LINK21

CONNECT NORTHERN CALIFORNIA

MARKET ANALYSIS SUMMARY REPORT

DRAFT FINAL

October 2022

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Prepared By:
Link21 Program Management Consultants (PMC)

BART

CAPITOL CORRIDOR

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ISSUE AND REVISION RECORD

REVISION	DATE	PREPARER(S)	PMC REVIEWER(S) / BART/CCJPA REVIEWER(S)	APPROVER / BART/CCJPA APPROVER	DESCRIPTION/ NOTES
0	12/22/2021	Richard Batty, Steer	Elisa Tejedor, Steer	Peter Gertler, HNTB	Working DRAFT submittal
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1B	10/14/2022	Richard Batty, Steer	Elisa Tejedor, Steer	Peter Gertler, HNTB	Revised DRAFT FINAL submittal
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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
BIPOC	Black, Indigenous, and People of Color
CAGR	compound annual growth rate
Caltrain	Peninsula Corridor Joint Powers Authority
GRP	gross regional product
MAST	Market Analysis Spreadsheet Tool
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
OD	origin-destination
PBA	Plan Bay Area
PMC	Program Management Consultants
tph	trains per hour
U.S.	United States

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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INTRODUCTION

This *Market Analysis Summary Report* presents a high-level summary of the market analysis work that was performed in support of the Link21 Program (Link21). Detailed results are presented in the main *Market Analysis Report*.

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.

This program, including a new transbay passenger rail crossing between Oakland and San Francisco, will enhance **environmental quality, livability, and economic opportunity** while protecting against community instability and displacement in the Megaregion as it improves the **travel experience**. With key investments that leverage the existing rail network and increase capacity and system reliability, rail and transit will better meet the travel needs of residents throughout the Megaregion. Advancing equity is central to Link21, it is a specific goal of Link21 and a lens through which to assess the achievement of all Link21 goals and objectives.

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

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

Purpose of the Market Analysis Summary Report

The key goals of the *Market Analysis Summary 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 statement and support the development of program concepts.
- Identify market opportunities and corridors with high ridership potential that could be served by Link21.

Approach and Report Structure

To achieve these goals, the market analysis work focused on three key areas, which are reflected in the structure of the *Market Analysis Summary Report*, 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:** The identification of specific markets with high rail ridership potential, in particular unmet rail potential, and of corridors with high market potential for new or enhanced rail service. The outputs from these analyses were tested for robustness against various future scenarios (uncertainty analysis) and were compared to results using an alternative analysis approach (emergent network).

Key Findings

The key findings from the market analysis are as follows:

- While the Megaregion has experienced above average growth in its population and economy, the distribution of this growth has been geographically uneven. This unevenness of growth is expected to continue with a greater concentration of employment growth in the Bay Area, generally, and in specific counties within the Bay Area.
- Growth in the Megaregion has also been inequitable with evidence of increasing inequality in household income and an increasing housing and transportation cost burden for lower income households. This increasing inequality constrains where residents can live and work, impacting their travel patterns and transportation decisions. Advancing equity has been identified as a goal of Link21, and a priority populations definition was developed to allow specific groups to receive additional focus in the development and evaluation of Link21 concepts.
- There is insufficient capacity to accommodate growing travel demand across the Megaregion, particularly in the Transbay Corridor between San Francisco and Oakland[1]. Further substantial growth in travel, including Transbay Corridor travel, is expected in the future. This is likely to further strain the already overcrowded and congested crossings, even when accounting for planned capacity increases to both the BART Transbay Tube and the San Francisco–Oakland Bay Bridge (Bay Bridge),

[1] 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 patterns caused by the pandemic.

underscoring the need for substantial investment in a new crossing to serve the entirety of projected demand growth.

- Markets, corridors, and segments in the Megaregion were evaluated in terms of their rail potential and, in particular, their equity-weighted unmet rail potential.[2] This analysis revealed that the greatest potential for attracting new transbay rail riders is at the core of the Megaregion, closest to the Transbay Corridor – particularly in and around San Francisco and Oakland and to/from inner East Bay cities between Richmond and Oakland.
- Some segments further from the Transbay Corridor have relatively high to medium equity-weighted unmet transbay rail potential, particularly those including markets without existing high quality transbay service, such as San Pablo, Hercules, Martinez, Vallejo, Napa, Fairfield, San Ramon, and parts of San Mateo County. Other segments have high non-transbay potential, particularly in San Mateo and Santa Clara counties, indicating potential benefits from investments beyond the crossing.
- Uncertainty analysis (examining alternative scenarios) indicates the findings from the market and corridor rail potential analyses are very robust.
- The findings from the market and corridor rail potential analyses are also corroborated by alternative emergent network analysis, which is further explained in the Robustness Testing section.

EXISTING CONDITIONS

The first market analysis task was to investigate the historical socioeconomic, equity, and transportation conditions of the Megaregion and to understand existing travel patterns by analyzing:

- Population and employment
- Equity, in terms of racial, social, and geographic distribution of outcomes
- Megaregional travel

Population and Employment

An analysis of the geographic distribution of population and employment across the Megaregion is important to understanding interregional travel demand patterns. The market analysis examines the current population and employment and also the extent and distribution of growth in the Megaregion.

[2] Equity weighting of unmet rail potential is achieved by double counting trips made by priority populations, reflecting the importance of serving areas with high priority populations shares and totals and counteracting the historic tendency to underserve priority populations.

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.

- According to California state figures, the Megaregion was home to over 12.7 million residents and 6.2 million jobs in 2019.
- Most of the high-density population areas in the Megaregion are located in the Bay Area and certain parts of the Sacramento Area.
- There are high concentrations of both housing and employment in downtown San Francisco, Oakland, and San Jose.

The Megaregion has experienced above average growth in its population and economy.

Between 1990 and 2019, the megaregional population increased by 37% compared to national growth of 32%.

Despite three economic crises between 1990 and 2019, the overall Megaregion's gross regional product (GRP) increased at a compound annual growth rate (CAGR) of 3.6% (**Figure 1**), outperforming national and statewide growth. Over 73% of the Megaregion's GRP in that period was generated in the Bay Area.

Figure 1. Percent of CAGR (1990-2019)

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

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: Program Management Consultants (PMC) analysis of California Department of Finance, California Employment Development Department, and the U.S. Bureau of Labor Statistics data

However, the distribution of this growth has been uneven.

Within the Megaregion, the Sacramento Area and the Northern San Joaquin Valley experienced the fastest growth rates in population and in employment.

While growth in the Bay Area has been slower, the existing size of population and employment there means that most of the Megaregion's growth in absolute terms has been concentrated within the Bay Area.

Moreover, the Bay Area's share of employment growth has been higher than its corresponding share of population growth **(Figure 2)**.

Figure 2. Percent of 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.

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

Within the Bay Area, the West Bay (including San Francisco) has had a much higher share of employment growth than of population growth.

Since 2010, San Francisco has observed a 128,000 increase in number of jobs, which is 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 macro level across the Megaregion, and at a micro level between Bay Area counties has implications for travel demand within the Megaregion, and specifically increased travel demand within the Transbay Corridor.

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 facilitate the evaluation of Link21's benefits and impacts on equity, a program-specific geographic designation of equity has been 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 the general population. 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. An initial definition of priority populations based on state and regional geographic metrics related to equity was used for the market analysis. An updated version of this definition, based on the most impactful burdens felt by Megaregion residents, will be used for future work.

Link21's *Draft Equity Commitment* includes a focus on partnering with priority populations to create needed benefits and to minimize harms to those who need it most, including:

- Transit-dependent riders
- Those harmed by past transportation projects

- Those with limited access to important resources, such as housing or job opportunities

To assess how Link21 advances equity, the program must first understand how current conditions across the Megaregion are distributed both geographically and demographically. The data points used for this analysis are summarized in **Figure 3** and are not an exhaustive list of equity considerations for the program.

Figure 3. 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.

Metrics	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 one, five, and ten 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*

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

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

- 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%.
- Bay Area counties Marin, San Francisco, and San Mateo have among the highest degrees of income inequality as measured by the Gini Index in 2019.

There is evidence of increasing inequality in household income in the Megaregion, especially in the Bay Area.

- The Megaregion has seen the greatest growth from 1990-2019 in the highest income bracket — households earning over $150,000. In non-Bay Area counties,[3] 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.

Moreover, as home values and rents have increased in the Megaregion, lower-income households face an increasing housing cost burden:

- 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.
- Since 2010, among households earning below $75k annually, the proportion that are housing-cost burdened has increased.

Black, Indigenous, and People of Color (BIPOC) make up a large and growing proportion of the Megaregion's population, and they are disproportionately likely to have low incomes:

- The BIPOC proportion of population in the Megaregion's four areas ranges from 47% in the Sacramento Area to 65% in the Northern San Joaquin Valley.
- Between 1990 and 2019, the number of BIPOC households in the Megaregion increased at a CAGR of 2.6%, whereas White, Non-Hispanic households have declined.
- Across the Megaregion between 2015 and 2019, a higher proportion of Black (Non-Hispanic), American Indian/Alaska Native, and Hispanic/Latino residents earned less than $30k a year compared to residents of other races/ethnicities.

Equity issues are particularly apparent in transportation. High housing costs are pushing low-income households, including many BIPOC households, further from the transbay core, 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.

- While 64% of priority populations live within 5 miles of a rail station, this accessibility to rail is not universal throughout the Megaregion, particularly in the outer non-Bay Area counties.
- Priority populations already residing within close proximity to rail (21% live within 1 mile) would benefit from improved service levels and improved connectivity to key destinations.

[3] Counties within the Monterey Bay Area, the Sacramento Area, and the Northern San Joaquin Valley

Having access to more affordable, high-quality rail has the potential to improve livability for priority populations by allowing households to reduce transportation costs and improve access to affordable housing and living-wage jobs. To deliver program benefits to priority populations, it will be important to:

- Maintain access to Link21 for priority populations in the Bay Area by mitigating displacement.
- Connect priority populations and improve quality of service throughout the Megaregion.

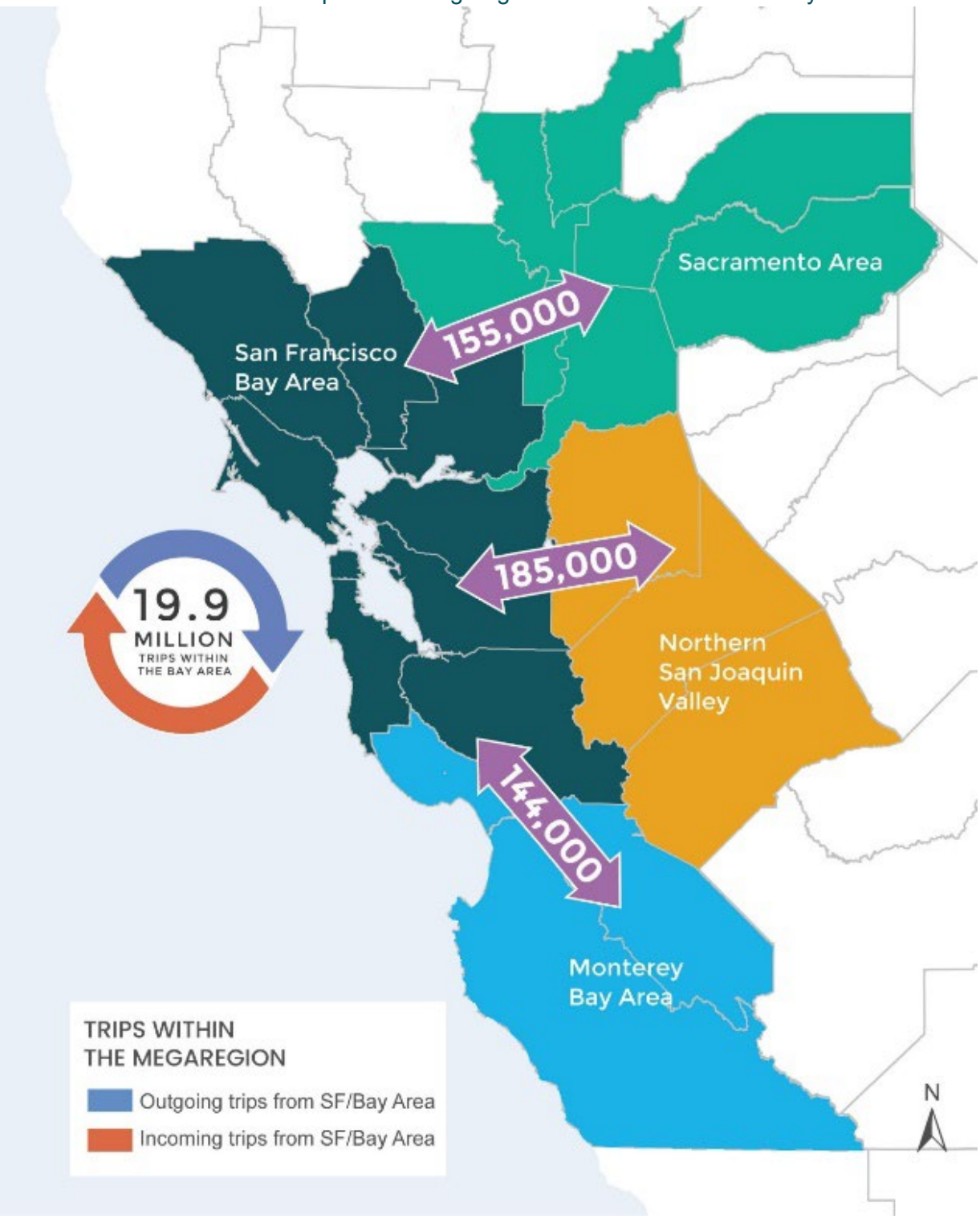
Megaregional Travel

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 these trips, 19.9 million (62%) occurred within the Bay Area, particularly to/from the East Bay, San Francisco, San Mateo, and Santa Clara counties and 675,000 people crossed the San Francisco Bay using one of four crossings (three bridges and the BART Transbay Tube). Key travel flows within the Megaregion are shown in **Figure 4**.

Figure 4. Trips within the Megaregion (2015)

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



Source: PMC analysis of StreetLight and other travel pattern data

In 2015, auto was the dominant mode of travel in the Megaregion with over 95% of total daily trips. Among the relatively small number of non-auto trips, only 28% were made by rail (heavy/regional rail and subway/metro services) with the remainder made by other forms of transit such as bus, ferry, or street-running light rail.

In contrast to the overall Megaregion, the Transbay Corridor has a much higher rail mode share. In 2015, BART captured a 32% daily share of transbay trips (38% during the peak), while 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.

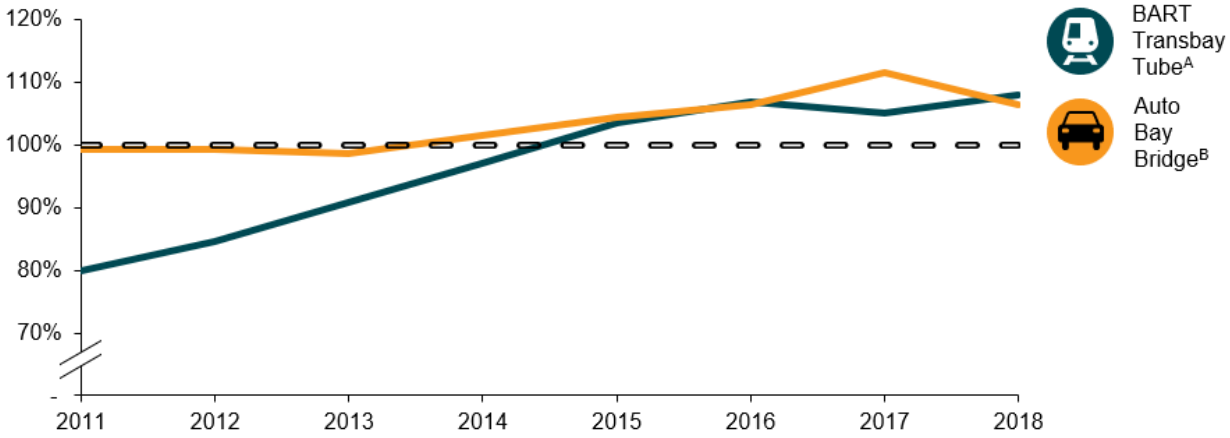
In 2015, the majority of rail services in the Megaregion were provided by BART, Capitol Corridor, Caltrain, Altamont Corridor Express (ACE), and San Joaquins. All five recorded at least 10% growth in demand between 2010 and 2019, including an approximate doubling of ACE and Caltrain ridership. While BART has observed more modest ridership growth in percentage terms and even a slight decline since 2017, it still carries a large majority of megaregional rail demand, and peak volumes have steadily increased in the Transbay Tube.

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. Inaccessibility of stations is particularly noticeable in several areas of the Megaregion 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, forcing most travelers to drive or in some cases use other public transit to make their trip.

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, both the Bay Bridge and Transbay Tube have been operating consistently above their planned capacities during peak periods, as summarized in **Figure 5**.

Figure 5. Percent Peak Demand Volume Over Capacity

Both Transbay Crossings have been over capacity since 2015



Source: 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

Furthermore, while a substantial proportion of BART travelers currently drive to access stations, demand for BART parking facilities at stations exceeds available capacity.

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. Long commutes have become increasingly prevalent.

In 2019:

- An estimated 14% of trips were longer than one hour, up from 10% in 2010.
- Five percent of trips were over 90 minutes, up from 3% in 2010.

The upward shift in commute times may be partially attributed to the capacity issue described above; another likely contributing factor is rising housing costs and housing cost burdens causing segments of the population, notably priority populations, to live further from their workplaces.

Uncompetitive rail travel times (compared to auto) are a barrier to rail travel in the Megaregion:

- Rail trip times exceeded auto times for over 99% of origin-destination (OD) pairs analyzed.

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

The disparity in times may be attributed to a variety of factors, including long access and egress times to and from rail stations, slow and infrequent trains, and long transfers. Rail operators' difficulty in meeting their on-time performance targets further undermines confidence in the service. 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.

The resulting 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.

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, network connectivity, less need for transfers, and coordination between rail operators. As such, the foundational goal of the program is to transform the passenger experience, which enables the achievement of the three other program goals: promote equity and livability, support economic opportunity and global competitiveness, and advance environmental stewardship and protection.

FUTURE CONDITIONS

Building on the existing conditions analysis, the next stage of the market analysis is to provide an overview of:

- Future population and employment growth
- Future megaregional travel (including travel demand patterns and transportation investments)

Future Population and Employment Growth

The 2040 adopted regional transportation plans of the Megaregion's Metropolitan Planning Organizations (MPO) serve as the baseline scenario for Link21, including for the Metropolitan Transportation Commission's (MTC) Plan Bay Area (PBA) 2040. Since the adoption of PBA 2040, MTC has developed three alternative Horizon Futures 2050 forecasts for the Bay Area, which are used to inform Link21's uncertainty analysis described later in this report.[4] A base year of 2015 was selected for Link21, aligning with most of the adopted MPO plans.

[4] While this document was being finalized, MTC and the Association of Bay Area Governments (ABAG) adopted PBA 2050, an updated plan for the Bay Area which builds on PBA 2040 and incorporates the results of the Horizon Futures 2050 forecasting work.

Note that the MPO forecasts used by Link21 were developed well before the COVID-19 pandemic, when there has been an unprecedented decrease in travel demand across the Megaregion and in cities across the world. The impact of COVID-19 on population and employment growth along with travel demand has been examined as part of the Link21 uncertainty analysis.

Based on the adopted plans, 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 Bay Area's population is forecast to increase by 2.0 million out of the 3.3 million increase for the Megaregion.
- The Bay Area accounts for 1.0 million of the 1.5 million increase in jobs forecast.

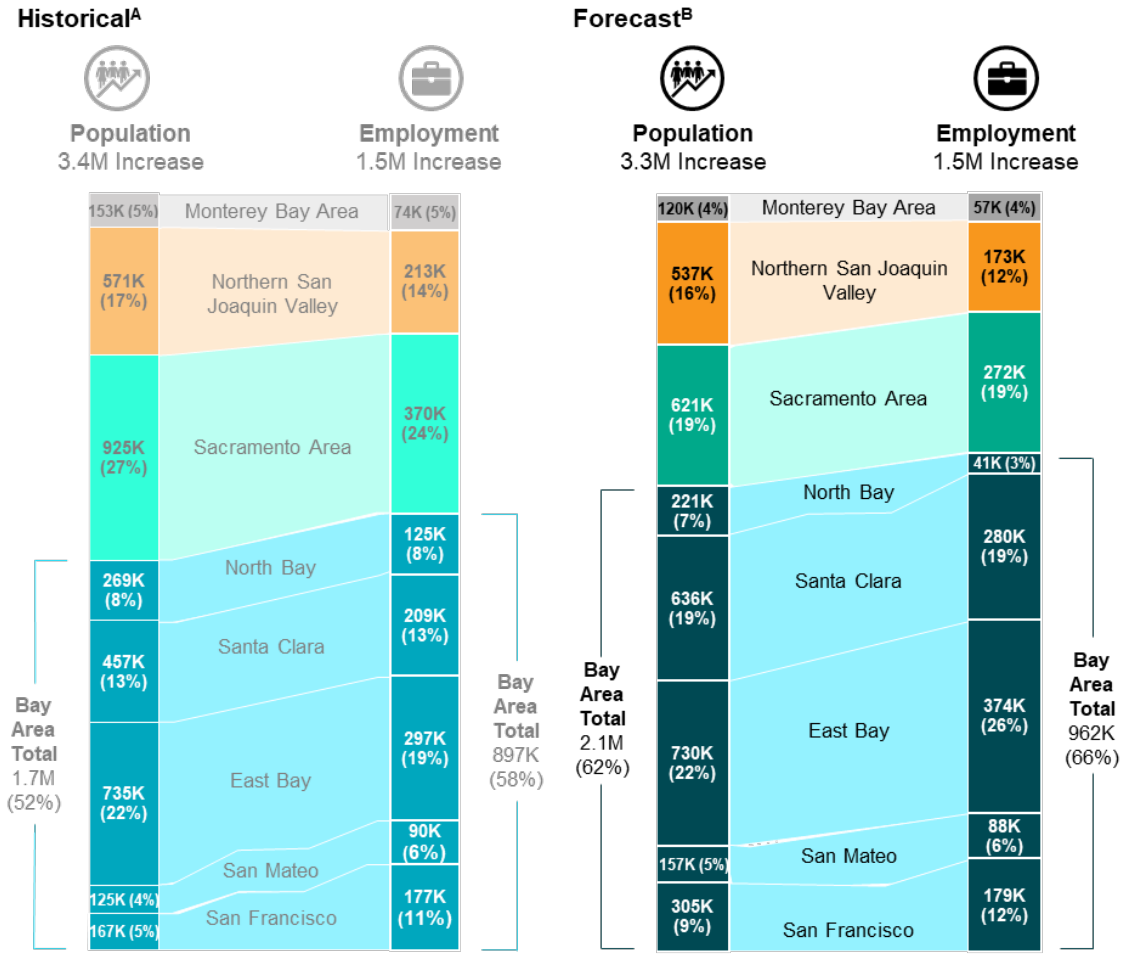
The historically uneven distribution of population and employment growth is expected to continue with a greater concentration of employment growth in the Bay Area generally and in specific counties within the Bay Area.

- The Bay Area is forecast to have a 62% share of the increase in megaregional population but 66% of the increase in employment.
- The East Bay is forecast to have a 22% share of the population growth but 26% of the increase in employment. Similarly, San Francisco and San Mateo counties are forecast to have a combined 14% share of population growth but 18% of the jobs increase.

This continuing imbalance in the distribution of population and employment, illustrated in **Figure 6**, may lead to further increased travel demand on already congested transbay road and rail infrastructure.

Figure 6. Historical Growth and Baseline Forecasts for Population and Employment

The baseline forecasts the Bay Area to have 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, Association of Monterey Bay Area Governments [AMBAG], Sacramento Area Council of Governments [SACOG], Stanislaus Council of Governments [StanCOG], and Merced County Association of Governments [MCAG])

[A] *Historical growth rates are from 1990 to 2019.*

[B] *Future forecast growth rates are from 2015 to 2040.*

Following the adoption of PBA 2040, MTC undertook an initiative named Horizon that attempted to incorporate the uncertainty of external forces into the early stages of its 2050 regional planning process. MTC's *Horizon Futures 2050* forecasts were still in development at the time of writing this report; it applies only to the Bay Area counties.

There are three different forecast scenarios, illustrated in **Table 1**: Back to the Future, Clean and Green, and Rising Tides, Falling Fortunes. These scenarios 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.

Table 1. Three Forecast Scenarios from Horizon Futures 2050

SCENARIO	DESCRIPTION
Back to the Future	▫ 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.
Clean and Green	▫ Defined by an aggressive federal carbon tax to curb carbon dioxide emissions. ▫ Assumes that 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.
Rising Tides, Falling Fortunes	▫ 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 (three feet of sea level rise by 2050).

Source: PMC analysis of Horizon Futures Final Report

Population and employment growth projections vary widely between the baseline and the *Horizon Futures* scenarios. For example:

- Compared to the baseline forecast, the Back to the Future scenario projects much higher population and employment growth in the Bay Area (1.7% CAGR vs. 1.0% for population, 1.8% vs. 0.9% for employment).
- By contrast, population and employment growth in the Bay Area in the Rising Tides, Falling Fortunes scenario is much lower than in the baseline with a decline in population in the East Bay and declines in employment in San Mateo and North Bay counties.
- All three Horizon Futures project significantly higher employment growth in San Francisco than PBA 2040. Furthermore, San Francisco's share of Bay Area employment growth is vastly greater than its share of population growth for the Back to the Future and Clean and Green scenarios, making the potential imbalance between population and employment even more marked.

These wide variations in growth projections for population and employment will also impact transbay travel demand, as discussed in the following sections.

Future Megaregional Travel

In Link21's baseline forecast, 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.

Projected growth rates vary across the Megaregion, as illustrated in **Table 2** and **Table 3**.

- 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, which will lead to an increased need for travel between the two.
- On the other hand, the largest absolute growth in travel is expected to occur entirely within the Bay Area, particularly on the 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, again driven by an increasing geographic imbalance of population and employment growth.

The projected growth in megaregional travel is accompanied by changes in residents' mode choice. In the Transbay Corridor, the number of rail trips in the key San Francisco-East Bay market is projected to grow by 16%, although this represents a slight decrease in rail mode share. Other region pairs, including San Francisco to Santa Clara County and the Northern San Joaquin Valley to San Francisco, are forecast to have high increases in rail mode share, which will likely be driven by planned new or enhanced rail service in these corridors.

Little change is forecast in the accessibility of rail across the Megaregion:

Even with planned baseline investments to the rail network, only 31% of projected trips in 2040 originate within 1 mile of a rail station, only a one-point improvement from 2015.

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

Non-Bay Area counties in the outer regions 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.

DESTINATION/ ORIGIN	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%

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

DESTINATION/ ORIGIN	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

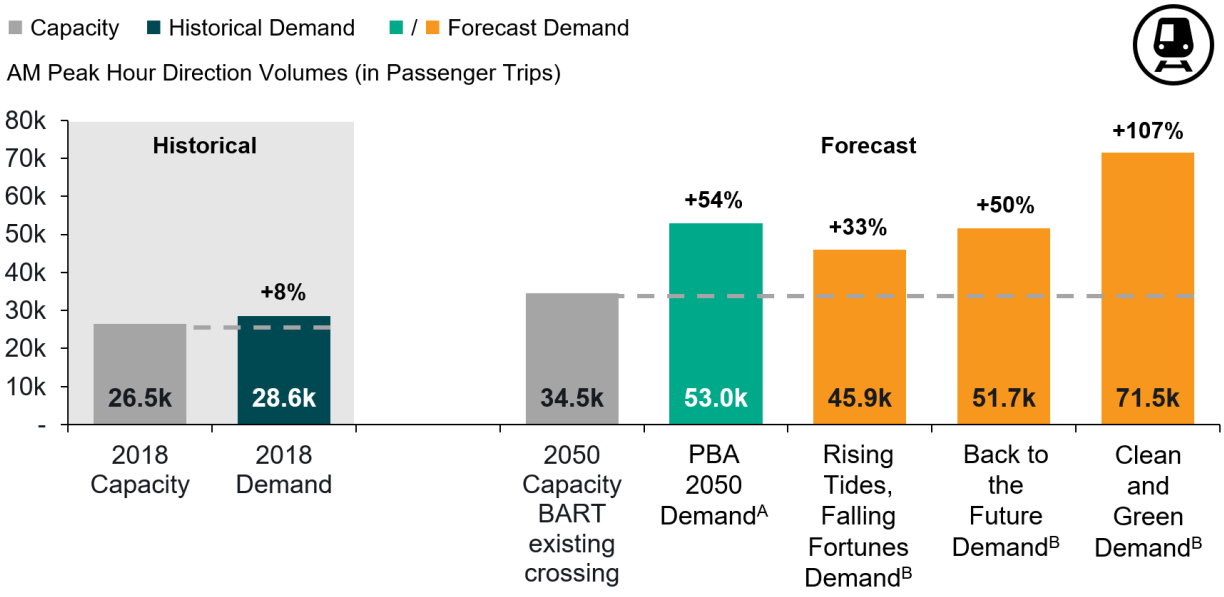
The significant growth in Transbay Corridor travel will likely strain the already overcrowded and congested crossings further, even when accounting for planned capacity increases to the Transbay Tube and the Bay Bridge.

Figure 7 illustrates that, while the BART Core Capacity project will enable an additional six trains per hour (tph) to travel through the Transbay Tube (from 22 to 28 tph[5] in each direction), this is insufficient to meet projected demand under the baseline forecast or any of the three scenarios generated using *Horizon Futures 2050*. Travel demand is projected to exceed planned capacity by the early 2030s at the latest, and under the most aggressive (Clean and Green) growth forecast, the system could be 107% over capacity by 2050.

[5] The market analysis assumed implementation of Phase 1 of the federally funded portion of the Core Capacity project to 28 tph. The locally funded Phase 2 will increase train throughput to 30 tph.

Figure 7. AM Peak Hour Peak 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 still 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

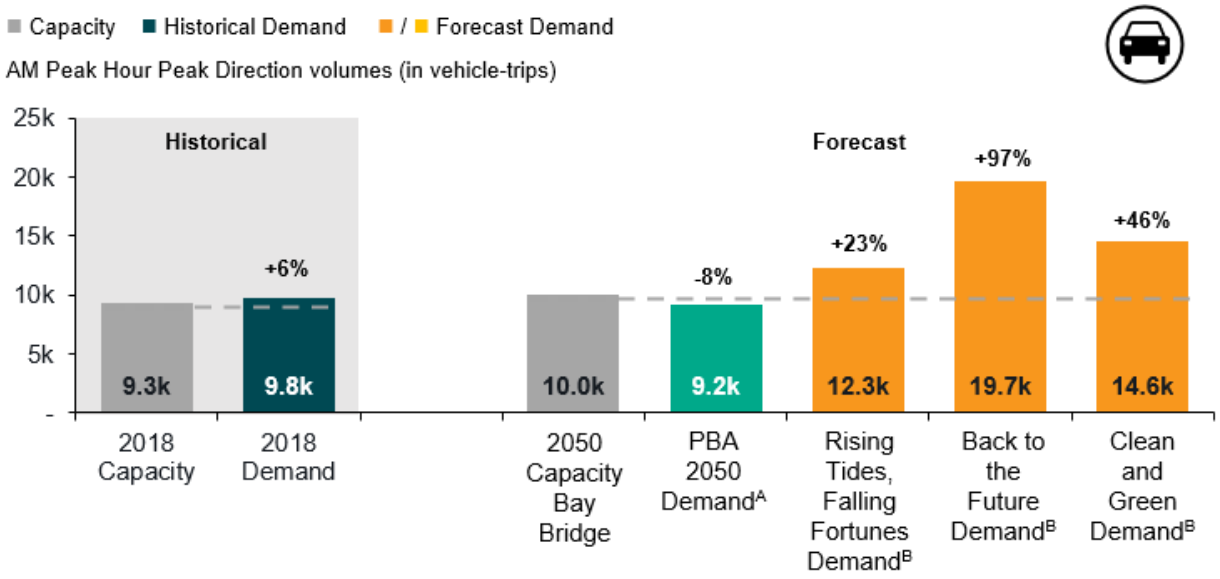
[B] Excludes PBA 2050 projects

For the Bay Bridge, the implementation of all-electronic tolling has provided a slight boost to vehicle capacity. However, **Figure 8** shows that this is insufficient to meet future demand in any of the scenarios analyzed. Even in the most conservative auto demand growth forecast (Rising Tides, Falling Fortunes) projected 2050 demand exceeds capacity by 23%, while the Back to the Future forecast projects demand 97% above available capacity.

Despite these investments, travel demand is projected to exceed planned capacity. 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 Bay Bridge capacities exceeded by 33% and 23%, respectively.

Figure 8. 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, further straining the Bay Bridge.



Source: PMC analysis of MTC travel model data

[A] *Includes the Link21 Program*

[B] *Excludes PBA 2050 projects*

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 subsequently used to inform the development of program concepts.

Equity is central to all aspects of Link21 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, and counteracting the historic tendency to underserve priority populations.

Given the inherent uncertainties in the inputs and assumptions used in the market analysis (compounded by the impacts of the COVID-19 pandemic), uncertainty analysis is an important component of the overall approach. It allows us to test the robustness of the analysis by considering how travel demand patterns could change from today's estimates as land use patterns, mobility trends, and rail competitiveness evolve.

Rail potential is assessed under the following three headings:

- **Market rail potential analysis:** identifying specific markets with high, unmet ridership potential.
- **Corridor rail potential analysis:** bundling high-potential, geographically proximate markets into high-potential rail corridors**.**
- **Robustness testing:** performing an uncertainty analysis under various scenarios and verifying findings using alternative approaches.

Market Rail Potential Analysis

The purpose of the market rail potential analysis is to identify markets with the highest ridership potential for Link21 by focusing on trips using the Transbay Corridor between San Francisco and Oakland.

Markets are defined as individual neighborhoods or entire municipalities that may be served by rail. They are represented by clusters, which are the main geographic unit of analysis for the market analysis, and cluster pairs. Clusters are a group of multiple hexcells, which are uniform hexagonal areas that are 0.5 miles in diameter and that collectively cover the entire Megaregion; each cluster has a hub at its center. The market rail potential analysis identifies clusters and cluster pairs with the greatest unmet rail potential, while prioritizing equity by double counting trips made by priority

populations (consistent with Federal Transit Administration [FTA] guidance on equity analysis).

Rail potential is estimated using a regression model, 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 the Market Analysis Spreadsheet Tool (MAST), a spreadsheet developed by Link21 to calculate the good service rail potential and unmet rail potential for all cluster pairs in the Megaregion. Unmet rail potential is 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.

The results of this analysis are shown in **Figure 9** that maps the locations of the greatest unmet transbay rail potential. These are the markets where service improvements have the greatest potential to increase transbay rail ridership.

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.[6] 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 Boulevard corridor in Oakland
- Markets with poor, non-direct 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

[6] Here, and throughout the market analysis, note that only those trips longer than 3 miles have been analyzed.

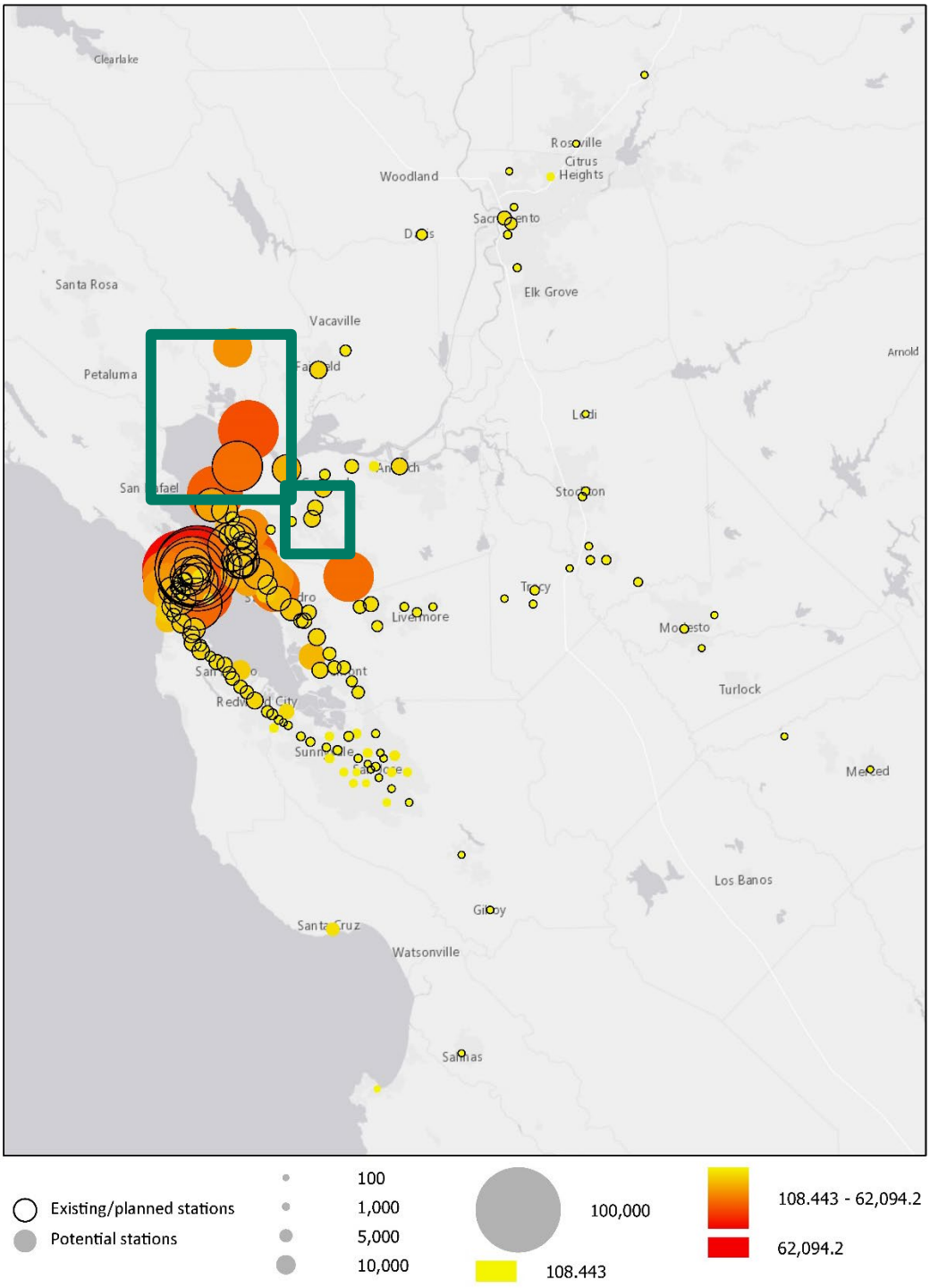
Beyond the core of the Megaregion, relatively high to medium unmet transbay rail potential exists in markets further from the Transbay Corridor. These markets include San Pablo, Hercules, Martinez, Vallejo, Napa, San Ramon, and parts of San Mateo County.

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

- All clusters benefit when “good transbay rail service” is provided with MAST results suggesting that the largest benefits come from improved journey times and the elimination of transfers (increasing peak trips by 22% and 16%, respectively).
- 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. This could translate into commensurately 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, air quality improvements, and greenhouse gas emissions reductions.
- The benefits of Link21 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 (via the East Bay).

Figure 9. Transbay Equity-weighted Unmet Rail Potential (number of potential trips), 2040[7]

Forty-five percent of total unmet rail potential involves a trip in the Transbay Corridor.



Source: PMC rail potential analysis

[7] Analysis is based on trips longer than 3 miles.

Corridor Rail Potential Analysis

Corridor rail potential analysis builds on previous market rail potential analysis by connecting geographically proximate high-potential markets. Once individual high-potential markets have been identified, they can be connected to form segments, which in turn can be grouped to form corridors. These corridors are a useful geographic unit of analysis to inform subsequent program concept development, as they are high-level representations of potential rail alignments. Note that at this point, these corridors reflect market potential only and do not yet take into account engineering, operational, cost, or other factors that need to be considered in the design of transit corridors.

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. Similarly, the analysis emphasizes equity by doubling the importance of potential trips made by priority populations, reflecting the central role that equity plays in Link21 and to counteract the historic tendency to underserve priority populations.

The high-potential corridors and segments identified in this analysis subsequently inform the development of program concepts alongside other sources, such as public studies/plans and stakeholder engagement.

Most of the clusters analyzed in the market rail potential analysis fall naturally into one or more of 12 geographically organized corridors: nine in the East Bay and three in the West Bay, as illustrated in **Figure 10** and **Figure 11.**

Figure 10. East Bay Corridors

East Bay corridors are approximate linear groupings of markets originating in Alameda/Oakland and extending to Sacramento, San Jose, Stockton, and Modesto.

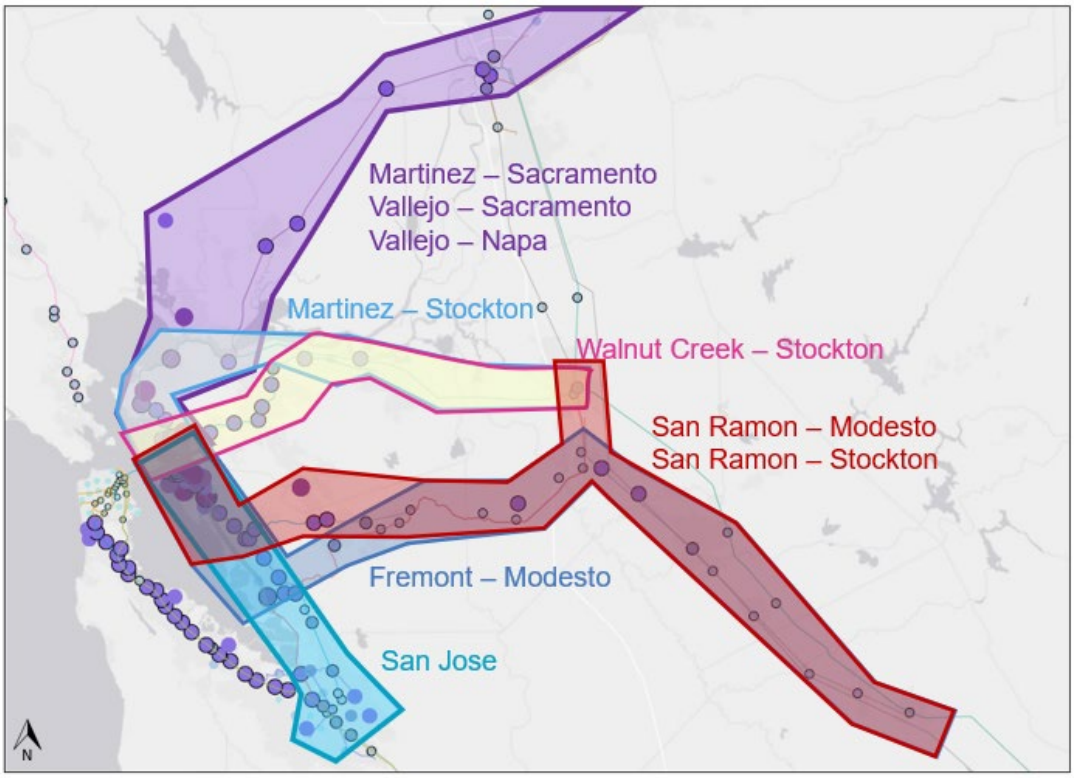
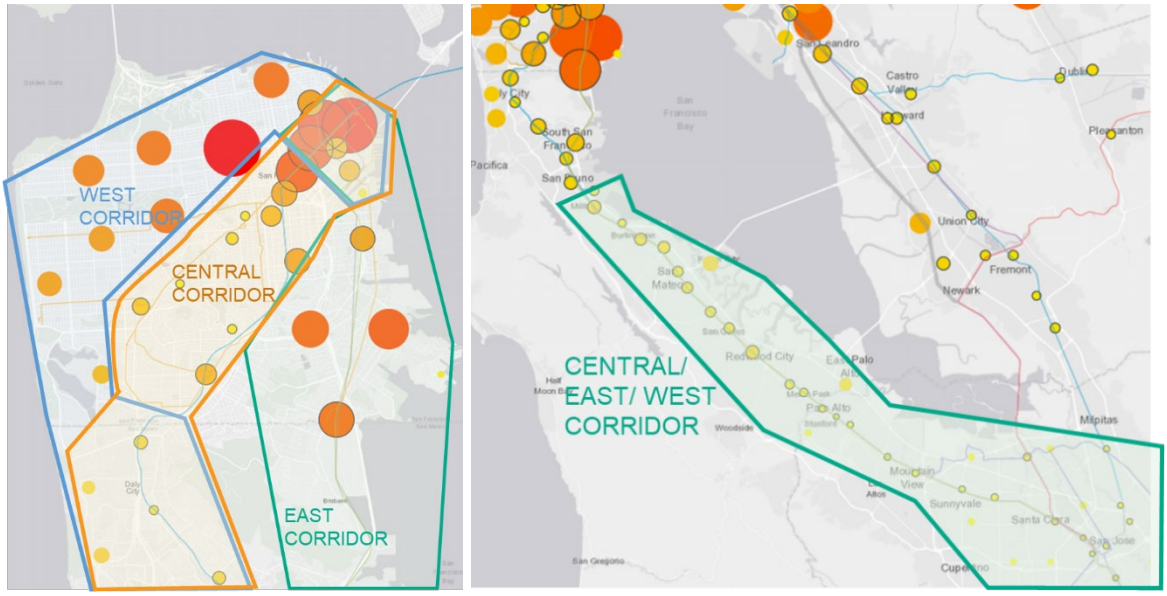


Figure 11. West Bay Corridors

West Bay corridors originate in San Francisco and take three different paths before converging on one main segment that follows existing rail service through San Mateo and Santa Clara counties.



The unmet rail potential for each corridor was estimated using the following steps:

- Split the corridors into segments with logical breakpoints based on large markets or infrastructure barriers.

For each segment, identify market concepts by connecting high-potential markets.

Evaluate the transbay equity-weighted unmet potential of each market concept by connecting all its markets with existing and planned stations on the other side of the San Francisco Bay.

- For each segment, identify the market concept with the highest transbay equity-weighted unmet potential.
- For each corridor, incrementally identify segments with the highest combined potential.

A key finding across all corridors studied is that the greatest potential for attracting new transbay rail riders is at the core of the Megaregion, closest to the Transbay Corridor.

The analysis results are shown in **Figure 12** and **Figure 13**, which displays the unmet rail potential by segment. The segments with the greatest unmet rail potential are in and around San Francisco and Oakland, and to/from inner East Bay cities between Richmond and Oakland.

The top five segments for transbay unmet potential are connected directly to either end of the Transbay Corridor.

Figure 12. Total Equity-weighted Unmet Rail Potential (number of potential trips) for Segments in East Bay Corridors, 2040

Top five segments for transbay unmet potential are connected directly to either end of the Transbay Corridor.[8]

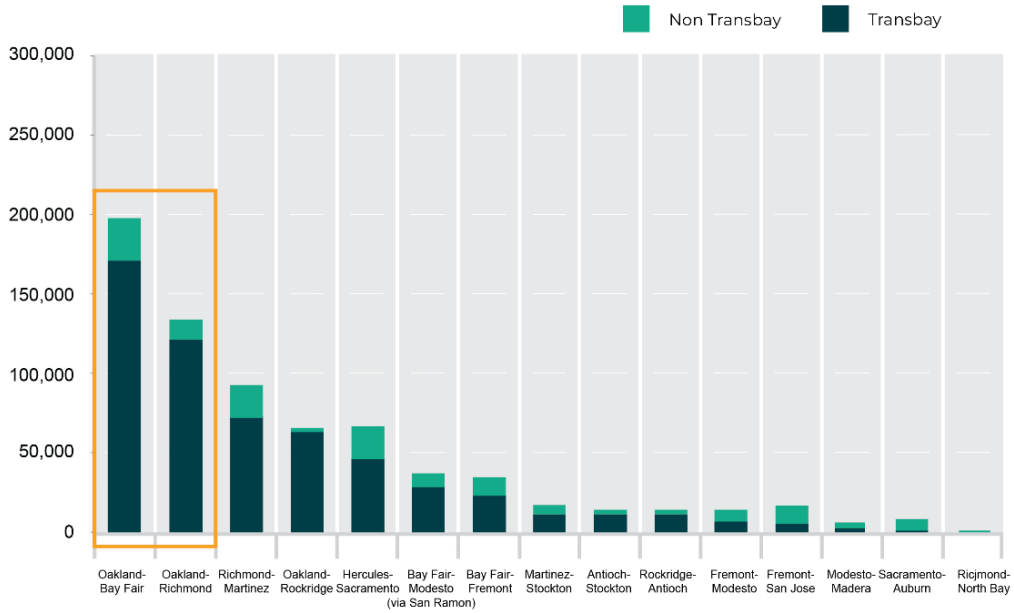
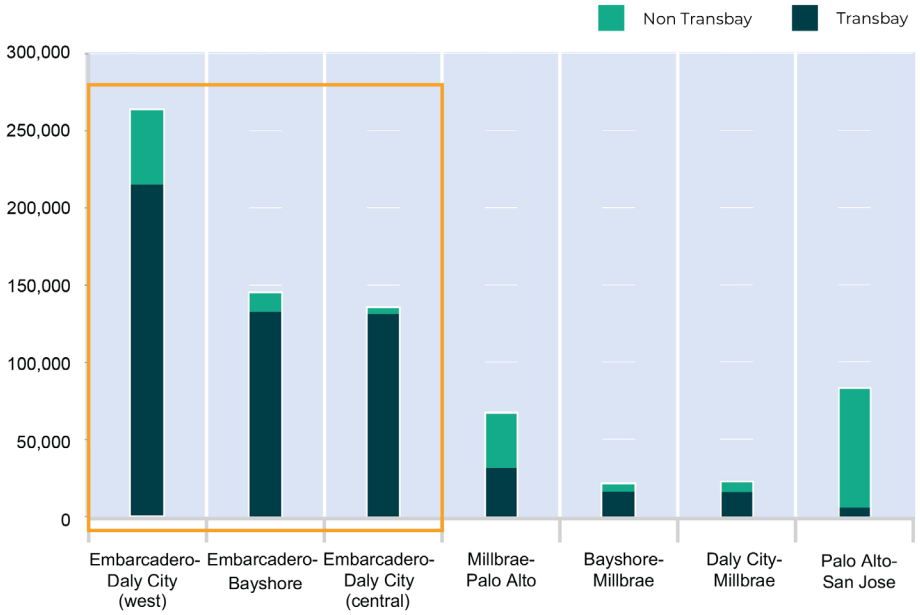


Figure 13. Total Equity-weighted Unmet Rail Potential (number of potential trips) for Segments in West Bay Corridors, 2040



Source: PMC rail potential analysis

[8] Note that the segment labels in the figures, and mentioned elsewhere in this section, refer to geographic areas and not trips between location pairs. For example, Oakland-Bay Fair refers to a geographic area encompassing all locations between Oakland and Bay Fair, it does not mean trips between Oakland and Bay Fair.

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. However, unmet potential in the Oakland – Rockridge segment (within the Walnut Creek/Stockton corridor in Figure 10) is substantially lower than for other core segments as this segment is already well served by BART.

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 to or unwilling to use the existing service.

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

- Several segments located a medium distance from the Transbay Corridor mostly 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, identified previously, of markets such as Sacramento, Stockton, and Modesto translates into low unmet potential for segments connecting these markets, such as Modesto – Merced or Suisun – Sacramento.

Some segments have high non-transbay unmet potential compared to their transbay unmet potential, particularly in San Mateo and northern Santa Clara counties (e.g., for the Millbrae – Palo Alto, Palo Alto – San Jose, and Fremont – San Jose segments). This suggests there may be ridership and other associated benefits to be realized from investments beyond the crossing.

Robustness Testing

Given the critical importance of Link21 to the Megaregion, and the uncertainty regarding the future of travel and transportation there, it is vital to test the robustness of the market analysis methods and outputs. This testing has taken two forms:

- **Uncertainty analysis:** tests the impacts of changes to key parameters.
- **Emergent network modeling:** uses an alternative approach to verify and to add to the findings of the main market analysis approach.

The **uncertainty analysis** enables the prioritization of corridors and segments that perform well under a variety of possible future scenarios and makes sure the team can

future-proof the analysis by considering how travel demand patterns could change from today's estimates as land use patterns, mobility trends, and technologies evolve.

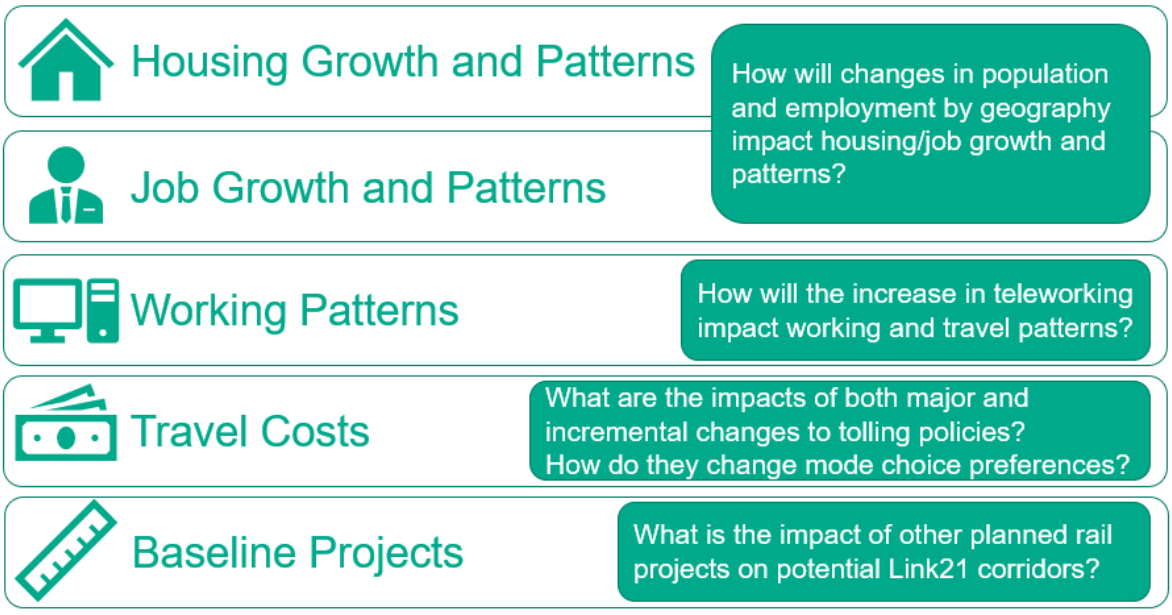
The uncertainty analysis tested up to five scenarios within each of the following five categories: housing growth and patterns, job growth and patterns, working patterns, travel costs, and baseline projects (**Figure 14**). Each set of scenarios is intended to represent a broad range of possible futures — some correspond to high or low values of a parameter while others correspond to specific potential developments, such as implementation of a congestion pricing zone.

The uncertainty scenarios were tested using the MAST. Under each scenario, corridors and segments were ranked for their equity-weighted unmet rail potential, and the rankings were compared to those from the baseline scenario. Any significant changes in ranking needed to be considered carefully in order to avoid:

- Overrating concepts that perform well in the baseline scenario but poorly across several sensitivity scenarios.
- Underrating concepts that perform poorly in the baseline scenario but well across several sensitivity scenarios.

Figure 14. Future Scenarios

Five sets of future scenarios captured a wide range of possible future conditions that might impact travel demand patterns.



The key finding from the uncertainty 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.

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. None of the

corridors or segments tested increased 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 potential in the baseline scenario.

This reinforces the main market analysis findings, in terms of identifying corridors and segments with high equity-weighted unmet rail potential.

The uncertainty analysis indicates the findings from the market and corridor rail potential analyses are very robust.

Emergent network modeling was used to identify high-potential rail corridors in the nine-county Bay Area. The Emergent Network Modeling Framework is a methodology used by the San Francisco County Transportation Authority (SFCTA) to assess rail transit market potential in promising but yet-to-be-studied corridors. The emergent network 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 analysis 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 the Richmond and Sunset districts of San Francisco in the west.

The unmet transbay rail potential is likely to be 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, the Alameda – Bay Fair corridor, and several markets in western San Francisco.

The findings from the emergent network analysis corroborate the findings from the market and corridor rail potential analyses.