is substantially lower than that for other

corridors and core segments. This is because the Oakland–Rockridge segment is already well served by BART. The unmet rail potential that exists is due to crowded conditions on existing BART service.

Other segments that have existing transbay BART service, such as the Market Street corridor between downtown San Francisco and Daly City, have higher amounts of unmet rail potential because trains traveling through those segments have higher levels of crowding that results in many potential riders choosing not to use rail.

Figure 9-4. Unmet Rail Potential for the Walnut Creek – Stockton Corridor

There is comparatively low unmet potential for segments with existing BART service that is sufficient to serve most potential rail riders; some of the unmet potential in the Oakland – Rockridge segment can be attributed to new markets such as Grand Lake and Alameda.



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Segments connecting markets further from the Transbay Corridor have relatively low unmet potential.

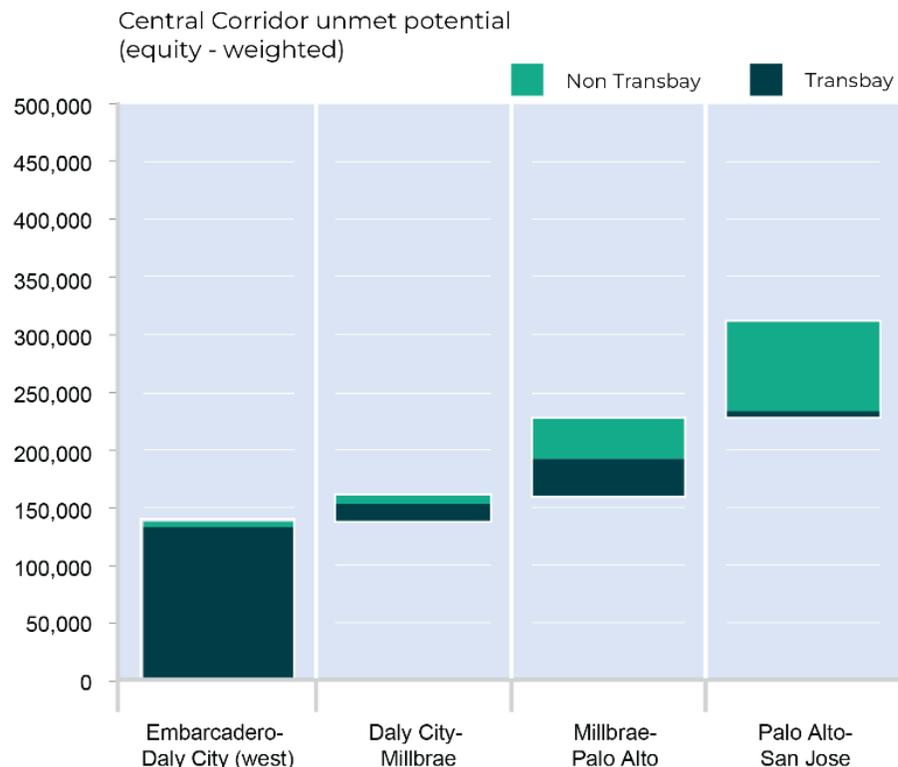
As noted in Chapter 8, markets located a long distance from the Transbay Corridor, such as Sacramento, Stockton, and Modesto, have relatively limited unmet transbay rail potential. This translates into low unmet potential for segments connecting these markets, such as Modesto–Merced or Suisun–Sacramento.

In the West Bay, segments in San Mateo and northern Santa Clara counties have substantial amounts of non-transbay unmet rail potential.

Chapter 8 also indicates that investment in a new transbay passenger rail crossing could also benefit non-transbay rail travel. **Figure 9-5** reinforces this concept, showing a sizeable amount of non-transbay unmet rail potential in the Millbrae–Palo Alto and Palo Alto–San Jose segments. This unmet potential could include trips to and from other parts of Santa Clara and San Mateo counties, as well as parts of San Francisco, mostly covering new markets (e.g., Foster City, East Palo Alto, and new stations in San Jose).

Figure 9-5. Unmet Rail Potential for the Central San Francisco – Peninsula Corridor

While performing poorly in terms of transbay unmet rail potential, the San Mateo and particularly northern Santa Clara counties segments have comparatively high amounts of non-transbay unmet potential.



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9.4. Summary

The Megaregion's core has the highest potential for attracting new transbay rail riders.

Unmet transbay rail potential is concentrated at the Megaregion's core, in particular in and around San Francisco and Oakland, the two ends of the Transbay Corridor, and in inner East Bay cities between Richmond and Oakland.

Figure 9-6 displays the unmet potential by segment, and it highlights the top five segments for transbay unmet potential as being directly connected to either end of the Transbay Corridor. As such, the extent to which a program concept or alternative can serve unmet potential will largely be

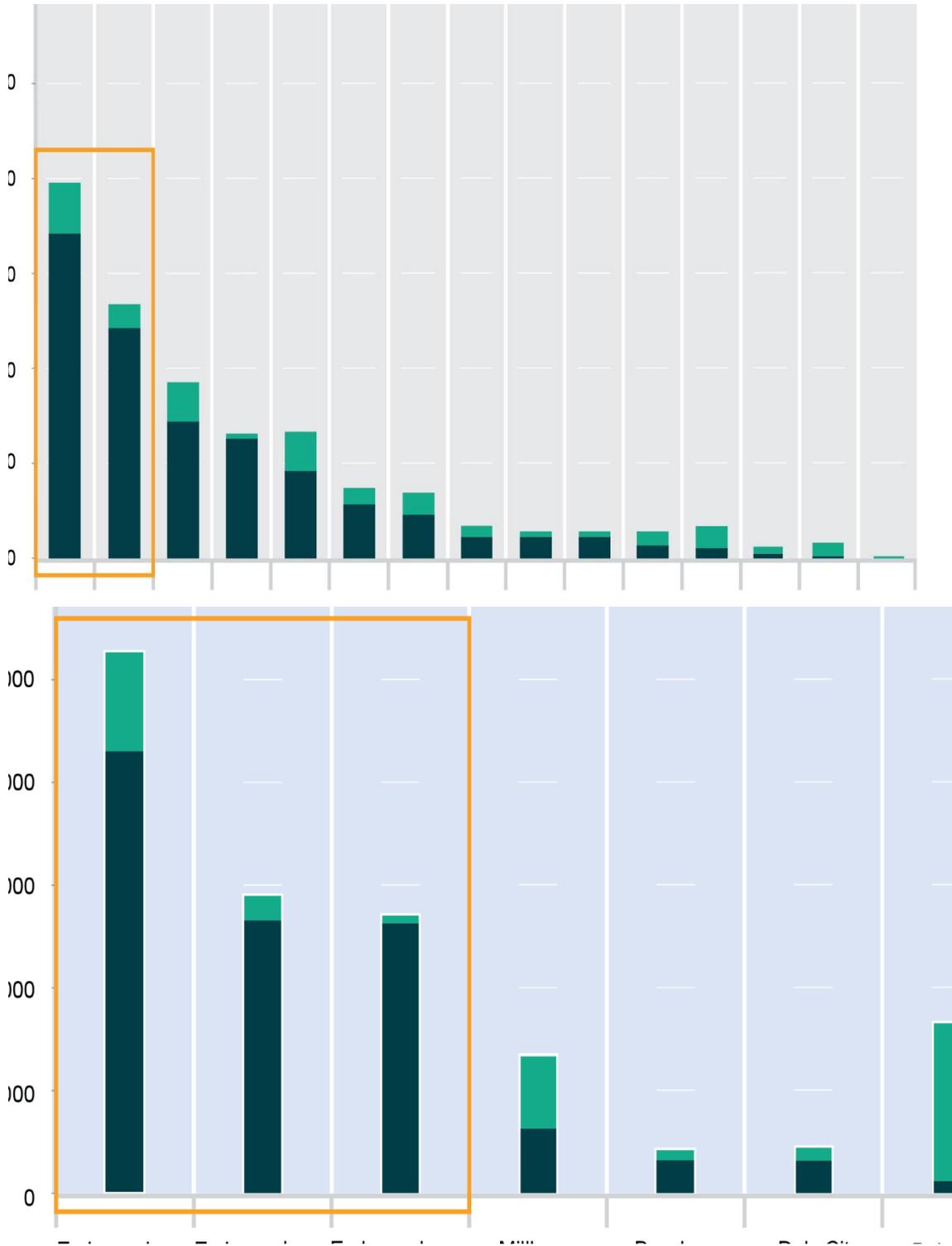
driven by the markets and segment(s) it serves in the Megaregion's core.

This high amount of unmet potential can be attributed primarily to new markets without transbay rail service in these core areas, such as western San Francisco and parts of East Oakland outside the existing BART corridor, or to markets with poor existing transbay rail service, such as Emeryville or southeastern San Francisco. In addition, certain segments, such as Embarcadero–Daly City (Central) experience significant crowding, which causes many potential riders to choose not to use rail service.



Figure 9-6. Total Equity-weighted Unmet Rail Potential (number of potential trips) for Segments in East Bay Corridors (top) and West Bay Corridors (bottom), 2040

The top five segments for transbay unmet rail potential are directly connected to either end of the Transbay Corridor.



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There is unmet rail potential for several medium-distance segments.

Several segments located a medium distance from the Transbay Corridor have transbay unmet rail potential. Most of this unmet potential can be associated with new markets without existing transbay rail service or poor existing transbay rail service, including San Pablo, Hercules, Martinez, Vallejo, Napa, San Ramon, and parts of San Mateo County.

Lower potential segments on the outskirts of the Megaregion could add value to and benefit from Link21 in other ways.

As with individual markets, segments located a long distance from the Transbay Corridor, such as Antioch–Stockton have low transbay unmet rail potential. Some segments, however, have comparatively higher non-transbay than transbay unmet potential. These mostly cover San Mateo and northern Santa Clara counties: Millbrae–Palo Alto, Palo Alto–San Jose, and Fremont–San Jose. The Millbrae–Palo Alto and Palo Alto–San Jose segments have high absolute amounts of unmet rail potential that suggests that there are ridership and other associated benefits to be realized from investments beyond a new transbay passenger rail crossing. In particular, shorter travel times and higher frequencies could open up these long-distance markets to greater ridership potential.



10. ROBUSTNESS TESTING

Two types of robustness testing were performed for the market analysis:

- An Uncertainty Analysis was performed to ensure that the corridors and segments that were identified as having strong rail potential would perform well under a variety of possible futures. It tested the impacts of changes to five key parameters: housing growth and patterns, job growth and patterns, working patterns (specifically levels of remote work), travel costs, and baseline projects.
- Emergent Network Modeling was used to verify the findings emerging from the market and corridor rail potential analysis described in the previous two chapters and to identify additional promising rail corridors. The scope of this exercise was limited to the nine-county Bay Area.

This chapter describes the methodology adopted for and the main findings from each testing approach.



10.1. Overview

Given the uncertainty around the future of travel and transportation in the Megaregion, Link21 needs to advance options that perform robustly under a variety of future conditions.

To ensure robustness of performance, the uncertainty analysis is incorporated into each phase of Link21. This analysis enables the prioritization of corridors and segments that perform well under a variety of possible future scenarios and allows Link21 to future-proof the analysis to some degree by considering how travel demand patterns could change from today's estimates should land use patterns, mobility trends, and technologies evolve.

Within the context of the market analysis, the uncertainty analysis focused on the following five key parameters, depicted in **Figure 10-1**:

- Housing growth and patterns
- Job growth and patterns
- Working patterns, specifically levels of remote work
- Travel costs
- Baseline projects

The goal of this analysis is to compare the relative performance, specifically changes in the ranking of corridors and segments, between each of the uncertainty scenarios and the baseline

corridor analysis. The results show small or no changes to rankings, meaning the **relative rankings of the corridors and segments are robust to the uncertainty scenarios tested**. This section presents the methodology and findings of the uncertainty analysis performed within the Market Analysis task.

In addition to the uncertainty analysis, emergent network modeling was used to identify additional high-potential corridors within the nine-county Bay Area.

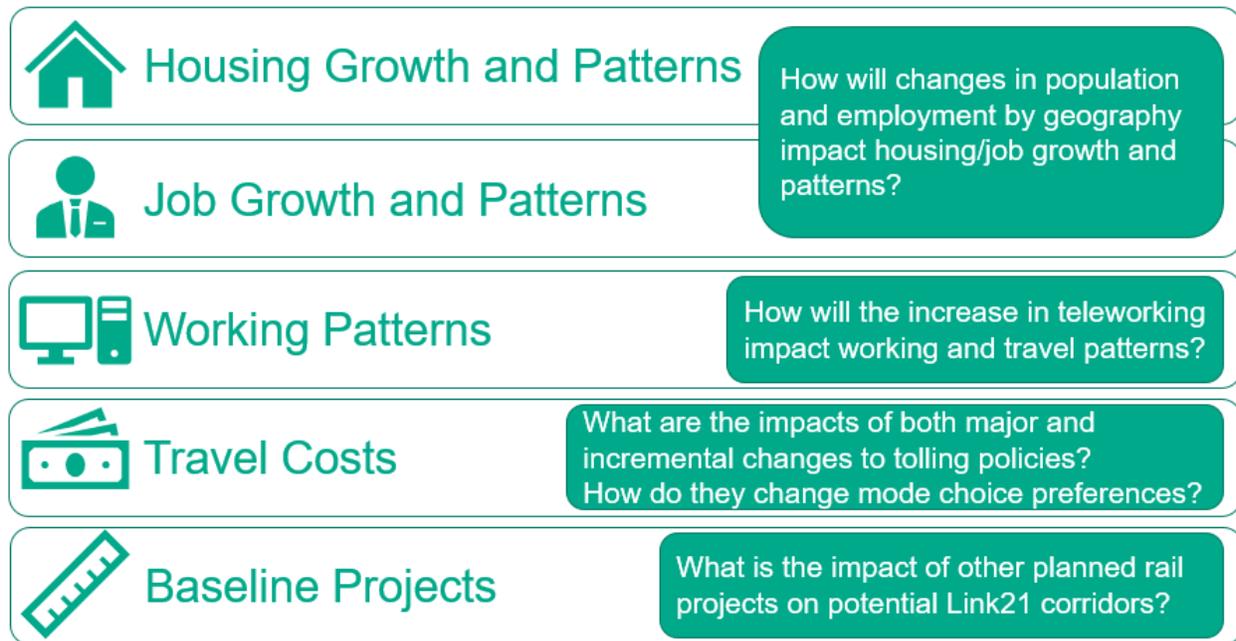
The Emergent Network Modeling Framework is a methodology used by SFCTA to assess rail transit market potential in promising but yet-to-be-studied corridors. The Emergent Network Modeling Framework features an abstract transit network of seamless/ubiquitous rail/transit services covering the study area. Examining the ridership results from providing seamless/ubiquitous rail transit throughout a study area provides an indication of which rail corridors travelers might use if good rail service were provided.

The Emergent Network Modeling Framework was implemented and adapted using MTC's TM 1.5 to identify promising rail corridors and verify the findings emerging from the market and corridor rail potential analyses described in the previous two chapters.



Figure 10-1. Five Future Scenarios

Five sets of future scenarios captured a wide range of possible future conditions that might impact travel demand patterns.



10.2. Uncertainty Analysis

Uncertainty scenarios were tested using the MAST, and the resulting equity-weighted unmet rail potential rankings across corridors and segments were then compared to those from the baseline scenario.

The uncertainty analysis approach was designed to test the impacts on equity-weighted unmet rail potential of changes to the key parameters listed previously, which were judged to have the potential to substantially affect the relative performance of corridors, segments, and cluster pairs. Equity-weighted unmet demand was chosen as the key metric to ensure this work aligns with the program-wide focus on equity.

Based on research and professional judgment (including that of various

technical panels), up to five scenarios were defined for each key parameter with each set of scenarios intended to represent a broad range of possible futures in terms of the relevant parameter. Some scenarios correspond to high or low values of a parameter, while others correspond to specific developments, such as the implementation of a congestion pricing zone.

The complexity of the scenarios was also limited by the requirement that associated changes from the baseline needed to be effectively represented by changes to inputs to the rail potential model or post-processing of rail potential model outputs. Development of rail potential model inputs for the uncertainty scenarios relied on data from a variety of

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sources, including MPO and municipal land use forecasts, consumer segmentation data, and telecommuting research.

Once the scenarios were defined, equity-weighted 2040 unmet rail ridership potential was estimated for each of a set of key corridors and segments under each scenario, and rankings of this metric across corridors and segments were compared with the corresponding rankings in the baseline scenario.

Any changes in rankings were then considered when identifying corridors and segments with high unmet rail potential

with the goal of ensuring that Link21 does not:

- Overrate concepts that perform well in the baseline scenario but poorly across several sensitivity scenarios; or
- Underrate concepts that perform poorly in the baseline scenario but well across several sensitivity scenarios.

Up to five scenarios within each of the five key parameters were tested. Each of the uncertainty scenarios is described in **Table 10-1**. Details on the methodology used to develop these scenarios is in Appendix J.

Table 10-1. Uncertainty Scenarios

MTC Futures, primary research, and professional judgment were used to define up to five sensitivity scenarios for each parameter.

PARAMETER	SCENARIO	
Housing Growth and Patterns (HG)	HG1	High population growth (2x expected 2015-2040 growth from plans), increased clustering around rail stations
	HG2	High population growth, no change in clustering around rail stations
	HG3	No population growth, no change in clustering around rail stations
	HG4	No population growth in Bay Area, high population growth in outer MPOs, no change in clustering around rail stations
Job Growth and Patterns (JG)	JG1	High employment growth (2x expected 2015-2040 growth from plans), increased clustering around rail stations
	JG2	High employment growth, no change in clustering around rail stations
	JG3	No employment growth, no change in clustering around rail stations
	JG4	No employment growth in Bay Area, high employment growth in outer MPOs, no change in clustering around rail stations



PARAMETER	SCENARIO	
Working Patterns (WP)	WP1	60% of eligible work above the baseline takes place remotely, no change in non-work trips
	WP2	20% of eligible work above the baseline takes place remotely, no change in non-work trips
	WP3	60% of eligible work above the baseline takes place remotely, 20% increase in non-work trips by remote workers
	WP4	20% of eligible work above the baseline takes place remotely, 20% increase in non-work trips by remote workers
Travel Costs (TC)	TC1	Increased rail fares (50% increase)
	TC2	Reduced rail fares (50% decrease)
	TC3	Reduced rail fares (50% decrease) for cluster pairs with high priority populations shares (proxy for means-based fare policy)
	TC4	Reduced rail fares (50% decrease) for trips to/from downtown San Francisco (proxy for auto congestion pricing)
	TC5	Regional rail fares adjusted to use BART fare formula
Housing/Job Growth and Patterns (HJG)	HJG1	Low population growth (0.5x expected growth from plans), high employment growth (2x expected) in San Francisco; no change in expected growth elsewhere
Baseline Projects (BP)	BP1	Rail projects scheduled for implementation after 2035 (based on PBA 2050's adopted plans for other MPOs) removed

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While the absolute performance of the various corridors and segments changed considerably under many of the uncertainty scenarios, there were no significant impacts on relative performance.

While many corridors were tested in the corridor analysis, the need to run the MAST for each of the 19 scenarios for each corridor necessitated limiting the

number of the corridors examined in the uncertainty analysis. As listed in **Table 10-2**, six East Bay corridors and two East Bay segments that performed well in the corridor analysis, and all three West Bay corridors along with three key West Bay segments were tested. It was determined that there was a large enough performance gap between the corridors and segments that were



examined in the uncertainty analysis and for those that were not, it would be unlikely for any of the uncertainty

scenarios to cause any of the lower performing corridors or segments to become competitive.

Table 10-2. Corridors and Segments for Uncertainty Analysis

An uncertainty analysis was performed for the set of key corridors and segments identified in the corridor analysis.

LOCATION	TYPE	NAME
West Bay	Corridor	West San Francisco (to San Jose via Millbrae)
		Central San Francisco (to San Jose via Millbrae)
		East San Francisco (to San Jose via Millbrae)
	Segment	Embarcadero-San Francisco State
		Embarcadero-Bayshore
		Embarcadero-Balboa Park
East Bay	Corridor	Oakland-Vallejo-Sacramento
		Oakland-Fremont-Modesto
		Oakland-Fremont-San Jose
		Oakland-Martinez-Stockton
		Oakland-San Ramon-Modesto
		Oakland-Walnut Creek-Stockton
	Segment	Oakland-Bay Fair
		Oakland-Richmond

Table 10-3 presents the corridors and segments whose equity-weighted unmet rail potential ranking changed in each scenario. Scenarios not included in the table saw no changes in relative rankings

of corridors or segments, and corridors/segments not listed in a specific scenario saw no change in relative rankings.

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Table 10-3. Corridor and Segment Ranking Changes Following Uncertainty Analysis

No corridor or segment had a change in equity-weighted unmet rail potential of more than one rank in either direction.

SCENARIO	CORRIDOR/SEGMENT	CHANGE IN RANKING
HG1	Oakland-Fremont-San Jose Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1
HG2	Oakland-Fremont-San Jose Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1
HG4	Oakland-San Ramon-Modesto Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1
JG1	Oakland-Fremont-San Jose Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1
JG2	Oakland-Fremont-San Jose Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1
JG3	Oakland-San Ramon-Modesto Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1
JG4	Oakland-San Ramon-Modesto Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1
TC2	Oakland-Fremont-San Jose Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1
TC3	Oakland-Fremont-San Jose Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1
	Embarcadero-Balboa Park Segment	+1
	Embarcadero-Bay Fair Segment	-1
TC4	Oakland-Fremont-San Jose Corridor	+1
	Oakland-Martinez-Stockton Corridor	-1

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- Across all the uncertainty scenarios, there were only two unique pairs of corridors and one unique pair of segments that saw changes in relative rankings. These pairs of corridors and segments are listed below along with the number of scenarios in which they changed rankings:
- Oakland-Fremont-San Jose decreased one rank and Oakland-Martinez-Stockton increased one rank in the HG1, HG2, JG1, JG2, TC2, TC3, and TC4 scenarios.
- Oakland-Martinez-Stockton decreased one rank and Oakland-San Ramon-Modesto increased one rank in the HG4, JG3, and JG4 scenarios.
- Embarcadero-Bay Fair decreased one rank and Embarcadero-Balboa Park increased one rank in the TC3 scenario.

In each of these cases, the baseline unmet rail potential for each pair of corridors/segments is very close, meaning a small difference in the changes in unmet potential between the two corridors/segments can produce a change in relative rankings.

None of the corridors or segments tested increased or decreased by more than one rank in terms of equity-weighted unmet rail potential, and all cases where rankings did change were largely a result of two corridors or segments having similar unmet rail potential in the baseline scenario.

10.3. Emergent Network Modeling

There is significant unmet rail potential in core markets in Alameda, Contra Costa, San Francisco, and San Mateo counties.

As introduced in Section 10.1, the emergent network modeling exercise seeks to identify rail corridors with high rail potential, and to verify the findings emerging from the market and corridor rail potential analyses described in the previous two sections. It uses an abstract transit network of seamless/ubiquitous rail/transit services, adapted from an SFCTA framework to align with MTC's TM1.5 covering the entire nine-county Bay Area.

The analyses found significant potential in markets radiating from Oakland in the East Bay and San Francisco in the West Bay. In the East Bay, these markets span to Vallejo in the north, to Antioch in the

northeast, to Fremont in the south, and to Dublin in the southeast. In the West Bay, they span to Daly City in the southwest, to Millbrae in the south, and to San Francisco's Richmond and Sunset districts in the west. Also, Fairfield is an additional market with significant potential that was not identified in the previous market and corridor analyses.

The unmet potential is most significant in corridors and markets where there is poor or no existing or planned transbay rail service. These include the Oakland–Richmond–Vallejo corridor and several markets in western San Francisco. This finding strongly corroborates the findings from the market and corridor rail potential analyses. Additionally, while parts of the Alameda–Bay Fair corridor have existing transbay BART service, the overall



corridor still has significant unmet potential, likely attributable to parts of the corridor that do not have transbay service (e.g., Alameda) and/or other parts that experience high levels of crowding (e.g., inner East Oakland).

10.4. Summary

Two types of robustness testing were performed for the market analysis.

An Uncertainty Analysis was carried out to ensure that the corridors and segments that were identified as having strong rail potential would perform well under a variety of possible futures. This analysis tested the impacts of changes to housing growth and patterns, job growth and patterns, working patterns (specifically levels of remote work), travel costs, and baseline projects. Relative performance of key corridors and

Additional details on the methodology and results of the emergent network analysis are presented in Appendix H.

segments was generally found to be robust to the scenarios tested.

Emergent Network Modeling was used to verify the findings emerging from the market and corridor rail potential analysis described in the previous two chapters and to identify additional promising rail corridors. The scope of this exercise was limited to the nine-county Bay Area. Among other results, it found significant potential in core markets radiating from Oakland in the East Bay and San Francisco in the West Bay, corroborating the findings from the market and corridor rail potential analysis.



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11. CONCLUSIONS

The market analysis found that significant unmet potential for transbay rail ridership exists in the Megaregion. This unmet potential is greatest at the core of the Megaregion closest to the Transbay Corridor — particularly in and around San Francisco and Oakland and to/from locations in inner East Bay cities between Richmond and Oakland. Selected markets further from the Transbay Corridor have relatively high to medium unmet transbay rail potential, particularly those without existing high quality transbay service (such as San Pablo, Hercules, Martinez, Vallejo, Napa, Fairfield, San Ramon, and parts of San Mateo County), whereas other markets have high non-transbay unmet rail potential (particularly in San Mateo and Santa Clara counties). **These findings suggest that a new transbay passenger rail crossing and associated investments in the rail network would benefit travelers across the Megaregion.**

The rail potential findings are important inputs into developing the initial program concepts. It is important to note that other factors, including engineering, operational, cost, and deliverability, need to be considered when developing and evaluating program concepts. Additionally, the market analysis focused on potential rail trips longer than 3 miles, whereas other transit modes, such as local bus and light rail, may be able to serve the unmet rail potential on shorter trips. However, the data used and the analyses presented do not account for changes in travel patterns experienced as a result of the COVID-19 pandemic or for future changes in population and employment. All data and figures represent the pre-pandemic state as the pandemic may cause significant and unknown (as of yet) future changes in population and employment patterns.

Given the minor limitations around the current findings, additional study into the market and potential demand for Link21 — in particular considering all modes of travel and (when feasible) post-pandemic living, working, and traveling patterns — should be undertaken in future phases of work.