# The Third Crossing DRAFT

## A Megaproject in a Megaregion

www.thirdcrossing.org

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CP 218, Transportation Planning Studio
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## About Us

We are a team of 15 graduate students in City Planning and Transportation Engineering. This project aims to facilitate a conversation about the future of transportation between the East Bay and San Francisco and in the larger Northern California megaregion. We are part of the Department of City and Regional Planning in the UC Berkeley College of Environmental Design, with support from the University of California Transportation Center and The Institute of Transportation Studies at the University of California, Berkeley.

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# Executive Summary

The Bay Area is experiencing a period of rapid economic and population growth that is testing the transbay transportation systems and exacerbating equity concerns around housing and health. Along with growing challenges in system operations, these conditions make it particularly important to consider the case for a new transbay crossing that could potentially help improve urban and regional accessibility, unlock new land uses, and create a more resilient transportation network for a stronger, healthier, more equitable region. This report analyzes the potential of a new transbay crossing to provide additional travel capacity between San Francisco and the East Bay, complementing the existing Bay Area Rapid Transit (BART) tube and the Bay Bridge. This project would be larger in scope than the combined scale of many other major Bay Area transportation projects of recent years and has the potential to be significant for the nine-county region, the Northern California megaregion and the State of California. This new crossing is commonly referred to as the "second crossing." However, we call it a *third crossing* because it would augment the existing Bay Bridge and BART tube if constructed.

Working over the course of a semester, our team of 15 transportation planning, public health and engineering graduate students at UC Berkeley explored potential modes and alignments for such a crossing as well as the magnitude and distribution of potential benefits and challenges of the project. We also analyzed the social equity opportunities, potential governance structures, risk management, and funding and financing implications for a new crossing, providing recommendations in each case. It is our hope that the recommendations and analysis provided in this report will add to the literature published in recent years by regional organizations and will help guide future discussions of a new crossing. The below summarizes our key recommendations and findings.

## Social Equity Opportunities

Social equity must be addressed at every stage of the planning, financing, building and operating phases of a third crossing, and the project must include a number of co-benefits that can offset some of the negative impacts the project could have on historically marginalized communities.

## Key Considerations and Performance Metrics

The development of five key considerations, modeled after the problem statement formation process for major transportation projects, guided our analysis. The five key considerations are:

**1)** Social Equity
**2)** Accessibility and Connectivity
**3)** Land Use Planning Coordination
**4)** Climate Change Mitigation
**5)** Resilience and Adaptation

## Alternatives Analysis

- We analyzed four project alternatives and evaluated them in terms of the five key considerations with additional consideration for capacity and engineering feasibility.

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- With use of the Metropolitan Transportation Commission (MTC) travel demand model (Travel Model One) to estimate changes in travel patterns and UrbanSim to estimate land use impacts, we concluded preliminary findings and were able to compare across alternatives and point to areas worthy of future investigation.
- Based on the results of our models, the alternative crossing should not be viewed as a path for encouraging development. As a result, if built, a third crossing should be built to serve areas with existing residential and job centers and/or significant planned growth. The travel model seems to indicate that standard rail may remove longer trips whereas the BART alternatives add more transit trips. The reduction in VMT generated by the all of the alternatives is not insubstantial but the reductions are relatively minor when placed in the context of total Bay Area VMT. Further analysis is needed to evaluate how the alternatives differ from one another in terms of achieving emissions reductions to confirm the results from the travel model.

*Table 1: Analyzed alternatives and brief route description*

| Project Name | Alignment / Project Modeled | Model Conclusion |
|---|---|---|
| **Alternative 1: New Opportunities (BART)** | Includes a BART diversion south of MacArthur Station running along a reimagined I-980 corridor in Oakland.<br><br>Connects with San Francisco's South of Market (SoMa) before continuing West on Geary St. via Civic Center | Serves growing areas downtown San Francisco and Oakland, while creating a more resilient corridor |
| **Alternative 2: Critical Needs (BART)** | Includes a BART diversion south of MacArthur Station running along Franklin St. in Downtown Oakland. Connects with Mission Bay and Downtown San Francisco via Geary | Serves highest density areas of San Francisco and Oakland, while building similar resilience |
| **Alternative 3: Connecting the Megaregion (Standard Rail)** | Includes a standard rail diversion south of the existing Emeryville Station running along a reimagined I-980 corridor in Oakland.<br><br>Connects with San Francisco via the Transbay Transit Center. Extends Capitol Corridor service to Transbay Transit Center and extends Caltrain service to Richmond. | Creates new regional connections and job access, and a critical step in the state rail system |
| **Alternative 4: Performance Pricing** | Addresses transportation problems without a new crossing by increasing westbound Bay Bridge tolls during peak hours and using the revenue to fund increased bus service and land use changes that reduce demand on the corridor, in addition to other equity opportunities. Impacts to vulnerable groups would be mitigated by a lifeline discount. | Flexible response to an immediate need, with revenue to support regional goals |

## Governance, Risk Management, and Independent Oversight

The question of governance—organizational structures, agency relationships and responsibilities, and external coordination with the public—is of particular importance to any large-scale infrastructure undertaking. With regards to a third crossing, assembling the diverse set of local, regional, state, and private actors necessary to conceptualize, design, finance, construct, operate, and maintain such a

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critical piece of infrastructure is the first step on a decades-long journey towards implementation. Currently, no agency in the Bay Area possesses enough dedicated staff to both continue existing operations and manage a new megaproject, and thus a logical championing agency does not yet exist. A governing board will need to develop its own guiding principles to aid in decision-making. We recommend that external independent oversight should be formed from the early stage to minimize unexpected risks and poor communication.

An extensive literature review from project management, corporate governance, megaproject, and infrastructure planning discourses, paired with semi-structured stakeholder interviews as well as other stakeholder discussions served as the basis for identifying and analyzing alternative forms of governance structures. To account for unique factors stemming from geographies, political climates, and the nature of megaprojects, multiple different strategies for project delivery exist, including private involvement, management by an existing agency, and a joint powers authority. We provide "constrained" and "ideal" governance structure recommendations depending on the operational circumstance selected. However, the ideal governance scenario would involve an integrated multi-modal authority that merges major existing transbay operators. This multi-modal entity would be capable of managing travel demand in a megaregion, but would still continue to provide existing services through modal agencies. To complement the governance structure responsible for carrying out the third crossing, we also recommend the formation of a Community Advisory Board in an effort to ensure positive outcomes for vulnerable communities.

A megaproject like a third crossing has a significant risk potential. We established the risk management framework for a third crossing based on our review of the literature and analysis of recent State legislation regarding megaproject risks. This project requires a defined strategy that focuses on continuous improvement with an iterative progression, shared lessons learned, and the implementation of best practices. We recommend our risk management framework be incorporated into every step of the process through transparent accountability measures in both the governance and funding and finance structures.

## Funding and Finance

A third crossing will require an innovative funding and financing framework due to the project's complexity and the uncertain future of Federal and State support. Our analysis of this topic applies the academic literature concerning the development of cost estimates and the equity implications of various funding mechanisms to a potential new crossing. Case study analysis and conversations with experts also inform our discussion. Though in-depth engineering and environmental analyses have not yet been conducted, preliminary cost estimates for a new crossing are between $8 and $12 billion for the capital costs alone (AECOM Consult, Inc, 2012). While assigning new cost estimates is beyond the scope of this project, predicted costs of major infrastructure projects are often significantly lower than actual costs (Flyvbjerg, Holm, & Buhl, 2002; Flyvbjerg, Holm, & Buhl, 2004). Additionally, many secondary costs, like financing costs, transaction costs, and maintenance & operations costs are not included in public deliberations or sufficiently considered in overall project cost estimating. To address these issues, we propose several risk management techniques, including reference class forecasting, which adjusts costs estimates to align with comparable completed projects (Flyvbjerg, 2006).

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The main funding sources we identified include loans, grants, user fees, special assessment districts, regional measures, and value capture mechanisms. However, it is challenging to predict what funding and financing opportunities will be available in the coming decades. To address this uncertainty, we created both ideal and constrained scenarios and identified which of these funding sources might be available in each scenario.

## Moving Forward

A third crossing has the potential to provide increased connectivity for the region. However, any project would be a significant undertaking and it will be challenging to determine the best mode, alignment and governance structure. It is imperative that a third crossing project include community involvement at levels, incorporate risk management, external independent oversight and peer review in tandem with extensive geographic and political coordination.

Ultimately the third crossing has the potential to be a galvanizing project for the Bay Area and the Northern California megaregion. It will undoubtedly require significant regional cooperation between stakeholders and community members. This report offered our team the opportunity to explore this project from a variety of angles and it is our hope that the analysis conducted will provide a viable framework should the region and State move forward with a plan to build a third crossing.

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# Introduction

This report analyzes a new transbay crossing to provide additional travel capacity between San Francisco and the East Bay, complementing the existing Bay Area Rapid Transit (BART) tube and the San Francisco-Oakland Bay Bridge. Several Bay Area organizations have published reports advocating for or contemplating the implications of a new crossing.[1] At the same time, public agencies, city officials, regional bodies, and state-level agencies have begun to evaluate the potential for such a project. Many expect the new crossing to constitute a new line within the BART system, and simply refer to the project as a "second tube."

However, we approach this project in a new and holistic way; as such, we consider an additional BART line to be just one of several alternatives. Working over the course of a semester, our team of 15 transportation planning and engineering graduate students at UC Berkeley has analyzed a comparison of alternatives—both in travel mode and alignment—as well the magnitude and distribution of potential benefits the project would yield. We have also turned to the historical context of Bay crossings and regional megaprojects in analyzing the governance, risk management, and funding and financing implications for a new crossing, providing recommendations in each case.

Given a multi-billion dollar project with widespread and long-lasting impacts, a thorough social equity analysis is imperative. To that end, this report carefully considers project benefits and involvement in the planning process across a range of communities. We provide a set of recommendations for how a new crossing can best serve the needs of the region and promote equitable outcomes.

## A Megaproject in a Megaregion

There is a growing body of literature on megaprojects, which can most easily be thought of as multibillion-dollar infrastructure developments.[2] A new transbay crossing would definitely qualify as a megaproject, given early cost estimates between $8 billion and $12 billion.[3] (Such preliminary estimates usually mark the lower bound of eventual costs and do not include financing or operations and maintenance costs.) This project would be larger and more expensive than the combined scale of many other major Bay Area transportation projects of recent years, including the Bay Bridge Eastern Span replacement, the San Francisco Central Subway, Caltrain electrification, and BART extension projects in the East Bay and South Bay. The time scale for the project could also be immense—these same recent major projects in the Bay Area have taken between 15 to 28 years to complete from the start of planning.

Thus, a new transbay crossing would be significant not just for the nine-county Bay Area but also for a much larger *megaregion*. The megaregion concept is not new. A consolidated "Northern California Megaregion" including the Sacramento and Stockton metropolitan areas was first identified by the Regional Plan Association's *America 2050* project and expanded upon in a 2007 report from SPUR, *The Northern California Megaregion*. In 2016, the Bay Area Council published a report arguing that

[1] For a list reports that have informed this project, see Appendix A: Annotated Bibliography.
[2] Flyvbjerg, B. Buzelius, N. Rothengatter, W. *Megaprojects and Risk: An Anatomy of Ambition*. 2003.
[3] "The Case for a Second Transbay Transit Crossing." Bay Area Council. February 2014. http://www.bayareaeconomy.org/report/the-case-for-a-second-transbay-transit-crossing/

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"challenges in housing, land use, jobs, transportation, and the environment have crossed regional boundaries," making planning at the megaregion scale necessary.[4] Indeed, this project would likely benefit from a planning process at the megaregion level.

In the Bay Area, the Metropolitan Transportation Commission (MTC) complements the traditional concentration of planning at the municipal and state levels, but this organization is still limited to a scale smaller than the megaregion. The U.S. Department of Transportation has recently funded research into the role and importance of megaregions in transportation planning, and it is likely there will be more institutional interest in addressing infrastructure investment at the megaregion scale in the near future.[5] A new transbay crossing could be a test case for such an effort.

## Scope of Analysis

Our analysis of the potential new crossing is grounded in a consideration of social equity. Transportation infrastructure in the Bay Area has historically not been planned or executed with the needs of disadvantaged communities in mind. At the same time, these communities have frequently borne the costs of that infrastructure without sharing in the full benefits. This legacy informed an awareness of the need to not only avoid past mistakes, but also proactively orient a future project around improving social equity. Our primary geographic scale for this analysis is the five-county core of the region. However, we also take into consideration the traditional nine-county Bay Area, as well as the Northern California megaregion.

## Research Design

To inform our key considerations, we first reviewed recently published reports from advocacy and nonprofit organizations as well as public agency documents.[6] We supplemented our review with formal and informal interviews of representatives from transportation agencies; planning organizations; transit providers; advocacy organizations focused on social equity and disadvantaged communities; and municipalities from the Bay Area, California and across the country.

To analyze the impact of different travel modes and crossing alignments, we began with alignments proposed in published reports and in our interviews. We added stations and alignments that appeared promising for the group's equity goals, subject to engineering feasibility. We then ran the proposed alignments through both MTC's regional travel model and land use model to provide projected future land use and travel data for the various alternatives.

In addition to the modeling outputs, we utilized existing data on the transbay corridor and region to inform public health, economic development, and resiliency analysis. We conducted a supplementary

[4] "The Northern California Megaregion: Innovative, Connected, and Growing." Bay Area Council. June 2016. http://www.bayareaeconomy.org/files/pdf/The_Northern_California_Megaregion_2016c.pdf.
[5] Ross, Catherine L. "Megaregions: Literature Review of Organizational Structures and Finance of Multijurisdictional Initiatives and the Implications for Megaregion Transportation Planning in the U.S." U.S. Department of Transportation, Federal Highway Administration. October 2011. https://www.fhwa.dot.gov/planning/publications/megaregions_report_2012/megaregions2012.pdf.
[6] Refer to Appendix A: Annotated Bibliography for a list of reports and for summaries of each.

literature review and case study analysis to inform research on risk analysis, governance structures, resiliency, finance and funding, and social equity.

This report is organized into the following topics:

- **Key Considerations:** A presentation and justification of overarching purpose and need statements for a new crossing. The five key considerations guiding our analysis are: social equity; accessibility and connectivity; land use planning coordination; climate change mitigation; and resilience and adaptation.
- **Policy Context and Current Conditions:** This section gives context for the existing and future transportation and social equity issues facing the region. Includes a presentation of the existing travel and land use patterns, economic conditions, and socio-demographic makeup of the Bay Area. A discussion follows of the relevant state, regional, and local policies that directly affect and inform the potential construction of a new crossing, as well as a description of the key agencies likely to be involved.
- **Historical Context:** Discussion of a new crossing must grapple with the history of San Francisco Bay crossings and regional megaprojects. Major infrastructure projects in the Bay Area have often experienced controversy stemming from cost overruns and negative impacts to low-income neighborhoods. This section first assesses that history, then offers a series of case studies that explore how social equity is incorporated in megaprojects across the country.
- **Social Equity Opportunities:** The process by which a new crossing is designed, built, funded, and operated will determine the extent to which it benefits disadvantaged communities. These communities historically have suffered in the planning and construction of major infrastructure projects, and this section analyzes what opportunities exist at all stages of the process to maximize equitable outcomes.
- **Governance and Risk Management:** This section explores the potential benefits and drawbacks of different governance structures for the project delivery and operation of a new crossing. Risk management is a particularly important aspect of this analysis given the massive scale a new crossing represents. Case studies from across the country offer insight into the potential risks and rewards of these governance structures.
- **Performance Metrics and Alternatives Development:** Using the goals established in the key considerations, a set of performance metrics to judge potential crossings is proposed, defined, and justified. Four alternatives to be studied are then described. They include two BART-only alternatives, one standard rail alternative, and a no-build alternative with dynamic pricing and improved bus service on the Bay Bridge.
- **Alternative Analysis:** This section assesses the performance of each alternative compared to baseline and each other. Estimates for quantitative metrics are derived existing regional datasets, as well as from running each alternative through MTC's

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UrbanSim land use model and Travel Model One. The potential for further extension and refinement of the models is also analyzed.

- **Funding and Financing:** The funding & financing section outlines key recommendations for appropriate cost estimating and incorporation of equity concerns in transportation fundraising. Two funding scenarios are presented: an ideal and constrained, with assumptions explained by funding source. Innovative funding tools used in Sao Paulo and Denver are analyzed with discussion on applicability and adaptation for a third crossing.

The report also contains the following appendices:

- **Appendix A**: An annotated bibliography of reports and resources that discuss a third crossing.
- **Appendix B**: Communities of Concern Definitions from the Metropolitan Transportation Commission
- **Appendix C**: Transbay Travel Patterns
- **Appendix D**: Performance Metric Sources & Methodology
- **Appendix E**: Land Use Scenario Outputs for Various Model Runs

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# Key Considerations

## Approach

Drawing from existing reports on the potential next transbay crossing and adding our own concerns, we developed a set of considerations in five topic areas. These considerations guide our analysis of a new transbay crossing. We modeled the development of these considerations after the problem statement formation process used to guide major infrastructure reports. Our performance metrics for evaluating alternatives are based on these considerations.

The five key considerations are:

- Social Equity
- Accessibility and Connectivity
- Land Use Planning Coordination
- Climate Change Mitigation
- Resilience and Adaptation

It may seem counterintuitive that we have not included system capacity explicitly in this list. However, system capacity constraints are embedded in all of these concerns as a means of addressing the larger goal. For example, the social equity discussion explains how crowded transit vehicles create spatially uneven impacts. Similarly, land use planning coordination aims to allocate system capacity efficiently with coordinated development to encourage alternatives to driving. So although we do not list capacity as a concern per se, it is ubiquitous throughout the considerations.

# Social Equity

## Summary Statement

Low-income communities and communities of color are disproportionately burdened by the shortcomings of the existing transbay transportation system, adding to the historical harm large infrastructure projects have brought. In these communities, unreliable transit service can inhibit access to economic opportunities. At the same time, many low-income residents are exposed to air pollution from heavily traveled freeways and are more vulnerable to displacement pressures associated with new investment. Transportation projects like a new transbay crossing have the opportunity and obligation to provide social equity benefits that combat these challenges.

## Consideration Description

An equity analysis of a transportation project, plan, or policy typically involves grouping individuals to demonstrate benefits received or costs borne. Such analysis may show that a project privileges people of a certain geography, socioeconomic status, age or generation, or travel mode (Transportation Research

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Board, 2011).[7] In the Bay Area, large transportation investments have historically created inequitable burdens to two groups: low-income communities and communities of color.

For example, in the 1960s the construction of BART, new freeways (see Figure 1), and urban renewal projects destroyed over 5,100 housing units in the predominantly black neighborhood of West Oakland. The disruptions forced a net outmigration of over 14,000 residents—almost 4% of the Oakland population at the time (Rhomberg, 2004, Metropolitan Transportation Commission & Association of Bay Area Governments, n.d.).[8, 9]

*Figure 1: Demolition for the cypress freeway in West Oakland*

*Source: "The Changing Face of Oakland," n.d.*[10]

More recently, BART's Oakland Airport Connector project was found to have violated Title VI of the Civil Rights Act of 1964 by planning and designing the rail extension without properly considering the project's impact on low-income communities and communities of color, many of whom work in and around the Oakland Airport (Lekach, 2014).[11] Although the project proceeded and has achieved its ridership goals, transportation advocates have argued that bolstering the existing bus service would have been less expensive and enabled more investment in the overall BART system, benefitting a larger

[7] Transportation Research Board. (2011). *TRB Special Report 303: Equity of Evolving Transportation Finance Mechanisms*. Washington, D.C.: Transportation Research Board. Retrieved from http://www.nap.edu/catalog/13240

[8] Rhomberg, C. (2004). *No There There: Race, Class, and Political Community in Oakland*. University of California Press.

[9] Metropolitan Transportation Commission, & Association of Bay Area Governments. (n.d.). City of Oakland -- 1950 to 1960 Census data. Retrieved December 5, 2016, from http://www.bayareacensus.ca.gov/cities/Oakland50.htm

[10] The Changing Face of Oakland. (n.d.). Retrieved December 1, 2016, from http://oaklandplanninghistory.weebly.com/the-changing-face-of-oakland.html

[11] Lekach, S. (2014, November 20). "BART to OAK" airport connector to open after years of planning. Retrieved December 1, 2016, from https://oaklandnorth.net/2014/11/20/bart-to-oak-airport-connector-to-open-after-years-of-planning/

portion of the BART ridership population. (Baldassari, 2016[12], Cabanatuan, 2014).[13] The connector example illustrates the importance of properly analyzing the magnitude of the benefits of a transportation project in relation to the project cost, and analyzing who receives the benefits.

West Oakland still provides an example of inequitable outcomes today. The overcrowding on westbound BART trains during the morning peak hour impacts passengers boarding in downtown and West Oakland more severely than those who board BART in the suburbs. Passengers boarding in West Oakland are less likely to find a seat and more likely to be passed up by a full train. This reduction in travel reliability has a greater impact on people working hourly jobs with rigid schedules, and increased transit commute times have been linked to more frequent stress and anxiety. (Alameda County Public Health Department, 2013).[14] At the same time, proximity to transportation investments may exacerbate displacement pressures on West Oakland residents, further removing disadvantaged communities from the transportation access that is so critical.

Social equity is both the lens through which we frame our entire analysis and an explicit consideration. We focus on the topic because of our appreciation for the structural discrimination and inequities that impact lives on a daily basis. We draw inspiration from the City of Richmond's 2014 "Health in All Policies" ordinance, which explicitly encouraged all city staff to incorporate health outcomes in their decisions (Corburn, 2014).[15] A similarly holistic approach to social equity is necessary in studying a potential transbay crossing project to meaningfully address the social equity concerns with a project of this financial and geographic scale.

# Accessibility and Connectivity

## Summary Statement

The existing transbay transportation system currently provides inadequate and inequitable accessibility to the regional economy. To ensure that all Bay Area residents can easily and efficiently get to where they want to go, the transportation system must be connected, abundant, and reliable, with sufficient capacity in its links to significant job centers.

## Consideration Description

All communities benefit from easy accessibility to both essential and leisure activities like jobs, schools, social services, and family and community spaces. Disadvantaged communities face particular constraints in this area, as low-income individuals are less likely to have access to a car and are more

[12] Baldassari, E. (2016, November 27). BART's Oakland Airport Connector losing money; Uber, Lyft to blame? Retrieved from http://www.eastbaytimes.com/2016/11/27/barts-oakland-airport-connector-losing-money-uber-lyft-to-blame/

[13] Cabanatuan, M. (2014, April 25). Sky-high cost of BART Oakland Airport link - SFGate. Retrieved December 1, 2016, from http://www.sfgate.com/bayarea/article/Sky-high-cost-of-BART-Oakland-Airport-link-5428538.php

[14] Alameda County Public Health Department. (2013). *Getting on Board for Health - A Health Impact Assessment of Bus Funding and Access*. Alameda County Public Health Department. Retrieved from http://www.acphd.org/media/308854/transithia.pdf

[15] Corburn, J., Curl, S., Arredondo, G., & Malagon, J. (2014). Health in all urban policy: city services through the prism of health. *Journal of Urban Health*, *91*(4), 623–636.

dependent on public transit services.[16] Seniors and those with disabilities are also more reliant on alternatives to driving. Transit that is unreliable, infrequent, inaccessible, or otherwise inadequately provided can therefore cause significant economic and quality of life hardships for members of these communities.

In a Bay Area context, transit system users face fragmented operations without fare or schedule integration, train overcrowding during peak hours, a lack of overnight rail service, relatively high fares, and low station densities. Each of these factors affects real and perceived access to the regional economy and general movement throughout the region. The crossings between Oakland and San Francisco together represent the most significant transportation bottleneck in the region due to the extreme travel demand between the East Bay and San Francisco. Improvements to the transbay transit system are therefore likely to produce substantial benefits in this area.

While other Bay Area transit issues are more technical in nature, addressing intermodal connectivity requires additional political considerations. It is also one of the most pressing issues facing the region, as the integration of fares, schedules, and routes can significantly increase or decrease accessibility without major changes to the larger transit network. Transit operators and municipalities must also coordinate to provide safe walk and bike paths for the "last-mile" connectivity that allows people to easily access the transit network.

# Land Use Planning Coordination

## Summary Statement

Future major transportation infrastructure investments must be coordinated with land use changes in order to fully realize potential benefits. If land use policies are not adjusted to concentrate employment centers and key destinations near transit project nodes, the current transbay transportation system will continue to degrade, and the efficiency of improvements to the system will be reduced.

## Consideration Description

The low-density development predominant in the Bay Area since the 1950s has led to a region where most people are dependent on automobiles.[17] In addition to residential development in outlying areas, most office space since the 1970s has been built in suburban locations where low-density, auto-oriented development prevails.[18] Despite major investments in transit infrastructure, transit ridership in the Bay Area decreased by 14% between 1991 and 2012,[19] while ridership in comparable U.S. regions like Los Angeles, New York, and Miami experienced substantial increases.

[16] http://nhts.ornl.gov/briefs/PovertyBrief.pdf
[17] "Bay Area Regional Form and Population Growth." SPUR Urbanist. 1 February, 2010. http://www.spur.org/publications/urbanist-article/2010-02-01/bay-area-regional-form-and-population-growth. Accessed 6 December, 2016.
[18] "The Future of Downtown San Francisco." SPUR. March 2009. https://www.spur.org/sites/default/files/publications_pdfs/SPUR_The_Future_of_Downtown_SF.pdf.
[19] "Seamless Transit." SPUR Urbanist. 11 May 2015. http://www.spur.org/publications/urbanist-article/2015-05-11/seamless-transit. Accessed 6 December 2016.

Rail transit is typically built to both serve existing areas of land use activity and encourage denser and more sustainable development,[20] and current policies have not been sufficient to fully achieve these outcomes along BART and Caltrain lines. The development of BART did not include a planning process to require or otherwise lead to land use intensification near stations. Over forty years after BART began service, certain station areas are still not designated as regional Priority Development Areas nor have their municipal zoning regulations been altered to allow any increase in development intensity. As a result of this lack of land use response, the transportation benefit provided by BART access is available to a much smaller number of people than it otherwise would be. This reduces not only its overall impact, but also its equity benefits, as housing near a BART station can command an even higher premium. Furthermore, BART's orientation towards the suburbs rather than the core means that a car is required in order to easily access the transit network in many cases.

The inability to produce large amount of office and residential development near stations has resulted in cities across the state of California failing to reduce driving despite significant investments in transit infrastructure.[21] Barriers to growth include zoning and approvals processes that preclude multifamily housing and other dense infill development, organizational and agreement issues between development and transit agencies, and managing parking and local traffic. Existing policies have not been sufficient to overcome these challenges, and dealing with this issue must be a priority in order to maximize benefits from a potential new crossing.

# Climate Change Mitigation

## Summary Statement

Car travel in the Bay Area is a significant contributor to greenhouse gas (GHG) emissions, and the transportation system must shift towards greater transit use if the region hopes to meet its greenhouse gas reduction goals. The transbay corridor contains the highest travel demand, employment density, and capacity for growth in the region, and encouraging greater utilization of this corridor via improved transit is essential to this cause.

## Consideration Description

The long-range regional transportation plan currently under development by MTC and ABAG aims to reduce the region's GHG emissions to 15% of 2005 levels by 2035.[22] These efforts place a high priority on shifting Bay Area residents towards transit and active modes and away from solo vehicle travel, as the transportation sector is responsible for around 40% of the region's total emissions.[23]

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[20] Njus, Elliot. "MAX Orange Line riders aren't showing up as predicted." The Oregonian. 13 October 2016. http://www.oregonlive.com/commuting/index.ssf/2016/10/max_orange_line_riders_arent_s.html.

[21] Kolko, Jed. "Making the Most of Transit: Density, Employment Growth, and Ridership around New Stations." Public Policy Institute of California. February 2011. http://www.ppic.org/content/pubs/report/R_211JKR.pdf.

[22] Metropolitan Transportation Commission. (2016, May 16). Metropolitan Transportation Commission San Francisco Bay Area Regional Transportation Plan / Sustainable Communities Strategy Environmental Impact Report. Notice of Preparation. Retrieved from http://mtc.ca.gov/sites/default/files/PBA2040_NOP-EIR_LegalNotice.pdf

[23] Bay Area Air Quality Management District. (2015). *Bay Area Emissions Inventory Summary Report: Greenhouse Gases Base Year 2011*. San Francisco: Bay Area Air Quality Management District. Retrieved from

Roughly 125,000 vehicles travel west on the Bay Bridge each day, and BART and AC Transit transport an additional 128,500 daily riders westward across the Bay.[24] While daily flows are evenly distributed between cars and transit, around 75% of the morning peak's 39,000 hourly westbound travelers use transit, with BART carrying 64% of the load, AC Transit and WestCAT buses combining for 7%, and the Water Emergency Transportation Authority (WETA) transporting 3%.[25] However, BART is already at 110% of capacity during this time period, and planned increases in transit capacity will only raise corridor capacity to 46,000 people per hour, insufficient to meet a projected demand of 53,000 in 2040.[26] How this corridor and the rest of the transportation network accommodate this demand will in large part determine the success of the region's climate change mitigation efforts.

While climate change is a global issue, its impacts will be felt locally. Climate change is likely to exacerbate already-poor environmental conditions in disadvantaged communities, saddling them with a disproportionate share of the negative impacts. Additionally, efforts to reduce GHG emissions frequently include benefits that may not be easily accessed by disadvantaged communities. Recognizing and reversing these mismatched burdens and benefits is essential to ensuring that these communities receive equitable treatment in climate change mitigation strategies.

# Resilience and Adaptation

## Summary Statement

Transbay travel relies almost exclusively on the San Francisco-Oakland Bay Bridge and the BART tube. Reliance on a single crossing each for automotive travel and transit make the corridor vulnerable to disruptions from disasters or maintenance needs. To ensure resilience, the region must protect critical infrastructure and use this project to mitigate risk through redundancy.

## Consideration Description

The planning for a new transbay crossing must address long-term travel demand while also promoting resilience in the Bay Area's transportation system. Resilience is best understood as insurance of critical infrastructure against vulnerability from risks like natural disasters and maintenance failure.[27] In addressing resilience, we consider critical assets and the network as a whole to be important. The system is resilient if travelers have a robust set of choices—both travel mode and route—and if service can continue after unexpected disruptions.

Early planning for BART presented the system as providing congestion relief between suburban communities and the commercial core at peak commute periods. The promotion of a commute alternative, rather than a robust network, yielded a system ill-equipped for a major hazard or service

http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Emission%20Inventory/BY2011_GHGSummary.ashx?la=en

[24] Arup. Memorandum. 2016. May 23. Same as above.

[25] Arup. Memorandum. 2016. May 23. Same as above.

[26] Arup. Memorandum. 2016. May 23. Same as above.

[27] See discussion of definitions of resilience in section three: Mattsson, L.-G., & Jenelius, E. (2015). Vulnerability and resilience of transport systems – A discussion of recent research. *Transportation Research Part A: Policy and Practice*, *81*, 16–34. https://doi.org/10.1016/j.tra.2015.06.002

disruption.[28] The BART Transbay Tube, for example, is a critical piece of the Bay Area's daily travel patterns with no alternative in the case of a disaster or maintenance issue.

The Bay Area's high earthquake risk makes vulnerability to seismic activity a key concern. Quick restoration of BART and ferry service was critical for the region's economic vitality following the Loma Prieta earthquake in 1989.[29] However, the Transbay Tube also is also vulnerable to seismic activity and could take months to restore service in the event of an earthquake.[30] Many other critical BART assets are vulnerable to sea level rise and flooding in the coming years. This is particularly true in the East Bay where tracks and stations leading to the transbay corridor are built in low-lying coastal areas. A future transbay crossing project must create an opportunity to ensure a resilient corridor and system now and into the future.

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[28] See BART's history on early concepts for the system.
[29] See pg. 12 for findings from the Loma Prieta earthquake on travel behavior: Deakin, E. (1991). Transportation Impacts of the 1989 Loma Prieta Earthquake: The Bay Bridge Closure. *University of California Transportation Center*. Retrieved from http://escholarship.org/uc/item/6rb2j9pf
[30] See Section Two: Element One in BART's Climate Change Adaptation Pilot

# Policy Context and Current Conditions

Transbay travel consists primarily of private vehicles and buses on the San Francisco-Oakland Bay Bridge and a heavy rail tube operated by BART. The Transbay Joint Powers Authority (TJPA) is overseeing the construction of a new, estimated $3.9 billion Transbay Transit Center to unify and improve transit service into San Francisco. The first phase is a new bus terminal, scheduled to open in late 2017, that will serve transbay AC Transit buses and other intercity bus operators.[31] The second phase is the Downtown Rail Extension (DTX), which will extend existing Caltrain service from the peninsula into the Transbay Transit Center, 1.3 miles from its current terminus at 4th Street and King Street.[32]

## Policy Context

Transportation policy and provision in the Bay Area is situated within a complex policy context, featuring many actors with overlapping jurisdictions and responsibilities.[33] As the federally designated regional transportation planning agency, the Metropolitan Transportation Commission (MTC) coordinates with Bay Area municipalities, the nine county governments, transit operators, and a variety of other county, regional, and state agencies. MTC is responsible for allocating federal and state transportation funding and managing programs like freeway express lanes and the regional transit pass program.

MTC also coordinates with the Association of Bay Area Governments (ABAG) to lead the region's long range planning efforts. In 2013 the two agencies adopted Plan Bay Area, the most recent long range plan. The plan was developed in concordance 2008's California Senate Bill 375 (SB 375), which mandates coordinated transportation and land use planning to achieve 15% regional greenhouse gas emissions reductions by 2035. Plan Bay Area establishes Priority Development Areas (PDAs)—some of which touch the existing transbay crossings (see Figure 2)—that are intended to receive 80% of new housing and 60% of new jobs. A new transbay crossing would increase transit access and service in the PDA areas shown and would likely support sustainable development consistent with Plan Bay Area, due to be updated in 2017.

*Figure 2: Priority Development Areas*

[31] Transbay Joint Powers Authority. Current Activity web page. http://transbaycenter.org/construction-updates/updates-notices/current-activity. Accessed 8 December 2016.
[32] Sabatini, Joshua. "Funding blocked for transit center amid concerns of sinking Millennium Tower." San Francisco Examiner. 27 September 2016. http://www.sfexaminer.com/funding-blocked-transit-center-amid-concerns-sinking-millennium-tower/.
[33] Metropolitan Transportation Commission. "What We Do" web page. http://mtc.ca.gov/about-mtc/what-mtc/what-we-do. Accessed 9 December 2016.

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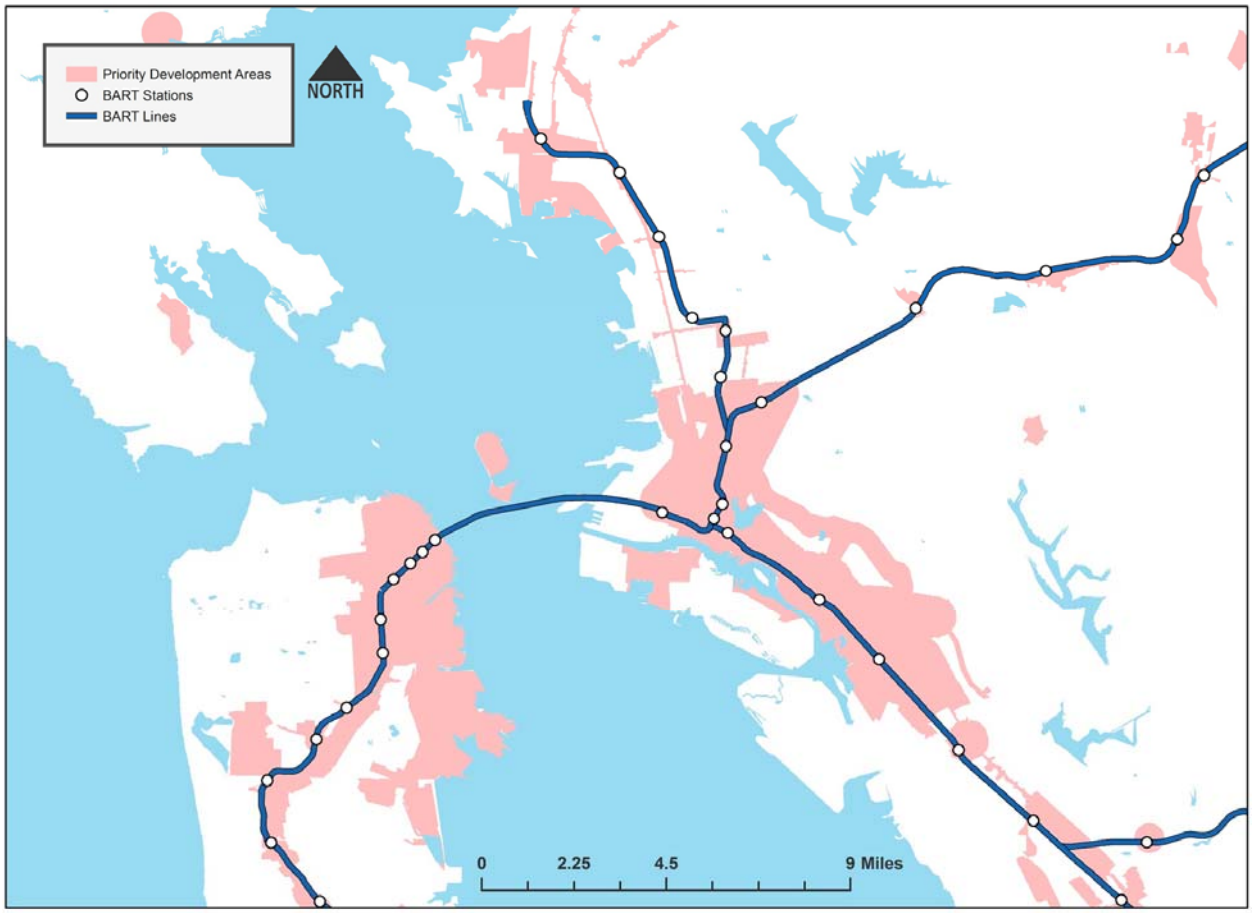


*Source: Map produced by students in the Fall 2016 Transportation Planning Studio.*

Another policy with funding implications for a new crossing is California's cap-and-trade program, which has become a major source for transportation and housing projects around the state. It forces large polluters to buy emissions offsets, the proceeds from which must be spent to reduce greenhouse gas emissions. Senate Bill 535 (SB 535, 2006) codified requirements for program expenditures on disadvantaged communities, and 2016's Assembly Bill 1550 (AB 1550, 2016) increased this apportionment. At least 25% of program money must be spent to benefit Disadvantaged Communities, with another 10% to benefit low-income households or communities.[34] [35] [36] [37] [38]

[34] AB 1550 defines low-income as at or below 80% of statewide median income, or at or below the state low-income limits designated by the Department of Housing and Community Development.
[35] Gomez. AB 1550. Greenhouse gases: investment plan: disadvantaged communities., Pub. L. No. AB 1550 (2016). Retrieved from https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB1550
[36] Official State Income Limits for the California Department of Housing and Community Development are provided at the following website: http://www.hcd.ca.gov/housing-policy-development/housing-resource-center/reports/state/incnote.html
[37] De León. SB 535. California Global Warming Solutions Act of 2006: Greenhouse Gas Reduction Fund (2012). Retrieved from http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120SB535
[38] The Greenlining Institute. (n.d.). Environmental Equity Senate Bill 535. Retrieved December 1, 2016, from http://greenlining.org/issues-impact/environmental-equity/cap-and-trade/senate-bill-535/

There is some debate about the program's definition of a disadvantaged community. Disadvantaged Communities are officially identified with an analysis tool called CalEnviroScreen 2.0, which makes a determination based on 19 environmental and social factors at the census tract level (Bridegam, 2014).[39] The tool is being revised, and MTC was one among many agencies that expressed concern that the revisions exclude many low-income communities from its *disadvantaged* classification. This reclassification could eliminate cap-and-trade funds that pay for transit and other programs in low-income communities, with negative outcomes for social equity.[40]

MTC and ABAG use a different set of criteria than the State of California and SB 535 to analyze the social equity impacts of Plan Bay Area. Their defined Communities of Concern differ from the cap-and-trade program's Disadvantaged Communities. Communities of Concern are census tracts with high concentrations of low-income households; people of color, the elderly, people with disabilities, zero-vehicle households, single-parent families, severely rent-burdened households, and households with limited English proficiency. A table further detailing these factors is in Appendix B. Figure 3 compares the boundaries of Disadvantaged Communities and Communities of Concern.

*Figure 3: Comparison of Disadvantaged Communities and Communities of Concern*

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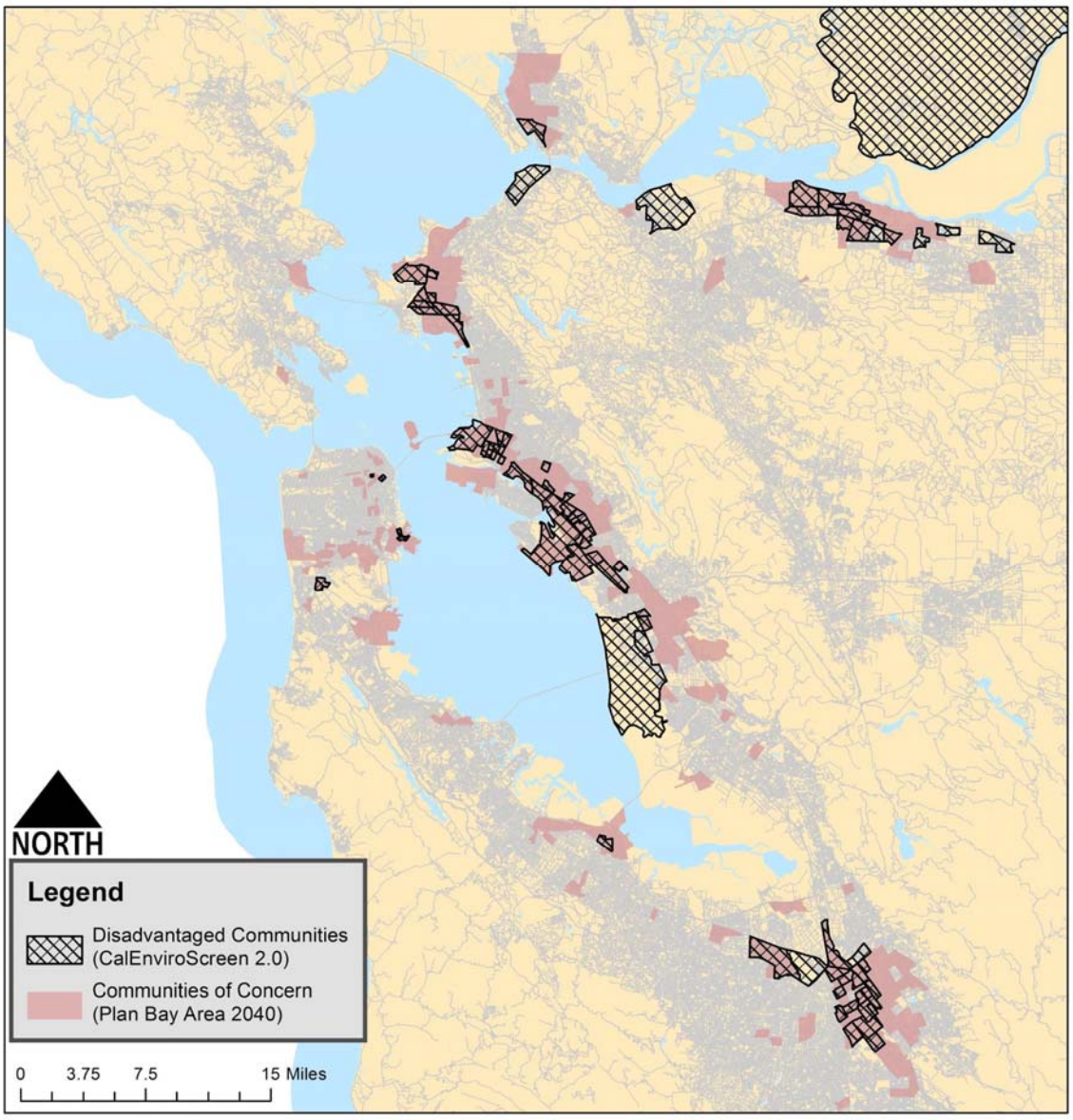
[39] Bridegam, M. (2014, September 12). Environmental justice and housing worlds seek meeting of minds on defining disadvantage | California Planning & Development Report. Retrieved May 9, 2015, from http://www.cp-dr.com/node/3570

[40] Metropolitan Transportation Commission. (2016, October 21). CalEnviroScreen 3.0 Draft: Public Comments. Retrieved from http://oehha.ca.gov/calenviroscreen/comment/calenviroscreen-30-draft-public-comments




*Source: Map produced by students in the Fall 2016 Transportation Planning Studio.*

## Additional Agencies and Authorities

The San Francisco-Oakland Bay Bridge is managed by the Bay Area Toll Authority (BATA), which has operated under the oversight of the MTC since 1998. In 2010, BATA and MTC worked to implement a peak pricing toll scheme on the Bay Bridge to discourage drivers from crossing the bridge during the busiest time periods.[41]

[41] "A Closer Look at Congestion Pricing on the Bay Bridge." Berkeley Transportation Letter, ITS Berkeley. Winter 2012. http://its.berkeley.edu/btl/2012/winter/bridge%20toll.

The California State Transportation Agency (CalSTA) is the state office that oversees a number of transportation-related entities, including the Department of Transportation (Caltrans) and the High Speed Rail Authority (HSRA). Caltrans is responsible for managing much of the highway and freeway systems in the Bay Area and through the state, as well as providing inter-city rail services.[42] Since 1990 Caltrans has also entered into several agreements with private entities for the development, construction, and operation of toll roads.[43] HSRA is responsible for building the high-speed rail system that is planned to connect San Francisco to Los Angeles by 2029.[44] When completed, the high-speed rail service is planned to operate along the DTX route into the Transbay Transit Center in downtown San Francisco, with underground walkway connections to the existing rail systems.

CalSTA and Caltrans have been working on an update to the State Rail Plan that includes consideration of numerous rail links connecting to the Bay Area. The update to be released in 2017 is expected to set new strategic system goals, plan for more connections to existing local transportation infrastructure, and complement planned high speed rail development. This will mark a shift from past plans that have focused on more on the operations of individual systems and less on connections across the state and with local transit.[45]

The state has also established a number of entities that operate transit services within the Bay Area. BART was created by the state in 1957 to plan, construct, and operate a new heavy rail system for the region and was given the authority to levy voter-approved taxes for system finance.[46] The Peninsula Corridor Joint Powers Board was formed in 1987 to operate the commuter rail line from San Francisco to San Jose, and the Board purchased the track right of way in 1991.[47] The Capitol Corridor commuter rail service that operates between San Jose and Sacramento is governed by the Capitol Corridor Joint Powers Authority (CCJPA), which contracts with Amtrak for service operations. The 171-mile Capitol Corridor line runs almost entirely on privately owned railroad tracks held by the Union Pacific Railroad (UPRR).[48]

A new crossing project would also have potential environmental and ecological impacts on the San Francisco Bay itself. The state-established Bay Conservation and Development Commission (BCDC) is a coastal zone agency that has regional planning and regulatory authority across the Bay and its shoreline.[49] As a state agency, BCDC's mission is to protect the Bay from environmental or other harm, to enforce state law, and to ensure public access to the Bay within 100 feet of its shoreline. Any project

[42] About Caltrans web page. http://www.dot.ca.gov/aboutct.html. Accessed 9 December 2016.
[43] California Department of Transportation. Toll Road Fact Sheet web page. http://www.dot.ca.gov/hq/paffairs/about/toll/status.htm. Accessed 9 December 2016.
[44] About California High-Speed Rail Authority web page. http://www.hsr.ca.gov/About/index.html. Accessed 9 December 2016.
[45] Based on interviews and research conducted by students in the Fall 2016 Transportation Planning Studio, UC Berkeley Department of City and Regional Planning.
[46] "A History of BART: The Concept is born." https://www.bart.gov/about/history. Accessed 9 December 2016.
[47] Caltrain Historic Milestones web page. http://www.caltrain.com/about/Caltrain150/Milestones.html. Accessed 9 December 2016.
[48] Capitol Corridor 2014 Vision Plan Update Final Report. November 19, 2014. http://www.capitolcorridor.org/downloads/CCJPAVisionPlanFinal.pdf.
[49] San Francisco Bay Conservation & Development Commission website. http://www.bcdc.ca.gov/. Accessed 10 December 2016.

that would fill in or remove material from the Bay requires a BCDC permit, so a major infrastructure project like a new crossing would need to clear BCDC's approval.

## Land Use and Growth

Land use and growth patterns in the Bay Area are intimately linked with the eventual benefit a new crossing could bring. Efficient transit investments have been linked to job location and housing density, and job density in particular has been shown to drive transit ridership.[50]

Employment in the Bay Area is growing faster than in any other metropolitan area in California.[51] As the region has grown, jobs have been spreading away from traditional downtowns. Job growth rates have been highest in the Sonoma, Napa, and Solano counties, and only 25% of job growth from 2002 and 2014 has occurred within half a of BART and Caltrain stations.[52] [53] One statewide study determined that there was virtually no new job growth around new transit stations between 1992 and 2006 and attributed this in part to a policy environment that favored residential uses over employment in transit station planning.[54]

Transportation and land use research has confirmed that employment density near stations is more important for driving transit use than residential density; the Public Policy Institute of California has estimated the relationship to be twice as strong.[55] Figure 4 illustrates where current job densities are highest and perhaps best suited for high-capacity transit infrastructure, especially around Downtown San Francisco and Oakland. San Jose and other parts of the South Bay stand in contrast where the large number of jobs are less spatially concentrated and potentially more difficult to serve with transit.

*Figure 4: Existing job density in 2012.*

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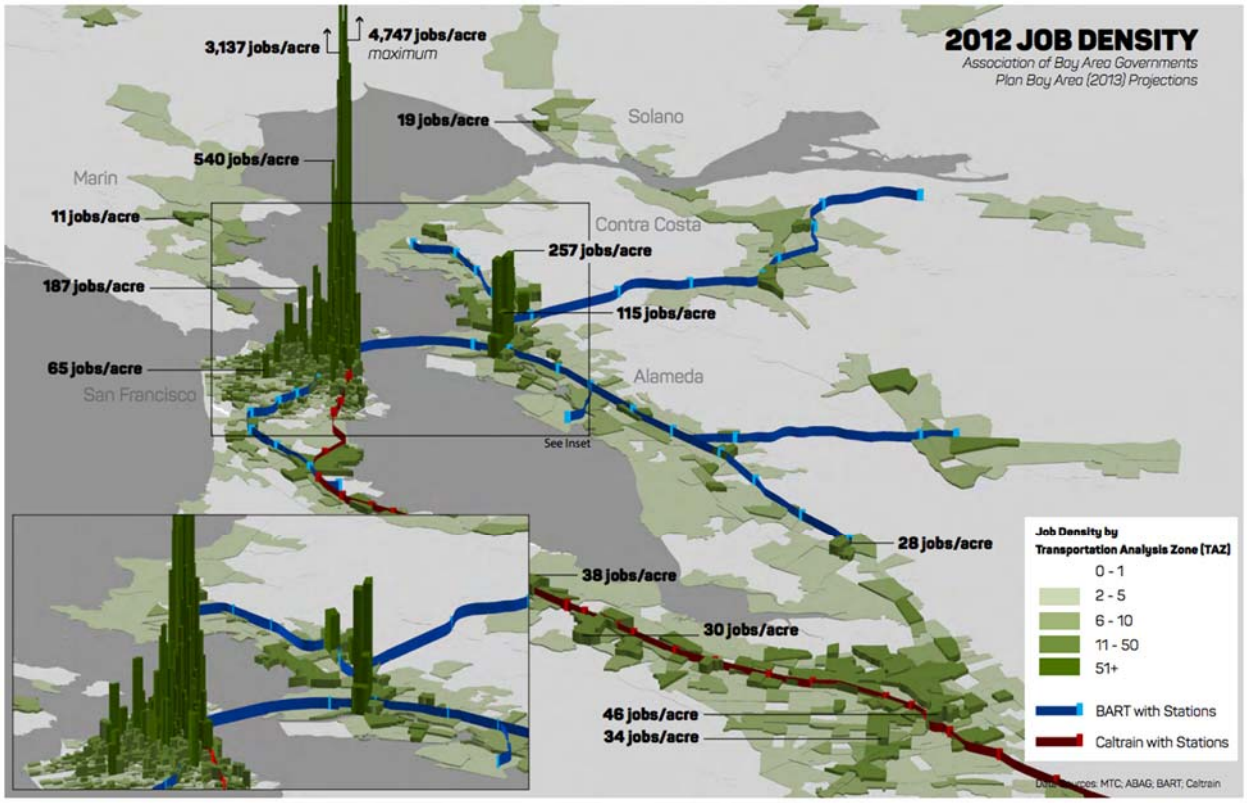
[50] Kolko, Jed. "Making the Most of Transit: Density, Employment Growth, and Ridership around New Stations." Public Policy Institute of California. February 2011. http://www.ppic.org/content/pubs/report/R_211JKR.pdf
[51] Metropolitan Transportation Commission. Vital Signs: Jobs web page. http://www.vitalsigns.mtc.ca.gov/jobs. Accessed 10 December 2016.
[52] Based on geographic data analysis carried out by students in the Fall 2016 Transportation Planning Studio using LEHD data.
[53] SPUR. "The Urban Future of Work." January 2012. http://www.spur.org/publications/spur-report/2012-01-09/urban-future-work.
[54] SPUR. "The Urban Future of Work." January 2012. http://www.spur.org/publications/spur-report/2012-01-09/urban-future-work.
[55] Kolko, Jed. "Making the Most of Transit: Density, Employment Growth, and Ridership around New Stations." Public Policy Institute of California. February 2011. http://www.ppic.org/content/pubs/report/R_211JKR.pdf

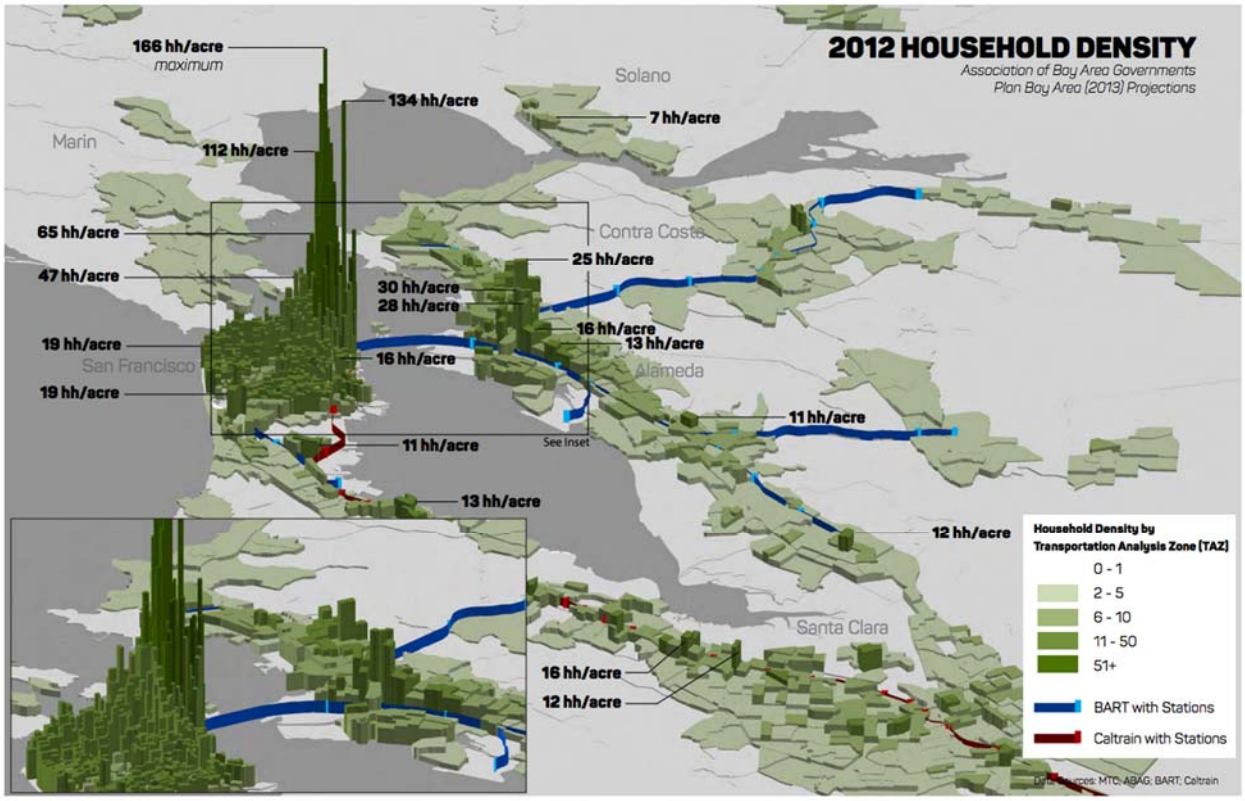



*Source: MTC Core Capacity Study Briefing Book.*

Although less decisive than employment density, residential density also impacts and relates to transit usage. Population in the Bay Area is growing at about 1%, which is slower than major sunbelt metropolitan areas like Houston, Dallas, Atlanta, and Miami.[56] The South Bay has changed and grown the most since 1960, with Santa Clara County now accounting for 25% of the Bay Area population.[57] Yet Figure 5 shows that the population is much less concentrated compared to San Francisco and the inner East Bay, indicating land use patterns in the latter locations may be better support high-capacity transit investment.

*Figure 5: Existing household density in 2012*

[56] Metropolitan Transportation Commission. Vital Signs: Population. http://www.vitalsigns.mtc.ca.gov/population#chart-3. Accessed 10 December 2016.
[57] Metropolitan Transportation Commission. Vital Signs: Population. http://www.vitalsigns.mtc.ca.gov/population#chart-3. Accessed 10 December 2016.




*Source: MTC Core Capacity Study Briefing Book.*

While residential density around transit stations can improve ridership and environmental outcomes, targeting station areas for infill development can also affect the lives of existing residents, particularly low-income communities and communities of color. Researchers at UC Berkeley have estimated that about 10% of Bay Area neighborhoods have already been transformed due to the influx of capital and higher-income, higher-educated residents into working-class neighborhoods.[58] They have identified that SB 375 and other initiatives to create transit-oriented development may create significant displacement among disadvantaged populations. As can be seen in Figure 6, many residents living near transit in and around the transbay corridor are renters and therefore vulnerable to displacement.

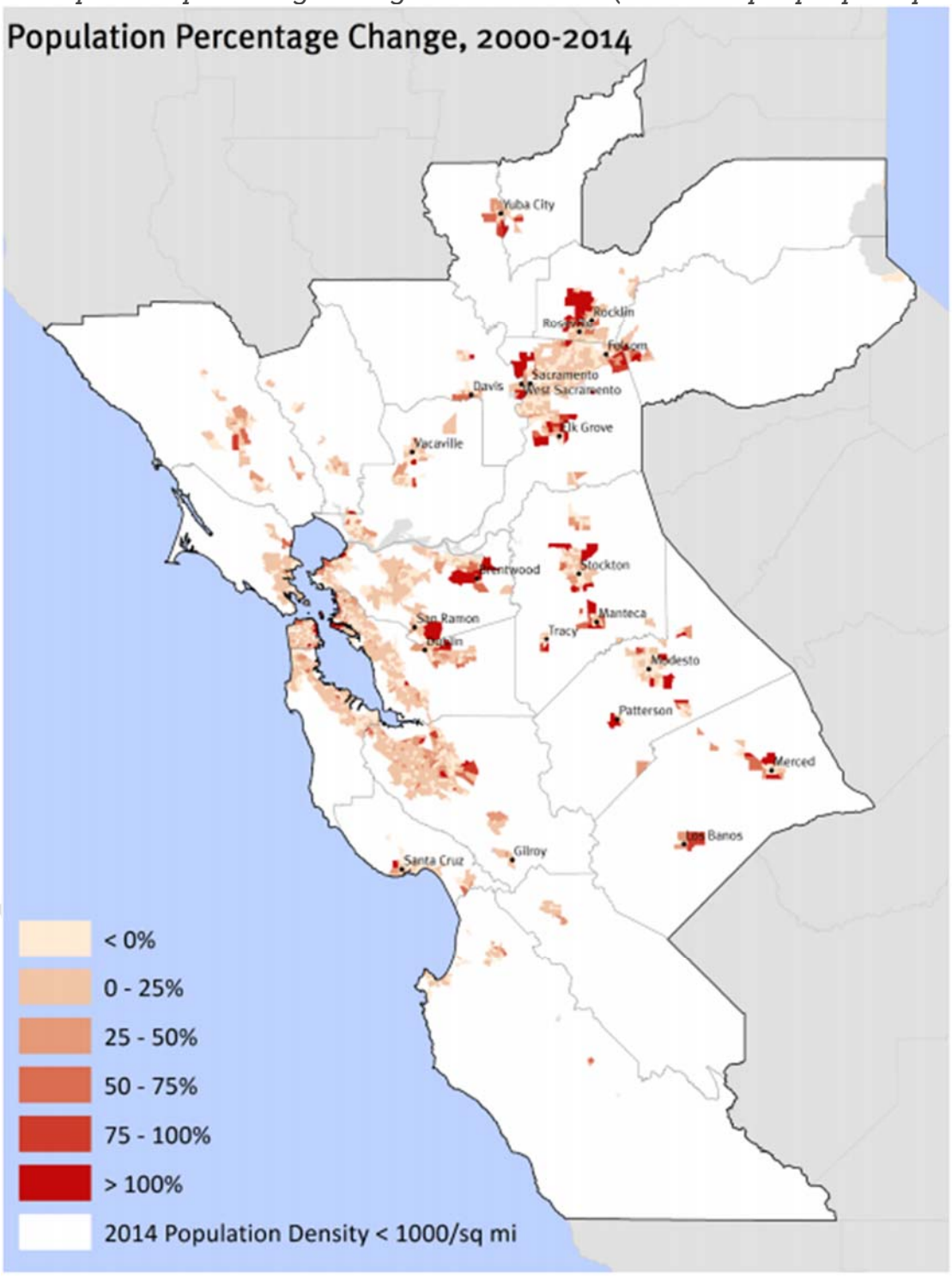
[58] Urban Displacement Project. "Executive Summary." UC Berkeley. December 2015. http://www.urbandisplacement.org/sites/default/files/images/urban_displacement_project_-_executive_summary.pdf.

*Figure 6: Homeownership rate as percentage of population*


*Source: Map produced by students in the Fall 2016 Transportation Planning Studio.*

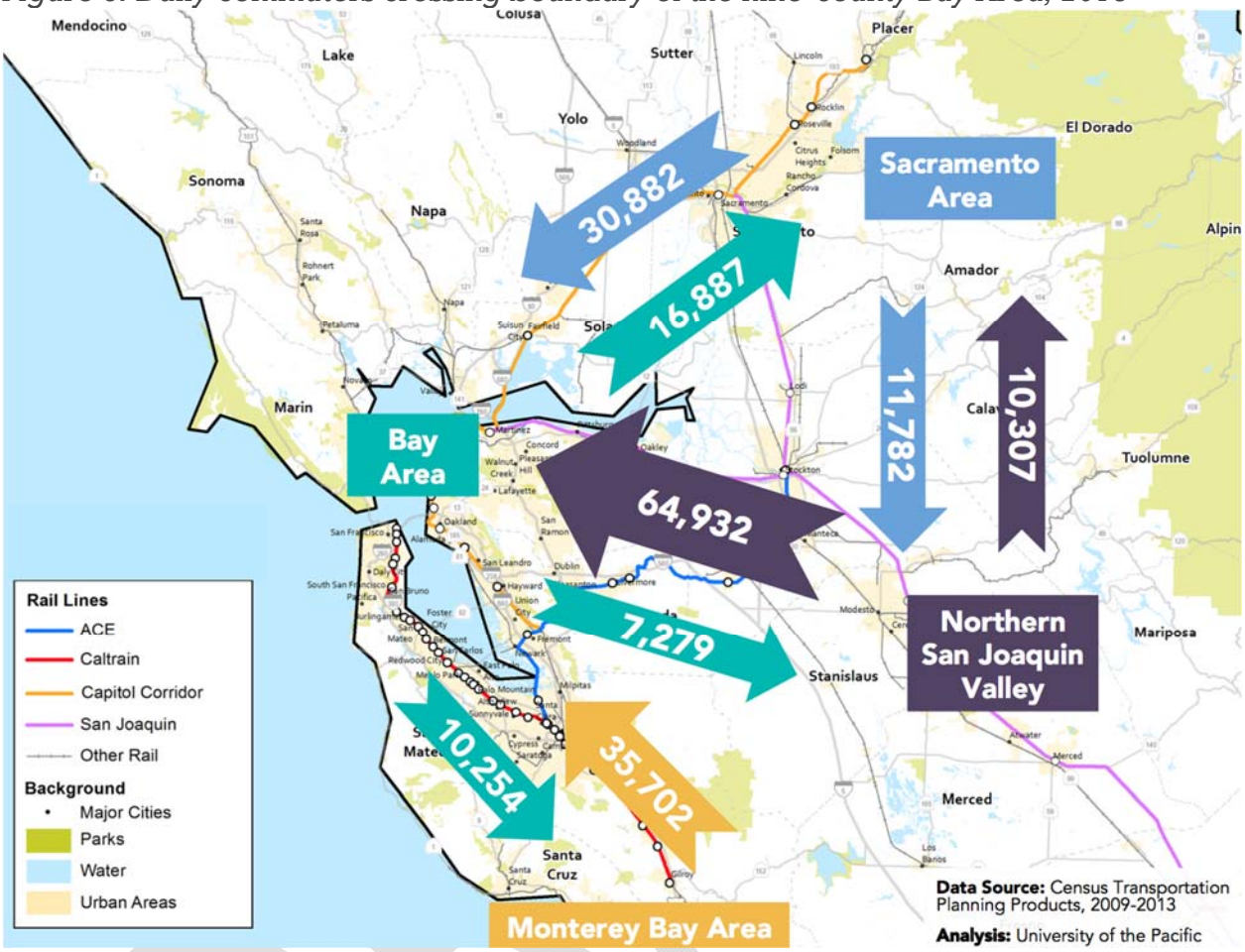
A large-scale transportation investment like a new crossing must be planned to serve future growth. Figure 7 shows the fastest growth is occurring at the edge of the region in the far East Bay into the Central Valley and Sacramento. This growth at the edge has brought more long-distance commuting into the nine-county Bay Area (see Figure 8).

*Figure 7: Population percentage change in urban areas (over 1000 people per square mile)*




*Source: Bay Area Council Economic Institute. "The Northern California Megaregion: Innovative, Connected, and Growing." June 2016. http://www.bayareaeconomy.org/files/pdf/The_Northern_California_Megaregion_2016c.pdf.*

*Figure 8: Daily commuters crossing boundary of the nine-county Bay Area, 2013*




*Source: Bay Area Council Economic Institute. "The Northern California Megaregion: Innovative, Connected, and Growing." June 2016. http://www.bayareaeconomy.org/files/pdf/The_Northern_California_Megaregion_2016c.pdf.*

## Land Use Planning Efforts

Because land use is dictated at the local level, designation as a PDA in Plan Bay Area does not necessarily mean that a location is zoned as such. In fact, within designated PDAs, the share of jobs has actually declined over the past two decades.[59] The lack of coordination between the regional and local levels creates these contradictions and may dampen potential benefits of a new crossing.

However, local planning in Oakland and San Francisco has resulted in more transit-supportive development. Oakland is currently completing a Downtown Specific Plan to make changes to zoning and land use regulations in the downtown area. The plan will complement the Lake Merritt Station Area

[59] SPUR. "The Urban Future of Work." January 2012. http://www.spur.org/publications/spur-report/2012-01-09/urban-future-work.

Specific Plan, which was adopted in 2014 and calls for residential and commercial development.[60] In San Francisco, the Mission Bay Redevelopment Plan, the Eastern Neighborhoods Plan, and the Central SoMa Plan have ushered in significant redevelopment of formerly industrial land in these neighborhoods. At the same time, 40 blocks located immediately southeast of downtown San Francisco and the Market Street corridor have been redeveloping since the creation of the Transbay Redevelopment Project Area in 2005.[61]

The Downtown Oakland Specific Plan Alternatives Report (DOSPAR) has also included consideration of reconstructing the 12 blocks of Interstate 980 into an at-grade boulevard just west of downtown. The project would reduce barriers between West Oakland and downtown, and it would free 17 acres of public land to new development or public uses. The report identifies the potential to support transit service in the corridor, connected to a new transbay crossing.

## Transportation Network and Operations

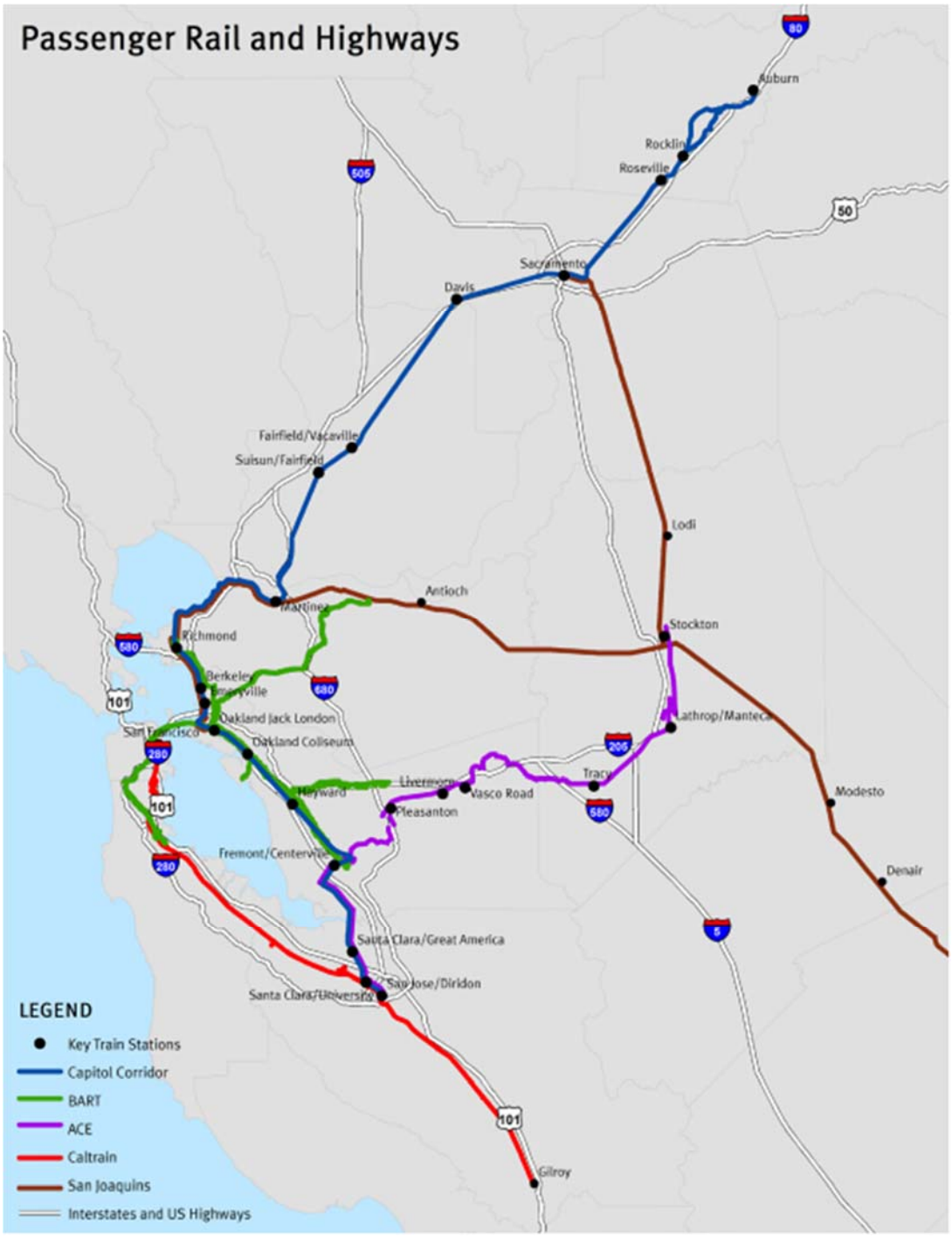
The Bay Area is served by several interstate highways, state and local roads, regional commuter rail, the BART heavy rail system, several light rail lines, local and regional buses, and ferry service (see Figure 9 for passenger rail and highway information). These services are provided by a variety of transportation agencies described in the sections below.

The primary transit agencies operating in and around the transbay corridor include the Bay Area Rapid Transit (BART) District, AC Transit, San Francisco Bay Ferry (operated by WETA), and Muni. The BART heavy rail line and AC Transit bus lines handle the bulk of transbay transit trips, while WETA ferries and a few WestCAT buses carry a small number of passengers across the Bay between San Francisco and Oakland. Muni connects transit riders between Treasure Island and San Francisco. Caltrain, Capitol Corridor, Golden Gate Transit, SamTrans, and County Connection connect to and complement the primary services in the corridor.

*Figure 9: Passenger rail and highway infrastructure serving the greater Bay Area region*

[60] Lake Merritt Station Area Plan website. City of Oakland. http://www2.oaklandnet.com/Government/o/PBN/OurServices/Plans/DOWD008198. Accessed 8 December 2016.

[61] San Francisco Office of Community Investment and Infrastructure. Transbay web page. http://sfocii.org/transbay. Accessed 8 December 2016.



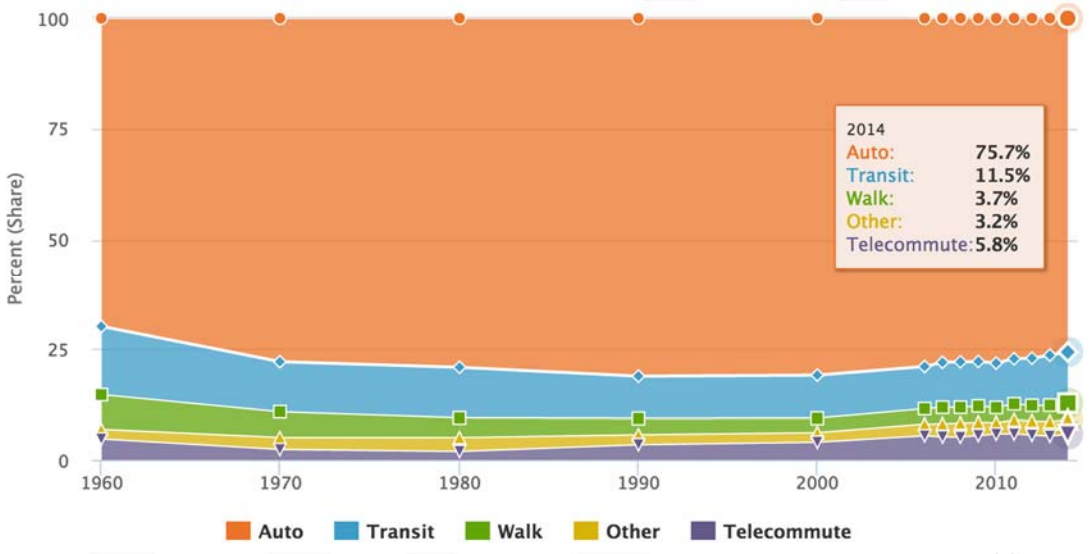

*Source: Bay Area Council Economic Institute. "The Northern California Megaregion: Innovative, Connected, and Growing." June 2016. http://www.bayareaeconomy.org/files/pdf/The_Northern_California_Megaregion_2016c.pdf.*

Urban development and transportation patterns were concentrated early in the Bay Area's history, but suburbanization and highway construction beginning in the 1950s led to sprawling residential patterns and more commuting from outside of the region's big cities. In the early 1980s, a number of

corporations left downtown locations to settle in suburban office parks, which further intensified daily commute patterns.

As a result of these land use patterns, the average Bay Area commute time continues to increase year-over-year, reaching 30 minutes in 2014.[62] Most Bay Area residents rely on the private automobile for work trips, as shown in Figure 10. Transit use accounts for 12% of work trips but only 3% of all travel.[63] This distinction makes sense because transit is most competitive relative to driving during peak periods of heavy traffic. Even so, drive-alone commuters spend an average of 27 minutes traveling, compared to transit commuters' 49 minutes.[64]

*Figure 10: Work trips by mode share for nine-county Bay Area*



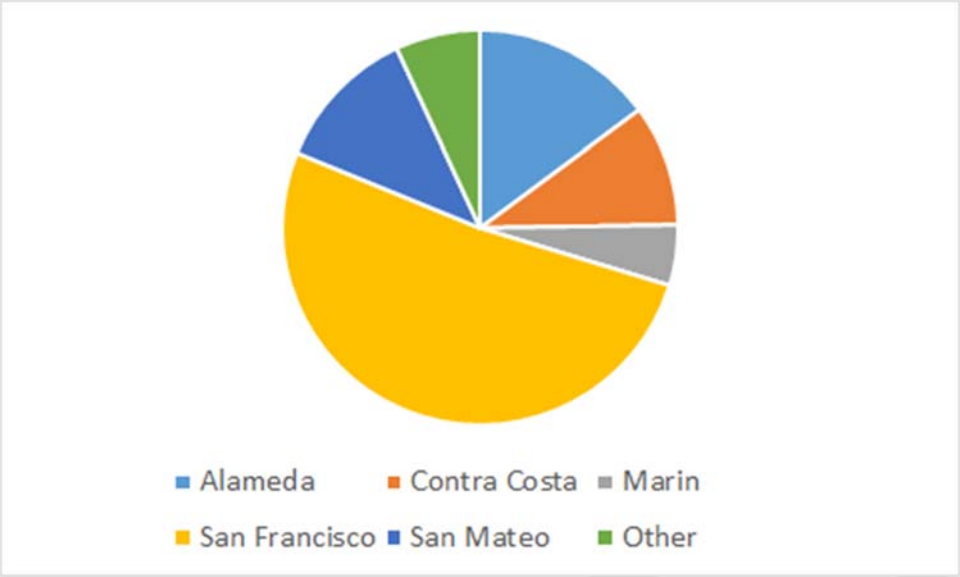

*Source: MTC Vital Signs, http://www.vitalsigns.mtc.ca.gov/commute-mode-choice*

## Transbay Corridor

Given its significant employment concentration, San Francisco is a major destination for commuters (see Appendix C for more charts and figures on transbay commute patterns). The largest share of workers commuting into San Francisco come from Alameda and San Mateo counties (Figure 11). During the morning peak period, approximately 27,000 people per hour travel westbound into San Francisco on BART, compared to 14,200 people per hour on the Bay Bridge (Figure 12). Of the Bay Bridge commuters, 2,700 people per hour are on AC Transit or WestCAT transbay buses. An additional 1,300 people per hour commute on WETA ferries in the morning peak period.[65]

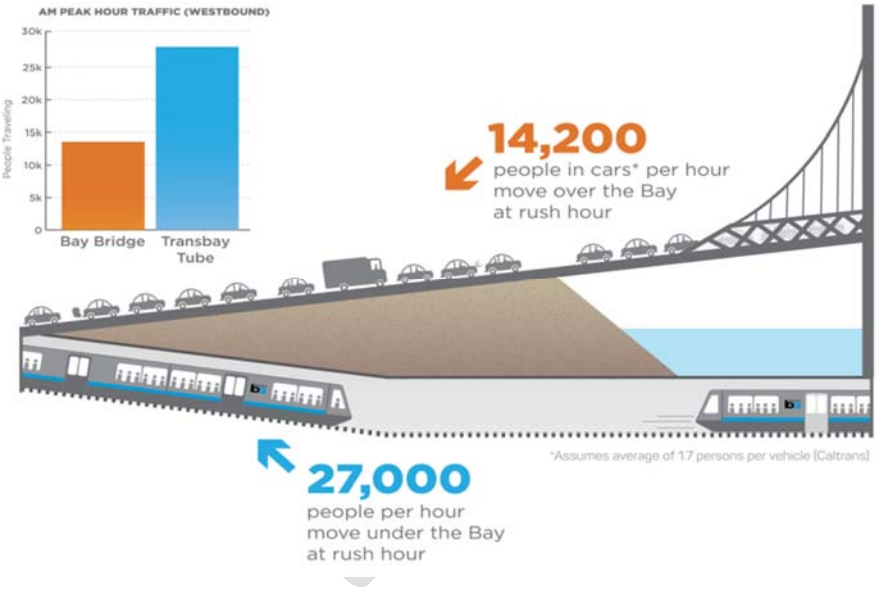
*Figure 11: Origin county for workers commuting to San Francisco*

[62] http://www.vitalsigns.mtc.ca.gov/commute-time
[63] http://www.spur.org/sites/default/files/publications_pdfs/SPUR_Seamless_Transit.pdf
[64] http://www.vitalsigns.mtc.ca.gov/commute-time
[65] Metropolitan Transportation Commission. "Core Capacity Transit Study Briefing Book." July 2016. http://mtc.ca.gov/sites/default/files/CCTS_BriefingBook_FINAL_WEB.pdf.




*Source: Produced by students in the Fall 2016 Transportation Planning Studio using MTC travel model data, 2010 Baseline Conditions; "Other" includes Napa, Santa Clara, Sonoma and Solano counties.*

*Figure 12: BART estimate of travel on the transbay crossings in the morning peak hour*



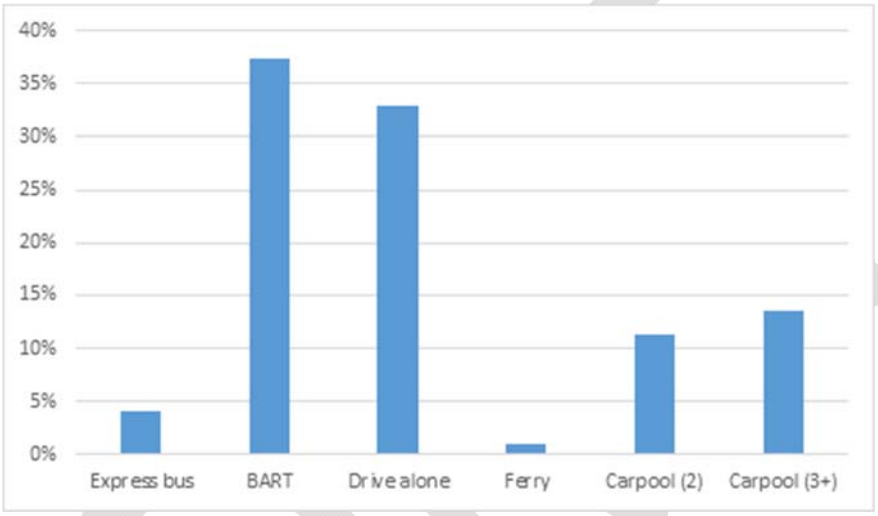

*Source: "Next Stop: Good TOD." Presented by BART at the San Jose SPUR Forum. 7 July 2016. Retrieved from http://www.spur.org/sites/default/files/events_pdfs/2016.07.07%20-%20Next%20Stop%20Good%20TOD.pdf.*

Interstate 80 is at capacity during the peak period, with cars queued at the Bay Bridge Toll Plaza throughout the morning peak period. AC Transit is also operating near its approximately 3,000 riders per hour capacity across 30 transbay routes. The primary constraint on bus capacity is the Temporary Transbay Terminal, which does not have room to accommodate additional buses. When the new

Transbay Transit Center opens, additional capacity could allow for up to 7,300 passengers per hour. Additional dedicated bus access lanes on the eastern Bay Bridge approach could also help achieve capacity, speed, and reliability increases.

As shown in Figure 13 below, approximately 37% of transbay travelers use BART and 33% drive alone. MTC's Core Capacity Study suggests that AM peak period transbay westbound travel is already over capacity at 105%. [66] Moreover, BART is at 110% capacity and the Bay Bridge's auto capacity is at 100%.[67] The demand for transbay travel continues to grow; over a 5-year period from 2010 to 2015, peak direction demand for BART grew by 44%.[68] Express bus service ridership has grown by 40% between 2010 and 2015.[69] Given projections of future employment and population growth in the Bay Area, the transbay corridor is not expected to support capacity needs.

*Figure 13: Mode share estimate for travel in the transbay corridor*

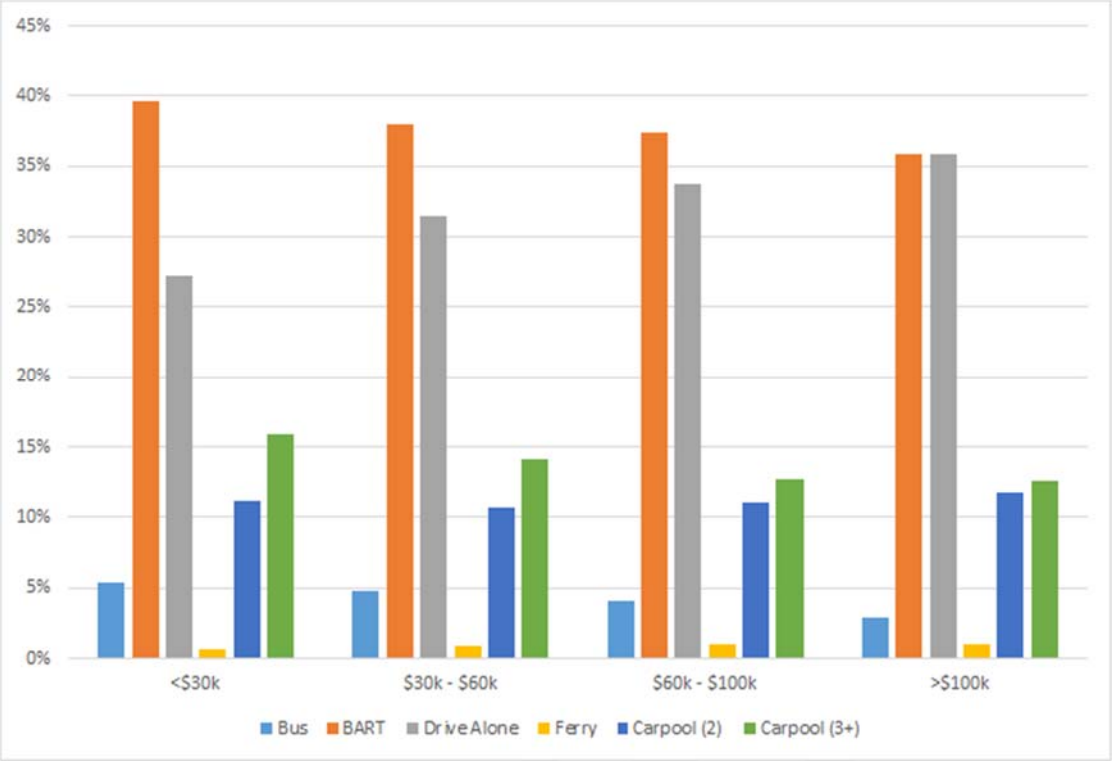



*Source: Produced by students in the Fall 2016 Transportation Planning Studio using 2010 MTC travel model data. This model estimates transbay mode share by combining all trips that are eastbound from San Francisco County to Contra Costa, Alameda or Solano counties, and combines all westbound trips from the latter counties to San Francisco Counties.*

Among transbay travelers, approximately 36% of those travelers making more than $100,000 drive alone, while only 27% of those making less than $30,000 drive alone. Lower income travelers (less than $30,000) are more likely to be taking BART than higher income travelers (more than $100,000), as shown in Figure 14. Travel mode use also varies by race and ethnicity. Using on-board ridership survey data, Figure 15 shows how the distributions of riders systemwide on BART, AC Transit, Muni, and Caltrain vary by race and ethnicity. White/Caucasian travelers constitute the majority or plurality of riders on BART, Muni, and Caltrain, while African American/Black travelers account for 39% of AC Transit ridership (the highest such share).

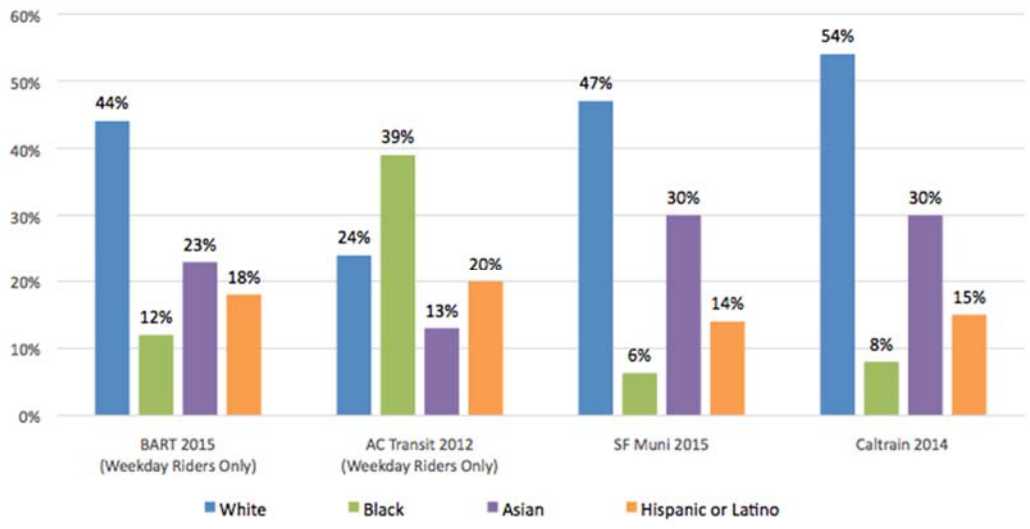
[66] http://mtc.ca.gov/sites/default/files/CCTS_TransbayCapacityandDemandSummary_FINAL.pdf
[67] http://mtc.ca.gov/sites/default/files/CCTS_TransbayCapacityandDemandSummary_FINAL.pdf
[68] http://mtc.ca.gov/sites/default/files/CCTS_TransbayCapacityandDemandSummary_FINAL.pdf
[69] http://mtc.ca.gov/sites/default/files/CCTS_TransbayCapacityandDemandSummary_FINAL.pdf

*Figure 14: Transbay mode share by income, 2010*




*Source: Produced by students in the Fall 2016 Transportation Planning Studio using MTC travel model data.*

*Figure 15: Systemwide passenger race/ethnicity by transit provider*




*Source: Produced by students in the Fall 2016 Transportation Planning Studio using MTC travel model data.*

These travel patterns provide a better understanding of the current needs around transbay travel, particularly in regards to travel by income, race and ethnicity.

## BART Operational Challenges

The BART transbay tube, with one track in each direction, is the only rail corridor between San Francisco and the East Bay. The lack of redundancy for a critical rail line makes the system vulnerable to catastrophic delay, with a single mechanical failure blocking or delaying trains throughout the system. BART also does not operate overnight rail service to allow for track maintenance, which limits access to jobs for late evening and early morning shift workers.

BART is already at or above capacity at rush hour in the peak direction on its transbay routes. Trains often carry more than 115 passengers per car, exceeding the maximum capacity of 107 passengers established by policy.[70] Overall BART ridership has risen to about 440,000 passengers per day, a five-year increase of 100,000, which is stretching the limits of the system's ability to operate reliably.[71] From 2012 to 2015, BART delays lasting longer than 15 minutes increased 26% while on-time performance dropped from 96% to 87%.[72] Primary causes of delay are problems with railcars, trackside equipment, police activity, and medical emergencies.

There are a number of improvement projects expected to improve BART service including higher capacity train car replacement and a new train control system. These have not been fully funded, but Bay Area residents recently showed support for financing system improvements when voters passed a $3.5 billion bond in November 2016 to fund such core system renewal projects. However, the impact of such improvements may still be limited. MTC has projected that potential BART improvements together with major transbay bus expansion will nonetheless be unable to meet peak transbay ridership demands past 2030 under a moderate growth scenario.

In the long term, there is also a significant maintenance challenge that impacts potential project analysis and consideration: BART officials have stated that at some point the existing BART tube will need to be rehabilitated or replaced, implying a very long period of downtime which would not be sustainable under current or projected travel patterns.[73] At one SPUR event, multiple experts stressed, "It isn't a question of 'if' the area needs a second [transit] crossing. It's a question of how to build it."[74]

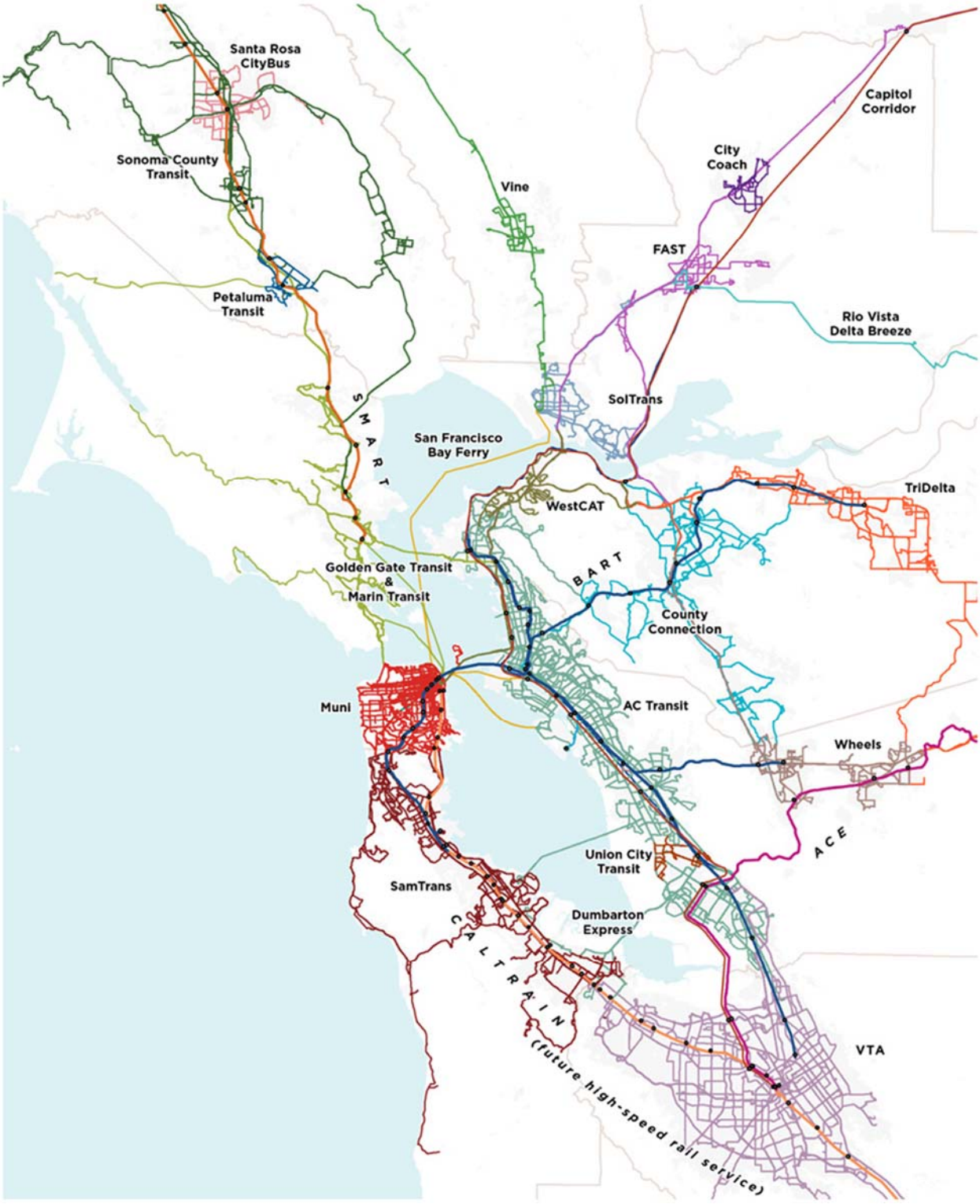
## Regional and Intermodal Connections

Rail and transit regional connections are notoriously weak in the Bay Area. This fragmentation is in part due to the sheer number of local transit agencies, each with different fare structure and operational

[70] Metropolitan Transportation Commission. "Core Capacity Transit Study Briefing Book." July 2016. http://mtc.ca.gov/sites/default/files/CCTS_BriefingBook_FINAL_WEB.pdf.
[71] Cabanatuan, Michael. "BART shutdown underscores aging system's overwhelming problems." San Francisco Chronice. 17 March 2016. http://www.sfchronicle.com/bayarea/article/BART-shutdown-underscores-aging-system-s-6916061.php. Accessed 6 December 2016.
[72] Batey, Eve. "BART's Breakdowns and Delays, By The Numbers." SFist. 2 March 2015. http://sfist.com/2015/03/02/barts_breakdowns_and_delays_by_the.php. Accessed 6 December 2016.
[73] Rudick, Roger. "SPUR Meeting Pushes Second Transbay Tube." Streetsblog SF. 20 April 2016. http://sf.streetsblog.org/2016/04/20/spur-meeting-pushes-second-transbay-tube/.
[74] Rudick, Roger. "SPUR Meeting Pushes Second Transbay Tube." Streetsblog SF. 20 April 2016. http://sf.streetsblog.org/2016/04/20/spur-meeting-pushes-second-transbay-tube/.

focus. Figure 15 and Figure 16 show the service areas and operating characteristics of 24 different transit providers around the Bay Area.

*Figure 16: Bay Area transit service lines by operator*



*Source: Seamless Transit (SPUR, 2015)*

*Figure 17: Operating characteristics by transit operators (brands)*

| Primary Transit Brand(s)<br>*Governing Transit Agency* | Transit Types | Year Formed | Annual Ridership[4] | Total Annual Costs[5] |
|---|---|---|---|---|
| Muni<br>*San Francisco Municipal Transportation Agency* | Bus, trolley bus, light rail, historic streetcar, cable car, paratransit | 1912 | 223,701,000 | $684 million |
| BART / *San Francisco Bay Area Rapid Transit District* | Heavy rail | 1972 | 126,603,000 | $569 million |
| AC Transit, Dumbarton Express<br>*Alameda–Contra Costa Transit District* | Bus, paratransit | 1960 | 55,235,000 | $327 million |
| VTA / *Santa Clara Valley Transportation Authority* | Bus, light rail, paratransit | 1972 | 44,244,000 | $320 million |
| Caltrain / *Peninsula Corridor Joint Powers Board* | Heavy rail | 1992 | 15,596,000 | $112 million |
| SamTrans / *San Mateo County Transit District* | Bus, paratransit | 1975 | 12,446,000 | $114 million |
| Golden Gate Transit, Marin Transit[6]<br>*Golden Gate Bridge, Highway and Transportation District, Marin Transit* | Bus, ferry boat service, paratransit | Bridge District 1928, Marin Transit 1964 | 9,203,000 | $105 million |
| The County Connection<br>*Central Contra Costa Transit Authority* | Bus, paratransit | 1980 | 3,297,000 | $31 million |
| Santa Rosa CityBus / *City of Santa Rosa* | Bus, paratransit | 1958 | 2,809,000 | $11 million |
| Tri Delta Transit<br>*Eastern Contra Costa Transit Authority* | Bus, paratransit | 1977 | 2,741,000 | $21 million |
| Wheels / *Livermore Amador Valley Transit Authority* | Bus, paratransit | 1986 | 1,727,000 | $15 million |
| SolTrans / *Solano County Transit* | Bus, paratransit | 2011 | 1,394,000 | $10 million |
| Sonoma County Transit / *County of Sonoma* | Bus, paratransit | 1958 | 1,361,000 | $13 million |
| WestCAT / *Western Contra Costa Transit Authority* | Bus, paratransit | 1977 | 1,282,000 | $9 million |
| Capitol Corridor<br>*Capitol Corridor Joint Powers Authority and BART* | Heavy rail | 1998 | 1,250,000[7] | $30 million |
| Fairfield and Suisun Transit (FAST), Solano Express / *City of Fairfield* | Bus, paratransit | 1975 | 1,049,000 | $10 million |
| Altamont Commuter Express (ACE)<br>*San Joaquin Regional Rail Commission* | Heavy rail | 1998 | 940,000 | $16 million |
| San Francisco Bay Ferry<br>*Water Emergency Transportation Authority* | Ferry boat service | 2007 | 607,000 | $24 million |
| VINE<br>*Napa County Transportation and Planning Agency* | Bus, paratransit | 1974 | 550,000 | $7 million |
| City Coach / *City of Vacaville* | Bus, paratransit | 1981 | 508,000 | $2 million |
| Union City Transit / *City of Union City* | Bus, paratransit | 1974 | 505,000 | $4 million |
| Petaluma Transit / *City of Petaluma* | Bus, paratransit | 1976 | 318,000 | $2 million |
| Rio Vista Delta Breeze<br>*City of Rio Vista Transit Services* | Bus, paratransit | 1978 | 13,000 | $0.5 million |
| SMART / *SMART Rail* | Heavy rail | 2002 | Not yet in service | n/a |
| (future high-speed rail service)<br>*California High-Speed Rail Authority* | Heavy rail | 1996 | Not yet in service | n/a |

*Source: Seamless Transit (SPUR, 2015)*

The lack of coordination among systems results in a poor user experience, gaps and service duplication. The BART, Caltrain, and Capitol Corridor systems, for example, have only limited connections at the end of BART lines (Millbrae and Richmond stations, respectively), located well outside of the core service areas.

## Sea Level Rise and System Resilience

The Bay Area's distinctive geography and diverse urban forms together produce unique challenges for ensuring resilient transportation in the transbay corridor. As a coastal region, the Bay Area faces potential effects of sea level rise due to climate change. Thus, parts of the Bay Area that are adjacent to the ocean and the San Francisco Bay are at highest risk of water inundation. Sea level rise is anticipated to be as much as 4.5 feet by 2100 (Cayan, California Energy Commission, Scripps Institution of Oceanography, & California Climate Change Center, 2012).

As Figure 18 shows, critical components of the transbay corridor and large parts of Alameda Island, the Financial District and the Central Waterfront are all at risk. Even with just two feet of sea level rise, the combination of a higher shoreline and a strong storm could affect adjacent communities and infrastructure if adequate mitigation measures are not taken. Research on BART and vulnerability to climate change has found that critical infrastructure, including the West Oakland Portal, is vulnerable to water damage in the event of sea level rise and/or a storm surge (Federal Transit Administration, 2013).

To help mitigate the effects of potential flooding, BART relies on storm drainage systems in the communities in which its infrastructure is located to mitigate effects on system assets including stations. There is currently a range of conditions near BART assets due to different municipalities' prioritization of upgrading and maintaining storm drainage systems. In addition to BART assets, other important regional transit assets and connections are vulnerable. This includes existing Capitol Corridor rail in the East Bay, AC Transit hubs in Oakland and Alameda and low-lying sections of I-80 that feed onto the Bay Bridge.[75] These natural and built environment factors raise concerns over the long-term viability of BART assets, including in the transbay corridor.

*Figure 18: Sea level rise scenarios in the Bay Area*

[75] See MTC's collection of SLR scenario maps here for more information and examples: http://mtc.ca.gov/sites/default/files/Chapter_6_Sea_Level_Rise_Maps.pdf

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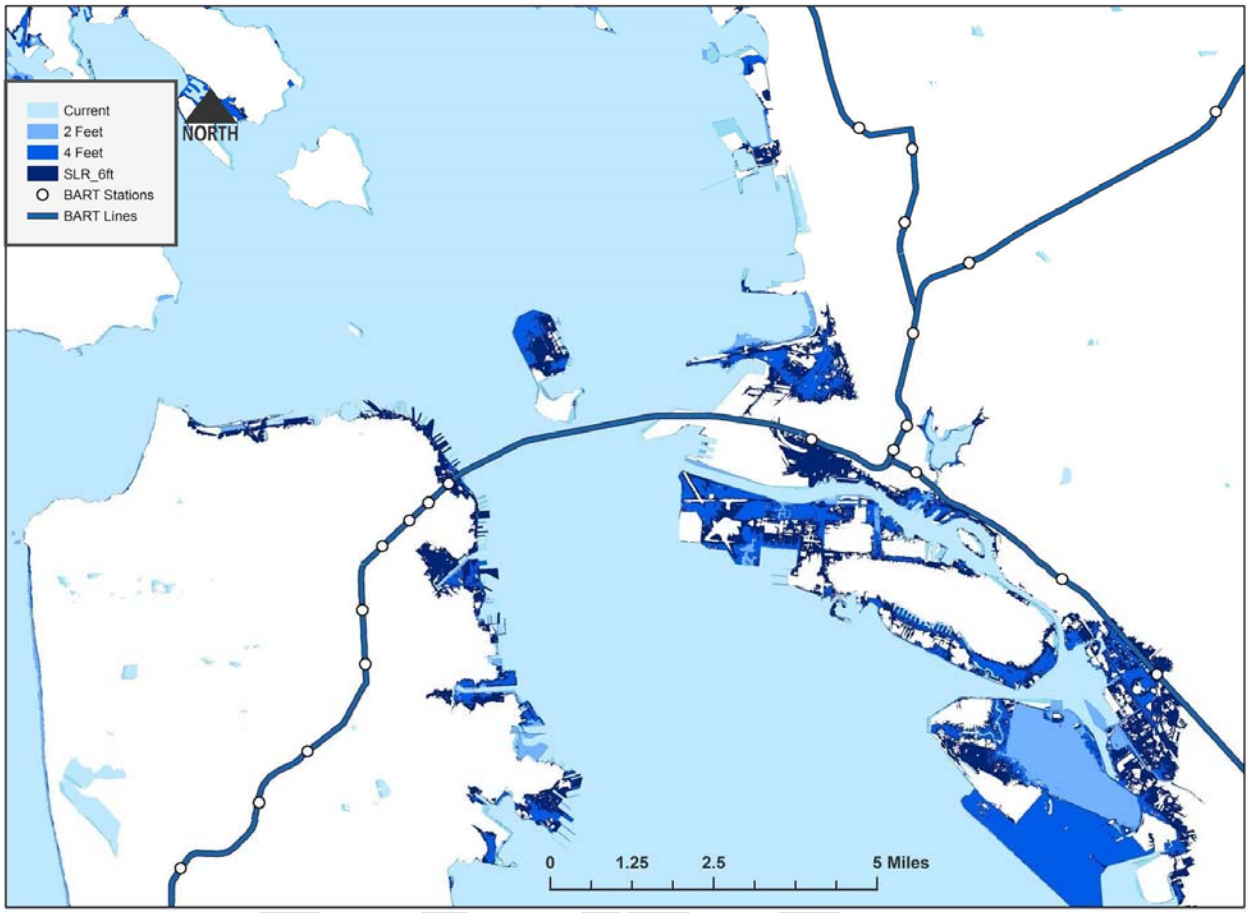



*Source: Map produced by students in the Fall 2016 Transportation Planning Studio using floodplain maps provided by ABAG Resilience Program.*

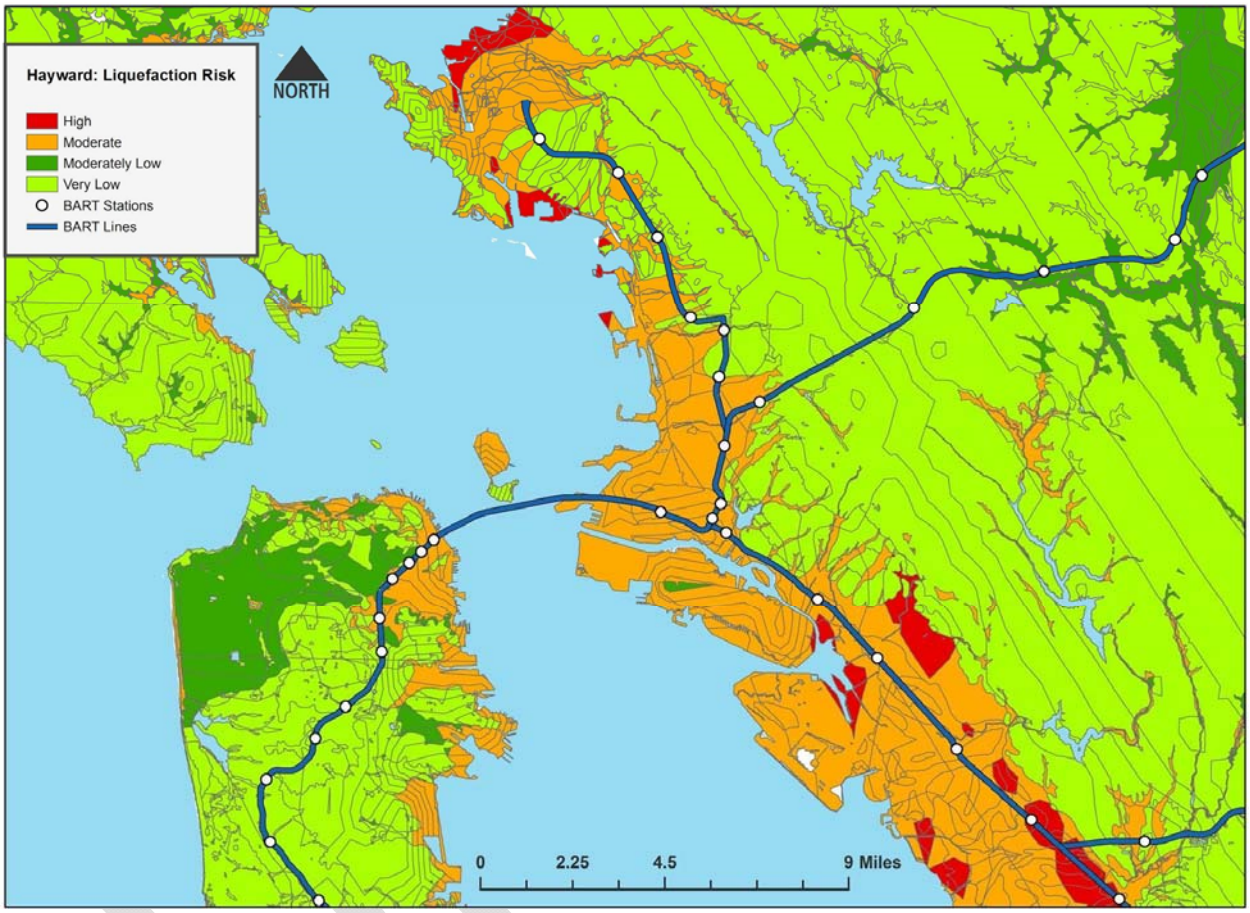
The Bay Area also is notable for vulnerability to seismic damage, which has serious implications for infrastructure planning. The region's position at the confluence of the Pacific and North American tectonic plates creates a high risk for earthquakes. Multiple fault lines crisscross Bay Area communities, including the San Andreas, Hayward and Calaveras faults. A major earthquake in the Bay Area's near future is very likely. Recent research estimates that there is a 72% chance of an earthquake of a magnitude of greater than 6.7 before 2043 in the Bay Area (Aagaard et al., 2016).

Vulnerability related to earthquakes is exacerbated by soil liquefaction risk. Soil liquefaction can cause serious structural damage as soil loses its strength during an earthquake. As Figure 19 illustrates, many coastal areas are at high risk of soil liquefaction. In the transbay corridor, land that is both the location of critical transportation infrastructure such as the Oakland Wye as well as residential and commercial development is at high risk of soil liquefaction in a seismic event (Knudsen, Wentworth, & Geological Survey, 2000).

Recent assessments suggest that the transbay tube is potentially vulnerable to structural failure in the event of a large earthquake, endangering the safety of BART personnel and riders while also presenting a serious risk to the overall transportation network due to the criticality of the tube (Bechtel Infrastructure Corporation, Howard, Needles, Tammen & Bergendoff, & San Francisco Bay Area Rapid

Transit District, 2002). To address this, BART directors have recently approved a quarter of a billion dollars to improve the safety of the Transbay Tube over the next two years.[76]

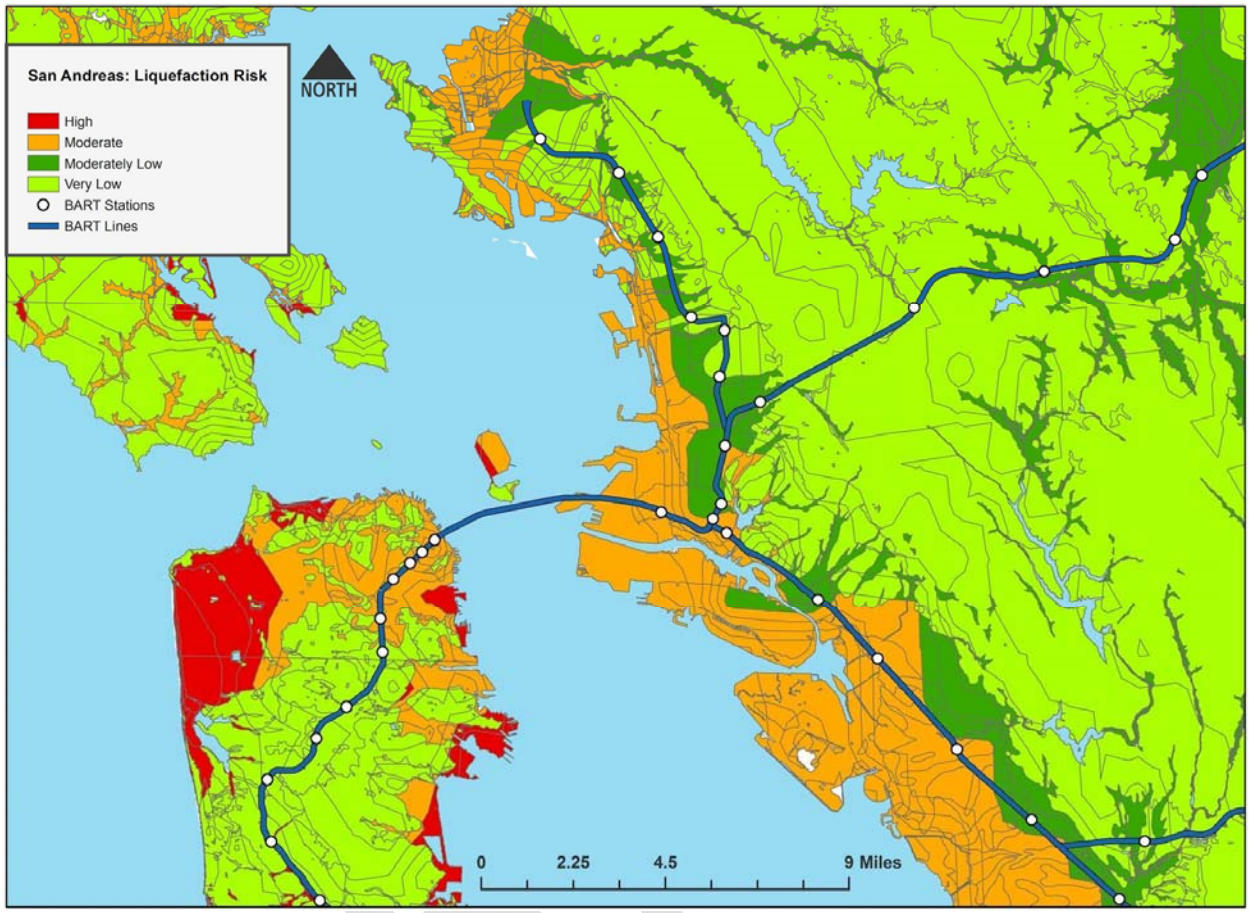
*Figure 19: Liquefaction risk for the Hayward Fault*




*Source: Map produced by students in the Fall 2016 Transportation Planning Studio using data provided by ABAG Resilience Program.*

*Figure 20: Liquefaction risk for the San Andreas Fault*

[76] See coverage here: http://www.sfgate.com/bayarea/article/Commuters-beware-BART-has-2-year-plan-to-10661176.php




*Source: Map produced by students in the Fall 2016 Transportation Planning Studio using data provided by ABAG Resilience Program.*

Vulnerability in the system is not only created through the potential of a natural disaster, but it is also due to ongoing, chronic maintenance issues. The system regularly experiences highly publicized delays due to operation and maintenance issues.[77] As the only rail system that connects San Francisco and the East Bay, current transbay transit options contain poor redundancy of service. This creates the conditions for potentially catastrophic delay in the event of a disaster or system failure (Metropolitan Transportation Commission, 2016). This is further exacerbated by the current alignments of the network in which multiple lines converge at the Oakland Wye. This makes the transportation system more vulnerable due to the amount of transit that is dependent on a specific part of the network (BART, 2013). This combination of lack of redundancy, continued operations issues and vulnerability to disruption is a potential threat to the Bay Area's economic development and quality of life. The recent

[77] For example, see KRON4's coverage of two recent system-wide delay caused by this issue. KRON4. (2016, October 14). "BART experiencing system wide delays Friday." Retrieved from http://kron4.com/2016/10/14/bart-delays-reported-in-oakland-due-to-equipment-failure. KRON4. (2016, July 20). Major BART delays in Hayward, Fremont due to equipment problems. Retrieved from http://kron4.com/2016/07/20/major-bart-delays-in-hayward-fremont-due-to-equipment-problems/

passage of Measure RR will begin to address some aspects of maintenance issues on the BART system, including over three billion dollars to address critical safety infrastructure.[78]

## Public Health

Transportation systems have public health implications, including the diseases, injuries, and/or fatalities associated with traffic collisions, air pollutants emitted from vehicles, the reliability of public transit, and how well the system supports active transportation. Often these health burdens are not distributed equitably and low-income communities and communities of color are disproportionately burdened. A study by the Bay Area Regional Health Inequities Initiative (2008) found stark differences in life expectancy within the region as West Oakland residents are expected to live an average of 10 years less than residents of the Berkeley Hills and residents of Bayview/Hunters Point are expected to live an average of 14 years less than people who live in Russian Hill.[79] Focusing more specifically on transportation-related health also shows disparities, Alameda County residents living in neighborhoods with higher levels of poverty have been shown to have higher pedestrian injury and death rates than residents of more wealthy neighborhoods (See Figure 21).[80] Similarly, in San Francisco, corridors with high concentrations of serious and fatal traffic injuries have been shown to be located disproportionately in communities of concern.[81]

*Figure 21: Rates of pedestrian injuries and deaths by neighborhood poverty level in Alameda County*

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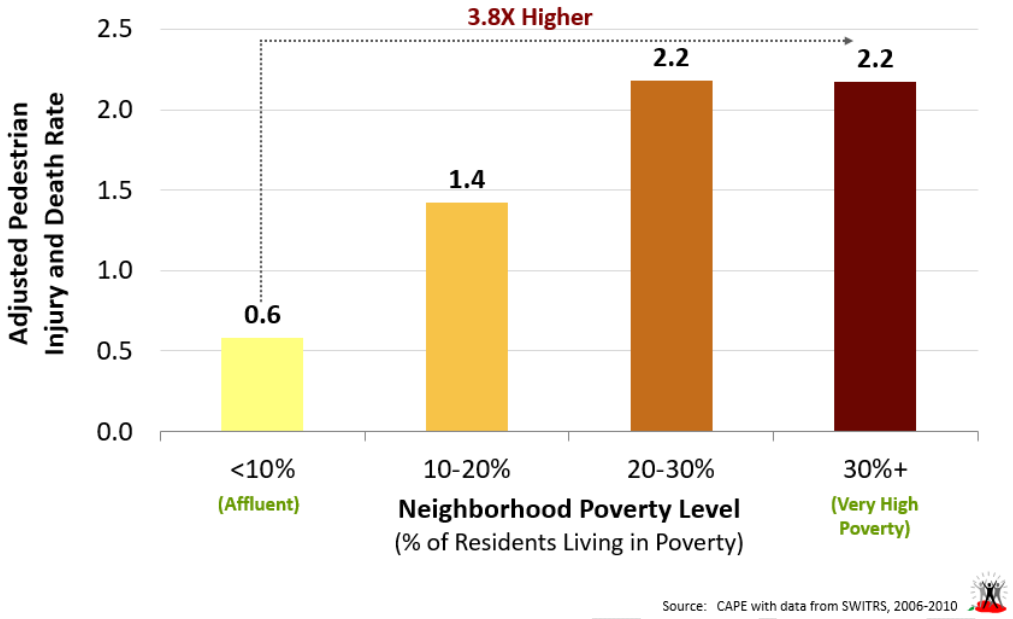
[78] For a more detailed breakdown of Measure RR, see: https://spurvoterguide.org/sf-nov-16/measure-rr-bart-bond/

[79] Bay Area Regional Health Inequities Initiative (BARHII). (2008). *Health Inequities in the Bay Area*. Oakland, CA. Retrieved from http://barhii.org/wp-content/uploads/2015/09/barhii_hiba.pdf

[80] Alameda County Public Health Department. (2013). *How Place, Racism, and Poverty Matter for Health in Alameda County Presentation*. Retrieved from http://www.acphd.org/data-reports/reports-by-topic/social-and-health-equity.aspx

[81] City and County of San Francisco. (2015). *Vision Zero San Francisco Two-Year Action Strategy*. City and County of San Francisco. Retrieved from https://www.sfmta.com/sites/default/files/projects/2015/vision-zero-san-francisco.pdf




*Source: Alameda County Public Health Department, 2013.*

Health inequities have also been shown with regards to the impacts of air pollutants emitted from the Bay Area transportation system. The residents of West Oakland, who live near the Port of Oakland, and multiple freeways, including the approaches to the Bay Bridge, are "exposed to 3 times more diesel particles than the rest of the Bay Area", (Alameda County Public Health Department, 2013). Figure 22 shows that the residents of West Oakland, as well as many other areas in the Bay Area near freeways, are among those experiencing the highest rates of emergency department visits due to asthma.

*Figure 22: Asthma emergency department visit rates (age-adjusted) by zip code, 2012*

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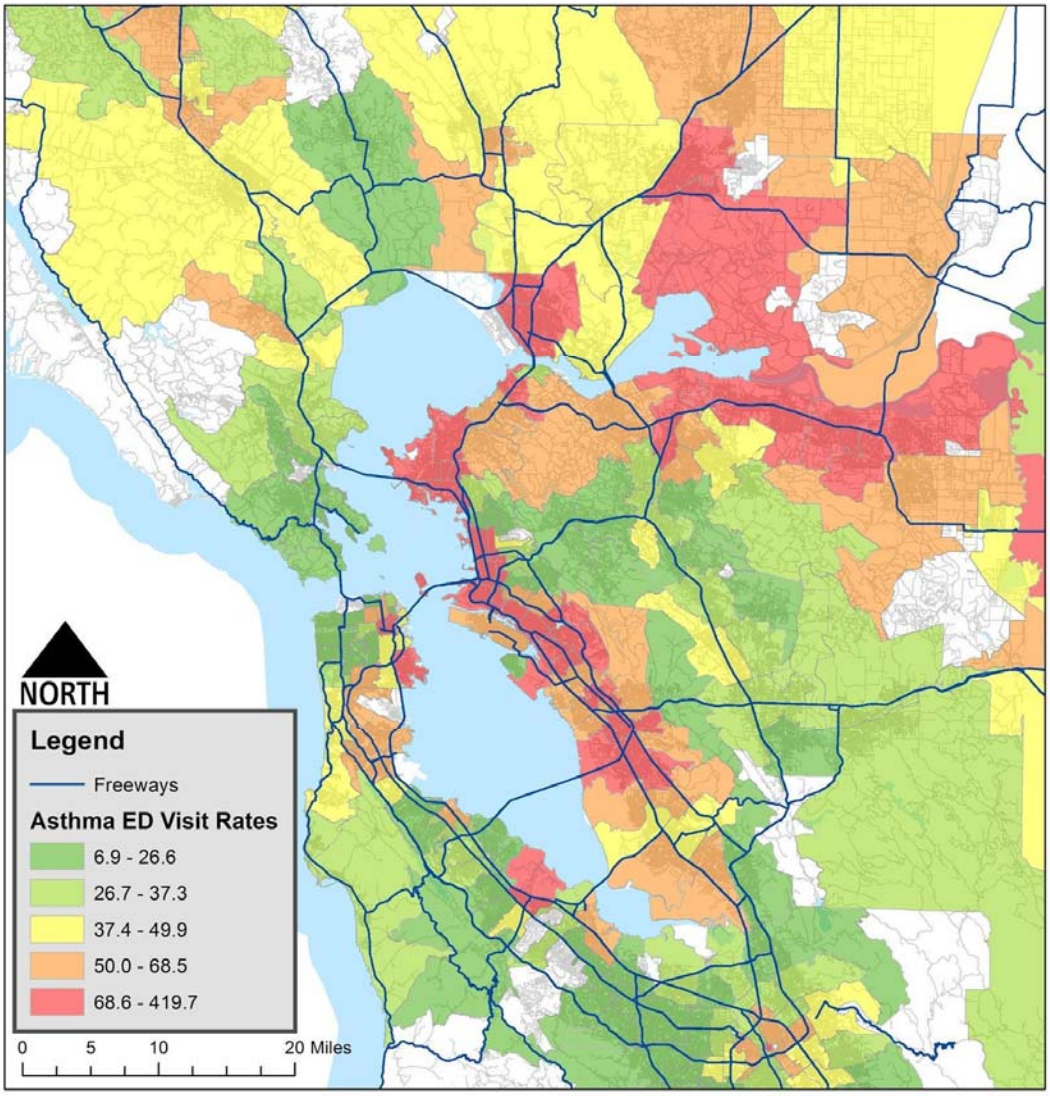


*Source: Reproduced by Studio using data from California Department of Public Health* [82]

[82] California Department of Public Health. (n.d.). Asthma Emergency Department Visit Rates by ZIP Code 2012. California Department of Public Health. Retrieved from https://chhs.data.ca.gov/Diseases-and-Conditions/Asthma-Emergency-Department-Visit-Rates-by-ZIP-Cod/5f6i-kert

# Historical Context

Consideration of a new crossing must be informed by the historical context of prior megaprojects and the politics of transportation infrastructure across the country. After defining megaprojects, this section focuses on that context primarily in terms of histories of crossings of the San Francisco Bay and case studies of megaproject planning and implementation with respect to historically disadvantaged communities.

## Megaprojects Defined

Multibillion-dollar infrastructure projects, also known as megaprojects, have come under increasing scrutiny due to their massive scale and frequently poor project performance.[83] Megaprojects involve the mobilization of capital, both financial and political, in ways that can transcend the spectacular feats of engineering they might involve. Despite the large amount of attention and planning these projects receive, they are often poorly executed, with substantial cost overruns and fiscal shortfalls.

To investigate the subject of megaprojects in a bit more detail, we next examine at a specific set of megaprojects: crossings of the San Francisco Bay.

## A History of San Francisco Bay Crossings

Some of the most notable megaprojects in Bay Area history consist of crossings of the San Francisco Bay. In total, there have been five bridge crossings of the Bay and one submerged tube used by the BART system.[84]

*Figure 23: The first passenger train crosses the Dumbarton Bridge, 1910*

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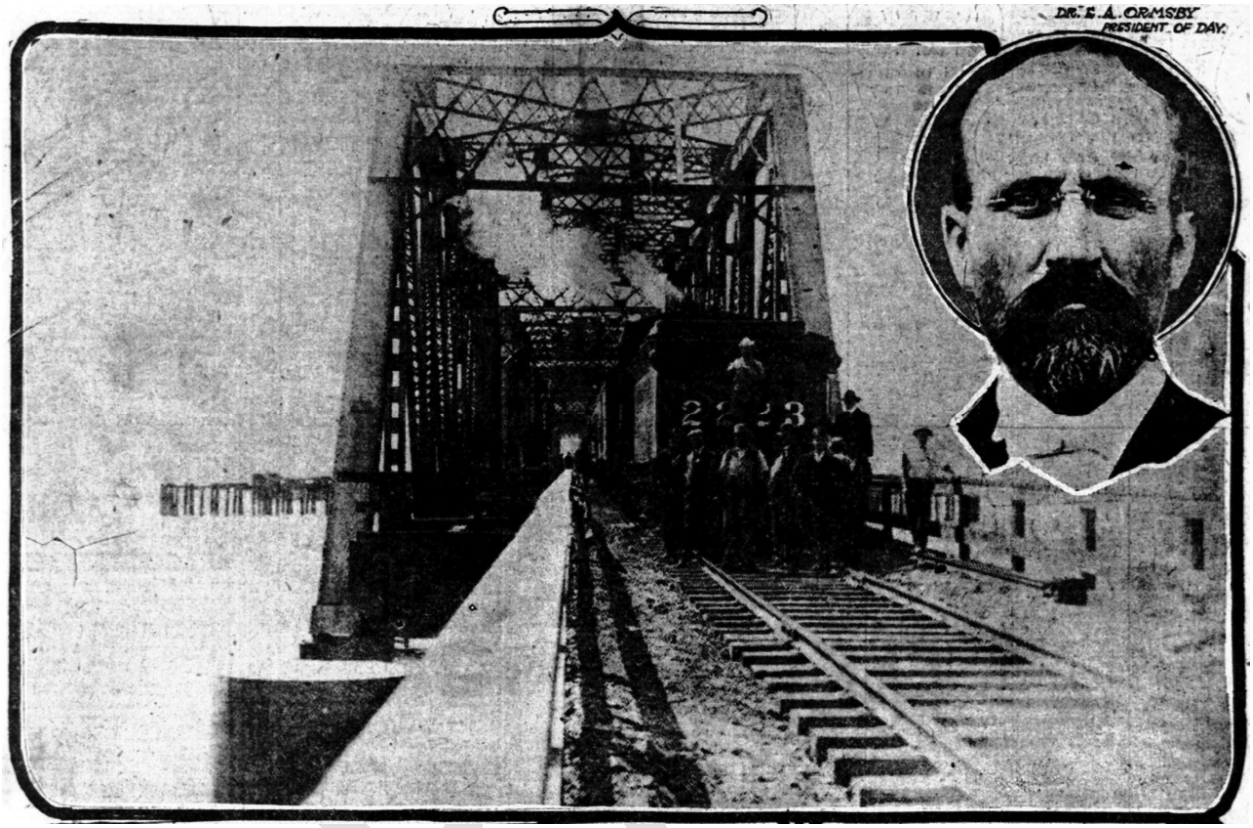
[83] Flyvbjerg, B. Buzelius, N. Rothengatter, W. *Megaprojects and Risk: An Anatomy of Ambition*. 2003.
[84] The Golden Gate Bridge, opened in 1937, is omitted here. Technically, it spans the Golden Gate Strait, not the Bay itself, and moreover, it is not a State-owned bridge. While it certainly has its own rich and lengthy history, it falls outside the scope of this report, as do the Carquinez (between Vallejo and Richmond), Benicia-Martinez, and Antioch Bridges.




*Source: San Francisco Call.*

## Initial Crossings

The very first crossing of the San Francisco Bay was the now-collapsed Dumbarton Rail Bridge, completed in 1910 and operational through 1982 (see Figure 23). The engineering required to construct the span was challenging due to swift currents and estuarine land.[85] The first automobile crossing of the Bay, the current Dumbarton Bridge,[86] was built on the same challenging terrain and opened in 1927 (see Figure 24). The bridge was rebuilt in 1982[87] with new environmental measures[88] and was subsequently widened to six lanes in 2004. This widening was funded by MTC's 1988 Regional Measure 1 toll increase.[89]

*Figure 24: The original two-lane Dumbarton Bridge, 1966*

[85] "Dumbarton Bridge is Approaching Completion". San Francisco Call. **103** (2). 2 December 1907.
[86] The bridge span itself has no name, aside from being a segment of California Route 84.
[87] "Dumbarton Rail: a bridge to the past ". San Mateo Daily Journal. Accessible at: http://www.smdailyjournal.com/articles/lnews/2016-07-11/dumbarton-rail-a-bridge-to-the-past/1776425164804.html
[88] C.M. Hogan, Leda Patmore, Harry Seidman et al., *Air Quality and Acoustics Analysis for the Dumbarton Bridge Replacement Project*, ESL Inc., prepared for the Bay Area Division of Toll Crossings (1973)
[89] Regional Measure 1. MTC Website. Accessible at: http://mtc.ca.gov/our-work/invest-protect/toll-funded-investments/regional-measure-1


The seven-mile long San Mateo-Hayward Bridge was the next to cross the Bay. It was the longest bridge in the world upon completion in 1929,[90] and it originally included a lift that allowed ship traffic to pass underneath.

## Construction of the Bay Bridge

Construction then commenced on the San Francisco-Oakland Bay Bridge in 1933 (see Figure 25). Constructed over a three-year period, the process of building and maintaining the Bay Bridge has frequently attracted substantial worldwide attention. The bridge's engineering is extremely complex, and its political context is no simpler. The Bay Bridge has been subject to numerous alignment proposals advocated by cities and private bridge building consortia competing for the benefits that particular crossing offers (see Figure 26). The current version of the Bay Bridge consists of two spans. The two sides connect through a tunnel on Yerba Buena Island and travel a total distance of 8.4 miles. Planning for the bridge was complicated by the United States Navy, whose authority constrained the locations and specifications of potential crossings. The period of planning and building also coincided with the start of the Great Depression and provided a realistic means for job stimulus and economic relief.[91]

*Figure 25: San Francisco-Oakland Bay Bridge from Yerba Buena Island during construction*

[90] San Mateo-Hayward Bridge Facts. California Department of Transportation Website. Accessible at: http://www.dot.ca.gov/hq/esc/tollbridge/SM-Hay/SMfacts.html
[91] State of California Department of Public Works (1932); Trapenberg Frick (2016)


*Source: www.alamedainfo.com.*

*Figure 26: Locations of proposed San Francisco-East Bay Bridges, 1927*

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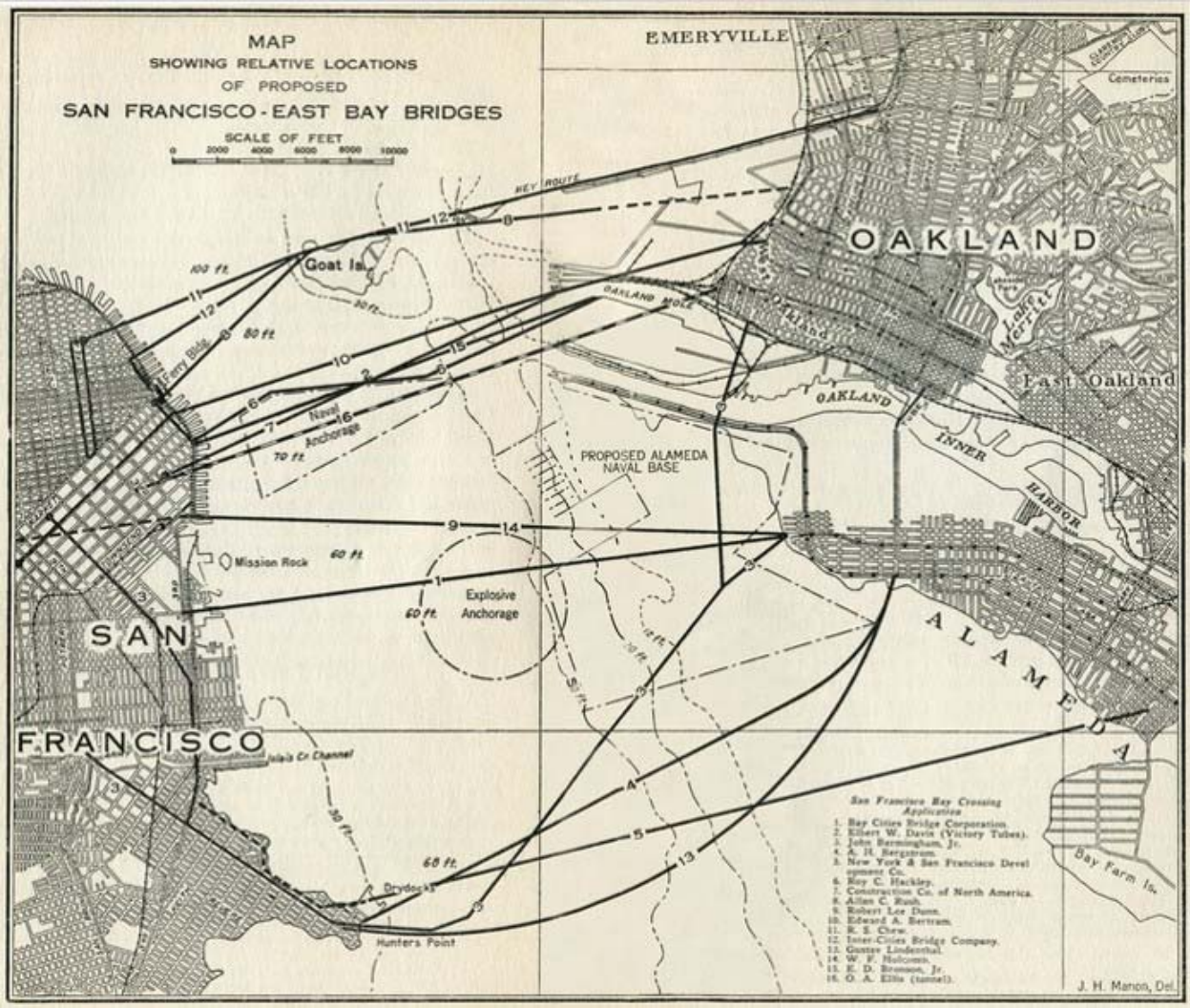
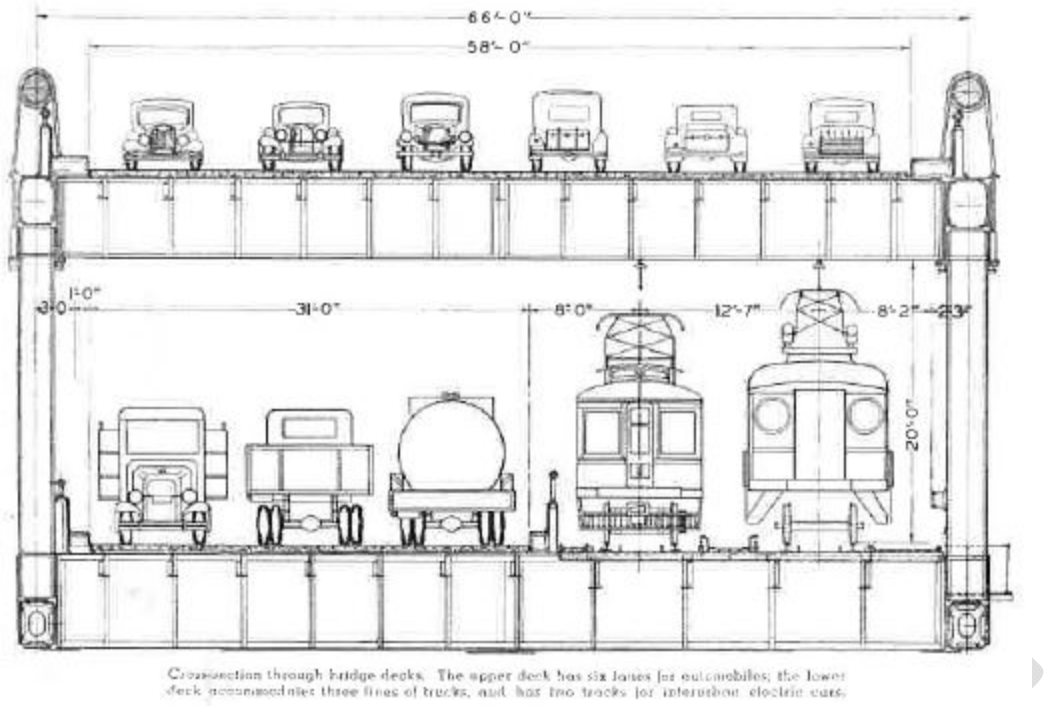



*Source: San Francisco Bureau of Governmental Research, 1927.*

Rail service operated on the lower deck of the Bay Bridge during its first twenty years (see Figure 27). As travel and congestion increased between San Francisco and the East Bay during this time, elected officials, citizens, academics, and professionals developed plans to increase capacity, including new auto bridges and a regional rail system. By the 1950's, though, as rail ridership flagged and auto travel increased, the Key System, a privately-owned transit company based in the East Bay, ceased service on the Bay Bridge. The State of California subsequently removed rail from the lower deck of the Bay Bridge between 1958 and 1963 (itself a massive project, involving the reconstruction of the Yerba Buena Island tunnel and upper-deck strengthening) and converted its surface to eastbound car and truck traffic.

*Figure 27: Diagram showing designated lanes for trains and trucks on the original Bay Bridge, 1936*




Cross-section through bridge decks. The upper deck has six lanes for automobiles; the lower deck accommodates three lines of trucks, and has two tracks for interurban electric cars.

*Source: Courtesy of the American Bridge Company.*

## Plans for a Southern Crossing

Plans for an additional Bay crossing, which became known as the Southern Crossing, began to materialize not long after the completion of the Bay Bridge. In 1949, architect Frank Lloyd Wright drew plans for a striking new bridge called the Butterfly Wing Bridge that included rail and pedestrian amenities (see Figure 28). Wright sought to create "something better suited to the times and their needs, to the superb scenery of the area, something more scientific, simpler, quieter…" This design, created alongside Bay Area architect J.J. Polivka, remains an enduring unbuilt vision for the San Francisco Bay.

*Figure 28: Frank Lloyd Wright and J.J. Polivka's design for the Butterfly Bay Bridge on display at SF Museum of Art, 1953*

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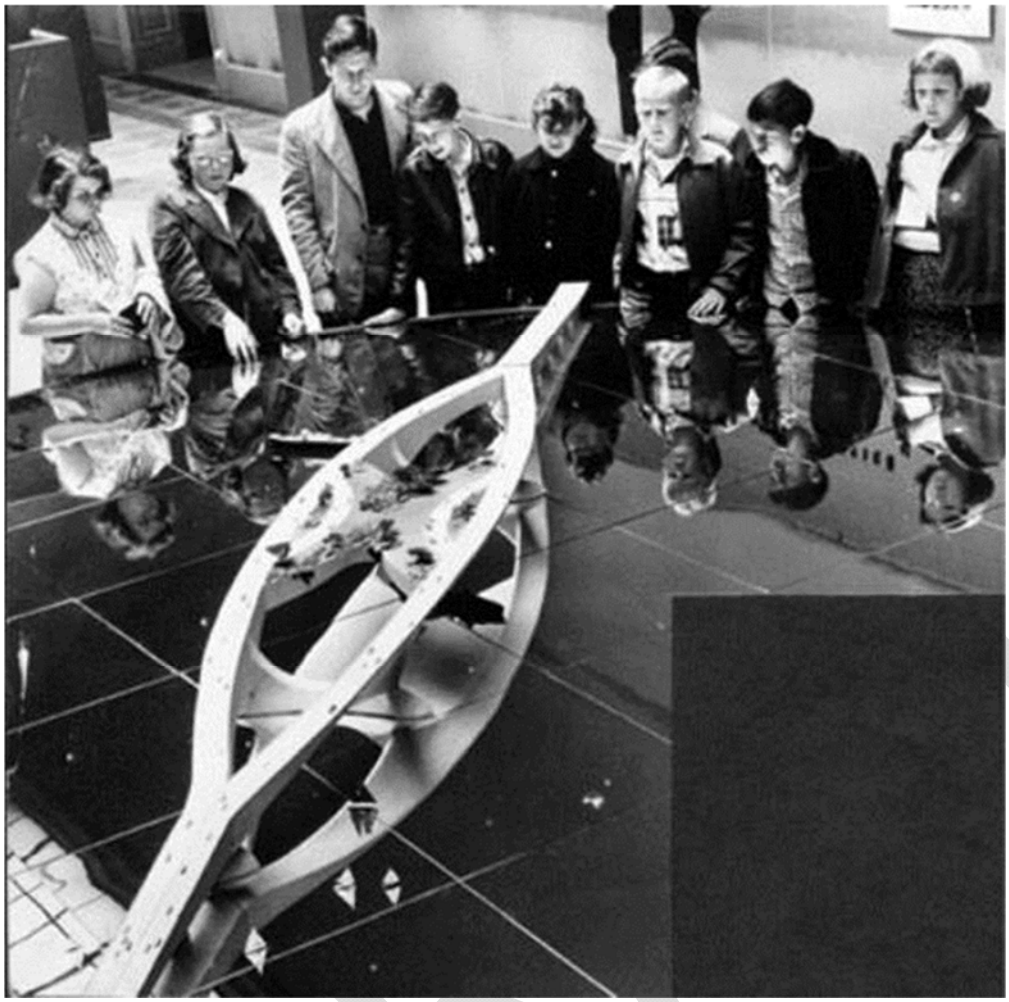

*Source: San Francisco Public Library.*

Advocates for a Southern Crossing lost substantial support when the Key System withdrew, as it appeared that the rail removal would create sufficient capacity for cars without the need for a new bridge, and the idea was defeated at the ballot box in a 1972 referendum.[8] That same year, a different kind of crossing went into service, as a new regional rail system, Bay Area Rapid Transit (BART), began operation.

Discussion of a Southern Crossing was revived in 1999 by United States Senator Dianne Feinstein, who sent a letter to Governor Gray Davis during the planning process for the Bay Bridge eastern span replacement requesting further study of the matter:

> *Both the Silicon Valley Manufacturing Group and the Bay Area Economic Forum have recently released studies citing growing traffic congestion as one of the primary threats to the Bay Area's economic vitality for the 21st century… a regional traffic and transportation study for the Bay Area with respect*

> *to alternative Bay crossings and other options to increase the capacity and mobility for transbay travel between San Francisco, the East Bay and the Peninsula [should] be undertaken promptly.* [92]

Senator Feinstein, an opponent of the 1972 Southern Crossing measure, explained her newfound openness to the idea by arguing that "work patterns have changed. There wasn't a Silicon Valley. There wasn't a biotech industry. There wasn't the volume coming in at the seaport and airport."[93] However, the resulting study concluded that a major new crossing project, whether highway or rail, was not needed at the time and that the lack of political consensus made a project of that magnitude infeasible regardless.[94]

## Transbay Visionaries

The fourth auto bridge to span the Bay was the Richmond-San Rafael Bridge, completed in 1956 (see Figure 29). This northernmost span replaced ferry service between Marin County and Richmond and had been a key element of bridge transportation advocacy and politics for over thirty years prior to completion. One visionary of the era was T.A. Tomasini, a Marin capitalist who designed a series of plans to link Marin, San Francisco, and Alameda Counties with a combined tube-bridge structure.[95] Quoted in the Sausalito News on July 13, 1928, Tomasini spoke confidently of his ambitions:

> *Engineers and eastern financial interests who have carefully studied every phase of the situation are even more enthusiastic over the success of the projects than many here at home. The eyes of the east are upon the bay district and toll bridges have proven to be such meritorious investments that there is no difficulty in getting ample capital with which to conduct development work of this character. If there is no delay in obtaining the franchise from the San Francisco [S]upervisors we can have Marin. Alameda and San Francisco [C]ounties all linked together with bay crossings in three and a half years.*[96]

While Tomasini's specific plans failed to come to fruition, his attention-generating plans helped garner eventual political support for the bridge's completion.

*Figure 29: Richmond-San Rafael Bridge under construction, 1955*

[92] United States Senator Dianne Feinstein. Letter to Governor Gray Davis. November 8, 1999
[93] Nolte, Carl. "Southern Crossing – Boulevard of Broken Dreams." San Francisco Chronicle, January 20, 2000.
[94] MTC's Bay Crossings Study: More Than Just Talk, retrieved at:
http://www.baycrossings.com/Archives/2002/06_July/mtc_bay_brossings_study.htm
[95] Madera Tribune, Number 34, 12 December 1927
[96] Sausalito News, Number 27, 13 July 1928

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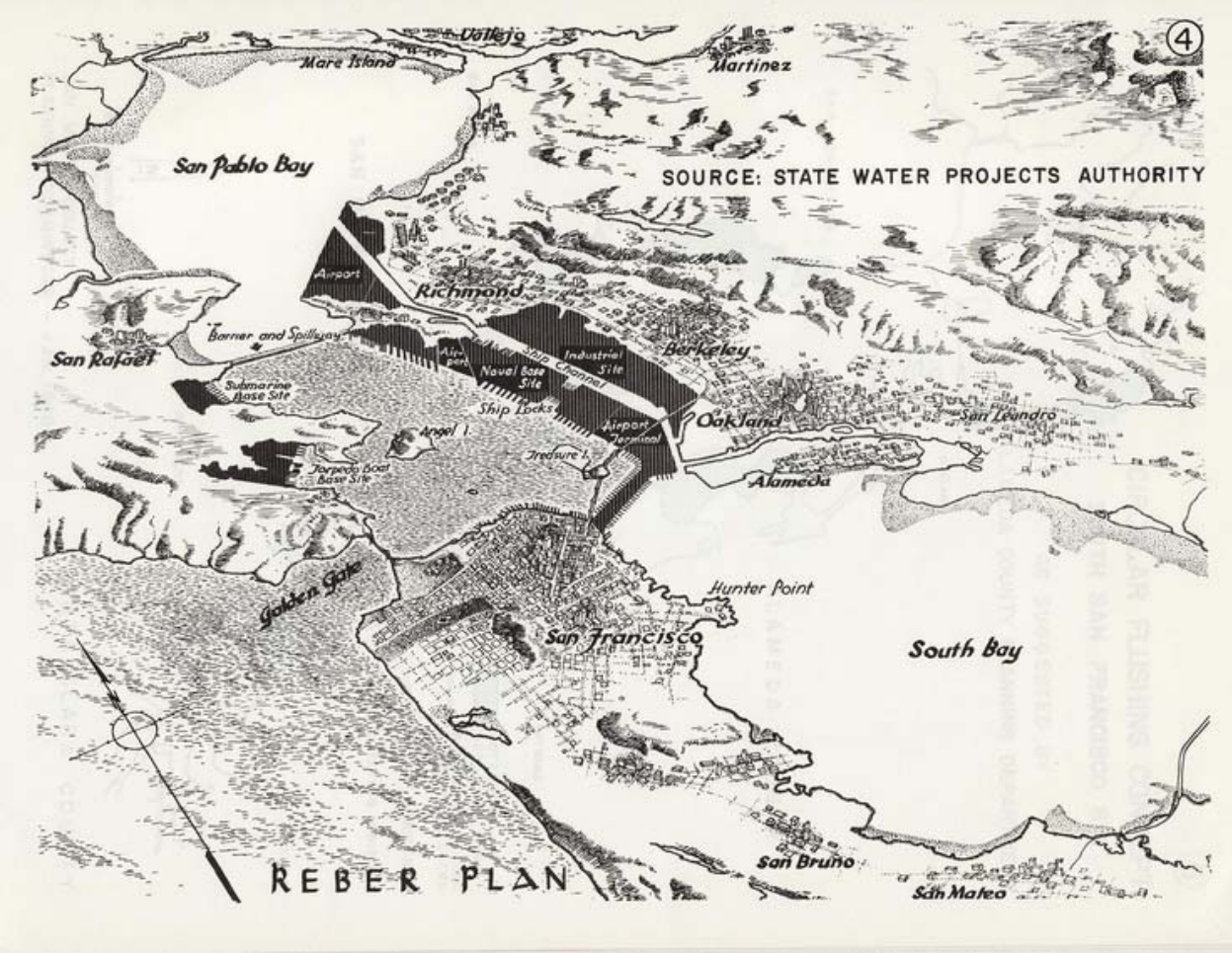
RICHMOND—SAN RAFAEL BRIDGE (4 mi. long) had low trusses in the foreground placed by floating in. Erection is underway in center section, using aluminum falsework trusses. Catilever span nearest the far shore is also underway, using the balanced method of erection.

*Source: The Richmond-San Rafael Bridge: A Photographic Story. James B. Jennings, 1955.*

John Reber was another transbay visionary, calling for the infill of 20,000 acres of the Bay. His plan envisioned creating two new freshwater lakes, with trains and several new roadways over a land bridge

south of the Bay Bridge (see Figure 30).[97] A 1947 Army-Navy study on Southern Crossing alignments included elements of the plan,[98] but the Reber Plan was ultimately discarded for being infeasible due to both the enormity of the project and concerns about its potentially environmentally hazardous impact. Political opposition to this plan spurred the rise of the "Save the Bay" movement to protect the Bay from further infill. It also led to the creation of the California State Legislature's creation of the Bay Conservation and Development Commission in 1965 with the regulatory authority to protect the Bay from environmental harm.[99]

*Figure 30: Diagram of the Reber Plan, 1949*




*Source: Institute for Governmental Studies, UC Berkeley.*

[97] "Bridging the Bay, Bridging the Campus: Salt Water Barriers". University of California, Berkeley.
[98] Adler, Sy. "Infrastructure Politics: The Dynamics of Crossing San Francisco Bay." The Public Historian 10.4. 1988
[99] https://boomcalifornia.com/2015/04/14/the-man-who-helped-save-san-francisco-bay-by-trying-to-destroy-it/

## Modern Day Megaproject: Bay Bridge Eastern Span Replacement

The most recent Bay crossing project was the construction of the new eastern span of the San Francisco-Oakland Bay Bridge. The original eastern span's upper deck collapsed during the 1989 Loma Prieta earthquake, and after making initial repairs, the State of California decided to replace the span rather than undergo seismic retrofitting. Though construction of the new span occurred between 2002 and 2013, the entire process spanned five governors, with all the shifting priorities and state agency turnover that entails.

The new eastern span project produced the widest and longest a self-anchored suspension span in the world, winning awards for both its complex design and engineering.[100] It was also plagued by severe cost overruns, with a final headline cost of $6.5 billion, not including financing costs.[101] The process was highly controversial, with major conflicts over engineering decisions, aesthetics, and a perceived lack of oversight, risk analysis, and independent peer review. The political situation was extremely complex, as engineers, architects, academics, elected officials, local residents, and government agencies at all levels of government sought to contribute substantively to the process.

The public debate focused on the bridge's design and the extent to which the desire for an aesthetically and technologically sublime structure should compete with cost concerns. The potential to include a rail link on the bridge was another point of contention. Though the MTC's design recommendations for the new eastern span included that the bridge be strong enough to carry light rail (modern streetcars), this recommendation was not binding.[102] The mayors of San Francisco, Oakland, Berkeley, and Emeryville advocated for the inclusion of a rail crossing on the bridge, passing advisory ballot measures with overwhelming voter support. These efforts were further supported by Senator Feinstein, who requested that the new eastern span have the structural capacity to include rail in the future.[103]

As with the original Bay Bridge, the Navy objected to the new bridge's alignment north of the existing bridge. This time, though, the concern was economic rather than military. Together with the City of San Francisco, they argued that this alignment would negatively affect property on Yerba Buena Island that that the Navy was transferring to the City, and their resistance on this matter caused a two-year long delay.

The Bay Bridge rebuild is the most recent and vivid example of a transportation megaproject in the Bay Area, and the clashing political priorities, cost concerns, and long timeline provides context for potential issues in the planning and construction of a new crossing. It is essential to learn from and apply this history of visionary innovations, political maneuvering, and shortcomings in design, cost estimating, and project oversight. In doing so, we can build upon the wisdom, energy, visions, and challenges of previous crossings of the San Francisco Bay, and make plans for a more connected, equitable, and just region.

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100 "SAN FRANCISCO-OAKLAND BAY BRIDGE WINS EXCELLENCE IN STRUCTURAL ENGINEERING HONOR". California Department of Transportation Website. Accessible at: http://www.dot.ca.gov/hq/paffairs/news/pressrel/14pr095.htm

101 Potentially twice that, including the cost of financing.

102 Trapenberg Frick, 2016, pp. 93-96

103 United States Senator Dianne Feinstein. Letter to Governor Gray Davis. November 8, 1999

# Social Equity Case Studies of Transportation Megaprojects

Consideration of social equity in transportation megaprojects requires attention to how the planning, building, and operation of new large-scale transportation infrastructure affects low-income and historically disadvantaged communities. This attention is especially important in light of the historical damage done to these communities by megaproject planning and construction. We first consider a case from outside the Bay Area that helps establish a general principle of social equity considerations in transportation planning before discussing two local case studies directly related to a potential third crossing megaproject: the planning and construction of the BART system and Interstate 980.

## Socially Equitable Distribution of Benefits: Milwaukee's "Zoo Interchange"

The "Zoo Interchange" is the state of Wisconsin's busiest section of highway, and the high level of congestion promoted state transportation officials to embark on a project to widen and improve it. However, the $1.7 billion project they settled on contained no public transit improvements. This absence led a coalition of community groups representing black and low-income Milwaukee neighborhoods, led by the Black Health Coalition of Wisconsin and the Milwaukee Inner-city Congregations Allied for Hope, to file suit against the State. These groups argued that the project would exacerbate the city's historical legacy of racial segregation, racial wealth, and employment disparities (see Figure 31 and Figure 32).[104]

*Figure 31: Equity-based transit advocacy in Wisconsin, 2013*


[104] The State of Black America: Locked Out (2016), A National Urban League Publication.

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*Source: American Civil Liberties Union*

*Figure 32: More equity-based transit advocacy in Wisconsin, 2014*


*Source: Environmental Law and Poverty Center*

Their 2013 suit alleged that the State was discriminating against urban racial minorities by allocating transportation resources exclusively to freeway improvements without commensurate funding for transit modes used more heavily by disadvantaged groups.[105] The lawsuit was settled in mediation, and the coalition secured $13.5 million in public transit funding for the City to expand and improve bus service between Milwaukee and suburban communities.[106] This result sets an important precedent concerning the importance of the socially equitable distribution of benefits in transportation megaprojects, as well as the ability for disadvantaged communities to effectively advocate for their interests in infrastructure planning through community organizing and legal action.

## Social Equity in Bay Area Transportation: BART and I-980

BART is one of the key components of the Bay Area regional transportation system. As affluent Bay Area residents moved further out to the periphery, BART expanded to meet them. BART provided an easy way for these residents to be able to live outside of the core while still retaining easy access to jobs and airports.[107] The focus on outward suburban expansion demonstrates the historical development priorities for the region. A focus on suburban communities remains today, though it has been tempered somewhat with an awareness of the vital link BART provides for some disadvantaged communities and municipalities where a high percentage of people rely on public transit to reach jobs and services. Even

[105] "State to spend $13.5 million on transit to settle Zoo Interchange suit". Milwaukee Journal-Sentinel. Accessible at: http://archive.jsonline.com/news/milwaukee/state-to-spend-135-million-on-transit-to-settle-zoo-interchange-suit-b99273749z1-259843881.html

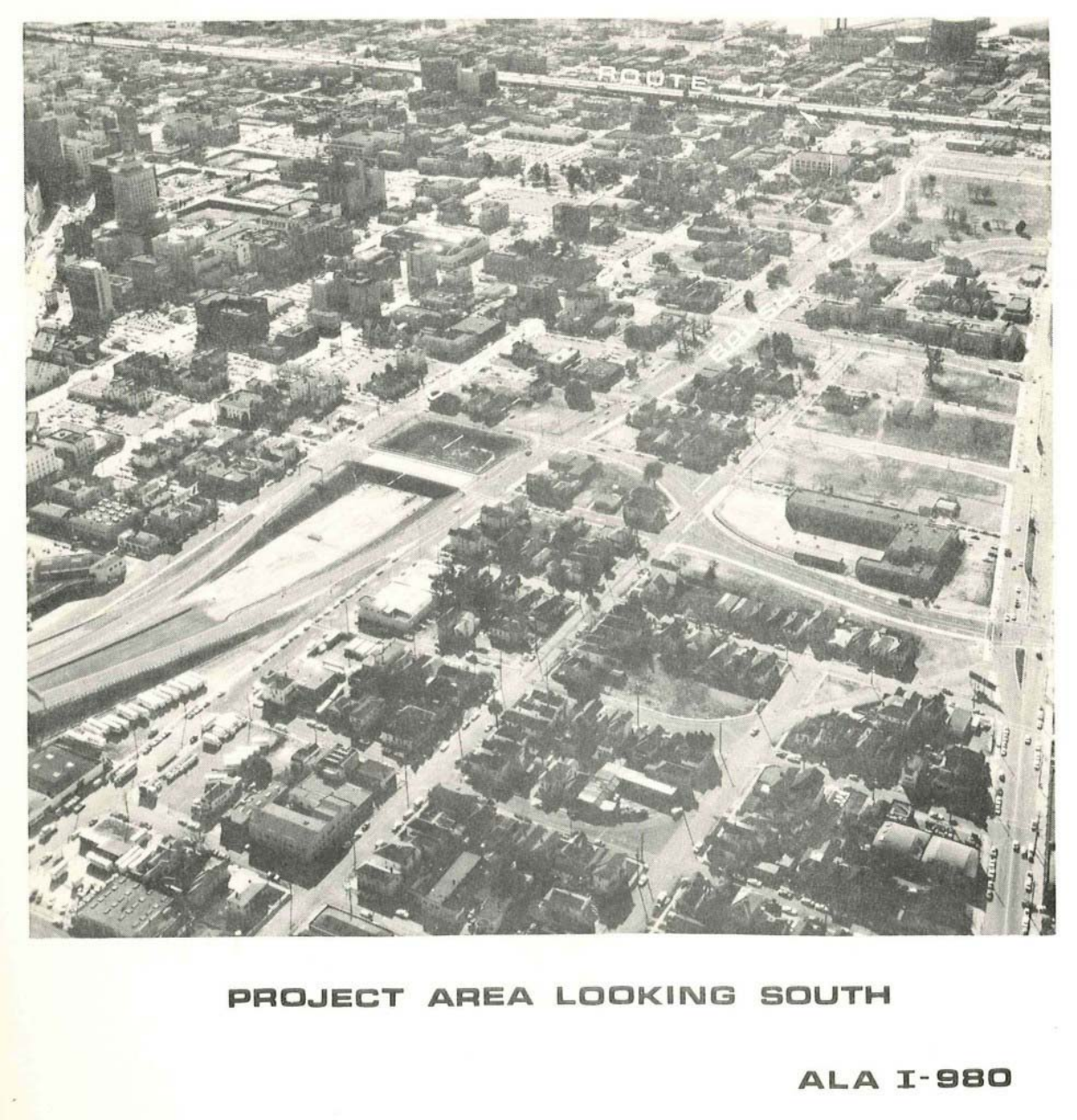
[106] "Milwaukee Transit Advocates Win $13.5 Million Settlement From State DOT", retrieved from http://usa.streetsblog.org/2014/05/22/milwaukee-transit-advocates-win-13-5-million-settlement-against-state-dot/

[107] MTC Resolution 1876 was a funding agreement among BART counties for SFO's extension in tandem with the other extensions, so each major growing area in the BART district had an extension.

with a shift in priorities to the inner core, an improvement in social equity is not assured as those inner areas also see an increase in higher-income residents.

The construction of Interstate 980 is another project with significant social equity implications that was completed in that same era (Figure 33). Construction of the highway tore a path through West Oakland communities, separated it from downtown, and displaced many African-American households.

*Figure 33: Neighborhood in West Oakland, prior to intrusion by the Interstate 980*



*Source: www.connectoakland.org* [108]

In recent years, the City of Oakland and transportation advocacy group ConnectOakland have recommended the removal of I-980. They suggest that this could occur in tandem with the construction of a third crossing, or separately as a stand-alone project. The goal of this project would be to reconnect communities torn apart by previous transportation infrastructure projects. In its 2016 application for Smart City funding from the United States Department of Transportation, the City of Oakland described its goals as such:

> *This is a bold vision to transform a segment of Interstate 980 into an at-grade boulevard to reconnect West Oakland neighborhoods into the fabric of the City. The construction of the freeway resulted in significant dislocation, effectively sealing off and surrounding West Oakland and its primarily African-American residents with freeways.*[109]

Additionally, SPUR asserted in a recent white paper that the third crossing project should build on projects like the I-980 reconstruction.[110] The filling-in of I-980 would be one of the largest social equity-oriented transportation projects in the area to date, and it represents a great opportunity for advocates of social equity in transportation and municipal economic development.

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[108] "Repairing the Gash in the Heart of Oakland", available at: http://sf.streetsblog.org/2015/12/09/repairing-the-gash-in-the-heart-of-oakland/.
[109] Oakland, CA's Smart City Application, retrieved at: https://www.transportation.gov/smartcity/visionstatements/Oakland-CA
[110] Designing the Bay Area's Second Transbay Rail Crossing (2016) SPUR, retrieved at: http://www.spur.org/publications/white-paper/2016-02-10/designing-bay-areas-second-transbay-rail-crossing

# Social Equity Opportunities

The development of transit infrastructure can increase accessibility to critical employment centers and social services for those who cannot afford the costs of car ownership. Despite that, transit infrastructure projects do not inherently improve social equity outcomes, and increased transit accessibility does not necessarily increase the job and educational opportunities available to low-income communities and communities of color. This section describes how social equity is considered in this report and presents the case for why a third crossing is not by itself adequate to effectively promote social equity. A summary of a process for governing bodies to co-produce knowledge with local communities is also included. This process is particularly important to help agencies evaluate and address the concerns of historically disadvantaged communities and develop alternate strategies to promote social equity. This section concludes with suggestions for social equity-oriented projects that could be pursued along with a third crossing.

## Approach

Assessing whether a transportation project is equitable requires grouping individuals by geographic location, socioeconomic status, travel mode, and other characteristics.[111] The question of how to fairly allocate transportation funding frequently concerns geographic equity, which focuses on whether costs and benefits are appropriately distributed between different geographic locations. What defines a "fair" distribution depends on the values of the stakeholders, some possibilities of which are detailed below.

- **Return to Source:** Transportation investment should be geographically distributed in proportion to the amount paid in taxes.
- **Equality of Spending:** Transportation investment should be spread evenly among geographic locations, regardless of the amount paid in taxes.
- **Equality of Results:** Transportation investment should produce equal levels of access and service across geographic locations, regardless of the amount paid in taxes or share of spending.[112]

These three conceptualizations of equity can also be applied to different socioeconomic and demographic groups (Taylor, 2004). For this report, our concept of social equity focuses on ensuring that historically disadvantaged communities benefit from equality in access and service from transportation investments, and not merely equality in spending. These communities have historically had their transportation needs neglected in favor of wealthier communities and at the same time been forced to shoulder a disproportionately high share of the negative impacts from that same infrastructure. It is therefore vital that future projects not only benefit these communities, but also begin to rectify past injustices.

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[111] Transportation Research Board. (2011). *TRB Special Report 303: Equity of Evolving Transportation Finance Mechanisms*. Washington, D.C.: Transportation Research Board. Retrieved from http://www.nap.edu/catalog/13240

[112] Taylor, B. D. (2004). Chapter 1 The Geography of Urban Transportation Finance. *The Geography of Urban Transportation*, 294.

As described in the Key Considerations section, a social equity framework forms the basis for this entire report and at the same time is a specific problem to be address. This dual role is motivated by our understanding that implicit discrimination and inequity pervades all facets of the planning and decision-making process, perhaps especially in the field of transportation planning. Social equity cannot merely be a box to be checked, but rather must be fundamentally incorporated into every step of the process, particularly for a project of the financial and geographic scale of a third crossing.

## History of Equity and Transportation Infrastructure Projects

Low-income communities and communities of color have frequently been harmed by massive transportation infrastructure projects that resulted in displaced households and divided communities. Paradoxically, these transportation projects often actually reduced accessibility to employment, services, and recreational activities for these communities and were detrimental to health outcomes.[113] Much of the transportation infrastructure built in the Bay Area in the 20th century matched this pattern, including the construction of I-980 and BART in West Oakland. However, recent decades have seen somewhat of a shift in regional priorities, as projects like the redevelopment of Cypress Freeway in Oakland[114] and the development of the Fruitvale Transit Village[115] have worked to actively limit negative impacts to historically disadvantaged communities. These two projects involved community groups and advocates in the decision-making from the start and proactively addressed potential social equity issues throughout the entire process of financing, building, and operating the projects. See the Historical Context section for more information on the history of transportation infrastructure and social equity in transportation in the Bay Area and United States.

## Accessibility to Employment Opportunities

Public transit is a vital social service for those who, due to age, income, or disability, either cannot afford or do not have access to a private vehicle (Garrett & Taylor, 1999). Without the mobility that transit provides, these individuals would lack access to employment and social services and experience "social isolation and a lack of social capital."[116] The Alameda County Public Health Department (2013) found that cuts to AC Transit left some bus riders experiencing more frequent stress and anxiety, in part due to the increased likelihood of arriving late to work and facing lost wages.[117] In addition to providing access to existing jobs, transit provision can create new jobs, including construction jobs and

[113] Deyaiyoti Deka. (2004). Social and Environmental Justice Issues in Urban Transportation. In *The Geography of Urban Transportation* (pp. 332–355).
[114] Cypress Freeway Replacement Project. (n.d.). Retrieved November 25, 2016, from http://www.fhwa.dot.gov/environment/environmental_justice/case_studies/case5.cfm
[115] Shibley, R. (2005). Fruitvale Village Oakland, California Case Study. *Rudy Bruner Foundation*, 1–33.
[116] Transportation Research Board. (2011). *TRB Special Report 303: Equity of Evolving Transportation Finance Mechanisms*. Washington, D.C.: Transportation Research Board. Retrieved from http://www.nap.edu/catalog/13240
[117] Alameda County Public Health Department. (2013). *Getting on Board for Health - A Health Impact Assessment of Bus Funding and Access*. Alameda County Public Health Department. Retrieved from http://www.acphd.org/media/308854/transithia.pdf

jobs created as a result of economic development stemming from an expansion or improvement in service.[118]

Research conducted during the Dublin-Pleasanton and Castro Valley BART extensions found that low-income, black, and Latino individuals living in Oakland experienced reduced commuting travel time and cost to access employment centers in suburban, predominantly white areas after the new stations opened.[119] Despite these reductions, the study found that the accessibility impact varied by race. While there was an increase in Latino new-hires within 3 miles of the new BART stations after opening, the likelihood of a black new-hire in the immediate station area was unchanged. The results of this study illustrate that increasing accessibility does not necessarily increase opportunity for all groups. Planning for a third crossing must consider this context and ensure that the project increases accessibility for members of all historically disadvantaged groups. In order to achieve this goal, additional benefits must be included in each of the planning, building, operations and maintenance phases of the project.

It is also essential to provide and protect affordable housing near transit to ensure that low-income workers benefit from increased transit service. A report prepared for the Bay Area Regional Prosperity Plan Housing Working Group found that while San Francisco experienced a large growth in lower-wage jobs between 2008-2010 and 2011, it saw no net increase in affordable rental units during that time.[120] Likely due to this mismatch, San Francisco workers earning less than $1,250 per month experienced the largest increase in commute distance of any wage group. A new low-wage worker in San Francisco had to travel an average of about four times further than a new high-wage worker. Even when there are increases in low-wage jobs in transit-rich places like San Francisco, access to these jobs may not improve if transit is not linked with affordable housing.

## Gentrification and Displacement

Chapple (2009) analyzed gentrification in the Bay Area between 1990 and 2000 and found that convenient access to transit for commuters was one of the most significant factors associated with whether a neighborhood experienced gentrification. Chapple (2009) defines gentrification as the process of a neighborhood experiencing increases in real estate investment, household income, and educational attainment. These increases can be seen as benefits to a neighborhood, but since most of the gains marked by gentrification are not experienced by existing residents of the neighborhood (Chapple, 2009), who experiences these benefits and who does not has social equity implications. Going further, since the most prominent negative impact associated with gentrification is indirect displacement (Zuk et al., 2015), the discussion becomes about who is displaced and who is not. Involuntary displacement disrupts lives as people are forced to move from their homes, but the potential negative impacts include diminished access to critical destinations after being displaced. Zuk et al. (2015) found that the trend of neighborhood change is toward increased economic segregation,

[118] American Public Transportation Association. (2016). Need for Investment. Retrieved December 10, 2016, from http://www.publictransportation.org/benefits/needforinvestment/Pages/default.aspx

[119] Holzer, H. J., Quigley, J. M., & Raphael, S. (2003). Public transit and the spatial distribution of minority employment: Evidence from a natural experiment. *Journal of Policy Analysis and Management*, *22*(3), 415–441. https://doi.org/10.1002/pam.10139

[120] Karner, A., & Benner, C. (2015). *Job Growth, Housing Affordability, and Commuting in the Bay Area*. Bay Area Regional Prosperity Housing Working Group. Retrieved from http://planbayarea.org/pdf/prosperity/research/Jobs-Housing_Report.pdf

which has led to "low-income and families of color [experiencing] limited access to affordable housing, high quality schools, and good-paying jobs." Zuk et al. (2015) also found that while the emphasis of the literature is on the impact on residential property values, available studies have found that rail investments are associated with increases in commercial property values. This indicates that businesses and non-profits are also potentially vulnerable to displacement due to a new transbay crossing project.

The potential for gentrification, and ultimately for displacement, is particularly salient for discussions around an additional transbay crossing as the draft Preferred Scenario for Plan Bay Area 2040 is expected to increase the risk of displacement by 9% (6 Wins for Social Equity Network, 2016).[121]

## Policy Context

Legislation at the federal, regional and agency levels are in place to protect under-represented groups in the transportation field, including low-income, racial and ethnic minorities and disabled individuals. The proposed project alternative will need to satisfy a number of requirements at these various levels in order to receive funding and garner the support of jurisdictions.

At the federal level, the Title VI of the Civil Rights Act of 1964 significantly impacts the development of federally funded transportation infrastructure. Title VI states that "[n]o person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance" (42 U.S.C. §2000d). This act is authorized through the Federal Transit Administration's (FTA) Office of Civil Rights, which has a set of requirements that must be met in order for transportation projects to receive federal funding. These requirements prohibit services from being denied to protected classes, prohibit protected classes to be subject to separate treatment, and prohibit protected classes from being denied an opportunity to participate in a program through the provision of services (Metropolitan Transportation Commission, 2013). The FTA requires that the governing body submit a Title VI Analysis, including:

1) All general requirements set out in most recent Title VI Circular;
2) "A demographic profile of the metropolitan area that includes identification of the locations of minority populations"
3) "A description of the procedures by which the mobility needs of minority populations are identified and considered within the planning process"
4) "Demographic maps that overlay the percent minority and non-minority populations as identified by Census or ACS data … and charts that analyze the impacts of the distribution of State and Federal funds in the aggregate for public transportation purposes"
5) "An analysis of impacts identified in paragraph (4) that identifies any disparate impacts on the basis of race, color, or national origin, and, if so, determines whether there is a substantial legitimate justification for the policy that resulted in the disparate impacts, and if there are alternatives that could be employed that would have a less discriminatory impact" (FTA Circular 4702.1B, 2012, p. VI-1f; Metropolitan Transportation Commission, 2013).

[121] 6 Wins for Social Equity Network. (2016, October 13). Plan Bay Area 2040 Preferred Scenario. Retrieved from http://www.publicadvocates.org/uncategorized/6-wins-comment-letter-on-the-draft-preferred-scenario-for-plan-bay-area-2040/

There are also a number of environmental justice acts that attempt to mitigate projects that disproportionately burden low-income neighborhoods and communities of color. These include Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations, which led to similar actions adopted by the US DOT and Federal Highway Administration (FHWA) (Deka, 2004).[122] In 2011 and 2012, the US DOT and FHWA order has been updated to increase the responsibility of the DOT to determine whether projects have disproportionate impacts on the health and environmental well-being of low-income and minority communities (Metropolitan Transportation Commission, 2013).

Regionally, MTC has adopted principles that align with Title VI and environmental justice requirements set out by federal agencies. MTC is responsible for ensuring that programs, policies and activities they fund comply with federal agency regulations, developing and implementing programs that work to protect the needs of low income individuals and communities of color, and producing regional Title VI compliance reports and environmental justice analyses (Metropolitan Transportation Commission, 2013).

Transit agencies, including BART and Caltrain, must comply with federal and regional policies that protect the health, safety and well-being of low-income riders and riders of color. For instance, BART's Disparate Impact and Disproportionate Burden Policy is used to determine when a major service change or fee change disproportionately impacts a specific group, and outlines how the agency should avoid these impacts (BART, 2013).

Many communities, transportation users and advocacy groups have pushed back against these regulations, arguing that the regulations are not stringent enough to protect the wellbeing of low-income communities and communities of color or that the regulations are not enforced properly (Golub, Marcantonio, & Sanchez, 2013). For instance, in 2005, a group of racial minority bus riders and advocacy organizations filed a federal civil rights lawsuit against MTC: Darensburg et al. v. Metropolitan Transportation Commission. The lawsuit was based on disparities in subsidies per bus rider compared to rail rider (about $3 per trip for bus riders compared to between $6 and $14 per rail riders) and policies that promoted rail expansion over bus service expansion (Golub, Marcantonio, & Sanchez, 2013). This report takes the position that federal, regional and agency requirements must be met, and additional programs and processes should be adopted in order to protect the health and wellbeing of the Bay Area's low-income individuals and people of color.

## Making the Case for Active Equity

In light of these findings, and based off of past transportation infrastructure projects' propensity to disproportionately negatively affect low-income communities of color in the Bay Area, we reject the assumption that a new transbay crossing will inherently benefit the Bay Area's low-income communities and communities of color. Instead, we argue that social equity must be addressed at every stage of the planning, financing, building and operating phases of a third crossing, and the project must include a number of co-benefits that can offset some of the negative impacts the project could have on historically marginalized communities. This approach, which we call the "active-equity" approach, is

[122] Devajyoti Deka. (2004). Social and Environmental Justice Issues in Urban Transportation. In *The Geography of Urban Transportation* (pp. 332–355).

similar to perspectives that local equity organizations in the Bay Area and governmental bodies in other American cities have taken (Seattle Office of Planning & Community Development, 2016).[123]

While not all of the funds that would go to a multi-billion dollar transbay crossing project would be available for transportation projects in the Bay Area without the construction of a new crossing, investing in this megaproject does mean that taxpayer funds that would have gone to projects to improve the regional transportation network in other ways may not materialize. These are opportunity costs could have implications for social equity. See the Funding & Finance section for information and the Co-Benefits section below for possible projects that could be funded even in the absence of a transbay crossing project. Building off the case that a transit project is not necessarily the most effective form of promoting social equity, the next section describes a process for community involvement to utilize community members and their expertise on their neighborhoods to ensure an additional transbay crossing project effectively serves low-income communities and communities of color.

## Community Involvement

Based on academic research findings and best practices used in transportation infrastructure development in the Bay Area, the United States and internationally, the most equitable transportation infrastructure projects comprehensively involve impacted communities over and above what is legally required (Seattle Office of Planning & Community Development, 2016; "Cypress Freeway Replacement Project," n.d.; "Community Advisory Committee," 2016; Moore, Prakash, Garzon, Hernandez, McNeil, 2009; Costa, Palaniappan, & Wong, 2002).[124] Building from the active-equity approach this paper takes, communities impacted by the third crossing should be involved in all aspects of the planning, building, maintenance, and operations phases of the development, from setting project goals and timelines and collecting and analyzing baseline data, to developing ideas for community-relevant opportunity groups to incorporate into the larger project, and to building the infrastructure and being hired to operate transit that will use the infrastructure. We outline below how communities, advocates and governing bodies should be actively involved in the third crossing development to ensure that this project not only mitigates negative impacts on the Bay Area's low-income communities of color, but also strategically works to bring political and economic power to these communities (Gomez, 2015).[125] These avenues include setting up an independent Community Advisory Board, developing and monitoring community metrics, and involving communities in building, operating and maintaining transit and infrastructure.

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[123] Seattle Office of Planning & Community Development. (2016). *Equitable Development Implementation Plan*. Retrieved from http://2035.seattle.gov/wp-content/uploads/2016/05/EDI-Imp-Plan-042916-final.pdf

[124]Seattle Office of Planning & Community Development. (2016). *Equitable Development Implementation Plan*. Retrieved from http://2035.seattle.gov/wp-content/uploads/2016/05/EDI-Imp-Plan-042916-final.pdf; Cypress Freeway Replacement Project. (n.d.). Retrieved November 25, 2016, from http://www.fhwa.dot.gov/environment/environmental_justice/case_studies/case5.cfm; Community Advisory Committee. (2016). [page]. Retrieved November 26, 2016, from http://www.morpc.org/transportation/public-involvement/community-advisory-committee/index; Eli Moore, Swati Prakash, Catalina Garzon, Cristina Hernandez, Leonard McNeil. (2009). *Measuring What Matters*. Pacific Institute.; Costa, S., Palaniappan, M., & Wong, A. (2002). *Neighborhood Knowledge for Change*. Pacific Institute.

[125] Gomez, M. (2015). *Realizing Possibilities of the Connected Economy*. Haas Institute for a Fair and Inclusive Society. Retrieved from http://haasinstitute.berkeley.edu/sites/default/files/leapforward_connectedeconomy_publish_1_0.pdf

## Develop an Independent Community Advisory Board

In recently released reports on the potential new transbay crossing, agencies advocate for the need to develop a robust governance structure to oversee the crossing's development and implementation (SPUR, 2016; Bay Area Council, 2016). Similarly, all community groups, advocacy groups and elected officials representing the needs of low-income communities and communities of color should also be coordinated in order to ensure that impacted communities are involved and their needs are being taken into consideration at every aspect of the project (Caigns, Greig, & Wachs, 2003; TransForm, 2016).

To build on these recommendations, we propose that an independent Community Advisory Board (CAB) be created to represent and advocate for the needs of communities impacted by the project during all phases of the third crossing's development and implementation, including on-going project monitoring and evaluation. We recommend that the CAB be developed to ensure that impacted residents, employers and employees, and commuter groups are included in the project planning, financing, building, operations and maintenance processes. The committee should be primarily made up of individuals and groups who represent demographics that have traditionally been left out of transportation decisions, including individuals who are low-income, racial and ethnic minorities, immigrants or disabled (Simpson, 2009).[126] The CAB should also be comprised of elected officials and advocacy groups that represent the needs of these communities.

We recommend the CAB be involved in the following ("Community Advisory Committee," 2016)[127]:

1) Mediating between community groups
2) Coordinating community involvement in planning, building and operating processes
3) Monitoring the impacts the project has on communities using community metrics (as described below) and performance metrics (see Performance Metrics section)
4) Providing guidance on and reviewing planning, financing and construction proposals for the project
5) Overseeing key project processes, such as cost estimations for project capital, operations and maintenance, and revenue generation
6) Voting on revenue generation, funding decisions CAB members must be compensated for the time they put into being on this board.
7) Allocating community grant funding for project co-benefits (see Funding & Financing section)

Our proposed CAB builds off of the Community Advisory Committee Caltrans formed during the redevelopment of Cypress Freeway, which comprised of an existing Citizens Emergency Relief Team (CERT), West Oakland residents, commuter groups and West Oakland officials ("Cypress Freeway Replacement Project," n.d.).[128] We recommend a CAB be developed as soon as possible, similarly to the Cypress Community Advisory Committee, which was an extension of a group that formed within the first 72 hours of the 1989 earthquake with the goal of representing the needs of the West Oakland

[126] Simpson, J. (2009). *Everyone Belongs: A Toolkit for Applying Intersectionality*. Canadian Research Institute for the Advancement of Women.
[127] Community Advisory Committee. (2016). [page]. Retrieved November 26, 2016, from http://www.morpc.org/transportation/public-involvement/community-advisory-committee/index
[128] Cypress Freeway Replacement Project. (n.d.). Retrieved November 25, 2016, from http://www.fhwa.dot.gov/environment/environmental_justice/case_studies/case5.cfm

community during the redevelopment ("Cypress Freeway Replacement Project," n.d.).[129] For more information on the third crossing CAB, please look to the Project Governance section.

## Community Driven Metrics

As outlined as one of the tasks the CAB should be responsible for, we recommend a set of metrics that measure the impact the proposed project will have on under-represented communities in the Bay Area. We recommend that these metrics be developed and used by impacted communities throughout the multiple phases of the project. This recommendation is developed from the "Co-Production of Knowledge" approach, which integrates public health and city planning work to improve project outcomes, health and community wellbeing. This approach suggests that state and citizens have "different but complementary forms of knowledge" (Watson, 2014). By using approaches in which both of these kinds of knowledge are valued equally and state and citizen groups work to share their knowledge, projects often more effectively provide services to the communities they are located in and often also operate more cost-effectively (Watson, 2014).

### Process for developing community-driven equity metrics

We recommend that impacted communities develop a set of metrics to determine and monitor impacts, assets, liabilities and opportunities the transbay crossing will have on their neighborhoods (Moore, Prakash, Garzon, Hernandez, McNeil, 2009). We recommend that the Community Advisory Board (CAB) be responsible for overseeing the development of these metrics and follow the process outlined below. This process is based off the Pacific Institute's *Measuring What Matters* report and The West Oakland Environmental Indicators Project (examples from these projects are outlined in the textbox below).

**Step 1: Engage Communities**

The CAB should develop a set of criteria to define which communities are impacted during the building and operations phases of the project. Based on these criteria, the CAB should identify community leaders in impacted communities and work with these individuals to reach out to community-based organizations, parent groups, churches, neighborhood councils, elected officials and local businesses within impacted communities.

The CAB should then develop a steering committee of interested organizations that the CAB will work with more closely to develop metrics that address a variety of neighborhood assets, liabilities and opportunities. Examples of community metrics in Richmond and Oakland, CA are discussed below.

**Step 2: Identify Metrics**

The CAB and the metric steering committee should identify current community assets and issues as well as potential opportunities and liabilities that may arise due to the project development. The goal of this step is to develop metrics that meet the following criteria:

- **a)** Metrics that can be tracked over time by community groups
- **b)** Metrics that represent the wellbeing of the community
- **c)** Metrics that can be compared across communities

[129] Cypress Freeway Replacement Project. (n.d.). Retrieved November 25, 2016, from http://www.fhwa.dot.gov/environment/environmental_justice/case_studies/case5.cfm

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**d)** Metrics that can provide quantitative and qualitative data

**Step 3: Capacity Building and Data Collection**

Because the metrics are meant to be developed and monitored by communities, it is critical that the CAB work to build capacity of community groups in data collection and analysis related to the metrics. We recommend that the CAB hold workshops for community members and organizations to learn primary and secondary data collection and analysis. These workshops should include engaging community groups in:

- collecting baseline information for metrics
- identifying secondary information for metrics that already have data available at the neighborhood or census tract level
- collecting primary information for metrics that do not have data available

**Step 4: Incorporate Metric Data into Decision-Making, Planning and Advocacy**

The ways in which the community metric data is incorporated into decision-making processes related to the project should be clearly outlined and publicly available. The data itself should also be available for community groups to use. For instance, the data should be publicly available at the disaggregate and aggregate level on an online platform and as fact sheets in multiple languages.

The CAB should also prepare impacted groups to use this data to advocate for the needs of their communities. The CAB should hold workshops for community members and leaders to develop ways in which to present metric data at community meetings and to governmental departments. These workshops should also prepare community organizations to integrate community-generated research into current and future organization, advocacy and planning work.'

*Examples of Community Metrics used in Richmond and Oakland, CA*

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### *Community-Driven Metrics from West Oakland and Richmond*

***Freight Transport and Community Health***

The Richmond community identified diesel exhaust as a significant risk community members' health because of increased risk of cancer, asthma, heart disease, premature birth, and other health problems in individuals exposed to high levels of diesel exhaust. This metric measures the number and proportion of residents living within 1,000 feet of freight transport areas, examining these proportions by income and race (Moore, Prakash, Garzon, Hernandez, McNeil, 2009).[130]

***Employment of Formerly Incarcerated Residents***

The Richmond community also identified the lack of services and resources for formerly incarcerated members of the community as a significant issue the community currently faces. This metric measures the number of employers in the community that ask applicants whether they have been incarcerated and tracks this over time (Moore, Prakash, Garzon, Hernandez, McNeil, 2009).[131]

***Transit Mobility***

The West Oakland community identified transit accessibility from their neighborhood to employment, schools and services as a key issue, and chose to involve community members in tracking changes in the frequency and range of transit service available in the community. The metric measures AC Transit bus service by miles for routes that travel through West Oakland by weekday and month over a given time period. The community found that service frequency and range fell by 15% within a four year time period (Costa, Palaniappan, & Wong, 2002, p. 61).[132]

***Gentrification and Displacement: Community Stability & Market Trends***

The West Oakland community also identified gentrification and displacement as key issues their community is currently and will be facing in the near future. They measured community stability and market trends by monitoring "the percentage of parcels that are bought and sold over a 30-month period," analyzing the types of land uses of the parcels and turnover rates in West Oakland (Costa, Palaniappan, & Wong, 2002, p. 31). They then compared neighborhood-level data to citywide data.

## Co-Benefits

As discussed above, a project that involves expanding transit does not necessarily promote social equity. This section includes projects, called equity opportunity projects, that could be paired with the construction of a new transbay crossing to help ensure that (1) the potential improved access this project could provide to low-income communities and communities of color materializes, (2) potential harms are actively avoided, and (3) past impacts inflicted on these communities by similar transportation projects are acknowledged and addressed. In order for an opportunity project to be relevant for a particular community or geography, members of that community need to be a part of the selection of that project. This aligns with the objectives of Community-Based Participatory Research

[130] Eli Moore, Swati Prakash, Catalina Garzon, Cristina Hernandez, Leonard McNeil, Carla. (2009). *Measuring What Matters*. Pacific Institute.
[131] Eli Moore, Swati Prakash, Catalina Garzon, Cristina Hernandez, Leonard McNeil, Carla. (2009). *Measuring What Matters*. Pacific Institute.
[132] Costa, S., Palaniappan, M., & Wong, A. (2002). *Neighborhood Knowledge for Change*. Pacific Institute.

(CBPR), which aims to involve community members in all aspects of project planning, management, monitoring and output as a way of developing projects that fit with social contexts (Leung et al., 2003). MTC's Community-Based Transportation Plans, for which 30 low-income communities identified desired projects (Metropolitan Transportation Commission, n.d.),[133] provide a precedent for this type of community-developed projects in the region. Above recommendations are provided for a process that could help yield community-relevant opportunity projects. The opportunity projects that are described here are examples of what could potentially be considered appropriate, depending on the context.

As a multi-billion infrastructure project, constructing a new transbay crossing would present opportunities to receive additional funding for smaller, complementary projects that would maximize the benefits of the larger project for the region. For recommendations on how to acquire funding for these complementary opportunity projects, see the section on Funding & Financing.

## Improve Regional Accessibility

Constructing a new transbay crossing would add a major regional link to the Bay Area's transportation network. The following list includes example projects that could be paired with a new crossing to potentially increase the opportunities for low-income communities and communities of color to be more effectively served by the regional network.

- **Provide frequent bus service to rail from low-income communities during peak and off-peak hours** to increase access to the region's existing and new rail network
    - A recent project was programmed by MTC's Lifeline Transportation Program to preserve the existing frequency of seven County Connection bus lines that link residents in communities of concern in Contra Costa County to jobs, services, retail, schools, health care, and BART stations (Metropolitan Transportation Commission, 2016)[134]. In addition to preserving existing service, opportunity projects could include increasing service to the existing and new regional rail network for communities of concern. To adequately serve service sector employees, increases in bus service to rail would need to include increased service during the late night and early morning hours.
- **Guarantee that the new crossing will provide overnight transbay rail service**
- **Initiate regional transit fare structure** to simplify connections between modes, particularly for customers not using credit cards
    - (See Funding & Financing section for more information)
- **Provide discounts on regional fare structure** and create mechanisms for using a Medicare of Medicaid card as a fare loading card in order to reduce administrative barriers for eligible riders to use the discount.

[133] Metropolitan Transportation Commission. (n.d.). Community-Based Transportation Plans | Plans + Projects | Our Work. Retrieved December 4, 2016, from http://mtc.ca.gov/our-work/plans-projects/other-plans/community-based-transportation-plans

[134] Metropolitan Transportation Commission. (2016, September 26). MTC's Lifeline Transportation Cycle 4 Program of Projects for FY 2014 through FY 2016. Retrieved from http://mtc.ca.gov/sites/default/files/A-47_RES-4179_Lifeline_FY14_thru_FY16.pdf

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- (See Funding & Financing section for more information)

- **Provide discounted bridge tolls for low-income motorists** on all bridges across the Bay
    - Blumenberg & Pierce (2014)[135] found that low-income individuals were more likely to find employment when they had consistent access to an automobile than when they only had transit access, even in dense metropolitan areas. Therefore, providing discounted bridge tolls to low-income motorists could serve as an effective complement to increase employment access with this large transit investment.

## Housing, Gentrification and Indirect Residential Displacement

In light of SB 375's call to Metropolitan Planning Organizations to link transportation and land use in regional planning, an additional transbay crossing could reasonably be paired with a large investment in land development. This investment could go towards affordable housing, including protections to keep families in their existing homes and increases in the region's housing supply.

- **Provide incentives for cities with existing and new rail transit stations to adopt rent stabilization and just cause eviction ordinances.**
    - Rent stabilization, or rent control, ordinances protect tenants from excessive increases in rent (Zuk & Chapple, 2015).[136] As of 2015, only seven cities in the Bay Area had rent control ordinances, with only three of those cities, Berkeley, East Palo Alto, and San Francisco, having ordinances that are considered strict (Crispell, 2016).[137]
    - Just cause eviction ordinances limit the reasons for which tenants can be evicted (Zuk & Chapple, 2015).
- **Provide incentives to cities with existing and new rail transit stations to adopt policies that expedite the review process for housing development projections that include affordable housing.**
    - Reid et al. (2016)[138] argue that California could address the affordable housing supply shortage in jurisdictions that have not successfully zoned or planned for increases in affordable housing by adopting policies similar to The Massachusetts Comprehensive Permit Act. The laws included in this Massachusetts Act enable "qualified" developers to have an expedited review process for projects that include affordable housing units (Reid et al., 2016). Promoting these policies at the local level could present opportunities to increase the supply of affordable housing near existing and new rail

[135] Blumenberg, E., & Pierce, G. (2014). A Driving Factor in Mobility? Transportation's Role in Connecting Subsidized Housing and Employment Outcomes in the Moving to Opportunity (MTO) Program. *Journal of the American Planning Association*, *80*(1), 52–66. https://doi.org/10.1080/01944363.2014.935267
[136] Zuk, M., & Chapple, K. (2015). Urban Displacement Project. Retrieved December 10, 2016, from http://www.urbandisplacement.org
[137] Crispell, M. (2016, February). Rent Control Policy Brief. Urban Displacement Project. Retrieved from http://www.urbandisplacement.org/sites/default/files/images/urbandisplacementproject_rentcontrolbrief_feb2016_revised.pdf
[138] Reid, C. K., Galante, C., & Weinstein-Carnes, A. (2016). *Borrowing Innovation, Achieving Affordability: What We Can Learn From Massachusetts Chapter 40B* (Policy Paper No. 1). Berkeley, CA: Terner Center for Housing Innovation. Retrieved from http://ternercenter.berkeley.edu/california-40b

stations in the Bay Area.

- **New public lands may be targeted for development as a result of an additional transbay crossing project. Establish a percentage of newly available land to be included in a community land trust.**
    - Community land trusts are non-profit organizations that work to provide affordable housing in perpetuity (Zuk & Chapple, 2015).
- **Provide incentives to cities with existing and new rail transit stations to adopt policies that support the development of Accessory Dwelling Units (ADUs).**
    - ADUs are dwelling units that are on single-family properties that are independent of the primary dwelling unit (Sage Computing, Inc., 2008)[139]. They provide an inexpensive way for jurisdictions to increase their housing supply (Sage Computing, Inc., 2008).

## Social Services

Access to social services to those who are transit dependent could be increased by providing community-relevant services near new and existing rail transit stations. The Unity Council's community involvement led to the Fruitvale Village at the Fruitvale BART station including community-relevant education, health, and social services including a Head Start program, a high school, and a children's health clinic (The Unity Council, n.d.).[140] Community-relevant services at existing and new rail stations could include:

- **Child Respiratory Health Care Program**
- **Childcare services**
- **Ride-to-Health-Care-Provider Programs**

## Employment Opportunities

In addition to providing access to existing and new jobs through the expansion of the regional transportation network, a new transbay crossing project could also be paired with policies and projects that are specifically aimed at protecting or generating job opportunities for low-income communities, communities of color, and/or nonprofits and small businesses that serve these communities.

- **Hire locally and from Disadvantaged Business Enterprise (DBE) Contractors for construction jobs** on an additional transbay crossing project**.**
- **Expand the new BART and Santa Clara Valley Transportation Authority (VTA) programs that offer training for skilled and technical positions to other transit agencies in the region.**
    - BART and VTA received grants from the Federal Transit Administration's Innovative

[139] Sage Computing, Inc. (2008). *Accessory Dwelling Units: Case Study*. U.S. Department of Housing and Urban Development Office of Policy Development and Research.
[140] The Unity Council. (n.d.). Fruitvale Village – The Unity Council. Retrieved December 11, 2016, from https://unitycouncil.org/property/fruitvale-village/

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Public Transportation Workforce Development Program to provide training for jobs within their agencies (Federal Transit Administration, 2015).[141]

- BART's program is called The Transit Career Ladders Training Program and is a partnership with community colleges and Regional Workforce Investment Boards (Bay Area Rapid Transit, 2016).[142] It aims to promote careers as an electrician in the transportation sector in low-income communities and among people of color, veterans, and women (Bay Area Rapid Transit, 2016).
- VTA's program is called Discover Opportunities - In Transit! (DO-IT!) and is offered to students in their late teens and early 20s with a focus on recruiting people of color, women, people with disabilities, and low-income and other underserved individuals (Childress, 2015).[143]

- **Establish "ban the box"/fair chance hiring policies for construction and permanent jobs created by an additional transbay crossing project.**
  - In its Economic Prosperity Strategy to improve economic opportunities for low- and moderate-wage workers in the Bay Area, SPUR et al. (2014) recommends eliminating the check box on job applications where prospective employees are asked if they have been arrested or convicted of or pled guilty to a crime. SPUR et al. (2014) argues that the use of this box can "turn even a minor offense into lifelong exclusion from many types of employment."[144]
- **Establish affordable workspace on potentially newly available land due to a new transbay crossing project for work centers and industry guilds for low- and moderate-wage private sector jobs.**
  - SPUR et al. (2014) argues that work centers and industry guilds should be supported because employees that are organized are better equipped to work with employers to establish minimum wages and job standards.
- **Establish affordable workspace on potentially newly available land due to a new transbay crossing project for non-profits and small businesses** to help prevent displacement of community-run and community-serving organizations and businesses.

[141] Federal Transit Administration. (2015, October 26). Innovative Public Transportation Workforce Development Program (Ladders of Opportunity Initiative) Project Selections [Text]. Retrieved December 11, 2016, from https://www.transit.dot.gov/funding/grants/innovative-public-transportation-workforce-development-program-ladders-opportunity

[142] Bay Area Rapid Transit. (2016, April 8). Transit career program. Retrieved December 11, 2016, from https://www.bart.gov/news/articles/2016/news20160408-0

[143] Childress, B. (2015, September 25). VTA Receives Federal Grant to Develop Opportunities In Transit – DO IT! Retrieved December 11, 2016, from http://www.vta.org/News-and-Media/Connect-with-VTA/VTA-Receives-Federal-Grant-to-Develop-Opportunities-In-Transit-DO-IT#.WEzGcb7UUgs

[144] SPUR, Center for Continuing Study of the California Economy, San Mateo County Union Community Alliance, & Working Partnerships USA. (2014). *Economic Prosperity Strategy: Improving economic opportunity for the Bay Area's low- and moderate-wage workers*. The Bay Area Regional Prosperity Plan Steering Committee. Retrieved from http://www.spur.org/publications/spur-report/2014-10-01/economic-prosperity-strategy

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# Project Governance

The question of governance—organizational structures, agency relationships and responsibilities, and external coordination with the public—is of particular importance to any large-scale infrastructure undertaking. Regarding a third crossing, assembling the diverse set of local, regional, state, and private actors necessary to conceptualize, design, finance, construct, operate, and maintain such a critical piece of infrastructure is the first step on a decades-long journey towards implementation. Beyond these duties, a project sponsor also must be responsible for land development around station areas, regional transit planning, fare setting, parking provision and pricing, and negotiating contracts with technology providers and labor unions, coordination with connecting transit services and potentially collaboration with private freight rail.

Additionally, governance must endure shifting political realities, public support, and economic conditions, as well as rise to meet any technical challenges prevalent in large projects. Currently, no agency in the Bay Area and larger megaregion possesses enough dedicated staff to both continue existing operations and manage a new megaproject, and thus a logical championing agency does not yet exist. The Bay Area holds no shortage of transportation operators and stakeholders, and any choice of governance structure will by default benefit or disadvantage some of these groups. A governing board will need to develop its own guiding principles in alignment with the key consideration discussed earlier, to aid in decision-making; additionally, a specific community advisory board structure to complement a traditional project board is detailed below in Equity and Governance.

The approach to governance in project management literature considered here is developed by Aloha et. al, wherein the concept of governance is inherent to a project[1]. Because projects can be immense, and exist only at a particular place in a particular time, each requires its own unique set of procedures and relationships to succeed, and thus, a standard recipe for governance cannot be drawn from a set of common principles. Regarding megaprojects, the project itself in a sense becomes a stakeholder and influences decision-making processes[2]; for example, Bay Area residents need only to recall the long process to replace the San Francisco-Oakland Bay Bridge (SFOBB), where the bridge took on a life of its own, representing more than a piece of infrastructure, but a statement about the Bay Area[3].

Understanding projects in this way limits the transferability of concepts and approaches from one to another and can potentially reduce repeated mistakes in estimation that often plague megaprojects[4]— cost, schedule, ridership, and others—by avoiding the duplication of potentially flawed examples. Internal project governance requires that any exercises in governance take any policy or strategy transfer from previous projects, identify strengths and weaknesses, eventually base a new approach upon the specific context of its place and time.

An extensive literature review from project management, corporate governance, megaproject, risk management, and infrastructure planning discourses, paired with semi-structured stakeholder interviews as well as other stakeholder discussions served as the basis for identifying and analyzing alternative forms of governance structures. Translating these findings into the environment of the Bay Area revealed strengths and weaknesses of each approach; keeping in mind the inherent risks of megaprojects, we present the most appropriate structures for the third crossing; these balance drawbacks with significant potential benefits. As mentioned, this project necessitates a long planning

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horizon and a solution able to retain a sense of continuity in the face of changing circumstances. Further, external independent project oversight and peer review as well as a comprehensive risk management program should be integrated fully into a project's governance structure from the onset of project planning and development (see Risk Management and Independent Project Oversight section).

## Consideration of Project Circumstances

For the purposes of governance, only a distinction between the transportation mode of the third crossing is necessary to develop different governance alternatives. A governance structure will need to be in place long before any specific decisions regarding alignment and station placement are made. Thus remaining agnostic regarding route alignment, four operational circumstances consistent with alternatives pursued in further detail in other sections of the report are considered:

1) BART operation only
2) Standard rail operation only
3) BART and standard rail two-tunnel operation
4) Performance Pricing (no third crossing)

The fourth operational circumstance considers that, in lieu of the infrastructure undertaking, a suite of policies and programs designed to benefit the Bay Area are implemented. This is discussed in further detail in the alternatives section of the report.

A constrained and ideal scenario have been considered regarding project governance (similar to the analysis in the Funding & Finance section). The constrained scenario takes into account the economic, political, and public realities of the Bay Area, particularly regarding large-scale infrastructure projects. The ideal scenario seeks to leverage the maximum potential benefits that could be brought about by a third crossing and incorporates ideas that may be more politically challenging to implement. For each operational circumstance listed above, recommendations are made for governance structure under a constrained and ideal scenario.

## Governance Structure Alternatives

To account for unique factors stemming from geographies, political climates, and the nature of megaprojects, multiple different strategies for project delivery exist. This section details those most relevant to the third crossing, with each alternative illuminated by case studies listed in Table 2 below.

*Table 2: Alternative governance structures and case studies*

| Structure | Case | Ideal/Constrained? |
|---|---|---|
| Private Involvement | Texas Central Railway | C |
| Management by an Existing Agency | Gateway Tunnel Project (New York/ New Jersey) | C |
| Joint Powers Authority | Los Angeles-San Diego-San Luis Obispo (LASSON) Rail Corridor | N.A. |

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## Private Involvement: From Public-Private Partnerships to Private Provision

To leverage the expertise of the private industry, many public entities have begun entering into public-private partnerships (P3s) for the execution of projects ranging in size from a few million to a few billion dollars. P3s range in scope and complexity, the simplest being a contract to one entity for both the design and construction of a particular project; this is known as a design-build contract or agreement[5]. A design-build contract differs from a traditional design-bid-build contracting structure, wherein an owner lets one contract for design, and a subsequent contract for construction; design-build can capitalize on the value of shared knowledge between individuals familiar with the design and construction processes. Design-build approaches hold the potential to deliver projects more quickly, both due to fewer bid processes and the overlapping of design and construction activities possible when one entity is responsible for both, and can also cut down on cost escalations during construction that can arise from change orders and schedule delays[6]. These savings have been examined projects with costs below $100 million, but for megaprojects these cost and schedule savings may be outweighed by the inaccuracies prevalent in projections during planning processes. The stakes increase non-linearly as project cost does, so any benefits or drawbacks of pursuing a P3 structure are potentially magnified. Further, consolidating tasks also includes putting more risk into the hands of a single entity, and can limit the ability for a project owner to replace an underperforming design-builder. Design-build also necessitates a project owner or sponsor that is knowledgeable of the specific tasks related to the project, as only one round of bidding exists and bidders can disguise costs in different ways than in design-bid-build contracts. While design-build agreements have drawbacks, they may be worth considering for certain elements of a third crossing, such as smaller construction packages.

More complex types of P3s exist, and can include additional provisions for operation of a facility or transit network, maintenance, and project financing and ownership; some agreements stipulate a transfer of ownership back to the public sector after an agreed upon amount of time. These agreements can be used to transfer ownership of large pieces of infrastructure in need of repair or replacement beyond the financial and/or technical capability of a public entity to a private one able to perform the work. The private concessionaire most commonly seeks revenue in the form of user fees for facilities over the duration of the agreement. A significant transfer of risk occurs when the majority of rights over large facilities are ceded, with the private entity taking on almost all of the future uncertainty of operations and maintenance in addition to traditional construction risk; the public entity in turn loses the ability to incorporate ceded facilities into long-term planning efforts. Many P3s include non-compete clauses regarding operation, and can lead to disputes in the future. Additionally, P3s can suffer from limited public engagement and outreach, which is of key importance to the success of the third crossing[7].

### Private Provision

While more complex P3s may not be appropriate for the third crossing due to the existence of operating agencies across the Bay already with nearly the capability to execute a large project, the example of fully private provision of high speed rail in Texas provides some insight of use to the third crossing. The Texas Central High-Speed Railway (TCR), begun in 2012, is a venture led by TCR, and an independent

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developer, Texas Central Partners, with the goal of providing high-speed rail service between Dallas/Fort Worth and Houston by 2022, using only private funding sources[8]. Although smaller in scale—at roughly 250 miles in length with yet to be disclosed costs on the order of $10 - $20 billion—than the California High-Speed Rail (CAHSR) project at about 800 miles in length at a cost of roughly $70 billion, TCR is following a more aggressive timeline even than the initial CAHSR phases, intending to construct the project in roughly five years[8]. By avoiding internal bureaucratic and political processes that can delay project implementation, TCR argues it will meet this schedule, and hopes to become the first high-speed rail operator in the United States. TCR raised $75 million dollars last year in its first round of fundraising, and is currently using these funds to move through the federal environmental review process, with the Federal Rail Administration leading the preparation of a draft Environmental Impact Statement (EIS)[9],[10]. TCR is seeking legal status under Texas Statutes to be considered a private entity capable of exercising eminent domain rights over private property, although the only ruling thus far regarding this issue went in the favor of landowners[11]. However, a piece of the Texas Transportation Code regarding the legal definition of a railroad as an entity incorporated before 2007, or any other legal entity *operating* a railroad[12],[13] is delaying TCR. Due to the language's vague nature, it remains unclear as to what constitutes the operation of a railroad, and thus TCR remains in limbo regarding its legal status. Regardless, project sponsors are continuing with the environmental process, with the goal of beginning construction in 2017.

Considering other aspects of project governance, the project appears to be suffering from a lack of public communication and coordination: the project website hosts minimal information regarding public outreach processes and includes many sections intended to defend the project against perceived myths regarding project costs, timelines, funding, technology, and others, present in media coverage and speculation about the project. A dissenting organization, Texans Against High-Speed Rail has formed to represent landowners and legally combat the project, representing any landowners wishing to take legal action against TCR, including the property owner in the court case earlier this year. Furthermore, while TCR claims that no public dollars will be used for the project, two types of federal loans are specified as possible avenues for funding: Railroad Rehabilitation and Improvement Financing (RRIF)[14] and funds through the Transportation Infrastructure Finance and Innovation Act (TIFIA)[15]. These are both federal programs that TCR claims are structured similarly to private loans, with full repayment, and thus do not represent public capital risk[16]. Although the term structures do require full repayment of principal and interest, the federal government, if it issued these loans, would become an investor in the project, and could stand to lose money if the project were unsuccessful. While this has not yet become an issue because no grant proposals have been submitted, requests for federal funding support could add to the opposition against the project.

In addition, the issue of foreign influence in megaprojects is highlighted by the TCR case, with opponents questioning the involvement of Central Japan Railway as technical advisor and train supplier. Strong objections have been made about decisions to opt out of Buy America programs, for example in the use of Chinese pre-fabricated bridge decks on the recently completed SFOBB[17], and although the conversation to date does not focus on construction materials, changing political tides at the federal level could result in more scrutiny of foreign involvement in major infrastructure projects in the future.

Thus, the example of TCR demonstrates the need for clear channels of communication between project sponsors and outside stakeholders, even prior to conceptualization. The private governing structure

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may have curtailed some of the more time-consuming public processes required to scope and plan a megaproject, but TCR's unclear legal status poses hurdles that can erase any time savings, especially with large amounts of right-of-way acquisition necessary as the project moves forward. While TCR is an entirely new system, and the third crossing would be an extension of an existing network, the lessons learned as TCR continues could be of particular interest to third crossing stakeholders, especially if there is any private involvement in the financing, construction, or management.

## Management by an Existing Agency

The Bay Area is host to no shortage of transportation agencies, as discussed in the Current Conditions section of the report. While none of these agencies currently has the staff capacity to both carry out its current operations and oversee the construction of a third crossing, the example of the Gateway Tunnel Project between New York and New Jersey provides lessons for an existing agency attempting to manage a megaproject. Further, the Gateway Tunnel Project provides an alternative view of a publicly managed project at a similar stage in the process as TCR.

The Gateway Tunnel Project, or Hudson Tunnel Project, is a planned additional tunnel underneath the Hudson River for use by Amtrak's Northeast Corridor and New Jersey Transit. The 2-mile tunnel will provide much needed system redundancy, double capacity, and allow for extensive repairs to be made on the existing tunnel, which is over 100 years old and was damaged during Hurricane Sandy[18]. This project, with projected costs on the order of $10 to 20 billion, is in turn part of the larger Gateway Program, which is a bundle of strategic rail infrastructure improvements along the New York-New Jersey corridor, including significant expansions at New York Pennsylvania Station[19]. To deliver the Gateway Tunnel Project, the Port Authority of New York and New Jersey (PANYNJ) created a special purpose entity, the Gateway Development Corporation, which will oversee the construction and assume ownership of all new infrastructure, granting use rights to Amtrak and New Jersey Transit in the future[20]. The four-person board of the Gateway Development Corporation consists members from PANYNJ representing each state, as well as one member each from Amtrak and the US Department of Transportation. Unanimous approval is required for any project decisions, meaning consensus must be reached among the major stakeholders for the project to move forward[20]. Interestingly, New Jersey Transit is not represented on the project board, but is still heavily involved in the preliminary engineering work[21]. Final project cost estimates will be released with the draft EIS in the summer of 2017, with the federal government having committed to providing half of the funding and the two states the other half[20].

While matters appear to be proceeding smoothly on the Gateway Tunnel Project, this entire undertaking is actually a revitalization of the shelved Access to the Region's Core (ARC) project. New Jersey Governor Chris Christie cancelled ARC in October of 2010, around four years after its initial conception because of cited cost projection increases and a weak fiscal climate in New Jersey. This cancellation came after New Jersey Transit, the project sponsor, had already received $601 million from the Federal Transit Administration's (FTA) New Starts Program and was finishing final design[22]; New Jersey Transit then had to forfeit the funds. A report by the Government Accountability Office found that some of the 2008 FTA cost estimates stated a range of $8.4 - $12 billion and remained consistent throughout, signaling that escalations may have been expected. New Jersey Transit's initial estimate in the 2006 draft EIS was $7.4 billion, which then increased to $7.6 billion in the final EIS in 2008, and to $8.7 billion in the grant request to FTA. Outside sources indicated that the governor's intention in

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cancelling the project was to free up its earmarked funds for injection into the diminishing state transportation trust fund; Christie may also have used the cancellation to add to his image of fiscal hawk[23]. Regardless of intentions regarding the cancellation, roughly $300 million was sunk into on engineering, design, insurance, and environmental review work, and the results of the environmental process were unusable for the purposes of the Gateway Tunnel Project due to data expiration three years after the completion of an EIS[24]. Additionally, regarding inter-agency cooperation, the MTA originally viewed the ARC project as potential competition for available funding, and subsequently did not want to be involved[25]. Because the MTA had their own standard rail projects in the pipeline, leading to tensions between Long Island Railroad and Metro North—both agencies under the MTA—backing a project meant without direct benefit to the authority stretched available staff too thinly and shrunken the pot of matching funds. Understanding the lack of cross-Hudson buy-in lends a bit of credibility to Christie's claims that the project was more than just New Jersey could afford. In light of the failed ARC, the Gateway Tunnel Project carries a higher price tag and longer timeline and many New Jersey residents may still remain skeptical as the project moves forward, which could hurt public buy-in.

With a second chance at the tunnel project, the knowledge gained from the previous experience can hopefully benefit the overall effort. Moving control into the hands of a development corporation as part of PANYNJ, the largest entity involved, and one that comprises members from both states, opens up more institutional knowledge to leverage moving forward. The project also has managed to survive harsh political climates, potentially because of its critical economic importance. Further, Amtrak, a player with a tremendous amount at stake, spent roughly $250 million in 2013—in the absence of any apparent project—to preserve rail right of way in a rapidly developing part of Manhattan without which the Gateway Tunnel Project would never have been possible; this kind of foresight in the face of adverse conditions is strikingly important for projects with long planning horizons. There are some striking similarities between this project and a potential third crossing: the need for system redundancy and maintenance, alleviating congestion on both transit and on roads, increasing economic competitiveness and allowing for future growth. Furthermore, as a third crossing potentially benefits counties beyond the current BART districts, seeking buy-in from places such as San Jose and Santa Clara will be important for the future success of the project, particularly in an area with tight competition for shrinking federal funds. Tracking the progress of the Gateway Tunnel Project as it progresses can yield insights for parties interested in delivering a third crossing.

## Joint Powers Authorities

Joint Powers Authorities (JPAs), in the realm of transportation, are legal entities consisting of two or more public authorities sharing control over the provision of some transportation good or service. Capitol Corridor and Caltrain are examples of JPAs that exist in the Bay Area to provide rail services, and both would stand to gain from some of the operational circumstances of a third crossing, gaining access to larger service areas, higher ridership, and potential funding sources.

In southern California, the example Los Angeles-San Diego-San Luis Obispo (LOSSAN) Rail Corridor provides insights regarding rail operations structures, particularly regarding standard-gauge rail. LASSON is JPA originally formed in 1989 to provide service on the coastal rail route between the cities from which it takes its name[26]; while no major infrastructure projects have been carried out by LASSON, its management is of interest in the case of the third crossing. The 11-member board of directors consists of elected representatives from transportation agencies, transportation authorities,

and local governments along the corridor, as well as Amtrak, Caltrans, and CAHSRA[25]. LOSSAN receives dedicated funding via transportation sales taxes from its member counties, except for Ventura county which has no such tax. It operates with relative ease on rights-of-way owned by other agencies, having negotiated a favorable contract with Southern Pacific (SP) railroad as SP was moving towards bankruptcy. The managing agency, which provides staffing and day-to-day operations is the Orange County Transportation Authority (OCTA). In 2015, LOSSAN officially assumed control over Amtrak's Pacific Surfliner Service, making the operations under the agency's control the second busiest inter-city passenger rail service behind Amtrak's Northeast Corridor[27]. By utilizing a JPA, LOSSAN's leadership structure is necessarily responsive to the needs of stakeholders along the route, including private freight rail operators who, although not represented on the board, are important players and right-of-way owners in the corridor.

More generally, JPAs can be susceptible to issues stemming from conflicts regarding a multitude of divergent opinions. With the provision of a service, often the needs of each public agency align enough that differences can be accommodated. However, for a large infrastructure project, the shared goal or incentive may not exist as concretely. In such a situation, each agency may have specific goals for its own constituents that are mutually exclusive to another set agency's goals, thus a stalemate could ensue. Even in a less contentious situation, a project could fall victim to the inclusion of too many aspects, attempting to accomplish too many things at once while doing none well. Additionally, JPAs can be subject to unstable funding sources, depending upon the nature of contributions, and willingness to contribute, from member agencies. Securing dedicated funding for an infrastructure project is possible, but operating funds can be harder to obtain of the nature of federal funding incentives, and the desire of political office holders to implement legacy projects. Although some agencies structured with JPAs may be partly included in the third crossing, pursuing a larger agreement amongst transportation agencies, and local, state, and regional public agencies could create a situation of discordant goals and interests.

## Governance Structure Recommendations

For each scenario, ideal and constrained, recommendations based on the literature, case studies, and stakeholder discussions, are offered on governance structures by different operating circumstances. Regardless of operating circumstance, however, external independent project oversight and peer review, and a comprehensive risk management program should be integrated into project governance from the onset (see Risk Management and Independent Project Oversight section).

Again, a project sponsor would be responsible for assembling the diverse set of local, regional, state, and private actors necessary to conceptualize, design, finance, construct, operate, and maintain a large infrastructure project, as well as for land development around station areas, regional transit planning, fare setting, and parking provision and pricing, negotiating contracts with technology providers and labor unions, collaboration with private freight rail depending upon scenario selected, and interfacing with both regional and state entities involved in transportation planning, such as MTC, ABAG, and the California State Transportation Agency (CalSTA), and other agencies such as the Bay Conservation and Development Commission. Remaining alignment agnostic, and considering a constrained vs. an ideal scenario, the recommendations are as follows. Internal planning regarding staffing remains important for any third crossing as well. Additionally, a project sponsor would need to overcome all challenges

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inherent to megaprojects, both technically, and politically, and remain adaptive enough to navigate a long planning and execution horizon.

## Constrained Scenario by Operational Circumstance

In the constrained environment of the Bay Area, choice of mode will shift the appropriate governance structure. Existing agencies and operators will influence future structures, and any benefits or drawbacks that currently exist may be carried over. Recognizing strengths and weaknesses can inform the best ways to complement positives and reduce negatives, particularly regarding the details of JPA and board structures. Any constrained governance structure must build upon the reality of the Bay Area and seek to inject innovation where possible, as well as maximize the political support, including from Santa Clara, and San Mateo Counties which currently do not have representatives on the BART board (The BART board currently consists of directors from counties of Alameda, Contra Costa and City/County of San Francisco).

### 1) BART Operation Only

If the new crossing is to solely provide BART service, then a structure similar to that of the Gateway Tunnel Project is appropriate. BART could create a special purpose entity to oversee the design and construction of a new tunnel, with the entity dissolving after construction and transferring all ownership rights over the infrastructure back to BART. Some shared staffing between the special-purpose entity and BART, along with dedicated staff on the project, would allow BART to continue its day-to-day operations while also managing a megaproject. The board of the new entity could be comprised of representatives from BART, as well as involved cities, and regional and state entities. The subsidiary entity would need to be careful to balance the present and future needs of the system, which could cause friction between it and BART. Regarding public buy-in, the recent passage of BART's major infrastructure bond (Measure RR of 2016) gives the sense that although some discontentment about the system exists (particularly regarding reliability, service hours, and cleanliness) the public could be open to backing a large project.

### 2) Standard Rail Operation Only

In the situation where only standard gauge tracks are incorporated as part of the crossing, it would not make sense for BART to the central governing body, although a board position could increase coordination between modes and benefit the region overall. Capitol Corridor, with its well-structured JPA, could absorb Caltrain, thus merging the East Bay and West Bay service areas and expanding its pool of member counties. A new funding agreement would need to be reached, with newly added counties contributing some portion of the eventual operating budget. As Caltrain currently operates based upon donations from its member counties, reaching a new agreement could prove difficult, although the prospect of true rail connectivity from Sacramento, through San Francisco, all the way to Silicon Valley might provide enough of an incentive for counties to provide dedicated funding. Both Capitol Corridor and Caltrain have limited full-time staffs, greatly below anything necessary to oversee the construction of a crossing and the operation of expanded service. Each of the managing agencies—BART for Capitol Corridor and SamTrans for Caltrain—could provide some employees, but a new managing entity would be required in the long-term. Because neither Capitol Corridor nor Caltrain has the kind of name recognition that BART has, enlisting public support for such a merger would pose a greater challenge than for BART. Furthermore, all owners of right-of-way in the corridor would need to

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be included in the project, and this could pit freight service against passenger service on tracks owner by freight providers. Even though freight demand is relatively low, few tracks exist to serve existing dispatches in the East Bay, and Union Pacific would be hesitant to allocate more track time to passenger service, particularly in light of future rail development around the Port of Oakland.

#### 3) BART and Standard Rail Operation

For a two-tunnel crossing, a special purpose entity created by BART, but which would retain ownership rights to the built infrastructure in a similar fashion as to the Gateway Tunnel Project, would be able to carry out the construction and eventually lease rights to any operators. BART, by far the largest transportation provider in the region, currently possesses the most dedicated staff, available funding and bonding potential, and name recognition to become a project champion. Further, BART staff have begun pursuing alternatives for a third crossing already, and although different technical constraints exist for non-electrified locomotives, alternatives could be amended regarding standard-gauge rail. A merger of Capitol Corridor and Caltrain would still likely be necessary, but the combined entity would only be responsible for current and future operations of the rail corridor. This network of relationships would be the most complex of the constrained scenario proposed here, but creating one entity solely in charge of capital project execution can insulate it somewhat from divergent goals of providing regional connections from Sacramento to Silicon Valley versus relieving congestion in the Bay Area and seeking benefits for historically disadvantaged communities.

#### 4) Performance Pricing (no Third Crossing)

In a Performance Pricing alternative, there is little justification for shifting any currently functioning governance structures in the Bay Area. The Bay Area Toll Authority and MTC would retain authority, and BART and AC Transit would continue their operations as planned. While there are potential changes to the overall Bay Area that could improve upon the overall regional governance, such as stronger coordination between transit providers regarding capital planning and service provision, in the current constrained environment these are assumed unlikely.

## Ideal Scenario by Operational Circumstance

Under the ideal scenario, favorable political conditions exist in the Bay Area that render difficult to achieve structures possible. Under such conditions, consolidation of transportation services to the maximum extent possible, creating a multi-modal transportation agency providing service across the bay, has the potential to yield the most benefit. This agency would need to control all bay crossings between Oakland and San Francisco, by putting BART, AC Transit, The San Francisco Bay Ferry, and Caltrain and Capitol Corridor—if standard-gauge rail tracks are included—under one roof.

Additionally, toll authority for SFOBB crossings would be needed to fully manage demand in the corridor. This merger needs to precede construction activities, so that the entity would be maximally responsive to decreases in capacity from any of the modes, both during and after construction. This structure would also allow for dynamic incentives based upon mode to bring about desired modal shifts; an integrated fare structure would set the basis for pricing that could also take into account financial means, although it would require synchronizing Bay Area FasTrak and Clipper Cards. While no agency of this particular scope and size exists, and the prospect of one may seem daunting, the benefits of integrated service, economies of scale in provision and management, and over individual mode choice

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decisions—automobile, bus, rail— outweigh the uncertainties regarding larger union agreements, organizational structuring, and legal basis for existence. Investigating the legal and other particulars of such a structure warrants a report in and of itself, but the process of looking for areas of coordination would be beneficial for any region seeking to unify transit services.

#### 1) BART Operation Only

In this conception, the above entity would exist, but would not incorporate Caltrain and Capitol Corridor, as neither service would cross from Oakland into San Francisco. Thus, the entities to merge would be BART, AC Transit, BATA, and SF Bay Ferry. Board membership would need to include San Mateo and Santa Clara Counties in addition to Alameda, Contra Costa and San Francisco.

#### 2) Standard Rail Operation Only

Even if a third crossing did not incorporate BART, under these circumstances BART, AC Transit, BATA, SF Bay Ferry, Caltrain, and Capitol Corridor would merge into a new entity, as BART currently operates a crossing.

#### 3) BART and Standard Rail Operation

This scenario would be the same as the Standard Rail operation only, with a merger of all major transit providers across the Bay between San Francisco and Oakland.

#### 4) Performance Pricing (no Third Crossing)

Even without a third crossing, this unification effort would be valuable to the region as it plans to accommodate significant growth in the coming years.

## Equity & Governance

To complement the governance structure responsible for carrying out the third crossing, there is an opportunity via governance to create positive outcomes for vulnerable communities. Particularly for residents underserved by transit, and historically left out of planning processes, this project must serve as an exemplar for future coordination between citizens and public agencies. Moving beyond traditional public outreach procedures, during which comments are accepted for previously prepared designs, any project sponsor must work with directly and indirectly affected communities to seek meaningful conceptual and design input.

### Community Advisory Board

To allow for this without over-extending public resources on rounds of intensive design workshops and scoping sessions, a representative board comprised of elected officials from directly and indirectly affected communities supplemented by appointees from community-based and advocacy organizations could incorporate the needs and goals of local citizens into those of the overall project. This community advisory board would function like a hybrid technical advisory committee, but would hold some of the same powers as the overall project board.

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In Minnesota, the Metro Council—the Twin Cities' Metropolitan Planning Organization and Regional Planning Agency—created a policy board comprised of members from local governments and transportation agencies, as well as non-profits, community-based organizations and philanthropic and academic institutions to head the Corridors of Opportunity (CoO) program[28]. The CoO program utilized funding via a grant from the U.S. Department of Housing and Urban Development (HUD) and private funding from Living Cities—a collaboration of large philanthropic and financial institutions—to carry out an integrated set of projects aligned under one common vision and governance structure[29]. The policy board was in charge of disbursing all funds, and established a set of desired outcomes to guide funding allocations. A Community Engagement Team was created to work closely with communities to identify ways to promote existing community assets along transit corridors, and recommend grants to the policy board for funding[30]. Following the successful completion of CoO, the Partnership for Regional Opportunity (PRO), comprised of many of the original CoO organizations, was created as a follow-up to focus on four major work areas: Regional Equity and Community Engagement, Shared Prosperity, Transit-Oriented Development, and Transportation Funding.

Focusing on the third crossing, adapting some of the aspects of the CoO and PRO to the case of a third crossing informs a potential structure. While CoO was a program combining individual projects to meet goals, the third crossing is one larger project in service of local, regional, and state goals. As such, it will require a governing board with a sole focus on the crossing and related issues, such as ongoing project monitoring, coordination of land uses and ancillary services, as well as funding. The community advisory board must hold equal voting powers to the governing board, so that community needs are as influential in decision-making as project needs; the community board would also provide oversight similar to the project board, with additional duties outlined below. A dual board structure of this type would be unique, but voting power is necessary to ensure meaningful engagement during conceptualization and design. Staffing the community advisory board to avoid conflicts of interests will be important; through staggered terms, and a mix of appointed and elected officials representing a wide array of viewpoints, a balance can be achieved. The question of whether to give a board chairperson the power to appoint members, to leave it to a vote amongst elected members, or to give selection power to the state legislature remains. Having the board adopt a set of guiding visions and goals in accordance with those set forth in the problem statements also works to support continuity over the life of the project.

Along with championing the needs of communities with regards to the third crossing, this community advisory board would be tasked with administering funds via grants funded by revenue generation around station areas. The specifics of the revenue generation are covered in the funding and finance section, and the details of grant evaluation and administration are discussed here. An outreach team could seek to identify areas of opportunity in communities and the board could evaluate grant proposals on their alignment with the guiding principles, utilizing the metrics developed in this report to rank proposals. The grants would serve to build upon benefits provided by the crossing, and address community needs beyond the scope of the crossing as well such as intra-city transit service, and jobs access programs to name a few examples. Any organization would be eligible to apply, and support would be provided to aid in the development of grant proposals, if necessary. The size of both the CoO and the PRO was orders of magnitude below expected estimates for the grant program, and scaling up the effort provides both opportunities and challenges. A wider array of projects and programs could be funded in pursuit of goals, but additional oversight and ongoing administration and internal evaluation

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would be critical to determine the overall effectiveness and institute any necessary internal tweaks adjustments accordingly.

Just as a project's governance structure including risk assessment and external independent oversight needs to be in place long before many project decisions are made, this community advisory board must be established in a parallel manner to the project governance team. Only by establishing such a board very early on can the third crossing truly break from historical patterns of megaproject planning by involving a diverse set of community stakeholders from the outset, and become an exemplar for projects to come.


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# Risk Management and Independent Project Oversight

Two key components of a Third Crossing's project planning and development are governance structure overseeing the project and the way it is funded and financed. The success of these components depends on the development of an effective and thorough Risk Management (RM) plan and project oversight. Given the many complexities of megaprojects, we find from our review of the literature and analysis of recent federal and state legislation, that it is critical that a new crossing governance structure incorporate robust risk management into project development and oversight.

A risk management program is a systematic process of identifying, assessing, analyzing, and responding to risks (Project Management Institute), 2001). The literature agrees that a risk management plan should be developed at project initiation (Greiman, 2013; New York State Department of Transportation, 2008; PMI (Project Management Institute, 2001). For the purposes of our study, we focus on the early stages of where risk management should be incorporated into a third crossing – during the development and establishment of the project's governance structure and funding and finance.

This section contains analysis on in the following:

- Megaprojects and risk management in practice: Boston's Central Artery/Tunnel ("Big Dig") project
- Recent legislative efforts regarding megaproject risk management plan requirements at the California state and federal level
- Concluding thoughts on risk identification: major risks from the literature and particular risks existing in the Bay Area context

Each section contains lessons and recommendations for a third crossing.

## Megaprojects and Risk Management in Practice

In this section, we discuss risk management plans of a megaproject in practice where state officials adjusted risk management during the course of project implementation Boston's Central Artery/Tunnel (the Big Dig) project

### Boston's Big Dig project

The Big Dig project is one of the largest infrastructure projects in U.S. Initially, the Massachusetts Highway Department (MHD, formerly the Massachusetts Department of Public Works) was responsible for the overall project's plan and construction (Board, Council, & Engineering, 2003). The Massachusetts Turnpike Authority (MTA) later was assigned to be both owner and operator of the overall responsibility for the project and its management (Board et al., 2003). Under the MTA's guidance, the management is functioned by an integrated project organization (IPO) of MTA staff and B/PB staff (Board et al., 2003). As its official name – the Central Artery/Tunnel project – describes, the project included: 1) replacing the elevated central artery in Boston (I-93) with an underground modern highway, 2) building two major bridges over the Charles River, and 3) extending I-90 to Logan Airport.

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The Big Dig project resulted in the replacement of congested elevated freeway with a technologically advanced new tunnel and bridge. The project achieved some of targeted benefits such as reducing traffic congestion for users, increasing property value that generates new property tax revenue, and making new development possible. The project was scheduled to start in 1982 and completed in 1998; however, due to delays, the project was not completed until 2007 (Greiman, 2013). The original budget for the project was $2.6 billion in 1982, but the final cost estimate $14.8 billion in 2007, which even when accounting for inflation, had more than a $9.28 billion cost overrun (Poole Jr & Samuel, 2011). Further, recent reports show $9 billion in financing and interest costs (Flint, 2015; Moskowitz, 2007). In the end, the state has been left to carry a huge debt - $9.3 billion – without any revenue to service it (Poole Jr & Samuel, 2011), which required them to pay over $100 million a year in state transportation funds (Flint, 2015).

### Risk Management Program in the Big Dig

The Big Dig risk management team consisted of international risk professionals, brokers, and insurers, holding the central place in every project as shown in Figure 34 below (Greiman, 2013). It had a clear goal from the early planning stages: zero-accident philosophy considering safety as the most important value (Greiman, 2013). With this shared value, different principles were set at the various phases of the project; but, risk was regarded as a primary attention of the project from every perspective (Greiman, 2013). Although there was a collaborative, integrated project management team in decision making, it was considered as a reason of the significant cost increases. In particular, project sponsors did not fully integrate risk management into project organization until the construction was about 50% complete and design of the project was 99 percent complete (Greiman, 2010). To be specific, there more than 100 major contracts involved in complex technical, legal, and economic issues and many processes and procedures, but at the early stage, there was little communication between and among many of internal and external stake holders (Greiman, 2010). Also, the government's role as both regulator and owner of the Big Dig discouraged efficient communication between project managers, and decreased the project's accountability and transparency (Greiman, 2013). Moreover, cost overruns were mainly caused by unexpected challenges related to subsurface condition, utilities, archeological discoveries and others (Greiman, 2010).

*Figure 34: Risk management organization*

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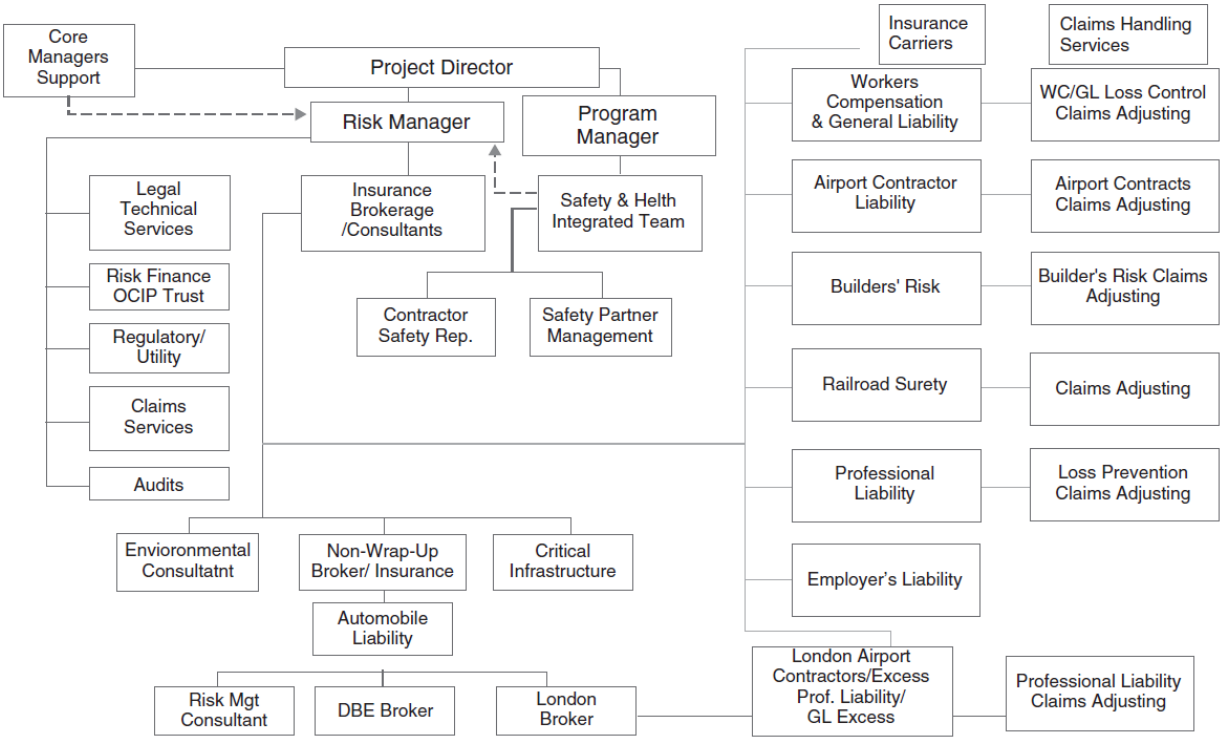


*Source: Central Artery/Tunnel Project, Integrated Project Organization (Greiman, 2013)*

## External Independent Oversight in the Big Dig

Due to the many challenges of the Big Dig, the state instituted a strong independent oversight body that consists of more than 33 local, state, and federal audit agencies, including the Central Artery/Third Harbor Tunnel Oversight Coordination Commission (OCC) (Greiman, 2013). Under the guidance of OCC's executive director, member agencies were able to understand each other's responsibilities and function, sharing expertise and others (Sloan, 1997). The OCC also was responsible for combining the expertise and statutory authority of three offices that are composed of the state auditor, the state attorney general and the state inspector general to investigate on various aspects of the Big Dig project (Sloan, 1997). Figure 35 shows the three major investigating offices and activities of the oversight commission. In addition to the OCC, the Big Dig had external audit agencies and outside organizations that mostly consist of specialists in construction contract financial reviews (Greiman, 2013). The types of their post audits contained unreasonable or undocumented damages assertions caused by a contractor or subcontractor associated changes or claims; technical assistance, cost recovery assistance, cost overrun assistance and review of schedules and contingency budgets (Greiman, 2013).

*Figure 35: Central Artery/Third Harbor Tunnel (CA/T) Project Oversight Coordination Commission responsibilities diagram*

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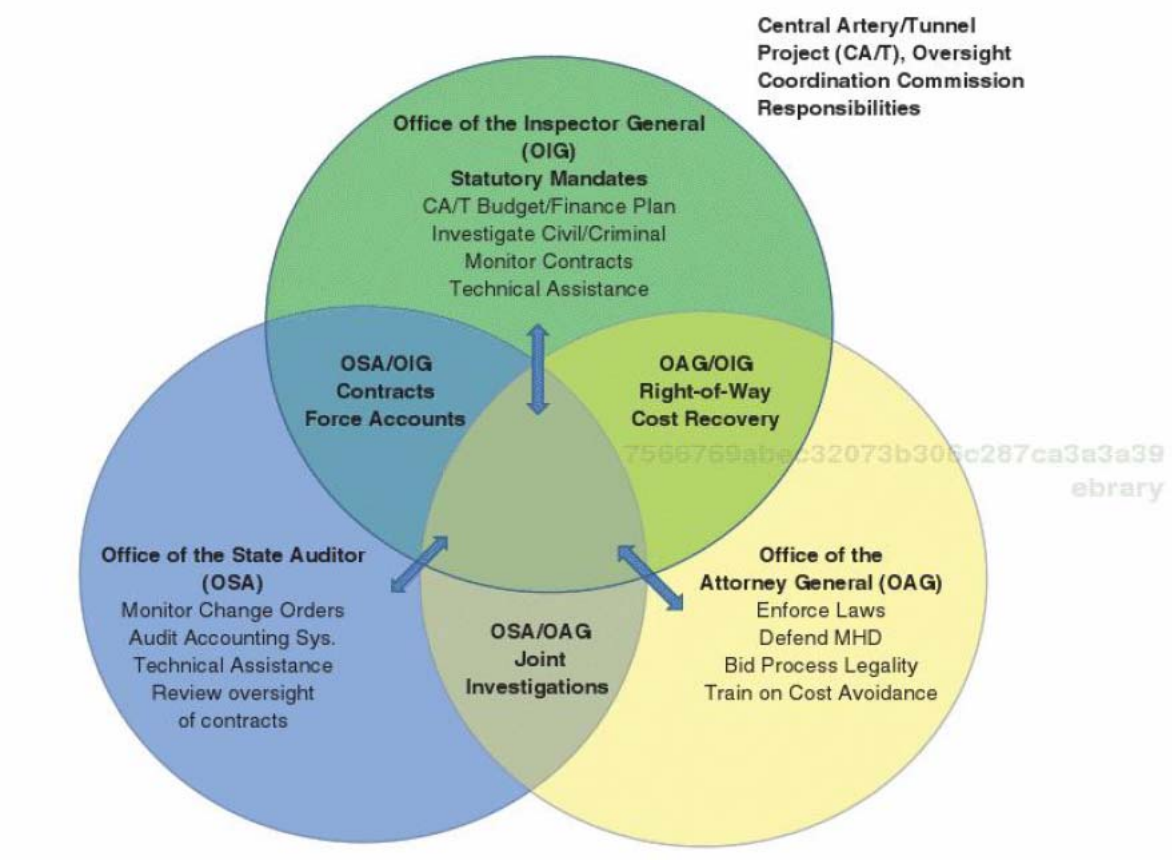


*Source: Commonwealth of Massachusetts. Central Artery/Third Harbor Tunnel Project Oversight Coordination Commission. Summary Report (July 1998)*

The case of the Big Dig reveals the difficulty of encompassing many stake holders and the importance of government's role for the communication between internal and external stakeholders. Additionally, the case shows that robust risk management organization and external independent oversight should be formed from the early stage to minimize unexpected risks, such as one caused by the poor communication.

# Recent California State and Federal Legislation on Megaproject Risk Management

Recent megaprojects have demonstrated the need for upfront risk management, and the failures of certain megaprojects have led to new legislation in California as well as proposed federal legislation.

## California Legislation

### Assembly Bill (144) of 2005, Hancock. Bay Area State-owned Toll Bridges: Financing

**Background**

In 2004 in response to cost overruns in the Bay Area's state-owned toll bridge program, particularly the Bay Bridge's new East Span, California State Auditor critiqued Caltrans for its lack of rigorous risk management (California Department of Transportation, 2014). Although Caltrans had attempted to perform risk assessment with hired consultants, Caltrans did not have a comprehensive risk management approach, meaning that there was no risk management process to create budget contingencies and construction schedules (California Department of Transportation, 2014).

**Actions**

In response to the state auditor's report, the Legislature passed Assembly Bill 144 of 2005. The bill requires Caltrans to: 1) establish a comprehensive risk management plan for Toll Bridge seismic retrofit projects, that contains clearly defined roles and responsibilities for RM, 2) quantify the impacts of identified risks in financial terms, 3) to develop and maintain documents to track identified risks and related mitigation steps, and 4) regularly integrate estimates for capital, capital outlay support costs, and contingency reserves into a program-wide report (California Department of Transportation, 2014). After the passage of AB 144, Caltrans implemented a formal risk management program to satisfy the requirement of AB144 (California Department of Transportation, 2014).

The bill also required the formation of a Toll Bridge Program Oversight Committee (TBPOC) that is composed of the Bay Area Toll Authority (BATA), Caltrans, and California Transportation Commission (CTC) directors. The role of the oversight committee is to: review project status; manage regularly cost estimates in excess of $1 million, conduct risk assessments and oversee cash flow; and provide program direction. Also, under the bill, Caltrans is required to provide monthly reports to the oversight committee. Initially the oversight's meetings were not open to the public but due to ensuing construction challenges with the new East Span, committee meetings were opened to public and media access.

**Lessons**

The formal oversight committee and RM program were implemented mid-way through the program during the construction phase of the project, the early phases of the project did not have larger project oversight nor scheduled risk analysis and thorough engineering estimates, and as such did not have benefit from the robust oversight and formal risk management plan (California Department of Transportation, 2014). Further of the three members on the oversight committee, one member is a director of an entity that already oversees Caltrans (California State Transportation Agency) and does not include additional external oversight like that of the Boston Big Dig such as state auditors.

### Senate Bill (1029) of 2012, Governor Brown. the Budget Act

**Background**

The California High-Speed Rail Authority (CHSRA) is an agency to plan, design and implement high-speed rail system in the California. The CHSRA (2009) reported that RM plan documents received from the Authority were in the form of 2007 technical memoranda produced by the

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private-sector program manager, not the Authority, and appeared to be generic, incomplete and likely out of date.

**Actions**

Provision 8 of Item 2665-306-6043 of the Budget Act (SB 1029, Chapter 152, Statutes of 2012) requires the CHSRA to offer the Legislature with a Project Update Report that contains extensive discussion of project risks and process taken to minimize those risks. The report requires a comprehensive risk management plan that describes roles and responsibilities for risk management. It addresses how the authority will identify and quantify project risks, implement and track risk response activities, and monitor and control risks throughout the duration of each project (California High Speed Rail Authority, 2013). The other requirements under the bill are to quantify the impacts of identified risks in financial terms, keep documents tracking recognized risks, form mitigation phases, offer a plan for regularly reevaluating its estimates of capital and support costs, offer a plan to reevaluate risks and reserves, and offer a plan for incorporating the estimates for capital, support costs and contingency reserves in required reports (California High Speed Rail Authority, 2013).

**Lessons**

According to the California High Speed Rail Authority, the new risk management program, when complying with all of requirements for SB 1029, offers a formal, systematic approach to identifying assessing, evaluating documenting and managing risks for the success of a given project (California High Speed Rail Authority, 2013).

## Senate Bill 425 of 2013, DeSaulnier. Public Works Project Peer Review Act of 2013; Senate Bill (969) of 2014, DeSaulnier. Public Works Project Oversight Improvement Act

**Background**

In response to the significant cost increases, delays, and construction challenges of the Bay Bridge's new East Span (see Historical Context section), the Senate Transportation & Housing Committee held hearings about these issues and reviewed megaproject literature that included recommendations for comprehensive and rigorous risk analysis and independent external peer review of elemental assumptions and analyses to improve projects delivery (Flyvbjerg et al, 2003).

**Actions**

As an initial response to the Senate Committee's work, the Legislature enacted SB 425 (DeSaulnier), Chapter 252, also known as the Public Works Project Peer Review Act of 2013. The bill established a framework for including the use of peer review on public works projects by requiring a transparent process for selecting peer review group members and requiring a charter describing the group's members, objectives, and aims. The following year, the Legislature passed Senate Bill 969, which changed the name of the Public Works Project Peer Review Act to the Public Works Project Oversight Improvement Act.

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Senate Bill 969 defines a megaproject as a transportation project with total estimated development and construction costs exceeding one billion dollars. It requires an administering agency to establish an independent peer review group to review the planning, engineering, financing, and other aspects (Thronson, 2014). In addition, the bill requires the establishment of a comprehensive risk management plan that will identify and quantify risks to the project, track responses, and control risks throughout the life of the project; the requirements are very similar to those described in SB 1029 (Thronson, 2014).

**Lessons**

The bill analysis by Thronson (2014) explained that this bill incorporates recommendations from megaproject scholarship (Flyvbjerg et al, 2003) by requiring administering agencies overseeing all future transportation megaprojects to establish adequate comprehensive risk management plans from the outset, and to incorporate independent external peer review into the project development process (Thronson, 2014).

### H.R.4228 (Transportation Megaprojects Accountability and Oversight Act) of 2015, Introduced by Congressman Mark DeSaulnier of California

**Background**

This bill draws from California Senate Bill 425 of 2013 and Senate Bill 969 of 2014 discussed above which were authored by then California Senator Mark DeSaulnier who then transitioned to becoming a member of the U.S. Congress. Before this bill, federal rules and regulations lacked significant oversight mechanisms for large, complex megaprojects beyond financial reporting requirement for projects more than $500 million ("Congressman DeSaulnier Introduces Bipartisan Legislation to Improve Accountability & Oversight of Megaprojects," 2015).

**Actions**

H.R. 4228, introduced by Rep. Mark DeSaulnier, requires agencies that receive federal funds for projects over $2.5 billion to submit a comprehensive risk management plan that contains a description of identified risks associated with the project, proposed mechanisms to manage such risks, updated cost estimates, among other information (*H.R. 4228— 114th Congress: Transportation Megaprojects Accountability and Oversight Act of 2015*, 2016). Moreover, it requires that an independent peer review group be established, avoiding conflict of interest for greater transparency and consisting of a minimum of five individuals tasked with giving expert advice on scientific, technical, and management aspects of the megaproject (*H.R. 4228— 114th Congress: Transportation Megaprojects Accountability and Oversight Act of 2015*, 2016). The peer review group is formed after the approval of construction for the project, and the group is required to have annual meeting. Also, under this bill, the publication of information about the project to increase transparency is required ("Government Relations and Public Affairs Committee Meeting," 2016).

**Lessons**

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Despite the presence of a peer review group, the bill does not specify exact roles of recipients of annual reports from the peer review group. For a third crossing, these reports from the peer review group should be incorporated into overall project governance risk identification and management.

# Risk Identification and Application to a Third Crossing

Many scholars identified and classified various types of risk in megaprojects. The process is referred to as "risk identification" and is necessary when deciding which risks can be transferred to stakeholders at each phase. Based on an extensive review of published research on risk management in megaprojects, Irimia-Diéguez, Sanchez-Cazorla, & Alfalla-Luque, (2014) argue there are nine main megaproject risks: 1) design risks, 2) legal and/or political risks, 3) contractual risks, 4) construction risks, 5) operation and maintenance risks, 6) labor risks, 7) clients/users/society risks, 8) financial and/or economic risks, and 9) force majeure (such as natural disasters, extreme weather conditions, and terrorist acts) (see Table 3).

## Risk Identification for the Third Crossing

From this list, consideration of certain risks needs emphasis if the region and state were to move ahead with a third crossing because of the Bay Area's complex larger political, geographical, and socio-economic context.

### Stakeholder Support (2. Legal and/or political risks)

As mentioned in the history and policy context sections, a variety of communities in the Bay Area include historically disadvantaged and low-income communities. When proceeding with the project, issues regarding various neighborhoods may surface. In particular, issues associated with public trust, political advocacy of special interest groups, and managing expectations of key stakeholders in the project process. Meaningful community involvement and public approval is critically important to its success. Maintaining public support at the local level poses its own risks to the project budget if the project does not meet expectations and need mitigation costs are not budgeted for in the cost estimates (California High Speed Rail Authority, 2015).

### Right-of-way (3. Contractual risks)

Acquiring right-of-way is very important to meet project deadlines, which may be influenced by timing of achievement of environmental milestones, receipt of funding, and completion of multiple levels of governmental review and approval processes (California High Speed Rail Authority, 2015). The problems caused by the delay of the acquisition process could affect overall project development and increase project costs (California High Speed Rail Authority, 2015).

As a successful example of acquiring right-of-way, the West Rail Line project by the Regional Transportation District (RTD) in Colorado provides several lessons ("West Rail Line lessons learned," 2014). As one of rail line planned by the RTD FasTracks projects—122 miles of commuter rail, light rail transit (LRT), and bus rapid transit (BRT) in Denver metropolitan area—the West Rail line Project is 12 miles from downtown Denver to Jefferson County (FasTracks Regional Transportation District of Denver (RTD), n.d.; "West Rail Line lessons learned," 2014). Despite its complex right-of-way acquisition process and different schedule for acquiring each parcel, RTD was able to succeed in the

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acquisition of right-of-way by: 1) communicating early and often with stakeholders, property owners and residents, 2) establishing processes to deal with contentious or disputed acquisitions and 3) ensuring a formal, approved schedule for acquisitions that included in the contract with the contractor ("West Rail Line lessons learned," 2014).

### Environmental Approvals (7. Clients/users/society risks)

One of common risks that megaprojects in California is the process of obtaining environmental approvals. In addition to National Environmental Policy Act (NEPA) provisions, California has specific environmental requirements through the California Environmental Quality Act (CEQA). This can cause delays in project development schedules (Project Update Report to the California State Legislature). Moreover, interdependencies between various agencies granting approvals/permits may generate delays of the entire process (Project Update Report to the California State Legislature). For more details, please see the Funding & Finance section.

*Table 3: Identifiable risk types*

| | Types of Risks | Description |
|---|---|---|
| **1.** | Design risks | Risks related with the planning phase of the megaproject, such as delivery method, contract formation, and scope control |
| **2.** | Legal and/or political risks | Risks derived from changes in the governing policy of the country where the megaproject is developed |
| **3.** | Contractual risks | Risks derived from the renegotiation of the contract, such as midstream change of project scope, and issues caused by imprecision and vagueness in the contract |
| **4.** | Construction risks | most significant risks, including cost overruns (or cost escalation), project schedule, coordination problems, and inappropriate design or accident during the construction |
| **5.** | Operation and maintenance risks | Risks related with the operational phase that can affect the operation cost, operation capacity or quality, such as economic viability issues, unnecessarily high operations costs, poor construction quality, and operator incompetence |
| **6.** | Labour risks | Risks related with the workers linked to training, language, accident cost, and culture |
| **7.** | Clients/users/society risks | Risks affecting revenues, including: 1) demand risks such as inflation, price trends, price range; 2) market risks such as variations in the client's requirement existence of the market;3) social profitability risk which puts into question if the project |

| | | |
|---|---|---|
| | | provides the expected benefits to society; 4) impact on local groups' risk; 5) environmental risks; 6) reputational risks |
| **8.** | Financial and/or economic risks | Risks encompassing a variety of events related with the financing and performance of the megaproject |
| **9.** | Force majeure | Natural disasters, extreme weather conditions, terrorist act |

*Source: Irimia-Diéguez, Sanchez-Cazorla, & Alfalla-Luquee, 2014*

## Incorporation of Risk Management, Oversight and Peer Review

Drawing from risk management and megaprojects literature about the key principles for successful risk management. and recent key legislation efforts discussed above, key lessons that are critical for incorporation into a third crossing's governance structure and risk management plan include:

- External Independent oversight and peer review are critical and should be incorporated from a project's inception in its governance at the planning stages.
- The RM project should have a robust management program for megaproject at the highest levels of the project that covers all aspects and phases of the project and risk such as those discussed in Table 3.
- The RM project should function as a center of the project.
- The RM project should accomplish a clear and shared vision of risk along the planned management aims of the organization.
- The RM project needs a defined strategy that focuses on continuous improvement with an iterative progression, shared lessons learned, and the implementation of best practices.
- The RM project should involve the public and the stakeholders at every step of the risk management.
- The RM process should be tied to the development and management of program cost contingencies, which determined by the risk assessment documented in the risk register.

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# Performance Metrics

This section describes the metrics used to analyze to what extent the studied alternatives achieve the five Key Considerations. These metrics have been developed with the goal of judging preferred ways for governing bodies and independent groups to:

1) Decide between project alternatives;
2) Allocate resources and funding sources developed from the project; and
3) Monitor and evaluate the selected project throughout its planning, financing, building, operating, maintenance and governing phases.

The metrics build directly off of the five Key Considerations of social equity, accessibility and connectivity, land use planning coordination, climate change, and resilience and adaptation. They were developed through by consulting scholarship regarding transportation infrastructure evaluation, as well as indicators and metrics used by agencies and organizations in the transportation, planning, public health, resource management, and environmental science fields. These metrics should be viewed as a starting point for considering how to measure projects and should be augmented and developed over time in response to changing needs and availability of reliable data.

Quantitative results were calculated for some measures using travel demand and/or land use models used by MTC (see Model Methodology section), while others utilized existing data. We also applied qualitative assessments in combination with quantitative results in recognition of the inherent limitations of these models.

Metric descriptions, the ways in which they align with the key considerations and potential limitations are briefly explained below. Look to Appendix D for additional information regarding methodology, data sources and resources.

*Table 4: Summary of project metrics*

| ***Key Consideration*** | ***Metrics*** |
|---|---|
| **Social Equity** | 1. Health Equity<br>2. Displacement |
| **Accessibility & Connectivity** | 1. Transit Access<br>2. Jobs Access<br>3. Healthcare Access<br>4. Recreational Access<br>5. Intermodal Connectivity |
| **Resilience and Adaptation** | 1. Redundancy<br>2. Vulnerability to sea level rise/flooding<br>3. Seismic vulnerability |

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|---|---|
| **Climate Change Mitigation** | 1. Carbon Dioxide based off of Mode Share<br>2. Carbon Dioxide based off of Land Use |
| **Land Use Planning Coordination** | 1. Population Growth<br>2. Job Growth<br>3. Land Development Opportunities Adjacent to Stations |
| **System Performance** | 1. Time Periods that Demand Exceeds Capacity<br>2. Westbound to Eastbound Person Trip Balance<br>3. Net Investment Cost of Alternative |

## Social Equity

Social equity refers to the ability of the proposed project to equally distribute opportunities and burdens to low-income communities and communities of color. The Social Equity metrics specifically aim to measure the impacts the proposed project will have on health outcomes and housing and transportation costs (a proxy for potential for displacement) in impacted communities. The data these metrics require cannot be attained through the use of existing travel demand and land use models, therefore other quantitative and qualitative measurement methods are necessary. These metrics have a limitation in that individual longitudinal data, which are hard to collect, are needed to develop a comprehensive understanding of the displacement impacts of the project or project alternative (i.e. who is displaced and where they are displaced to). For more information on the methodology, data sources and other metric resources, see Appendix D.

1) **Health Equity Metric** - This metric measures the benefits and harms the project will have in terms of changes in a) active transportation b) traffic safety, and c) exposure to air and water pollutants and noise in communities impacted by the development and operation of the project. This metric includes measuring the distribution of health benefits and harms by racial and income make-up of the communities impacted (Dannenberg, 2016; "Road Pricing Health Impact Assessment (HIA)," n.d.).[145]
2) **Displacement Metric -** This metric measures areas that are at risk of changes in affordability and compares this to areas in the region that have high proportions of low income groups and minorities and areas that have high access to opportunity, in terms of housing, transportation and other services near stations. The metric is comprised of a) changes in housing and

[145] Dannenberg, A. (2016). A Brief History of Health Impact Assessment in the United States. *Chronicles of Health Impact Assessment*, *1*(1), 1–8.

Road Pricing Health Impact Assessment (HIA). (n.d.). Retrieved December 6, 2016, from http://www.sfhealthequity.org/resources/hia-tools/21-elements/transportation/116-road-pricing-health-impact-assessment-hia.

transportation costs for households, b) vacancy rates of residences, small businesses and community services in impacted communities, c) access to opportunities related to economic well-being, education, transit, civic infrastructure, and public health (Chapple, 2009; Seattle Office of Planning & Community Development, 2016; Caltrans, 2016).[146]

Social equity metrics are integrated into a number of metric categories, including Accessibility and Connectivity, Resilience and Adaptation and Land Use.

## Accessibility and Connectivity

Accessibility refers to how easily people can reach different opportunities in terms of time and travel costs (Handy, 2002).[147] These opportunities can include access to employment centers, schools, and services and amenities, such as hospitals, retail centers, parks and recreation. Accessibility is important for all travelers, but particularly for communities that depend on transit as a primary mode of travel. In the Bay Area, many trips depend on connecting across different modes or service providers. Therefore, travel time reliability of service connections is a critical factor in determining the accessibility of a system. The metrics below provide indicators of how accessible a system is, in terms of time and cost, as well as connectivity. While these metrics are intended to be useful indicators of access, some limitations exist. For instance, it is difficult with healthcare and parks to identify if services or amenities are comparable; for instance, large parks with walking trails are not the same as small pocket parks, but may be considered the same in an accessibility analysis if weighting is not given to different amenity types. For more information on the methodology, data sources and other metric resources, see Appendix D.

1) **Transit Access** - this metric identifies the number of households within a quarter mile of a proposed transit station. Transit accessibility can be measured in several ways: gravity models, utility models, and cumulative access (LaMondia, Blackmar, and Bhat, 2010).[148] Transit access can be further analyzed by income and race to identify gaps in services for communities of concern.
2) **Jobs Access** - this metric identifies the location of major employment centers and the number of jobs available to households in different locations. Jobs access can be further analyzed according to income group and job type / education to quantify employment opportunities for

[146] Chapple, K. (2009). *Mapping Susceptibility to Gentrification: The Early Warning Toolkit*. Center for Community Innovation. Retrieved from http://communityinnovation.berkeley.edu/reports/Gentrification-Report.pdf

Seattle Office of Planning & Community Development. (2016). *Equitable Development Implementation Plan*. Retrieved from http://2035.seattle.gov/wp-content/uploads/2016/05/EDI-Imp-Plan-042916-final.pdf

Caltrans. (2016). *California Transportation Plan 2040*.

[147] Handy, S. L. (2002). Accessibility-vs. mobility-enhancing strategies for addressing automobile dependence in the US. *Institute of Transportation Studies*. Retrieved from https://escholarship.org/uc/item/5kn4s4pb.pdf

[148] LaMondia, Blackmar, and Bhat (2010). Comparing Transit Accessibility Measures: A Case Study of Access to Healthcare Facilities. Retrieved from http://www.caee.utexas.edu/prof/bhat/ABSTRACTS/ComparingAccessibility.pdf

residents. Affordable housing near jobs centers is key, especially for low income populations (Levine, 2007).[149] If there are not sufficient employment opportunities for the income groups in the neighborhood, that suggests a jobs-housing imbalance.

3) **Healthcare Access**- this metric identifies the location of primary care doctors and the access to these facilities by transit. While primary care doctors are not fully reflective of access to healthcare more generally, it can serve as an initial indicator of how easy it is for populations to reach healthcare. Studies have shown that transit access can be a major barrier to healthcare access, especially for low-income populations (Syed, Gerber, & Sharp, 2013).[150] As such, access can be further analyzed according to communities of concern, such as seniors or populations with disabilities. Access to healthcare is a standard measure in public health.
4) **Recreational Access** - this metric identifies the location of parks and the access to these amenities by transit. Parks are associated with opportunities for improved mental and physical health, but can be inaccessible to some communities of concern (UC Berkeley, 2011).[151] One challenge in measuring this metric is that it can be difficult to weigh the value of parks by size or amenities. Access can be further analyzed according to communities of concern, such as low-income populations.
5) **Intermodal Connectivity** - this metric combines local and regional connectivity considerations to measure efficacy of stations in connecting between local and regional transit. This measure reflects the number of intermodal connections available and whether or not overnight service is provided. Additional features could be added in the future, including availability of information and average wait time (Chowdhury, 2014).[152] One challenge in measuring this metric is accounting for service delays as part of the frequency of service. Connectivity can be further analyzed by race and income to identify gaps in service.

## Resilience and Adaptation

Resilience can be understood in the context of this project as addressing the vulnerability of critical assets in the transportation network based on various risks including natural disasters and maintenance failure. In addressing resiliency, the scale of both specific assets and the larger transportation network as it relates to the transbay corridor are used to provide a more robust understanding of the issues and possible interventions. In understanding flexibility of a system, redundancy in service is vital to providing service after unexpected incidents that affect components of the transportation network. Additionally, the availability of modes within different communities located near existing and proposed sections of the transportation network must be considered in defining criticality to ensure the resilience of all communities in the region. This includes understanding

[149] Levine, J. (2007). Rethinking Accessibility and Jobs-Housing Balance. *Journal of American Planning Association*, *64*(2). Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01944369808975972
[150] Syed, S. T., Gerber, B. S., & Sharp, L. K. (2013). Traveling Towards Disease: Transportation Barriers to Health Care Access. *Journal of Community Health*, *38*(5), 976–993. https://doi.org/10.1007/s10900-013-9681-1
[151] University of California, Berkeley. (2011). *Disparities in Park Space by Race and Income*. Retrieved from http://activelivingresearch.org/disparities-park-space-race-and-income
[152]Chowdhury, S., Cedar, A., & Velty, B. (2014). Measuring Public-Transport Network Connectivity Using Google Transit with Comparison across Cities. *Journal of Public Transportation*, *17*(4). Retrieved from http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1005&context=jpt

how race, income and other factors increase vulnerability. For more information on the methodology, data sources and other metric resources, see Appendix D.

1) **Redundancy -** This metric considers a transportation system's flexibility in the event of a sudden or planned closure of part of the network (Ta, Goodchild, Pitera 2009). In the context of the transbay corridor, this is considered in terms of a possible closure of the current transbay tube for maintenance and/or a sudden disaster. This will be measured in terms of ridership capacity. The difficulty of predicting exactly how a potential disaster might affect the corridor presents a limitation in terms of assessing the overall redundancy of the system ("Open Data - ABAG Resilience Program," n.d.).[153]
2) **Vulnerability to sea level rise/flooding -** This metric considers the relationship between proposed alternatives, current infrastructure and projected effects of sea level rise and flooding. This is addressed by looking at infrastructure location in relationship to sea level rise scenarios (Nicholls, Hanson, Lowe, Warrick, Long and Carter, 2011). It is important to consider that sea level rise scenarios do not always include possible mitigation efforts such as seawalls. While this is useful for assessing the overall risk of infrastructure in terms of its location, it does not account for the exact interaction of water inundation in existing and proposed infrastructure ("Open Data - ABAG Resilience Program," n.d.).
3) **Seismic vulnerability -** This metric considers the relationship between proposed alternatives, current infrastructure and seismic hazards. Soil liquefaction susceptibility in the Bay Area will be used as proxy for seismic vulnerability (IASME/WSEAS, 2009). While this metric can demonstrate the risk of a general area, this does not account for the wide range of variation in soil that can occur even within a single parcel ("Open Data - ABAG Resilience Program," n.d.).

## Climate Change

The climate change mitigation metrics aim to measure the impacts project alternatives will have on transportation-related and building development-related CO2 emissions across all travel modes. These metrics align with California Senate Bill 375 of 2008, which requires major metropolitan areas in California to reduce GHG emissions by 7% by 2020 and 15% by 2035 from 2010 emission rates. These metrics also align with CO2 mitigation metrics used by Plan Bay Area, Bay Area Air Quality Management District, and in MTC's Vital Signs report (Metropolitan Transportation Commission, 2013; Association of Bay Area Governments and Metropolitan Transportation Commission, 2013). For more information on the methodology, data sources and other metric resources, see Appendix D.

1) **Carbon Dioxide based off of Mode Share -** This metric uses travel demand model output data to measure the daily CO2 emissions per capita across all travel modes within the region. CO2 emissions produced within communities of concern should also be analyzed.
2) **Carbon Dioxide based off of Land Use -** This metric uses land use model output data to

[153] Open Data - ABAG Resilience Program. (n.d.). Retrieved December 10, 2016, from http://jmplus.net/vDhGUrCI, http://resilience.abag.ca.gov/open-data/

measure the CO2 emissions released by buildings developed due to the second bay crossing per capita across changed development within the region (United Nations Environment Programme, 2009). CO2 emissions produced by building types in communities of concern should also be analyzed.

## Land Use

The land use metrics are intended to capture the relationship between transit and where residents and business are located in the Bay Area, as well as understand what happens to different populations and communities over time. Where possible, similar land use change data was included in the current conditions analysis to highlight historic trends. The selected metrics build on this to consider future patterns of growth to evaluate alternatives. Two of the three measures are designed as differences over time - growth in population and growth in jobs to capture changes in response to proposed alternative plans. Some of this data can be modeled with existing land use and travel models, however, such results are highly dependent on assumptions related to current conditions and market assessments, which could change significantly in the future. Models are imperfect tools that are not always well suited to capture local variations in real estate markets, nor are they able to predict larger national economic trends that impact regional economic and population growth. For more information on the methodology, data sources and other metric resources, see Appendix D.

1) **Population Growth** - This metric compares projected population growth near transit in response to new transit service using MTC land use model outputs. The models project population at multiple geographic scales. This is important for determining whether population changes around stations reflect a redistribution of population growth or are part of a larger trend across the Bay Area that would have occurred without new transit. This metric analyzes changes in income; allowing for basic analysis of populations changes associated with changing incomes and redistributions of areas of poverty and wealth that are estimated to result from new transit (ACS data, Metropolitan Transportation Commission, 2013). This analysis can be done with Travel Model One and the UrbanSim land use model, as well as with data from the American Community Survey in conjunction with geographic transit location data. MTC tracks similar data with its Population Vital Sign.[154]
2) **Job Growth** - This metric compares projected job growth by location (including within a distance of transit stations) and by job type using the MTC land use model outputs. Similar to the population growth metric, it allows for geographic consideration to determine where and how job growth shifts under different alternatives. Ideally this metric includes analysis of job by wage to understand the type of jobs that are growing and where. This analysis can be down with Travel Model One and the UrbanSim land use model, as well as with LEHD employment data with geographic transit location data. MTC tracks similar data with its Jobs Vital Sign.[155]
3) **Land Development Opportunities Adjacent to Stations** - This metric is focused on identifying alternatives where station locations are surrounded by low-intensity development, such as parking lots or low-rise strip mall construction. This metric is drawn from the market

[154] MTC Vital Signs: Population. http://www.vitalsigns.mtc.ca.gov/population.
[155] MTC Vital Signs: Jobs. http://www.vitalsigns.mtc.ca.gov/jobs.

assessment reports produced as part of the Core Capacity study. The reports analyze the number of "soft-sites" to determine the capacity of areas for new growth.[156] SPUR also conducted a similar analysis for downtown Oakland by analyzing satellite imagery to identify vacant parcels and surface parking lots.[157]

## System Performance

The system performance metrics are intended to evaluate how the transportation system operates under a proposed alternative. They were selected with the goal of providing a basic understanding of the impact of transportation infrastructure investments on the efficiency and finances of transportation agencies. The metrics are central to understanding the impact of any alternative on specific transit agencies; however, the metrics must be considered in relation to performance of alternative on the other measures. It is entirely possible to do well on each one of the system performance metrics without solving any of the problems a transbay crossing or alternative project could attempt to address. For more information on the methodology, data sources and other metric resources, see Appendix D.

1) **Time Periods that Demand Exceeds Capacity** - This metric provides a measure of how many hours per week the transit and highway systems are operating beyond capacity. Collection and reporting of this data also allows analysis of *which* hours of the week are of capacity issues to clearly state the scale of crowding issues. It is a response to the tendency of reports (what reports?) on the transbay corridor to focus on whether services, specifically BART, are ever over capacity. This framing overlooks the fact that the system may only run at capacity during a limited period each week. This data provides a metric that is simple to analyze for transit agencies, where the MTC Travel Time Reliability and Time Spent in Congestion metrics are extremely highway user focused.[158][159] This metric can provide insight into when transit riders are likely to be on an overcrowded vehicle and it also focuses system operations and opportunities: it can provide insight for land use planners as to where additional growth could be accommodated without significant additional system investment. There may be additional analysis opportunities to consider in terms of whether and how to define capacity. Especially during off-peak hours, there is a difference between current levels of transit service versus maximum potential levels of service if more vehicles were operated. Some of this analysis was done for the MTC Core Capacity Transit Study using BART data.[160]
2) **Westbound to Eastbound Person Trip Balance -** This metric is a comparison of westbound to eastbound trips in the transbay corridor, including all persons traveling between San Francisco and Oakland/Alameda on the current Bay Bridge, the BART Transbay Tube, or the

[156] SF Market Assessment Report (full citation needed).
[157] SPUR. "A Downtown for Every One, Shaping the Future of Downtown Oakland." September 2015. p19. http://www.spur.org/sites/default/files/publications_pdfs/SPUR_A_Downtown_for_Everyone.pdf
[158] Metropolitan Transportation Commission. Time Spent in Congestion web page. http://www.vitalsigns.mtc.ca.gov/time-spent-congestion. Accessed 10 December 2012.
[159] Metropolitan Transportation Commission. Travel Time Reliability web page. http://www.vitalsigns.mtc.ca.gov/travel-time-reliability. Accessed 10 December 2012.
[160] Data is not publicly available. See p. 24 of "Core Capacity Transit Study Briefing Book." http://mtc.ca.gov/our-work/plans-projects/other-plans/core-capacity-transit-study.

ferry lines. The primary focus is looking at travel during the morning commute when crowding is most extreme, though the metric would ideally be calculated for different times of day (including AM and PM peak periods) on all days of the week to account for varied travel patterns and allow more comprehensive planning around achieving transit investment efficiency, which is a key measure that MTC tracks.[161] To fully track this metric on an ongoing basis would require coordination for data collection from BART, BATA, WETA and MTC.

3) **Net Investment Cost of Alternative -** This metric is based on a net present value analysis of each possible transbay alternative project based on upfront costs, operating losses or revenues (for example, increased tolling), and long-run maintenance costs. The goal of the metric is to show the cost of alternatives in a comprehensive manner. This metric is outside of the scope of this report, but will need to be fully evaluated in future research. Such analysis would require coordination for data collection from MTC, BART, BATA, Caltrans, and other transit operators. Some estimates of project costs have been analyzed by MTC.

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[161] Metropolitan Transportation Commission. Transit system efficiency web page. http://www.vitalsigns.mtc.ca.gov/transit-system-efficiency. Accessed 10 December 2012.

# Alternative Development

The five Key Considerations formed the basis of the development of specific alternatives for a new crossing. Every possibility contained trade-offs in service of these considerations, and we did not find one clearly superior preferred alternative. However, this section is not intended to provide an exhaustive list of potential alternatives. Instead, we will present several of our best-performing alternatives and alignments that address the problems outlined in the Key Considerations and represent distinct visions for the priorities of a new crossing.

Each alternative considers the factors described in the Key Considerations:

1) Social Equity: Improve service and mobility options for disadvantaged communities.
2) Accessibility and Connectivity: Improve in-system and intermodal connectivity of existing and future transportation infrastructure.
3) Land Use Planning Coordination: Serve existing density and catalyze new development opportunities.
4) Climate Change Mitigation: Maximize transit mode share by providing greater service to both existing and newly-emergent high-demand areas.
5) Resilience and Adaptation: Provide redundancy in case of an existing tube shutdown.

In addition to these considerations, capacity concerns and engineering feasibility were also taken into account. The two primary capacity issues for BART are overcrowding at Embarcadero and Montgomery stations and potential bottlenecks in the Oakland Wye. Transbay standard rail alternatives have capacity concerns as well, but they only affect service patterns, not potential alignments. In terms of engineering feasibility, we relied heavily on the Core Capacity Initial Engineering Study and expert interviews to eliminate potential alignments that are operationally impractical or add considerable construction risk or cost to the project. These engineering considerations include but are not limited to: turning radii, land entry points, hills, station depths, tunneling under buildings, and existing infrastructure. Table 5 presents the alternatives chosen for deeper analysis.

*Table 5: Analyzed alternatives and brief descriptions*

| | |
|---|---|
| **Alternative 1: New Opportunities (BART)** | Includes a BART diversion south of MacArthur Station running along a reimagined I-980 corridor in Oakland.<br><br>Connects with San Francisco's South of Market (SoMa) before continuing West on Geary via Civic Center |
| **Alternative 2: Critical Needs (BART)** | Includes a BART diversion south of MacArthur Station running along Franklin St. in Downtown Oakland. Connects with Mission Bay and Downtown San Francisco via Geary |
| **Alternative 3: Connecting the Megaregion (Standard Rail)** | Includes a standard rail diversion south of the existing Emeryville Station running along a reimagined I-980 corridor in Oakland.<br><br>Connects with San Francisco via the Transbay Transit Center. Extends Capitol Corridor service to Transbay Transit Center and extends Caltrain service to Richmond. |

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| | |
|---|---|
| **Alternative 4: Performance Pricing** | Addresses transportation problems without a new crossing by increasing westbound Bay Bridge tolls during peak hours and using the revenue to fund increased bus service and land use changes that reduce demand on the corridor, in addition to other equity opportunities. Impacts to vulnerable groups would be mitigated by a lifeline discount. |

# Alternative 1: New Opportunities (BART)

## Route Description

### East Bay

Alternative 1, which is shown in Figure 36, includes a BART diversion south of MacArthur Station where the existing BART track diverges from I-980. The new BART line runs along the existing I-980 right-of-way, including new stations at 14th Street and Howard Terminal. The I-980 trunk connects with the southern East Bay BART lines via a diversion between the existing Fruitvale and Lake Merritt Stations. The new line tunnels under 12th St, creates a new station, Eastlake, east of Lake Merritt on 12th Street between 5th and 6th Avenues, then continues under 11th Street with a stop sharing existing infrastructure for 12th St Station. It then converges southbound with the I-980 tunnel. Moving south from the Howard Terminal station, the new crossing tunnels below the Oakland Estuary, travels south through Alameda along the right-of-way immediately east of Main Street, turns west on Atlantic Avenue, where a new station would be located. Then it continues west as far as possible before tunneling under the bay towards San Francisco.

### San Francisco

This alignment approaches San Francisco at Pier 30-32, an entry point designated as "Promising" in the MTC's Core Capacity Transit Study Initial Engineering Memo (IEM). It then follows Brannan St through South of Market (SoMa), with one station between 3rd St and 4th St and another between 6th St and 7th St. The station at 3rd-4th St would provide a transfer to the Central Subway Brannan stop, as well as a short walk to the 4th and King St Caltrain and High-Speed Rail station. After 7th St, the line turns north to follow 8th St to a new station at Howard St. It then continues to another new station on Hyde St between Golden Gate Ave and McAllister St, providing a transfer to the Civic Center BART station. The line then heads west on Geary Blvd, with stations at Polk St-Van Ness Ave and Fillmore St. A full build-out of the line would see it continue westward on Geary Blvd to the Richmond District.

*Figure 36: Alternative 1 alignment, stations, and service pattern*

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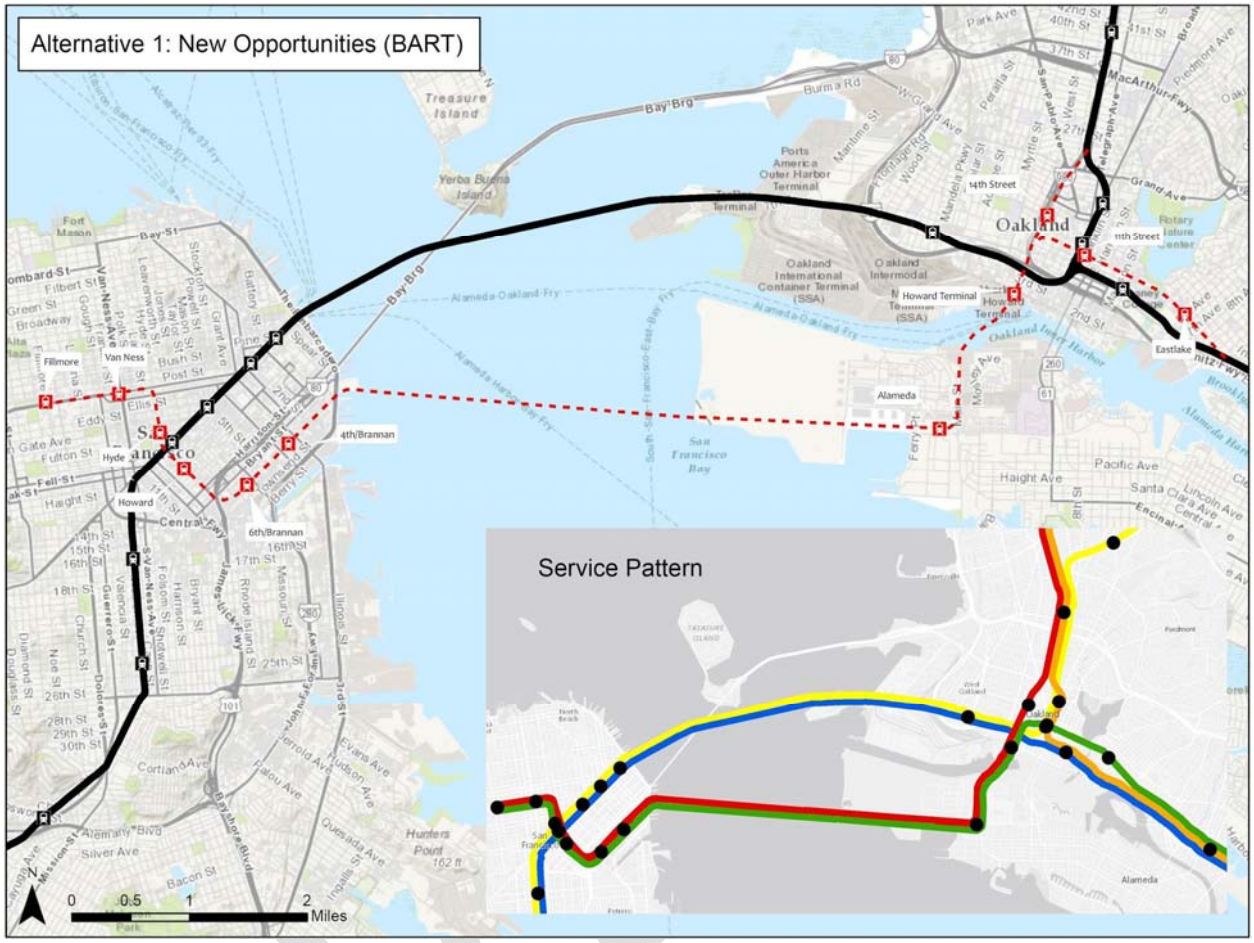


*Source: Map produced by students in the Fall 2016 Transportation Planning Studio*

## Operational Implications

### Northern Lines

The Red line would be routed into the new transbay crossing, while the Yellow line would continue through the existing crossing. Yellow line riders wishing to travel via the new crossing would switch lines via timed transfer at MacArthur Station. Red line riders would also have to transfer at MacArthur to access the 19th and 12th St Oakland stations, though much of the travel demand from southbound into Downtown and Uptown Oakland could be satisfied by the new station at 14th Street in the I-980 corridor. Travel time from the MacArthur station to the combined Civic Center-Hyde St Station would be reasonably similar via either crossing, as each route is similar in length and passes through three stations on each side of the Bay.

### Southern Lines

Coming from the South, Green lines would be routed through the new crossing, while Blue lines would continue their current operation. Riders seeking to switch between these two lines would transfer at Fruitvale Station. Green line riders travelling to Downtown Oakland will no longer need to transfer to an Orange line, as they would instead be taken to the 12th St Station. However, the new route would

result in four stops between Fruitvale and San Francisco, compared to two stops today. The Orange line would continue its current route on both the northern and southern ends, and Blue line riders traveling north towards Downtown Oakland and Berkeley would continue to transfer to the Orange line at or before Lake Merritt Station.

### Ridership Concerns

As discussed in the Current Conditions section, travel demand during the peak period is largely driven by destinations in the San Francisco Financial District. This demand suggests that the existing crossing would still be heavily utilized in this build-out scenario, with inbound Green and Red line riders transferring to this crossing.

However, the Financial District is currently at nearly full build-out and is forecasted to experience little employment growth according to the MTC's Market Assessment. We can expect the new crossing to attract riders with destinations in high-growth office areas in SoMa, Mission Bay, and Mid-Market that are not currently well-served by regional transit. This matching of crossings and destinations will mitigate capacity concerns and should justify the increased transfers. Additionally, the major East Bay growth opportunities at Eastlake, 14th St, Howard Terminal, and Alameda, as well as the South Bay extension stations, are all located on lines utilizing the new crossing.

### Service Impacts

The service impacts vary depending on the side of the bay. San Francisco gets a new line that opens up ridership access, with service on the existing trunk changing very little. On the other hand, the East Bay, sees fewer new stations but significant capacity increases through improved frequency on the entire network. Since each crossing would only have two lines instead of all four (as with the existing tube), peak frequencies would increase by 83% on the Green line, 60% on the Red and Blue lines, and 55% on the Yellow line compared to MTC's 2035 service levels. Downtown Oakland experiences a massive increase in frequency as all lines except the Blue line make stops directly in the core. However, frequency in the existing San Francisco trunk would be lower than what is assumed in the 2035 projections (decreasing from 27 trains per hour to 25), though still higher than the current service level (24 trains per hour). The only other stations to experience a decline in peak frequency compared to that baseline are Lake Merritt (from 16 tph to 13 tph) and West Oakland (from 27 tph to 25 tph).

## Context

### I-980 Removal

Alternative 1 operates under the assumption that Oakland proceeds with the transformation of I-980 into a multi-modal boulevard, as discussed in the Current Conditions section. This transformation would remove the physical and psychological barrier dividing the two communities, thereby providing better connections between West Oakland and downtown. This connection should yield equitable outcomes for historically disadvantaged communities in West Oakland. Also, the wide, trenched I-980 freeway right-of-way could make underground rail construction easier.

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### East Bay Land Use Opportunities

The new East Bay stations have the potential to stimulate significant development potential and create new transit hubs in the heart of Oakland. The Howard Terminal BART station would be accessible to Jack London Square and would directly serve a Howard Terminal redevelopment. The Downtown Oakland Specific Plan Alternatives Report (DOSPAR) studies three alternatives for the Howard Terminal site, including a new baseball stadium and a transit-oriented development with nearly 900 housing units.

Converting I-980 into a boulevard would by itself create significant development potential for Downtown Oakland. The DOSPAR includes two alternatives for the transformation, both of which would include over 1,000 housing units and over 500,000 square feet of combined retail/office uses. Additionally, the new Eastlake station would provide rail access to a dense residential community east of Lake Merritt and a multimodal connection to the Bus Rapid Transit line set to open along International Boulevard. The station would also only be a half mile walk from the currently under construction Brooklyn Basin development.

## Alternative 2: Critical Needs (BART)

### Route Description

#### East Bay

Alternative 2, which is shown in Figure 37, has a BART diversion immediately south of MacArthur station, resulting in one set of tracks traveling south on Franklin St instead of Broadway. A station at 15th St provides transfers to the existing 19th St and 12th St stations, resulting in the connection of all three central Oakland stations. From the other side, new track diverges from the existing line around 8th Ave between Fruitvale and Lake Merritt. It then crosses the creek and follows I-880 before connecting with the Franklin line. Unlike in Alternative 1, no new stations are created on this line between Fruitvale Station and the connection of the two lines. The combined track passes through a new station at Jack London Square before crossing into Alameda. After crossing under the Oakland Estuary, the line follows Webster St in Alameda before turning west on Atlantic Ave, with a new station west of Main St. It then continues as far west as possible before tunneling under the Bay towards San Francisco.

#### San Francisco

This alignment approaches San Francisco at Pier 52 in Mission Bay, another entry point deemed "Promising" by the IEM. It then heads north on 3rd St, with a station at Mission Rock facilitating an easy transfer to the Muni Metro station above. The line continues on 3rd St through SoMa, with stations at Brannan St and Mission St. The Mission Street station provides a free underground transfer to the Montgomery BART station, as well as an underground connection to Caltrain, High-Speed Rail, and transbay buses at the Transbay Transit Center. After crossing Market St, the line heads west on Geary. There is a station near Union Square between Taylor St and Mason St, with an underground connection to the future Union Square Muni stop. Two additional stations at Polk St-Van Ness Ave and Fillmore St are the same as in the other BART alternative. Likewise, full build-out of the line would also entail continuing west on Geary Blvd to the Richmond District.

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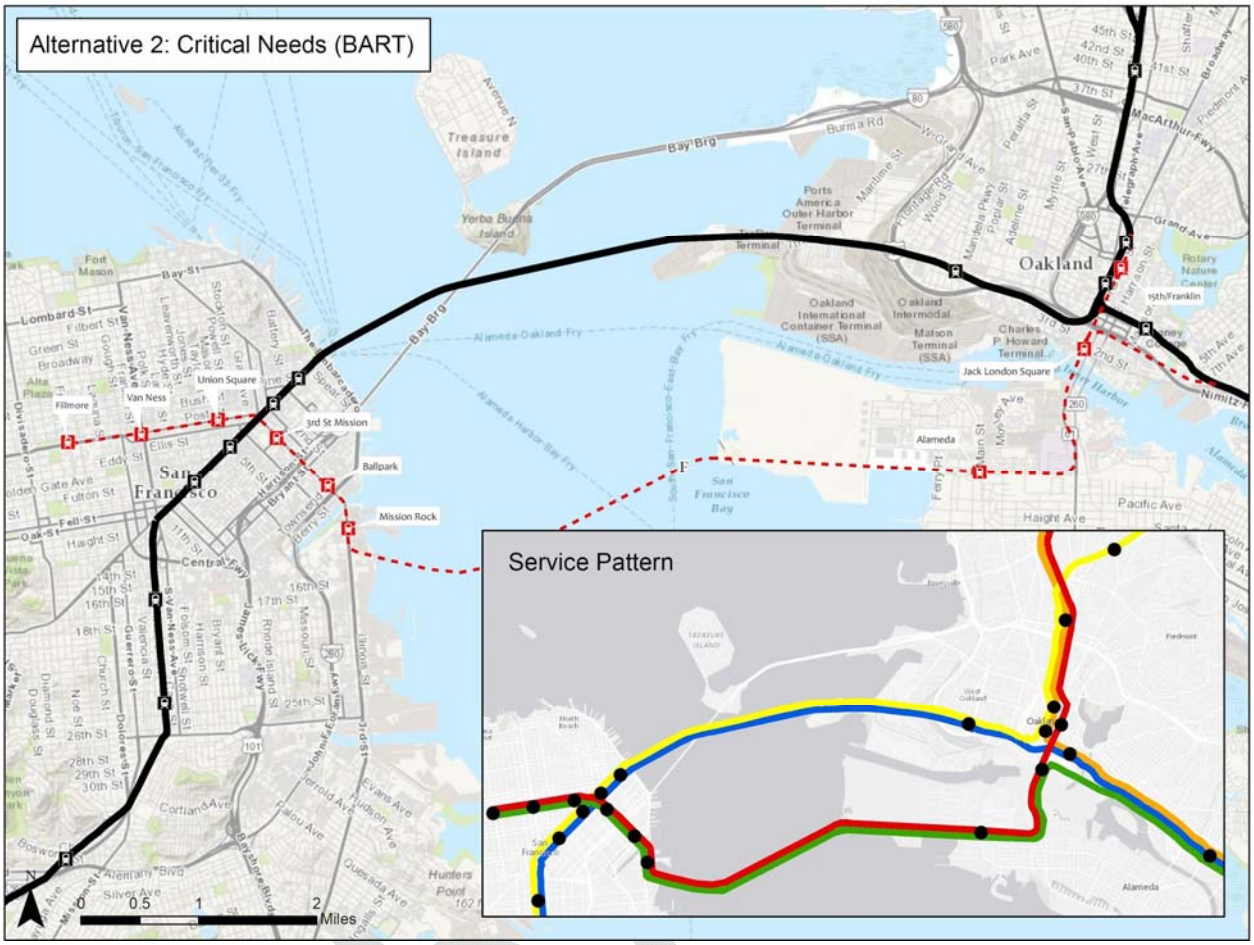
*Figure 37: Alternative 2 alignment, stations, and service pattern*




*Source: Map produced by students in the Fall 2016 Transportation Planning Studio*

## Operational Implications

### Northern Lines

As with the other BART alternative, the Red line would be routed through the new crossing, while the Yellow line would continue travelling through the existing tube. Transfers would again occur at MacArthur Station. Red line riders would retain direct access to Downtown Oakland via the 15th/Franklin station. Traveling from MacArthur to 3rd/Mission through the new crossing will be slower than traveling to Montgomery through the existing tube, as the new route has more stops and a longer travel distance.

### Southern Lines

As with the other BART alignment, the Green line would be routed through the new crossing, while the Blue line would continue travelling through the existing tube. Transfers would again occur at Fruitvale Station. The Orange line would continue its current route on both the northern and southern ends, and Blue line riders seeking to go north towards Downtown Oakland and Berkeley would continue to transfer to the Orange line at or before Lake Merritt Station. While the travel time differential to Downtown San

Francisco is not as large between these two lines as it is for the northern lines, it is still somewhat slower to travel to 3rd/Mission than it is to Montgomery.

### Ridership Concerns

Unlike in Alternative 1, this alignment provides direct service to the San Francisco Financial District and Union Square, the area with the highest demand in the BART system, and it does not reduce convenience of travel to the area with the second highest demand, Downtown Oakland. Although this route is not quite as direct as the existing crossing, the difference between the two is reasonable, and it is likely that most riders will opt for a one-seat ride and not transfer to the existing crossing. The other new stations in this alternative (Jack London Square, Mission Rock, and 3rd/Brannan) represent potential growth areas that are more mature and less speculative than those in Alternative 1. While that offers safer and more reliable rider demand, it also precludes the chance of transformative land use that might occur in the I-980 corridor, Howard Terminal, and Western SoMa.

### Service Impacts

Service patterns are exactly the same as in the other BART alternative. In summary, frequency in the existing San Francisco trunk slightly decreases compared to MTC's 2035 service levels (though still above current levels), while the frequencies of the East Bay lines dramatically increase, especially in the Downtown Oakland core. Also as in the other alternative, the only East Bay stations with a (slight) reduction in frequency compared to the 2035 projected levels are Lake Merritt and West Oakland.

## Context

### 3rd St vs 2nd St

One variation of this alignment involved traveling under 2nd St instead of 3rd St through SoMa. A 2nd St alignment would allow for better spacing between the BART line and the Central Subway running under 4th St. A station at 2nd/Mission would also directly abut both Montgomery Station and the Transbay Transit Center instead of requiring ~ 1,000 ft. long underground walkways. Lastly, the turn from 2nd St to Post St is unencumbered by existing buildings, unlike the turn from 3rd St to Geary. However, while a 2nd St alignment has significant service advantages, reliability and ease of engineering ultimately make 3rd St the more viable option. A 2nd St alignment would make a station in Mission Bay impractical due to the need to travel under AT&T Park. It would also, more significantly, travel directly under the Downtown Rail Extension for most of the length of 2nd St. Traveling under the length of another tunnel presents significant reliability concerns: if the BART tunnel requires repair, it can also affect the standard rail tunnel immediately above it. An attempt to avoid this situation by traveling under 3rd St before turning onto 2nd St immediately north of the TTC results in severe right turns that would require the demolition of numerous massive buildings and extremely slow travel speeds.

### Construction Considerations

One complication of a 3rd St alignment is the turn onto Geary, which requires tunneling underneath part of the 700 block of Market St. Whether this requires removing one or more of those buildings is dependent on the depth of the tunnel, as well as the depth of the buildings' support structure. However, two blocks after crossing Market St, this alignment already must travel underneath the Central Subway,

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which is roughly 100 feet deep. While this requirement means that the new BART tunnel would very deep, it does perhaps allow it to avoid conflicts with the 700 block of Market St.

#### Land Use Opportunities

As previously mentioned, several of the new stations in this alignment are located in areas that are already undergoing land use changes, which is both an advantage and disadvantage. These areas have fairly certain future demand that lacks quality connection to the regional transit system, and it makes sense to plan service to meet that demand. However, while the addition of a BART station may facilitate even further intensification, it will not be an impetus for brand new redevelopment opportunities by itself. The other stations in this alignment also provide direct access to existing areas of high demand such as Downtown Oakland, the San Francisco Financial District, and Union Square. Overall, this alignment trades the potential of transformative land use shifts for better service of more reliable locations of demand.

## Alternative 3: Connecting the Megaregion (Standard Rail)

### Route Description

#### East Bay

Alternative 3, which is shown in Figure 38, includes a standard gauge diversion south of the Emeryville Station before Sherwin Avenue. The new tracks tunnel below I-580 before turning southeast under San Pablo Avenue, where the tunnel runs for one mile before turning south into the 980 trench. Similar to Alternative 1, Alternative 3 includes a new station at 14th Street before traveling south below the Oakland Estuary, through Alameda along the right-of-way immediately east of Main St, and then west on Atlantic Ave as far as possible before tunneling under the Bay towards San Francisco.

In order to better integrate this alternative with existing transit infrastructure, Alternative 3 includes a BART diversion south of MacArthur Station where the existing BART track diverges from I-980. This BART diversion travels along the I-980 trench to the 14th St Station to allow for transfers between standard rail and BART. This diversion would leave the door open for a potential second BART crossing, as described in Alternative 1.

#### San Francisco

This alignment approaches San Francisco near Pier 14, an entry point designated as “Promising” in the MTC’s Core Capacity Transit Study Initial Engineering Memo. The tunnel travels under the Embarcadero and continues west under three blocks of buildings between Embarcadero and Main Street before connecting with the Transbay Transit Center between Main Street and Beale Street. The Transbay Transit Center would then be connected to the rest of the peninsula via the already planned Downtown Rail Extension, which will connect the Transbay Transit Center to the Existing Caltrain Terminus at 4th and King.

*Figure 38: Alternative 3 alignment and stations*

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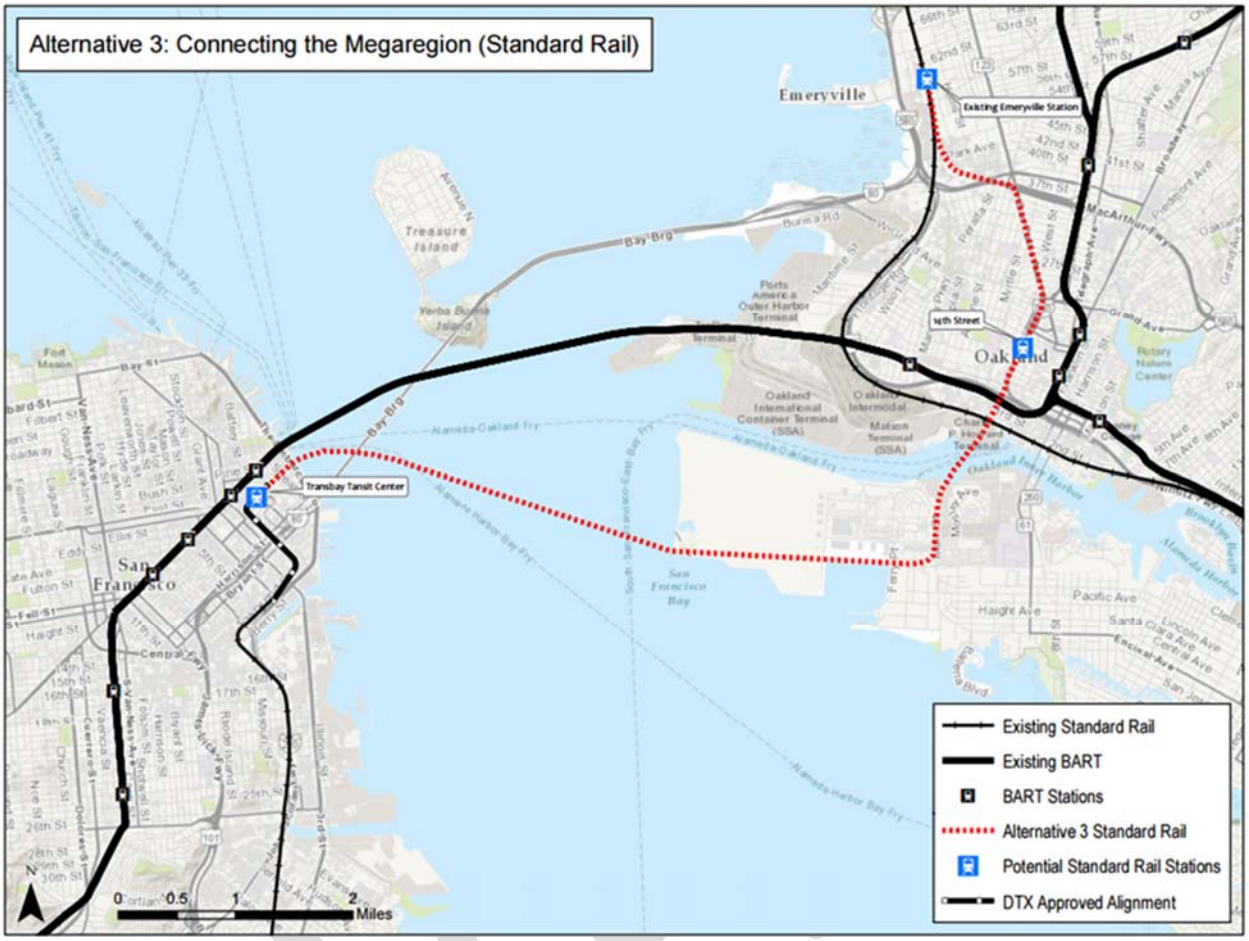


*Source: Map produced by students in the Fall 2016 Transportation Planning Studio*

## Operational Implications

### Operators

Alternative 3 allows for a variety of operators to make use of the third crossing, including Capitol Corridor, Caltrain, and California High Speed Rail. Capitol Corridor could send approximately four trains per day from its existing service originating in Sacramento through the new crossing and ending at the Transbay Transit Center in San Francisco. Caltrain could extend all of its Baby Bullet trains from the Transbay Transit Center through the new crossing to Richmond Station, with stops at the new 14th Street station and the existing Emeryville and West Berkeley Stations. There are currently six Baby Bullet trains per day in each direction, but this is slated to increase once Caltrain is electrified. Presumably, the crossing could also extend High Speed Rail service from San Francisco to Sacramento.

### Service Impacts

In order to accommodate the BART connection to standard rail at the 14th Street Station, new Yellow and Red lines would be introduced, running from their respective northern termini to the 14th Street station at three trains per hour during peak and 2 trains per hour for off peak. These new lines would increase frequencies for Red Line riders between MacArthur and Richmond and Yellow Line Riders

between MacArthur and Pittsburg-Bay Point, but would not impact frequencies anywhere else throughout the system. These new lines would create a direct connection standard rail and BART in the heart of the East Bay.

Capitol Corridor runs on tracks owned by Union Pacific Railroad (UPRR) and must share them with freight traffic. In an effort to minimize impacts to freight conflicts, the four trains per day that Capitol Corridor could run through the new crossing would not be added to existing service. Rather, these trains will be shifted from existing Sacramento–Jack London Square and Sacramento–Oakland Coliseum lines. This change would not affect the existing Sacramento–San Jose line. The net result of these changes would be reduced Capitol Corridor frequencies at Jack London Square (which are offset by the creation of the 14th Street Station) and at Oakland Coliseum.

## Context

There are two types of rail in the Bay Area: BART gauge, which is exclusive to BART, and standard gauge, which accommodates Caltrain, Capitol Corridor, and High Speed Rail. Unfortunately, the two types are incompatible. The region is already in the process of making large investments in its standard rail network, including the electrification of Caltrain tracks, High Speed Rail to San Francisco, and the Downtown Rail Extension from the current standard rail terminus at 4th and King St to the new Transbay Transit Center. Alternative 3 seeks to maximize those investments and connect San Francisco to the larger Northern California megaregion. This connection would open up South Bay jobs to Oakland's residents via rail. At a public presentation, a CalSTA official stated that she would like to see this project make its way into the 2018 State Rail Plan (SPUR Second Transbay Tube Event 2016).

### I-980 Removal

The New Opportunities and standard rail alternatives both operate under the assumption that Oakland moves forward with the transformation of I-980 into a multi-modal boulevard. For more information on this proposal, see the Current Conditions section and Alternative 1 discussion.

### Railyard Alternatives & I-280 Boulevard Study and Potential Construction Complications

The City of San Francisco is currently undergoing a Railyard Alternatives & I-280 Boulevard (RAB) Feasibility Study, which, among other things, is analyzing potential alignments for a Transbay Transit Center Loop. This loop is critical to realize the long-term benefits of the Transbay Transit Center for Caltrain and California High Speed Rail. It will become even more important if new service is introduced connecting Capitol Corridor to San Francisco. The potential loop alignments all exit the northeast side of the Transbay Transit Center and loop back to connect to the Downtown Rail Extension on Townsend.

Given the location of the Transbay Transit Center in the middle of the block between Howard Street and Mission Street, any loop alignment would need to run under three blocks of buildings. While analysis of these implications will be examined further in the RAB study, it is likely that some of these buildings will have to be repurposed to accommodate the rail tunnel between the Transbay Transit Center and Embarcadero. This reality undoubtedly incurs high construction costs, but it is the only direct way to enter the northeast side of the Transbay Transit Center. Given that the only realistic scenario in which a standard rail crossing would be built would be to connect the East Bay to the Transbay Transit Center,

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standard rail alternative assumes that the City will move forward with the Transbay Transit Center Loop and that the third crossing would share the tunnel between Embarcadero and Main St. with the Loop.

### East Bay Land Use Opportunities

As discussed under Alternative 1, transforming I-980 into a boulevard, alone, would create significant development potential for Downtown Oakland. The DOSPAR includes two alternatives for the transformation, both of which would include over 1,000 housing units and over 500,000 square feet of combined retail/office uses.

In addition to the new growth created around the 14th Street Station and along I-980, Alternative 3 creates significant development opportunities around existing standard rail stations that are connected to the third crossing. Given the service pattern outlined, this is particularly true for the Emeryville, West Berkeley, and Richmond Stations. Emeryville and West Berkeley stations are relatively close to BART stations, but providing a rail connection to Downtown Oakland, San Francisco, and Silicon Valley with meaningful frequencies would dramatically increase opportunities.

## Alternative 4: Performance Pricing (No Third Crossing)

### Description

The Performance Pricing alternative does not include a new crossing. Instead, transbay travel concerns are addressed by increasing westbound Bay Bridge tolls during peak hours and using the revenue to fund increased bus service and land use changes that reduce demand on the corridor, in addition to other social equity opportunities.

*Figure 39: Bay Bridge toll plaza during period of high demand with express lanes for carpools and buses visible at right*

*Source: Federal Highway Administration*

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## Components

### Increased Tolls during Peak Demand

The Bay Bridge currently runs at capacity going into San Francisco during both morning and evening rush periods (see Figure 39). Tolls are collected in the westbound direction only and are $6 on weekday mornings from 5am to 10am, $4 other times on weekdays, and $5 on weekends (BATA, 2016). This alternative would adjust bridge tolls during high-demand hours to maximize revenue while maintaining vehicular throughput. In keeping with current practice, carpools with 3 or more riders would be discounted and allowed to use the HOV lane on the bridge. The resulting shift to higher-occupancy vehicles due to these toll increases means that the bridge would increase passenger throughput even as vehicular throughput remained constant.

Ideally, the tolls would be periodically updated in response to changing demand, resulting in what is commonly referred to as performance pricing or congestion pricing. The frequency of toll adjustment would depend on the trade-off between commuter cost certainty and the bridge operator's need for flexibility to address short-term fluctuations in demand.

This alternative is inspired by the success of pricing schemes across the world and builds on the limited form of congestion pricing currently implemented on the Bay Bridge and through High-Occupancy Toll (HOT) lanes on many Bay Area highways. Although the new HOT lanes in the Bay Area adjust tolls in real-time to keep HOT lanes flowing at a faster rate than other lanes (Bay Area Express Lanes, 2016), it is likely more politically problematic to apply this to the entire Bay Bridge.

### Improved Bus Service

This alternative would also increase transbay bus service by AC Transit, reducing headways by 25 percent, and the toll increases for personal vehicles would improve AC Transit transbay travel times by reducing delay from congestion. Additionally, toll revenue could be used to redesign Bay Bridge entry points, making them more hospitable to buses by ensuring that cars do not block AC Transit vehicles from taking advantage of the carpool access lanes. This increased service would leverage the recent investment in new ramps that will go directly from the Bay Bridge to the bus terminal at the Transbay Transit Center.

## Social Equity Concerns

While those who commute to work by car typically have higher incomes than those who commute by other modes, increasing bridge tolls still has a potentially negative impact on social equity. Whereas higher-income drivers might still be able to pay the toll with ease, low-income drivers who cannot easily switch modes or time-shift their travel would be forced to pay a potentially burdensome amount. This could be eased by instituting a program similar to the Lifeline utility assistance program, where low-income travelers could sign up to receive a discount at point-of-service through FasTrak. MTC's travel model estimates that in 2010, individuals making less than $30,000 who drove alone accounted for only 6 percent of San Francisco-bound Bay Bridge drivers during the morning commute, so this program's effect on overall congestion-reduction and revenue-generation would be minimal.

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## Distributing Excess Toll Revenue

The amount of new revenue available depends on the size and duration of toll increases. As a point of reference, total Bay Bridge toll revenue was $228 million during fiscal year 2014-15 (BATA). In a simplified case where tolls were increased by $1 across the board with no decrease or time-shifting of crossings, it would generate approximately $50 million in annual revenue. This alternative's focus on revenue-generation and less-expensive transit improvements creates opportunities for funding projects more tangentially related to a transbay crossing. Redirecting toll revenue, however, has a complicated history in the Bay Area. When MTC considered implementing congestion pricing on the Bay Bridge in the 1990s, a persistent concern of residents was how the revenue would be used (Trapenberg Frick et al, 1996). Outside the Bay Area, some cities have used revenue from congestion pricing to improve public transit, while others used the revenue on road projects to benefit drivers now paying higher tolls (Eliasson, 2014).

For this alternative, funding is directed towards projects that address the Key Considerations identified at the beginning of this report, with a particular focus on social equity and supporting land use that reduces the number of trips across the Bay. After funding improvements to transbay bus service, remaining revenue would be administered by MTC in part to support housing construction in San Francisco and job creation in the East Bay core. Specific measures might include offsetting impact fees and paying for environmental reviews. The Social Equity Opportunities section contains further analysis for how to use this money to best serve the needs of underserved communities.

## Context

This alternative aims to address the Key Considerations with the construction of a new crossing. In particular, it has the potential to improve travel times by reducing congestion, reduce vehicle miles traveled (VMT) per capita by encouraging transit ridership and carpooling, and generate funding for projects that help rebalance demand across the corridor in addition to other social equity opportunities.

The major limit of the alternative is that it does not directly address regional transportation system resilience in the event of a disruption to the transbay BART tube or Bay Bridge. That said, the revenue it generates could be used in an emergency to fund additional bus or ferry service, or even a partnership with transportation network companies like Uber and Lyft. This alternative also provides more flexibility than a large infrastructure project to adapt to economic or technological changes. Further, this alternative does not preclude a future crossing project in response to changing conditions or extreme increases in demand. Other alternatives that include a crossing would likely in reality utilize a version of performance pricing across the Bay Bridge, but we chose to keep them separate to both isolate the individual effects and offer a complete vision of what would be possible to accomplish without building a third crossing. In addition, future work could consider the extension of peak pricing to BART.

## Other Alternatives Requiring Further Consideration

With limited time and resources, we only explored two BART alignments, one standard rail alignment, and the Performance Pricing alternative. However, there are many alternatives that we considered (including the Performance Pricing alternative), but did not have time to fully analyze. The alternatives below are could be analyzed further in future study:

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### Combined BART and Standard Rail

While the funding challenges are daunting, a combined BART and standard rail alternative could reap the benefits unique to each crossing. Somewhat counterintuitively, the IEM found that two separate two-track crossings would be approximately 25% less expensive than a four-track crossing due to the geometric demands of such a large crossing. A combined BART and standard rail alternative would therefore not have to settle on single entry and exit points on either side of the Bay. Integrating Alternatives 1 and 3 suggests strong potential benefits. BART would serve high-growth areas and help with transformative land use change, while a standard rail connection to the TTC would provide additional capacity and service directly to Downtown San Francisco. Because of these potential synergies, any station in the I-980 corridor should be built with the possibility of connecting the other service at a later date in mind.

### Southbound BART Alignments

Both of the BART-only alignments explored in depth in this report continue west along Geary due to the density and lack of existing rail transit in that corridor. However, we also considered alignments that traveled south towards Hunter's Point after entering San Francisco either north of Market St or in SoMa. These alignments avoid crossing under the Central Subway and could serve more new growth areas along the southwestern waterfront. However, we did not include any of them in our final analysis, as they typically performed extremely poorly on one or more Key Consideration.

### Auto-Inclusive Tunnel

We also considered ways to include automobiles in these alternatives, particularly in context of a means for additional funding. However, an auto-inclusive tunnel or tube dramatically increases construction costs due to the required increase in size and provides limited transportation benefit, as even a one-way four-lane highway can only transport 8,000 vehicles per hour at capacity.

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# Alternatives Analysis

This section assesses the performance of the four alternatives across the five Key Considerations. The data used to compare the alternatives is based on analysis of current conditions and outputs generated using the MTC's Travel Model 1 and Bay Area UrbanSim land use model. The methodology for the modeling work is described in the Modeling Methodology section. A more detailed description of the metrics used as well as metrics worth considering in future analysis can be found in the Performance Metrics section and Appendix D.

Based on our analysis, we find that the four alternatives provide distinct tradeoffs, with different benefits and visions:

- **New Opportunities:** Serves growing areas downtown San Francisco and Oakland, while creating a more resilient corridor
- **Critical Needs:** Serves highest density areas of San Francisco and Oakland, while building similar resilience
- **Connecting the Megaregion:** Creates new regional connections and job access, and a critical step in the state rail system
- **Performance Pricing:** Flexible response to an immediate need, with revenue to support regional goals

## Social Equity Analysis

The proposed alternatives should improve transportation options and conditions for historically disadvantaged communities in the region and increase the overall social equity of regional distribution of resources. For additional information on the current state of social equity in Bay Area transportation, see the Current Conditions section. While all sections provide information and base their analysis on how to deliver a project in a socially equitable way, the Social Equity Opportunities section offers an additional look at specific social equity-oriented projects.

### Communities of Concern

Transit projects can increase freedom of movement, reduce pollution, and provide access to new economic opportunities. However, they can also have the potential to drive growth that can result in displacement. It is critical to ensure that the opportunities and drawbacks of a transit project of this magnitude are distributed in a socially equitable way. The map below overlays MTC's Communities of Concern and areas designated by the State of California as "Disadvantaged Communities" with the studied third crossing alternatives. See the Current Conditions for further description of each designation.

*Figure 40: Communities of Concern and Disadvantaged Communities near proposed stations*

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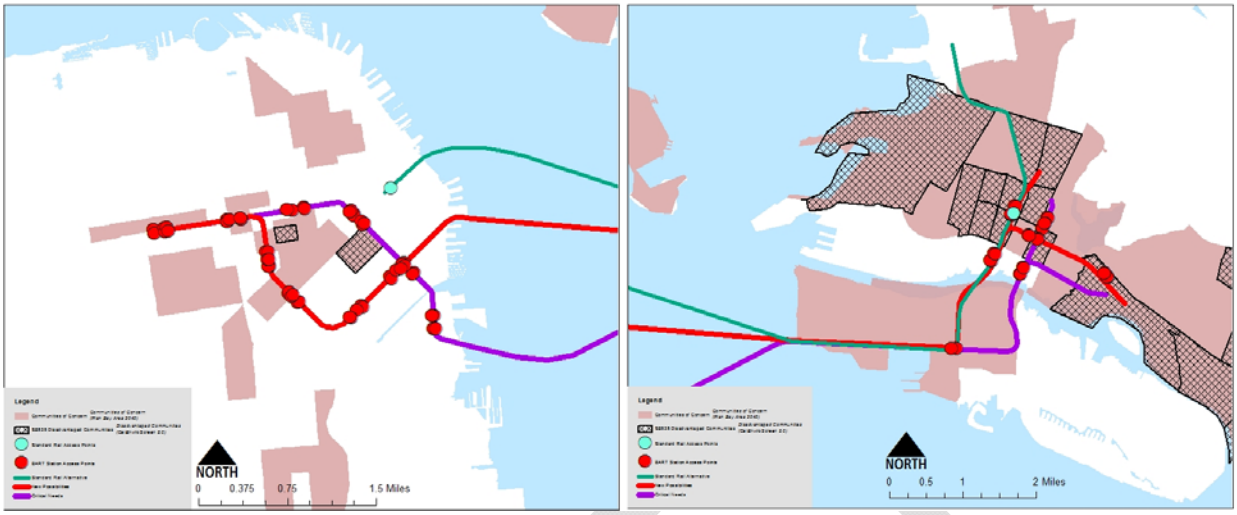


*Source: Map produced by students in the Fall 2016 Transportation Planning Studio using data from MTC's Communities of Concern and areas designated by the State of California as "Disadvantaged Communities"*

All three crossing alternatives have stations located in areas designated as both Communities of Concern and Disadvantaged Communities, though the New Opportunities BART alternative contains significantly more than the other two alternatives. This is due to having multiple stations in Downtown Oakland, as well as building new stations in the mid-Market and Tenderloin neighborhoods of San Francisco and a new station east of Lake Merritt in Oakland.

- **New Opportunities (BART):** Eastlake, 11th/Broadway, 14th Street, 8th/Howard, Hyde/McAllister, Van Ness, Fillmore
- **Critical Needs (BART):** 15th/Franklin, Van Ness, Fillmore
- **Connecting the Megaregion (Standard Rail):** 14th Street, Richmond *(existing station)*

## Travel Accessibility and Reliability for Disadvantaged Communities

By placing new stations in disadvantaged communities, these alternatives have the potential to improve residents' access to services, activities, and jobs. However, as the new transit service provided by these alternatives focuses on transbay travel, it represents significantly less of an improvement for local trips, and these areas are already well-served by Muni and AC Transit (Redhill Group, Inc, 2013).[162] As a result, accessibility improvement for these communities from the crossing alternatives is largely represented by improved access to jobs in San Francisco and the Peninsula.

- **New Opportunities and Critical Needs (BART):** The studied BART alternatives provide minor time savings on existing service lines due to decreased headways. They do, however, significantly reduce travel times for trips beginning or ending in areas that previously did not have a station nearby. These areas include Eastlake and the Brannan St stations in New Opportunities and Mission Rock in Critical Needs, as well as Van Ness and Fillmore in both

[162] Redhill Group, Inc. (2013). *AC Transit 2012 Passenger Survey* (Final Survey Findings). Metropolitan Transportation Commission & AC Transit. Retrieved from http://www.actransit.org/planning-focus/reports/2012-on-board-passenger-survey/

alternatives. Additionally, by reducing intermodal transfers, these alternatives should increase travel time reliability, which is particularly important for those working hourly jobs.

- **Connecting the Megaregion (Standard Rail):** This alternative significantly improves travel times to job centers on the Peninsula from the disadvantaged communities of Richmond and West and Downtown Oakland. However, as long-distance Caltrain service is typically much more expensive than BART and terminates in suburban locations, the extent of this benefit is dependent on the cost of tickets and availability of transit between Peninsula train stations and jobs.
- **Performance Pricing (No New Crossing):** This alternative decreases travel times for transbay bus riders by increasing reliability and decreasing headways. Since low-income individuals are typically less able to adjust their schedules, the increased tolls would save time, but could also create a significant burden for those who must continue to drive across the bridge. In contrast, most white collar high paying jobs in San Francisco are located in downtown and accessible by BART, bus, and ferry. The social equity impact of this alternative on accessibility is therefore largely dependent on implementation of a financial support system for low-income drivers. If such a system is implemented, these low-income drivers may even experience a net benefit, as they would gain from improved travel time reliability.

## Land Use and Displacement

As will be discussed in the land use component of this section, there is limited evidence that any of these alternatives would on their own lead to a substantive increase in the rate of development. That finding, however, is primarily a result of the fact that the binding constraint on San Francisco development is restrictive zoning rather than transit accessibility. Given those supply constraints, the increased demand created by a nearby rail station will increase already-high displacement pressures significantly above what they would have otherwise been. However, even land use scenarios that substantially relax zoning near transit do not improve the displacement pressure for those at-risk communities. Although the increased supply reduces regional pressures, there is a higher risk of direct displacement from increased development in those station areas.

As a result, the degree to which development and/or displacement occurs will depend to a very large degree on the details of how the project is delivered and what steps are taken to help local communities leverage the investment. Details can be found in the Social Equity Opportunities section. This is perhaps most important for the two alternatives that would remove Interstate 980, as specific investments to take advantage of this project could dramatically shift the purpose and use of the land, and which groups of people, services, and jobs are attracted to the new area.

## Air Quality

As discussed in the Current Conditions section, there are high rates of asthma and asthma-related hospitalizations in the low-communities along Interstates 580 and 880. West Oakland experiences particularly poor environmental conditions, as it is also bounded by Interstate 980. Air quality could be improved by reducing the number of vehicles traveling these roads. While the New Opportunities and

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Connecting the Megaregion alternatives would provide some direct air quality benefits by removing Interstate 980, the Performance Pricing alternative offers greatest promise for improving overall air quality. Increased tolls would likely reduce the total number of vehicles, but even more importantly, could lead to large reductions in particulate matter by eliminating congestion and the idling that accompanies it (Barth and Boriboonsomsin). As the stretch of roads approaching the entrance to the Bay Bridge experience the heaviest and longest-lasting congestion, the low-income communities nearby would disproportionately benefit from this policy.

### Funding Concerns

Bus systems in the Bay Area currently receive substantially smaller subsidies than rail systems, at $3 and $6-$14 per trip, respectively.[163] This is problematic from a social equity perspective because bus ridership has a higher percentage of racial minorities and low-income individuals than does rail service. The three crossing alternatives would continue this inequitable funding situation by directing a massive amount of regional funds to a rail system built to serve suburban commuters (Deka, 2004).[164] Funding a third crossing might diminish political will to properly fund for bus services like AC Transit that depend on voter approval and regional funds for operating costs, capital projects, and system improvements. In contrast, the Performance Pricing alternative require minimal public funds to implement and would generate revenue specifically for the purpose of improving bus service.

## Accessibility and Connectivity Analysis

In our accessibility and connectivity analysis, we evaluate the performance of the alternatives in relation to decreasing travel times and cost and in improving comfort and experience.

### Travel Time Reductions

In general, the alternatives generate time savings by providing more direct routes, reducing headways, and by reducing delays caused by crowding and congestion. However, they differ in the level and geographical distribution of those time savings.

- **New Opportunities (BART):** This alternative provides projected travel time savings of 15-20 minutes between most of the East Bay and the Brannan St stations in SoMa compared to baseline, which required the extra time and expense of transferring to/from Muni bus or metro. Travel times between the East Bay and the Van Ness and Fillmore stations would also be reduced by 15-20 minutes. Stations at 14th Street and Howard Terminal would reduce travel times to San Francisco from parts of West Oakland and the Jack London district by about 15 and 5 minutes, respectively. Eastlake station would experience approximately a 10-minute travel time reduction to Downtown San Francisco. Alameda would gain a one-stop ride to SoMa, which before would have been an extremely long trip.

[163] Golub, A., Marcantonio, R. A., & Sanchez, T. W. (2013). Race, Space, and Struggles for Mobility: Transportation Impacts on African Americans in Oakland and the East Bay. *Urban Geography*, *34*(5), 699–728. https://doi.org/10.1080/02723638.2013.778598

[164] Deyaiyoti Deka. (2004). Social and Environmental Justice Issues in Urban Transportation. In *The Geography of Urban Transportation* (pp. 332–355).

- **Critical Needs (BART):** This alternative offers an additional improvement over New Opportunities for the travel times to/from Van Ness and Fillmore due to a more direct route in San Francisco and fewer stops in the East Bay. Alameda and the Jack London district also benefit, as they gain a direct trip to Downtown San Francisco with no transfers. The most significant time savings are experienced in going between the East Bay and Mission Bay, reducing travel times by at least 20 minutes. While both BART alternatives offer the possibility by reducing platform congestion at Embarcadero and Montgomery, the impact is likely larger in the alternative due to additional direct service to the financial district.
- **Regional Connections (Standard Rail):** This alternative opens up new commute possibilities by dramatically reducing the travel time between the East Bay and the job centers of the Peninsula. Travel time from Richmond and Downtown Oakland to the Peninsula would be reduced by around 30 and 25 minutes, respectively, while also eliminating a BART-Caltrain transfer. Largest potential time savings come from those living near the Berkeley and Emeryville stations, though, because of longer distances from BART stations. Trips from the outer East Bay and beyond would also be reduced by the connection of Capitol Corridor and high-speed rail to Downtown San Francisco.
- **Performance Pricing (No New Crossing):** This alternative provides the largest time savings for drivers and carpoolers who choose to pay the toll. Currently, delay on the Bay Bridge can add up to 30 minutes to the commute during the morning peak, a figure likely to increase over time. Transbay bus service should also see time savings from decreased headways and improved transit infrastructure on the bridge. BART riders, on the other hand, may experience increased delay if former drivers begin taking BART, further straining the system.

## Initial Modeling Results

The relative importance of the time savings around each station area depends on how many travelers are impacted. In order to compare the overall time and cost savings experienced as a result of each alternative, we used MTC's Travel Model One to calculate the change in average travel times and costs for commuters traveling to San Francisco. The results are preliminary and somewhat limited, as the model is not able to account for changes in travel time due to crowding on BART. This ignores a significant benefit of the BART alternatives and hides one of the major drawbacks of the Performance Pricing alternative. In addition, our analysis did not account for trips to/from outside the nine-county Bay Area enabled by the standard rail alternative.

The two BART alternatives each reduced the average travel time for San Francisco-bound transbay BART trips by about a minute. This metric, however, does not capture the time savings experienced by riders who start using BART instead of another slower alternative. Ideally, we would compare travel times for similar trips (i.e. same origin, destination, trip purpose, and traveler demographics) between different alternatives, but unfortunately, time constraints prevented this analysis.

The Performance Pricing alternative resulted in the largest time savings for drivers, reducing the average travel time of driving trips by three minutes. Drivers earning less than $30,000 experienced the largest time savings, while drivers earning more than $100,000 experienced the largest cost increase,

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likely the result of a lower propensity to carpool or time-shift. However, average travel costs over the entire system were roughly similar across all four alternatives.

### Comfort and Experience

Transbay BART trains are currently over capacity during commute hours, leading to significant crowding issues that can cause delays as well as discomfort. The BART alternatives address crowding most directly, either by diverting enough riders to provide relief in New Opportunities, or by providing additional direct service to the San Francisco Financial District in Critical Needs. The standard rail alternative, however, would divert a much smaller portion of riders from the existing tube. Still, moderate relief may be sufficient depending on regional growth patterns. The impact of the Performance Pricing alternative requires additional research to determine how former drivers react, but it likely makes BART crowding worse.

Each of the three third crossing alternatives also provide the benefit of allowing more residents to complete their trips on a single ride, or at least within a single system. This simplifies trips and reduces potential delay and stress from waiting for a connection. This benefit is particularly notable at many of the new San Francisco BART stations, as while the stations are relatively close to existing transit service, reaching those destinations from the East Bay requires riders to transfer between BART and Muni.

## Land Use Planning Coordination Analysis

As described in the Key Considerations section, a primary goal of a new crossing should be to further a connection between the transportation system and land use patterns. It can do this by connecting existing areas of dense commercial and residential activity, as well as by encouraging further growth in underutilized core areas.

### Methodology

To assess land use changes caused by the addition of potential new stations, we identified parcels within a ½ mile walking (network) distance. We used a nearest neighbor analysis in the Pandana python package along with an OpenStreetMap walking network (provided by MTC) to assign parcels to the nearest station up to ½ mile away without double-counting parcels.

### Existing Conditions

The existing conditions around potential stations in the BART and standard rail alternatives were compared using three metrics: (1) current population, (2) current jobs, and (3) percentage of parcels that are either vacant or containing buildings with less than 67% of the allowed density under current zoning, also known as "soft sites."[165] Population and jobs indicate whether existing land use supports new service, and the percentage of soft sites offers a rough approximation of the ability to increase land use intensity without changing zoning. Although there is only one new station in the standard rail

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https://github.com/MetropolitanTransportationCommission/bayarea_urbansim/blob/master/output/capacity.md

alignment, existing stations expected to have significant new service patterns were included for analysis.

*Table 6: MTC UrbanSim analysis for proposed new station areas in 2010*

| | City | Station | Residents | Jobs | Soft Sites |
|---|---|---|---|---|---|
| **BART 1: New Possibilities** | Oakland | Eastlake | 7,252 | 2,872 | 51% |
| | Oakland | 11th/Broadway | 3,903 | 13,797 | 87% |
| | Oakland | 14th Street | 4,642 | 13,122 | 74% |
| | Oakland | Howard Terminal | 290 | 3,035 | 74% |
| | Alameda | Alameda | 2,184 | 673 | 21% |
| | San Francisco | 4th/Brannan | 3,141 | 6,837 | 34% |
| | San Francisco | 6th/Brannan | 2,526 | 10,112 | 31% |
| | San Francisco | 8th/Howard | 9,592 | 13,538 | 68% |
| | San Francisco | Hyde/McAllister | 16,080 | 29,618 | 60% |
| | San Francisco | Van Ness | 14,856 | 13,101 | 64% |
| | San Francisco | Fillmore | 13,972 | 10,669 | 53% |
| | | Total | 78,438 | 117,374 | |
| **BART 2: Critical Needs** | Oakland | 15th/Franklin | 5,402 | 26,362 | 82% |
| | Oakland | Jack London Square | 2,527 | 3,607 | 84% |
| | Alameda | Alameda | 2,184 | 673 | 21% |
| | San Francisco | Mission Rock | 1,213 | 1,766 | 4% |
| | San Francisco | Ballpark | 4,174 | 4,710 | 40% |
| | San Francisco | 3rd/Mission | 3,622 | 36,474 | 91% |
| | San Francisco | Union Square | 20,693 | 35,354 | 66% |
| | San Francisco | Van Ness | 14,856 | 13,101 | 64% |
| | San Francisco | Fillmore | 13,972 | 10,669 | 53% |
| | | Total | 68,643 | 132,716 | |
| **Standard Rail** | Berkeley | Berkeley | 2,097 | 4,383 | 43% |
| | Emeryville | Emeryville | 2,673 | 5,347 | 38% |
| | Oakland | 14th Street | 4,642 | 13,122 | 74% |
| | Richmond | Richmond | 3,767 | 2,143 | 61% |
| | San Francisco | Transbay Transit Center | 4,139 | 108,690 | 86% |
| | | Total | 17,318 | 133,685 | |

*Source: Table produced by students in the Fall 2016 Transportation Planning Studio using data from the MTC UrbanSim model.*

Despite having far fewer stations, the Critical Needs alternative brings more jobs and nearly the same number of residents to within a ½ of station areas. The New Possibilities alternative, on the other hand,

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includes more total soft sites, which is in part explained by the higher number of stations along the line. In all cases, the stations in Downtown Oakland and Downtown San Francisco have the highest percentage of soft sites. Of course, total available square footage is not considered when counting soft site parcels. Parcel counts likely under represent opportunities in areas like Mission Bay, which has considerable redevelopment potential.

While the Performance Pricing alternative does not result in new stations, it still has the potential to affect land use. A higher toll on the Bay Bridge would further incentivize East Bay commuters to move to San Francisco or look for jobs in the East Bay. Its effect on job location, however, is unclear. While it might make the East Bay more appealing as an employment center for companies with a large number of East Bay workers, it might also cause a stronger business preference for a San Francisco location due to decreased travel times and increased reliability on the bridge (Leape, 2006).

## Land Use Change Model Results

A new crossing may lead to additional development around new stations by improving accessibility. That said, it is not clear that lack of accessibility is significantly restricting development in San Francisco or Oakland. According to the CCTS San Francisco Market Assessment, the primary limiting factor on growth in downtown and around proposed stations is tight zoning and Proposition M, which restricts total commercial square footage. The CCTS Oakland Market Assessment, on the other hand, found growth in the core to be limited mostly due to less favorable financial conditions for developers compared to San Francisco, as the area is already very well served by regional rail.

The studio used the UrbanSim land use model to conduct model runs for each of the third crossing alternatives under two zoning and land use scenarios: (1) a business-as-usual scenario, and (2) the Plan Bay Area preferred scenario. Each result was then compared to a business-as-usual scenario with an unchanged transit network. We did not run a land use model for the Performance Pricing alternative, as MTC had not implemented a zoning scenario that aligned well with the scenario we designed and a custom implementation was not possible due to time constraints.

The models largely confirm our prior intuition that transit accessibility is not the binding constraint on development in these areas. With zoning held constant, none of the crossing alternatives significantly boosted residential growth compared to what would be otherwise expected through 2035. For non-residential development, only the “New Possibilities” BART alternative had a notable effect, though the additional 1.4 million square feet it created is not that large when considered over the entire modeled timeframe. Full results can be found in Appendix E.

Based on the results of this land use model, a new crossing will not by itself spur significant additional development without changes to existing zoning. Furthermore, it is possible that pent up demand for development in the Bay Area is so strong that additional transit accessibility does not make a significant difference even with the looser zoning of the Preferred land use scenario. A new crossing should therefore not be viewed as a vehicle that increases development except to the extent to which it drives zoning changes. If zoning decisions are considered to be external to the decision to build a new crossing, then the Performance Pricing alternative would offer a similar level of development while generating revenue that could be used to directly encourage desired development patterns.

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## Climate Change Mitigation

The alternatives each provide an opportunity to reduce regional greenhouse gas emissions by decreasing the number of private vehicle trips across the transbay corridor.

## Expectations

The modeled alternatives provide two primary methods for reducing greenhouse gas emissions by personal vehicles. The BART and standard rail alternatives shift driving trips to transit through new and improved service. The Performance Pricing alternative uses increased toll pricing to discourage single occupancy vehicle trips, shifting many travelers to carpool or use transit. Although emissions reduction would be somewhat tempered by new drivers seizing the additional capacity, the eventual equilibrium represents a definite decrease in emissions.

## Relative Reductions in Emissions

We used the MTC travel model to estimate emissions changes for Bay Area travel in 2035. We evaluated each alternative in comparison to baseline, using VMT as a proxy for emissions.[166] The standard rail alternative reduces 1.5 million miles of vehicle travel on an average weekday, roughly three times the reduction from other alternatives. This estimate does not include trips outside the region, potentially undercounting VMT reduction for long rail trips formerly made by driving. The Performance Pricing reductions are likely overestimated: the toll prices chosen resulted in peak morning travel well below the Bay Bridge's capacity. Any real implementation would eventually result in a lower toll price than was modeled, yielding more driving and somewhat higher VMT levels.

The standard rail and BART alternatives achieve VMT reductions by shifting drive alone and carpool trips to transit, reducing drive alone trips both in the peak and throughout the day. In contrast, the Performance Pricing sees an increase in carpooling and significantly reduces VMT in the peak periods. The early morning (3am to 6am) sees an increase in driving that is more than offset by peak period reductions. These results were consistent with our expectations. VMT actually increases among small commercial vehicles, indicating that commercial traffic may increase in response to an overall reduction in congestion.

## Takeaways and Context

Further analysis is needed to determine why the standard rail alternative reduces three times as much VMT as the BART alternatives. Standard rail has the potential to move relatively long driving trips to transit by connecting the Capital Corridor and Caltrain lines. However, the land use analysis shows that the new standard rail stations in the East Bay are surrounded by relatively few residents and jobs, minimizing the number of individuals impacted by the new service.

The VMT reductions are substantial but must be considered in the context of total Bay Area travel. Weekday VMT is projected to grow to about 370 million miles on an average weekday, making projected savings less than 0.5% of total VMT. To the extent that this project is focused on commuters, the

[166] A more complete discussion of the modeling is included in the Model Methodology.

modest reduction should not be a surprise. Commute trips are typically the longest regular household trips but only account for 28 percent of household VMT (Santos et al, 2009).

# Resilience and Adaptation Analysis

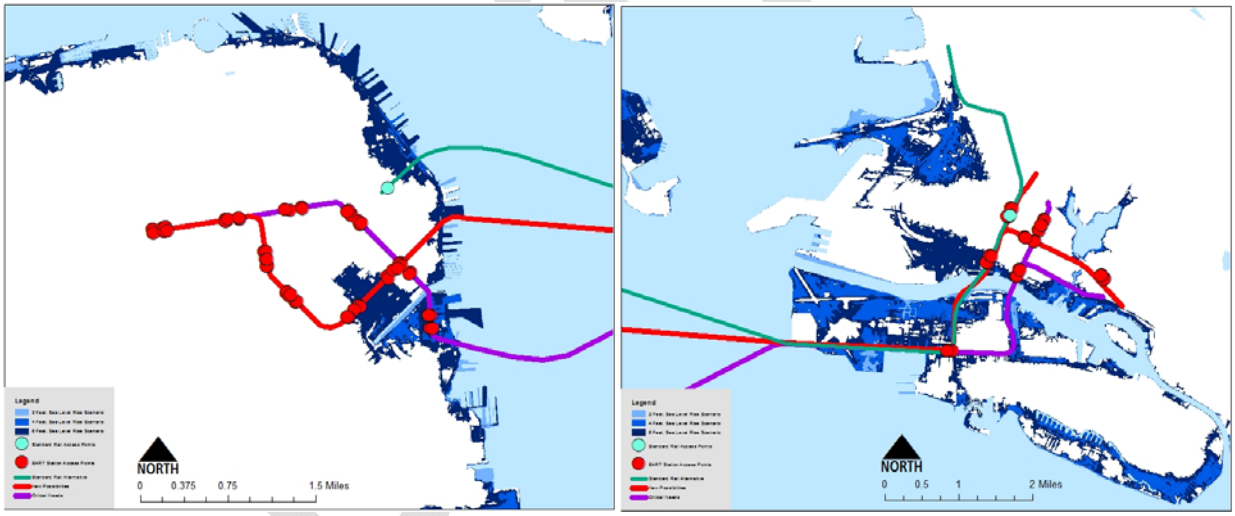
We evaluate the alternatives' contribution to system resilience by analyzing system redundancy as well as vulnerability to sea level rise and liquefaction hazard.

## Risk Considerations

### Sea Level Rise Analysis

Several of the proposed stations for both East Bay and San Francisco alignments are in areas that are at-risk to sea level rise (see Figure 41). As discussed in the current conditions, the projected sea level rise by 2100 is 4.5 feet. Two, 4, and 6 feet sea level rise from existing shoreline are given in the maps to show a range of possible outcomes. In San Francisco, both BART alignments include stations and track in at-risk areas in and around the Mission Bay area. In the East Bay, both BART alignments include a vulnerable station on Alameda Island.

*Figure 41: Set of diagrams of proposed transbay crossing alternatives with flood in San Francisco and Oakland.*



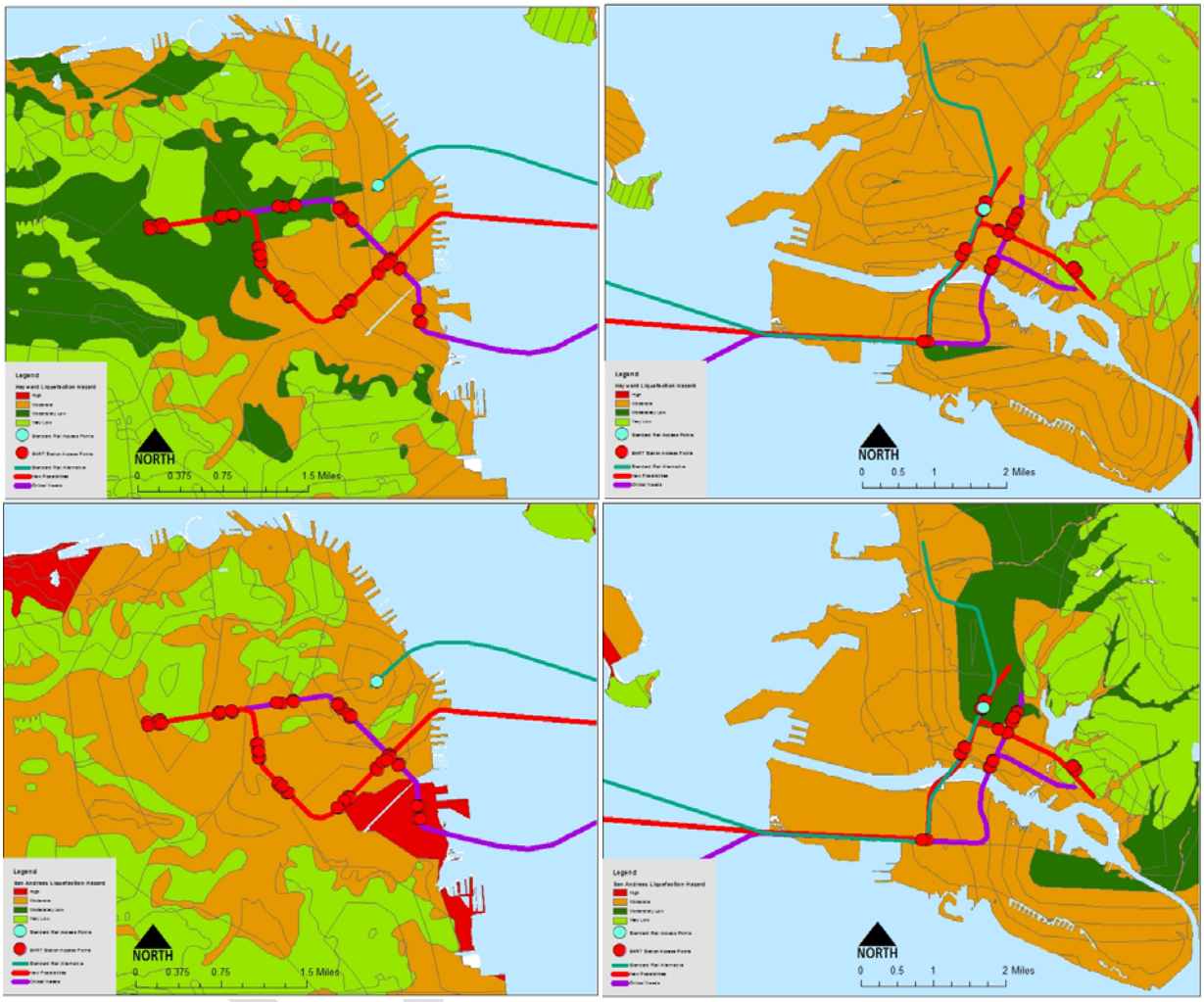

*Source: Map produced by students in the Fall 2016 Transportation Planning Studio using sea level rise scenario GIS data provided by ABAG Resilience Program.*

### Seismic Risk Analysis

We consider seismic risk by evaluating station proximity to soil liquefaction zones. As shown in figures X and X, all of the proposed stations have some degree of risk, which comes with being on the bay. However, similar to the sea level rise risk, the BART stations proposed in New Possibilities and Critical Needs for the Mission Bay area and Alameda Island pose the greatest liquefaction risk because of the

San Andreas and Hayward faults. This is in part due to sections of the San Francisco shoreline and Alameda Island being constructed through man-made infill.[167]

*Figure 42: Set of diagrams of proposed transbay crossing alternatives with seismic liquefaction risk posed by the Hayward (top row) and San Andreas (bottom row) faults.*




*Source: Map produced by students in the Fall 2016 Transportation Planning Studio using data provided by the ABAG Resilience Program*

## Protecting Critical Assets

The sea level rise and seismic risk analysis does not account for potential mitigation measures. For instance, stations at risk to sea level rise could be coupled with mitigation efforts such as seawalls to improve the long term viability of new transportation infrastructure. It is also important to consider the cost required for protecting at-risk stations. The work required to make stations safe would add significant cost to alternatives that include at-risk stations.

[167] See USGS's discussion of liquefaction and landfill in the Bay Area.

With that in mind, the Performance Pricing alternative has relative promise for protecting critical assets. As explained previously, this alternative generates significant revenue and could therefore pay for protecting the critical assets against such risks.

### System Redundancy

Redundancy of service is a particular concern on the transbay corridor, given just one crossing each for transit and driving. Neither crossing could serve the additional demand that would result from a temporary or long-term service disruption. Compounding the issue, the current BART tube will eventually be in need of repairs that may require a significant period of closure.[168] Both BART alternatives and the standard rail alternative improve system redundancy; in contrast, the Performance Pricing alternative does not address this concern.

The BART alternatives provide the best result in responding to a shutdown of the existing tube. Given unexpected disruptions, BART could adjust service in real time. Longer term, BART riders retain the ability to cross the bay. The standard rail alternative would require riders to transfer between systems given a disruption, incurring a new charge and adding substantial travel time.

There is no ideal alternative given the Bay Area's inherent vulnerability to seismic activity, soil liquefaction, and sea level rise. The BART alternatives provide transit system redundancy; standard rail does the same but with less convenience. Neither alternative provides infrastructure adaptation without incurring significant additional cost. The Performance Pricing alternative does not provide redundancy but may generate funds for protecting critical assets.

## Model Methodology

This section briefly introduces the methodology used to model changes in land use and travel patterns arising from the alternatives presented in Alternative Development. Limitations of the models are also discussed.

### Travel Demand Model

We used the MTC's travel demand model, Travel Model One (TM1), to estimate quantitative changes in travel patterns. TM1 was specifically developed for the nine-county Bay Area and is currently being utilized in the creation of Plan Bay Area 2040 (PBA 2040). We used the most recent version of TM1 (July 2016, release 0.6) and received significant support in this endeavor from David Ory and the Analytical Services Unit at MTC.

#### Travel Model One Background

**Activity-based Model**

TM1 is an activity-based model. An activity-based model is one that simulates the travel decisions of *individual* people and households instead of assigning overall travel flows based on generalized

[168] See SPUR's discussion on page 10 in *Designing the Bay Area's Second Transbay Rail Crossing*

estimates of time and cost. This makes activity-based models both more accurate and more sensitive to changes in the transportation system.

The choice of trip travel mode can demonstrate the decision-making process analyzed in an activity-based model. A traveler has a range of possible modes available for their trip (such as driving alone, driving to rail, walking to a bus, etc.). When choosing among these modes, an individual considers information like travel cost and travel time. The decision-maker's demographic characteristics and personal preferences also influence the choice. Ultimately, the individual chooses the mode that minimizes total costs, both monetary and non-monetary. A well-estimated activity-based model attempts to capture all possible variables that influence individual decisions, as well as how the relative importance of each factor shifts depending on socioeconomic characteristics.

TM1 is also a tour-based model, which considers the fact that people may make intermediate stops along the way to their final destination. One typical tour is the home-based work tour, meaning the journey from home to work and back to home. If there are no intermediate stops, then this tour is composed of two trips: home-work and work-home. If, however, there is a stop to go grocery shopping on the way home from work, then then those three trips (home-work, work-grocery, grocery-home) are chained together for the given tour. This representation of realistic travel behaviors adds complexity to the model but also increases the validity of its results.

**Baseline Assumptions**

In September 2016, MTC and ABAG released the Draft Preferred Scenario for PBA 2040,[169] and we adopted TM1's travel pattern predictions for 2035 from that scenario as our baseline. This 2035 baseline includes changes to the transportation system like BART frequency and capacity upgrades and extension to Santa Clara, Caltrain electrification and extension to the Transbay Transit Center, and slight Bay Bridge toll increases. Land use assumptions were fixed in different alternatives in the travel demand modeling process and are based on the Draft Preferred Scenario from the Bay Area UrbanSim land use model.

### Model Input

Travel demand is generated by a synthetic population of individuals and households that are representative of the Bay Area population in terms of residential locations and various socioeconomic characteristics. The travel preferences of these different groups are estimated by calibrating the model to predict similar travel patterns to what we presently observe. Then, based on these estimated preferences, TM1 predicts how individuals and households respond to changes in the transportation system. We left the demand side of the travel model untouched because the purpose of the exercise is to estimate how the same population responds to different new crossing alternatives in the same timeframe.

The supply side of TM1 is comprised of the highway network and transit network. The highway network is composed of roadway intersections and the links between them that represent the actual roadway network of the Bay Area. These links all contain information such as number of lanes, free flow speed,

[169] http://planbayarea.org/the-plan/Draft-Preferred-Scenario.html

and capacity. Several of the alternatives involve the removal of Interstate 980, which we modeled by re-defining these link characteristics to that of a large boulevard.

The transit network is based on the highway network and is connected to the highway network by special links. TM1 defines six categories of transit modes: local bus, express bus, ferry, light rail, heavy rail, and commuter rail.[170] The BART network, for instance, is defined by stations and links that represent the physical network, with distances and travel times attached to each link. To add a station to the network, we create a node representing the station and connect it with links to the existing BART network, as well as all other ways that people can access the station.

In addition to the physical infrastructure, service patterns are also used by the model. To translate a BART line service, for example, we include all the stations it travels through and how often trains arrive during different time periods. If a new BART station or line is added or changed, we also need to define the time and money cost for all possible trips to/from that station or on that line. In summary, the model inputs are a collection of definitions of the infrastructure and services that determine all possible paths for individuals to travel, as well as the travel time and price associated with each possibility.

### Model Output

Once the required inputs are entered, the individuals and households in the model decide which tours and trips they want to make throughout the day. TM1 then initiates an iterated simulation. In each iteration, individuals first make mode choices based on system conditions generated from the previous iteration. Then, the model assigns transit trips to the transit network and utilizes user-equilibrium principles[171] to assign individuals' driving trips to the highway network. These iterations are continued until a stable travel pattern is reached.

The fundamental output of TM1 is all the trips that the synthetic population makes in a typical weekday. For every trip taken by every individual in the model, we know the following information: why the trip was taken, what mode was used, what specific path was followed, and all the associated monetary and non-monetary costs. This information can allow us to summarize ridership estimates, modal splits, VMT impacts, and how effects vary by different income groups, among other possibilities.

## Land Use Model

To model the land use impacts of a new crossing, we used UrbanSim, an open-source land use modeling software package, and relied heavily on MTC's existing model specifications and policy scenarios. Modeling support was provided by Mike Reilly and MTC's land use modeling group, as well as Professor Paul Waddell of UC Berkeley and UrbanSim, Inc.[172]

[170] http://analytics.mtc.ca.gov/foswiki/Main/TransitNetworkCoding

[171] http://analytics.mtc.ca.gov/foswiki/pub/Main/Documents/2011_03_22_Release_First_Round_Travel_Model_Technical_Summary.pdf

[172] Additional support was provided by Fletcher Foti (MTC), Sam Maurer (UC Berkeley), and Sam Blanchard (UrbanSim, Inc.).

## UrbanSim Background

UrbanSim is a platform that allows users to simulate urban development.[173] Like TM1, it uses microsimulation models, representing decisions made by individual households, businesses, and real estate developers. UrbanSim is a free and open-source platform written in Python, and is used by many local and regional governments around the country and world.

UrbanSim simulates urban development by first applying a hedonic regression, which estimates land values based on each parcel's individual attributes, including transit accessibility, income of the surrounding area, and others. It then simulates real estate development and the location choices of households and businesses based on demand, zoning, and prices.

## Model Inputs

**Baseline Data and Control Totals:**

Each run of the UrbanSim model starts with data files representing individuals, households, jobs, parcels, buildings, and zoning for the entire Bay Area. This data is freely available online courtesy of MTC. As with TM1, households and jobs are represented as synthetic populations that are generated to statistically representative of the Bay Area at various geographic levels. MTC's projected regional growth of households and jobs is treated as exogenous and therefore also provided as an input to the model.

**Policy Scenarios**

MTC is using the Bay Area UrbanSim model to evaluate potential land use and transportation scenarios as part of the process of developing PBA 2040. MTC released three preliminary scenarios in May 2016 and a preferred alternative in November 2016. We used two of these scenarios ("No Project" and "Preferred") in the evaluation of our alternatives, which are described in Table 7.

*Table 7: UrbanSim scenarios used in model analysis*

| | No Project Scenario | Draft Preferred Scenario |
|---|---|---|
| **Zoning** | Existing | Upzoning in some Priority Development Areas |
| **Urban Growth Boundary** | Expand by 389 square miles | Existing boundaries/city limits add 68 square miles |
| **Development Caps** | Existing | Raises San Francisco office cap to 1.25 million |
| **Subsidies and Fees** | Subsidy to approximate SB 743 | Subsidy to approximate SB 743, One Bay Area Grants, Inclusionary housing policies, greater profitability for projects in Transit Priority Areas |
| **VMT Fee** | None | Assessed on office and retail development |
| **Parking Minimums** | Existing | Decreased in core Priority Development Areas |

[173]Waddell, P. (2002). UrbanSim: Modeling Urban Development for Land Use, Transportation, and Environmental Planning. Journal of the American Planning Association, 68(3), 297–314. https://doi.org/10.1080/01944360208976274

**New Crossing Alternatives**

We incorporated our alternatives into the UrbanSim model by modifying land prices within 1000 meters of network distance from new stations. Details are provided in Table 8. Travel times and other accessibility variables were not taken into account, as these variables are not currently included in MTC's official model. While this means that we do not capture the effect of lower travel times on residential or commercial location choice, previous MTC efforts suggest that land use is substantially more sensitive to the mere presence of a station than to specific accessibility variables.

*Table 8: Third crossing alternatives modeled in UrbanSim model*

| Alternatives | Models | Coefficients Used |
|---|---|---|
| **Alternatives 1 and 2 (BART)** | Residential hedonic regression[174], Non-residential hedonic regression | Equal to those used for inner-ring BART stations |
| **Alternative 3 (Standard Rail)** | Residential hedonic regression | $15/sq. ft., using standard error and t-statistic for category 2 BART stations |

For alternatives that include development of the Interstate 980 corridor, we allowed parcels within the corridor to develop according to zoning for nearby downtown parcels. We chose to simulate development in this corridor starting at the beginning of the model in 2010. While this is an obviously unrealistic assumption, opening parcels up for development later in the simulation yielded little to no development. While this could be due to a relative lack of demand and development profitability, it might also simply be a result of not allowing enough time for development or randomness in the model. In any case, allowing an artificially early start to development allows us to gauge what might happen over time in this corridor, and since the corridor only contains around 17 developable acres, it does not significantly affect overall model results.

## Model Output

The model outputs provide estimates of household, job, parcel, and building data for 2035. We summarized results at the census tract, station area (half-mile network distance from new stations), and municipal levels for total population, number of households, number of residential units, number of jobs, non-residential square footage, and proportion of parcels where the existing number of dwelling units is less than 67% of the allowable maximum.

[174] A hedonic regression is a method of estimating value (in this case, the value of real estate) based on observed characteristics.

## Limitations

### Basic Limitations of the Models

- **Stochasticity:** All UrbanSim and TM1 simulations involve some level of randomness. Because of this, multiple runs of the same model will result in slightly different results. When looking at small subsets of the population, however, this random variation can result in dramatic differences. An ideal solution is to generate many runs of each model specification and report results based on an average or range of values. Unfortunately, due to time constraints, we were able to report on only a single model run for each specification.
- **Interpretability:** The outputs of large agent-based models can be difficult to interpret accurately, as interpretation requires substantial knowledge of the modeling process and a clear understanding of the assumptions embedded in the system. Simulated outcomes are influenced not only by inputs we modify, but also by preset parameters. Results that seem to be driven by a modeled variable of interest might actually be due to artificial parameters or assumptions we make in the modeling process.
- **Feature Limitations:** Model development for this project was an iterative process of creating imperfect models, improving areas that provided implausible results, and fixing mistakes in coding. While we believe our models were specified well enough to provide a general indication of what might happen were a new crossing built, there is always room for further improvement, particularly in terms of estimating the coefficients used for hedonic regression and more accurate estimations of travel times and costs.

### Integration of Travel Demand and Land Use Models

Given the strong connection between transportation and land use, an ideal modeling approach would integrate the travel demand and land use models. Unfortunately, due to time and resource constraints, we were not able to perform this integration. As previously mentioned, however, empirical evidence suggests that the impact of changes to transportation infrastructure typically overwhelms the effect of transportation system performance variables on land use patterns. Because of this, our non-integrated methodology likely still captures most of the actual effects.

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# Funding and Financing

## Introduction

A third crossing will require an innovative funding and financing framework due to the project's complexity and the uncertain future of federal and state support. Our analysis of this topic applies the academic literature concerning the development of cost estimates and the equity implications of various funding mechanisms to a potential new crossing. Case study analysis and conversations with experts also inform our discussion. This section is organized as follows:

- *Improving Cost Estimation Accuracy*
- *Equity Concerns in Fundraising and Distribution*
- *Constrained and Ideal Funding Scenarios*
- *Case Studies – Denver and Sao Paulo*
- *Key Recommendations –*

Establishing trust between project managers, private financiers, and public taxpayers is essential to the successful completion of megaprojects and can easily be undone by financial mismanagement. Recent transportation megaprojects in the Bay Area and elsewhere have brought this issue to the forefront with significant project delays and major cost overruns (Trapenberg Frick, 2016). Focusing on strategies that minimize risk and maximize transparency and accountability is particularly important in the context of a new crossing, as a number of funding strategies require legislative or voter approval.

## Improving Cost Estimation Accuracy

Though in-depth engineering and environmental analyses have not yet been conducted, preliminary cost estimates for a new crossing are between $8 and $12 billion (AECOM Consult, Inc, 2012). While assigning new cost estimates is beyond the scope of this project, predicted costs of major infrastructure projects are often significantly lower than actual costs (Flyvbjerg, Holm, & Buhl, 2002; Flyvbjerg, Holm, & Buhl, 2004). Additionally, many secondary costs like financing costs, transaction costs, and maintenance & operations costs are not included in public deliberations or sufficiently considered in overall project cost estimating. To address these issues, we propose several risk management techniques, including reference class forecasting, which adjusts costs estimates to align with comparable completed projects (Flyvbjerg, 2006).

### Headline Costs Are Systematically Underestimated

A study of thirty-three large bridge and tunnel projects found final costs averaged 33.8% higher than estimated costs (Flyvbjerg, Holm, & Buhl, 2002), a difference attributable to optimism bias and "strategic misrepresentation" of project realities. Regardless of whether this systematic underestimation is intentional, cost estimates usually do not account for the possibility of typical project changes, conflicts, or accidents.

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## Additional Cost Considerations: Finance Costs, Transaction Costs, and Maintenance & Operations Costs

### Finance Costs

While the public can generally grasp the scale and opportunity cost of the headline estimate, the financing structure of most megaprojects involves borrowing funds that must be repaid later with interest. Debt repayment can add significant expense, as the additional revenue from the project must exceed the interest rate if the financing structure is not to contribute a net cost. This typically does not happen, though, as benefits and ridership estimates are as systematically overestimated as costs are underestimated. Megaprojects often result in interest payments over the lifetime of the loans that exceed the value of the principal (Wachs, "A Dozen Reasons").

### Transaction Costs

Transaction costs include contract and legal fees, inspection fees, financing and negotiating fees, and other administrative expenses. These costs are typically considered external to a project and are rarely accounted for in project estimates (Whittington & Dowall, 2006). Megaprojects are particularly susceptible to high transaction costs due to the need for highly specialized expertise (increasing outside contracting) and the amount of uncertainty at each phase of the project (Arena & Molloy, 2010. *Transaction Cost Economics*, Williamson, 1979).

Megaproject contracting has historically been structured with a design-bid-build (DBB) process, which separates design and construction. Recently, though, a design-build (DB) process, where one private firm completes both the design and construction of a project, has become more popular. It's unclear if DB actually leads to lower costs, however, as the reduction in transaction costs seems to be passed along to the construction phase (Whittington, 2012). As such, the efficiency savings from DB may be entirely captured by the contractor.

### Maintenance & Operations Costs

Project cost estimates typically end with the start of operations. However, there is rarely public discussion of how the eventual maintenance and operations of additional service will be funded and what level of ongoing funding will be required. For transit projects, user fees in the form of fares are a primary source of funding for operations and maintenance, with 74% of BART's (BART, 2015) and 60% of Caltrain's (Caltrain, 2015) operating costs paid for by passenger fares. It is imperative to address how new transit projects will affect current fares and how any deficit between farebox recovery and operational expenses will be covered.

## Mitigating Cost Estimate Inaccuracies: Risk Management & Reference Class Forecasting

Comprehensive risk management and increased cost estimate accuracy can improve both the public trust and private-sector interest in a project. This can greatly improve the likelihood of a successful project by easing the ability to secure taxpayer funds and leading to more competitive bids for the construction. In order to properly manage the risk of cost inflation and minimize inaccuracies, agencies

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responsible for megaproject delivery should present project milestone deadlines as ranges, plan for a lengthy and costly environmental review process, and use reference-class forecasting in cost estimation.

**Present Dates for Key Milestones as Ranges**

Project delays can cause construction cost increases of roughly 5% per year (Flyvbjerg, Holm, & Buhl, 2004), as well as increased financing costs due to accrued interest payments and the need to quickly assemble additional funding. Missed payments stemming from these delays can further increase costs by hurting credit ratings and requiring higher interest payments to obtain additional financing. Obtaining and publicizing accurate project costs and schedules from the beginning can help avoid this situation, lowering finance and transaction costs over the life of the project.

**Plan Strategically for Environmental Review Process**

Litigation during the environmental review process can lead to schedule delays, increased financing costs, and legal fees, and the effect of this potential litigation must be included in both time and cost estimates. Additionally, the design process should be nearly finalized before beginning construction to lower the risk of these lawsuits. While this can be challenging for DB projects, where the sequencing of environmental review has not typically synced with project selection, state governments in Texas and Oregon have begun to require a certain level of environmental review before selecting a final proposal (Whittington & Dowall, 2006). Agencies could also secure all necessary permits and approvals and complete environmental review themselves before involving the private sector.

**Utilize Alternative Cost Estimating Methods: Reference-Class Forecasting**

Rather than exclusively trying to predict costs for the particular project, agencies should also employ reference-class forecasting, which looks at the final cost of completed projects with similar type, complexity, and governance as the project at hand (Flyvbjerg, Garbuio, & Lovallo, 2014). This process helps to minimize optimism bias by forcing estimates to be grounded in real-world outcomes. This method can be used to estimate specific components of a project in addition to the cost of the project as a whole. Similar to presenting a project timeline, it is also important to present all cost estimates as ranges in order to recognize the inherent uncertainty.

## Equity Concerns in Fundraising & Revenue Distribution

The Transportation Research Board's special report "Equity of Evolving Transportation Finance Mechanisms" highlights the following frameworks for evaluating equity concerns in transportation funding:

- *Benefits received*: People who use the service or infrastructure should pay for it
- *Ability to pay:* Payment should be progressive and increase with income
- *Return to source*: Transportation investment should be geographically distributed in proportion to the amount paid in taxes

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- *Costs imposed*: People who impose negative externalities should pay additional fees

Any decision on a funding mechanism must take these competing visions of equity into account. Additionally, the assessment of the merits of a particular funding mechanism must be in relation to the most likely alternative. For example, while fuel taxes are regressive in that they represent a higher percentage of income for low-income individuals, they are less regressive than a sales tax add-on, which is the typical source of local transportation funding.

Sales tax measures are politically popular and have successfully funded transit projects in Los Angeles, San Francisco, and Alameda Counties (SPUR, 2003; LA Metro, 2016; Alameda County Transportation Commission, 2014). Despite this, we believe sales taxes to be one of the more strongly and obviously regressive potential funding mechanisms. As the following analysis does not include sources we believe to be inequitable, we do not discuss a sales tax in greater depth.[175]

## Funding Scenarios

It is challenging to predict what funding and financing opportunities will be available in the coming decades. To address this uncertainty, we have created both ideal and constrained scenarios (see Table 9). The constrained scenario accounts for the current economic and political realities of transportation funding, while the ideal scenario includes sources that are more politically challenging. There is also discussion of funding sources not included in either scenario due to equity concerns or extreme feasibility limitations. While these funding sources are analyzed within the context of a new crossing, they can also be considered in a Performance Pricing alternative. Lastly, the majority of the sources identified in the funding scenarios are mode-agnostic and would be available for either BART or standard rail, unless otherwise specified.

The main funding sources we have identified include loans, grants, user fees, special assessment districts, and value capture mechanisms. With the exception of a few mechanisms that were analyzed using the land use and travel models, sources are not assigned specific dollar amounts. Each source is identified as an option for capital expenditures (C) and/or operations and maintenance (O&M).

*Table 9: Funding scenario assumptions for federal sources*

| | ***Funding Source*** | ***Available in Constrained Scenario?*** | ***Available in Ideal Scenario?*** | ***Capital (C) / Operations & Maintenance (O&M)*** |
|---|---|---|---|---|
| **Federal** | Federal Transit Grants | | X | C, O&M |
| | Federal Loans | X | X | C |
| | Seismic and Resilience Funds (Federal and Regional) | X | X | C |
| **State** | State Right-of-Way Assets | X | X | C |

[175] Additionally, the abundance of sales tax measures in recent ballot cycles has put many Bay Area cities closer to the statutory limit of 10.5% on sales tax rates (AB 464, Mullin & Gordon, 2015).

| | | | | |
|---|---|---|---|---|
| | California's High Speed Rail Bond of 2008 (Proposition 1A) | | X | C |
| | California Infrastructure and Economic Development Financing Bank | X | X | C |
| **Local** | Bonds / BART Bond 2016 | X | X | C |
| | Geographic Fundraising Mechanisms (Special Assessment Districts & Value Capture Mechanisms) | X | X | C, O&M |
| | Regional Measure 3 | X | X | C, O&M |
| | Regional Measure 4 | | X | C, O&M |
| | Congestion Pricing | | X | C, O&M |
| | BART Fare Restructure | X | X | C, O&M |
| | Accessory Funding: Naming, Advertising & fiber optics | X | X | C, O&M |

# Federal Sources

## Federal Transit Grants

Gas taxes have traditionally been the main revenue source for standard transportation grant programs. The primary federal transit funding program for capital projects falls under the Capital Investment Grants authorized under Section 5309 of Title 49, U.S. Code. There are also specific grants available for operational expenditures and preventative maintenance such as the Urbanized Area Formula Grants (Santa Clara Valley Transportation Authority, n.d.). Other funding sources are available for projects that decrease congestion such as the Congestion Mitigation and Air Quality Improvement Program (CMAQ). Recent Bay Area transportation projects have received significant federal grant funding. The first phase of the Transbay Terminal amounts to $2.2 billion. Of that total, the project received $402 million in Federal Railroad Administration (FRA) grants through the American Recovery and Reinvestment Act of 2009 (ARRA) and $68 million in Federal Transit Administration (FTA) grants (Transbay Transit Center, n.d.). The Central Subway (total: $1.6 billion) received over $940 million from the New Starts program and $41 million in Congestion Mitigation and Air Quality (CMAQ) Improvement Program (SFMTA, n.d.).

### Constrained Scenario

The Government Accountability Office includes "Funding the Nation's Surface Transportation System" on its High Risk List of 32 agency and program areas in need of transformation (United States Government Accountability Office, 2015). The federal gas tax has not been raised since 1993. The revenue per mile of travel raised by this tax has been steadily decreasing due to the effect of inflation, increasing vehicle fuel efficiency. At the same time, the cost of transportation projects has increased

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dramatically due to increased land and labor costs and environmental regulations, among other factors. The need for the funding has also increased as the country's transportation system continues to age and expand (Wachs, 2006). Given Congress' continued reluctance to increase the gas tax, the constrained analysis assumes that federal funding will not be available for this project in the form of grant funding.

### Ideal Scenario

Ideally, there will be federal transit grant funding available for a new crossing alternative. It is possible that this funding comes from a VMT tax rather than a motor fuel tax, which has been piloted in Oregon and California (Oregon Department of Transportation, 2015; California SB1077 DeSaulnier, 2014). We expect this to become a more common form of transportation tax revenue and to serve as the primary mechanism of federal funding for public transit.

## Federal Loans

### Both Scenarios

While grant funds are not a reliable source, the federal government is a unique provider of credit, and this is not likely to change. Both the constrained and ideal scenarios assume the project will be able to access loans through programs such as the Transportation Infrastructure Finance and Innovation Act (TIFIA). While revenues come from the federal highway trust fund, which might be significantly diminished, and TIFIA may not exist in the same form, we assume that a mechanism for federal credit with similar terms will continue.

TIFIA offers loans, lines of credit, and credit enhancement. TIFIA loan interest rates are typically below market rate and repayment terms are longer and more flexible than typical private loans (Sasha Page, Bill Bishop, & Waiching Wong, 2016). Repayment can be amortized over 35 years (Regional Transportation District, 2004). Program fees range between $400,000 and $700,000 (U.S. Department of Transportation, 2016). Credit assistance is currently limited to 33% of a project's total cost. Project sponsors can include states, state infrastructure banks, private firms, special authorities, local governments and transportation improvement districts.

Sales taxes, tax increment financing, and special assessment district revenues typically secure TIFIA loans (U.S. Department of Transportation, 2016). For example, Denver Union Station secured a TIFIA loan backed by sales tax revenues, and the Transbay Terminal TIFIA loan of $171 million will be repaid through the Tax Increment district. If a new crossing project includes standard rail, the project could access funding through the federal Railroad Rehabilitation and Improvement Financing (RRIF) program, which has similarly attractive terms. TIFIA projects must significantly support the regional economy, international commerce, and/or the national transportation system. Applications are also judged on the extent to which a TIFIA loan could increase attractiveness for private involvement and how the project would help to maintain or protect the environment (U.S. Department of Transportation, 2015). A new crossing would score well on all accounts.

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## Federal & Regional Resilience & Seismic Funding

### Both Scenarios

Bay Area infrastructure is vulnerable to seismic and climate change threats, and funding resources often become available as a result of disaster relief appropriations or specific hazard mitigation needs. The Disaster Relief Appropriations Act and the Sandy Recovery Act of 2013, for example, not only authorized federal funding for disaster and emergency spending after Hurricane Sandy, but also mandated the development of a "national strategy for reducing future costs, loss of life, and injuries associated with extreme disaster events in vulnerable areas of the United States" (113th Congress, 2013). After Hurricane Sandy, the Federal Transit Administration announced the availability of $3 billion in funds for states impacted by the damage to fund resilience projects that would "address current and future vulnerabilities" (Federal Transit Administration, 2013).

Funding sources that are originally created for specific disaster mitigation projects can also be adapted for other purposes. Assembly Bill 1171 was passed in 2001 to increase Bay Area bridge tolls by $1 for seismic retrofit projects for the region. MTC's Resolution 3434, adopted in 2005, permits funding from AB1171 Bridge Toll seismic funds to be spent on projects eligible under MTC's Transit-Oriented Development (TOD) policy for Transit Extension Projects (Metropolitan Transportation Commission, 2005). Projects are eligible if they develop land near transit and establish coordination between transit agencies.

It is our hope that additional funding sources become available to prevent future hazards. Currently, the Federal Emergency Management Agency (FEMA) offers hazard mitigation grants and pre-disaster mitigation funds. The Environmental Protection Agency (EPA) provides grants to support development that will mitigate greenhouse gas impacts through coordination of land use and transportation planning. It is possible that this type of smart growth funding from the EPA will evolve to include funding for projects that increase resiliency and climate change impact adaptation measures. The U.S. Department of Housing and Urban Development (HUD) announced a National Disaster Resilience Competition in 2015 to fund nearly $1 billion in disaster recovery and long-term resilience efforts. While these funding programs have specific requirements and limitations on funding eligibility and administration, funding programs may continue to support seismic, climate change mitigation and adaptation projects, and resilience efforts.

# State Sources

## State Assets

### Both Scenarios

For projects receiving federal assistance, Title 23 of the United States Code section 323 (Donations and Credits) authorizes state transportation departments to credit the fair market value of state-owned assets incorporated into their projects. If a new crossing contributes to the removal I-980 in Downtown Oakland, the project could have access to a significant source of funds transferred from state assets. A related precedent is the removal of the Embarcadero freeway after the 1989 Loma Prieta earthquake and the subsequent authorization to transfer right-of-way parcels from Caltrans to the City and County

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of San Francisco and to dedicate the "excess right-of-way proceeds for local street improvements" (SB798 - Burton, 1999).[176]

## California Infrastructure and Economic Development Financing Bank

### Both Scenarios

The California Infrastructure and Economic Development Financing Bank (IBank) is one of 33 State Revolving Funds nationwide. The IBank was established in 1994 to promote infrastructure and development "that promote[s] a healthy climate for jobs, contribute[s] to a strong economy, and improve[s] the quality of life in California communities." Since its inception, the IBank has financed $38 billion of infrastructure and development, including $600 million in low-interest loans and over $37 billion in bond issuances. The Infrastructure State Revolving Fund (ISRF) provides direct loans for a variety of infrastructure projects in amounts anywhere from $50,000 to $25 million. The ISRF provides below-market interest rates, a non-competitive application process, and no matching requirements. Lastly, the application process would subject the project to a level of scrutiny that aligns with some of the risk-reducing recommendations already discussed (California IBank website).

## California's High Speed Rail Bond of 2008

### Ideal Scenario

In 2008, voters approved a $9.95 billion rail bond to construct high-speed rail linking San Francisco and Sacramento with Los Angeles and San Diego. Of that, $950 million was allocated for local transit systems that would connect to the high-speed rail. It is possible that this amount will increase as the bond money shifts towards statewide transportation modernization projects. For example, Assembly Bill 1889, passed in 2016, authorizes $1.1 billion of the bond to go towards Caltrain electrification. While the High Speed Rail Authority has committed $2.6 billion to match already-invested federal funds, the *Sacramento Bee* speculates that the remaining bonding from Proposition 1A may become a slush fund for regional transit operators (Dan Walters, 2016). Our ideal scenario envisions that the third crossing could obtain as much as 40% of this revenue source ($2.2 billion). We base this estimate on the "40-60" Northern California-Southern California split enshrined in 1997 Senate Bill 45 for state transportation improvements (Caltrans, 2016). Of course, it is important to recognize that any funding from this source would imply a reduction in funding for the state's High-Speed Rail project.

# Local Sources

## Bond Mechanisms

### Both Scenarios

Local bond authorizations for transportation have experienced recent success at the polls and will be a vital funding component. Bonds are typically backed by value capture mechanisms associated with increased development near stations, or by a dedicated repayment funding stream like sales tax add-

[176] Senate Bill 181 authorized repair or replacement of Route 101 (1991); Senate Bill 798 (1999) relinquished state highway 101 from Caltrans to City of San Francisco after the public voted to not rebuild the destroyed section of the highway downtown and committed the remaining right-of-way proceeds to local streets.

ons, property tax increases, or tolls. Although Proposition 13 and subsequent ballot measures have imposed a two-thirds voter approval requirement for any tax increase, these measures have proven to be reasonably popular in recent history.

#### BART Bond 2016

##### Both Scenarios

In November BART successfully passed a district-wide general obligation bond measure (Measure RR) authorizing the issue of $3.5 billion in bonds over 21 years. Bond funds will support state-of-good repair measures (infrastructure is maintained to a level that is safe and reliable) including track replacement and control system upgrades. The bond is backed by an increase in property taxes, up to $17.49 per $100,000 of assessed value. One inclusion in the measure that hasn't garnered much attention is $200 million allocated for "future projects to relieve crowding, increase system flexibility and responsiveness, and reduce traffic congestion." These funds could contribute to supporting costs associated with the early-stage planning of the third crossing (SPUR, 2016).

## Geographic Fundraising Mechanisms

##### Both Scenarios

In 2011 the California Legislature authorized legislation effectively ending the state's Redevelopment Agencies (RDAs), a move that was later upheld after a legal challenge from cities. RDAs were first authorized in 1945 and supported with federal funding until 1952, when Proposition 18 enabled the use of tax-increment financing (TIF). With the authority to declare an area blighted (and thus in need of redevelopment), a city or county could dedicate all future increases in property tax revenues to its RDA. The RDAs could issue bonds backed by future TIF revenues and assemble or clean up parcels to attract development.

After the passage of Proposition 13, RDAs were one of the few ways for municipalities to finance redevelopment, as local RDAs captured almost all of the new revenue, compared to the 5 to 20 percent of property tax revenue that cities usually retained. TIF is appealing because there are no revenue losses compared to baseline, but there are obviously opportunity costs associated with ceding future revenues for cities and the state. In the wake of RDAs' dissolution, a new TIF funding mechanism called an enhanced infrastructure financing district (EIFD) has been created. (sources: "The Demise of TIF-Funded …", Blount et al 2014, California Watch website)

Assessment districts, Mello-Roos districts and Enhanced Infrastructure Facilities Districts are three geographic fundraising mechanisms commonly used in California to generate funding for infrastructure and services, as shown in Table 10. The use of these districts has increased since the tax revolt of the 1970s caused severe funding constraints. Geographic fundraising mechanisms are more equitable for transportation infrastructure than sales tax measures because they are paid for by property owners rather than the general public. With the establishment of any geographic fundraising mechanism, we propose that the revenue generated is directed towards not only a new crossing, but a community grant program that would be managed by the aforementioned Community Advisory Board.

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*Table 10: Differences between types of special assessment districts*

| | Assessment District | Mello-Roos / CFD | EIFD |
|---|---|---|---|
| **What it Can Pay for** | Any improvement or activity that confers benefit to the properties within the boundary | Improvements or infrastructure benefitting the district | Infrastructure of "communitywide significance" called for in an infrastructure financing plan |
| **Formation** | Majority of property owners, with votes weighted by benefits accrued<br><br>OR,<br><br>two-thirds-voter approval (see Proposition 218 box) | Majority of residents if more than 12 residents live in district boundaries<br><br>OTHERWISE,<br><br>Majority of property owners | Local agency or JPA creates an infrastructure financing plan |
| **District size and boundary-setting opportunities** | District boundaries need not be contiguous, but benefit to all properties must be demonstrated | Boundaries need not be contiguous; generally limited to smaller geographies. | Boundaries need not be contiguous |
| **Assessment mechanism** | The encompassing agency must issue a report proving the benefits and showing the formula by which benefits match assessment for each property. | Each property owner is responsible for a tax lien, based on property use, improvement size, and lot size. | Tax increment financing |

*Sources: (californiataxdata.com, Fulton Chapter 19)*

**Assessment Districts**

Assessment districts are a popular method of funding infrastructure improvements, as the concept is easy for voters and elected officials to understand. A district boundary is drawn, and every property owner inside the district contributes to the cost of the improvement through a special assessment. This model could be extended to contribute revenue towards a new transbay crossing.

Assessment districts can fund infrastructure in two ways; the first of which is standard assessments. If the benefits in question can be shown to accrue as value to real property within district boundaries, then the authorizing agency issues a report that analyzes distribution of benefits and proposes commensurate assessment levels. Then, a benefit-weighted vote among property owners must clear a simple majority to approve the district. The second option is via a generally accepted benefit to the district. In this case, the agency may levy a "special tax" rather than an assessment (see Proposition 218 box). Additional evaluation is needed which method is

more viable for a new crossing. Such evaluation could draw from past research on the property value impacts of rail and BART stations (Strategic Economics, 2014).

**Proposition 218**

California State Proposition 218, the "Right to Vote on Taxes Act," tightened the rules on benefit assessments and distinguished between assessments and special taxes. When the Santa Clara County Open Space Authority formed an assessment district to preserve open space, the district assessed virtually every parcel in the county uniformly with a benefit assessment. After Proposition 218 passed, a lawsuit and eventual ruling established that the assessment was instead a special tax because it did not confer specific benefits to the broad base of property owners assessed. Subject to this ruling, an agency's proposed assessment must be accompanied by a technical report that quantifies the benefits to each parcel. A general benefit conferred to the district parcels falls into the category of special tax, which requires two-thirds voter approval.

**Mello-Roos/Community Facilities District**

The Mello-Roos Community Facilities Act of 1982 enabled the creation of assessment districts for new developments to pay for necessary infrastructure. Two-thirds voter approval is required for the formation of a district. If there are at least 12 people currently living in the district, they are the electorate; otherwise, landowners are the voters.[177] There are special considerations and risks with landowner Mello-Roos districts, commonly called "dirt bonds" because at the time the district is drawn, there is often nothing backing them except dirt and the promise of development. Therefore, while voter approval may be easier prior to development, there is also greater risk in depending on funds from a district that is not yet developed.

The district may levy a property tax, either to pay directly for facilities or services, or to service bond debt for the same. The enabling legislation does not specify how to apply the tax, except that it may not be assessed *ad valorem*[178]. The tax is commonly based on a formula involving lot size and improvements but can also be a per-parcel tax. Also, Mello-Roos districts do not need to be contiguous or conform to any jurisdiction's boundaries. If, for example, Alameda County wanted to draw a Mello-Roos district that extended into neighboring Contra Costa County, the two agencies would form a Joint Powers agreement for the formation of the district.

A Mello-Roos district also contains the advantage of the ability to add new property to the district by a process similar to the initial district formation. The incentive of additional density through upzoning may encourage participation in the district; such agreement was the driving force behind San Francisco's Transbay Terminal Mello-Roos District (see Mello-Roos in Transbay Transit Center box) (BORT ARTICLE cited by the legal study).

***Mello-Roos in Transbay Transit Center***

[177] There are special restrictions on landowner Mello-Roos districts,

[178] *Ad valorem* taxes are applied proportionally to assessed value; that is, a certain percentage of assessed value is levied. This is the typical mechanism for property tax assessment.

The first two phases of the $2.2 billion Transbay Terminal project have received around $1.2 billion from the formation of a Mello-Roos district. In 2012, the City of San Francisco authorized upzoning for several parcels in the Transit Center District Plan area. Property owners could opt to join the Mello-Roos district as a trade for additional height allowances. The Mello-Roos district allowed the Transbay Joint Powers Authority to issue bonds and impose special tax on the owners of those parcels. The tax was set in 2012 at 0.55% of the assessed value,[179] or roughly $3.30 per square foot. However, in 2015, the assessed values of these properties had increased such that the Mello-Roos assessment worked out to $4.91-$5.11 per square foot and could be estimated to generate considerably more revenue for the project. (SFCTA MEMO, SFGate "alter SF" story, SFGate "developers drop threats" article). After threatening to sue, several of the developers in the Mello-Roos district backed off and the project proceeded.

**Enhanced Infrastructure Facilities Districts**

Enhanced infrastructure Facilities Districts (EIFD) have come to the foreground with the extinction of the state redevelopment program. The EIFD model, authorized by Senate Bill 628 (SB 628) in 2014, uses value capture through tax increment financing.

Unlike Mello-Roos districts, EIFDs may capture *ad valorem* property tax from consenting agencies. Participating cities or counties must therefore consent to cede what is an anticipated increase in property tax revenues to the EIFD, whereas a Mello-Roos district simply levies a separate and additional tax. This form of revenue generation is more palatable for taxpayers because it does not generate additional burden. However, its success requires cities and counties to agree to set aside property tax revenues, and in an already built-out area, the increase in property values may not generate as much money as a parcel tax.

The formation of the district does not require a vote, and issuance of tax-increment backed bonds requires only 55% voter approval within the district. Funded projects are not required to be located within the district but must detail their connection to the district in an infrastructure financing plan.

The existing legislation for EIFDs does not adequately protect the provision of affordable housing. SB 628 requires low- or moderate-income housing that is lost through takings or other redevelopment to be replaced within 2 years, and temporary replacement units must be provided for immediate use at the time of displacement. (Cal Gov Code S53398.56(a)-(b)).[180] However, the bill does not set aside additional money for the provision of affordable housing, (California Planning and Development Report, 2014) unlike the former Redevelopment Agencies, which had to set aside 20% of tax increment revenues for that purpose. Senate Bill 2280 would have re-established tax-increment financing for community revitalization with a 25% affordable housing set-aside, but it was vetoed in 2014 (Alejo, 2014).

[179] The tax was not set on property value but based on a different formula whose rate worked out to be this level.
[180] (https://hklaw.com/publications/enhance-infrastructure-financing-districts-sb-628-beall-11-12-2014/#_edn20)

If the above shortcomings can be fully addressed, EIFDs would be well suited for combining multiple revenue sources and coordinating the efforts of many agencies or authorities.

**Half-Mile Enhanced Infrastructure Facilities District**

One possible use of the EIFD model would be to establish an EIFD for areas located within a half-mile of each proposed station location, as well as existing stations. These "station catchments" represent the areas in which the improvements to the transportation system would capitalize into property values (Strategic Economics, "BART Premium"). The total size of the value increase is greatly affected by the number of vacant parcels and properties that are not built to maximum zoning potential, as these would generate the greatest changes in property taxes. While the structure of this funding mechanism would not lead to additional displacement pressures compared to other mechanisms, the historically problematic relationship between tax-increment districts and urban renewal projects means that an EIFD should be used with sensitivity to potential conflicts of interest.

Modeling could be used to estimate total potential revenue generation and, if possible, should incorporate the potential for joint development in the half-mile districts, which could increase revenues generated both from land sales and from subsequent property taxes.

**Nine-County Land Value Tax**

Using the land use model discussed in the Model Methodology section, we have derived rough estimates of revenue potential for one geographic funding mechanism in particular: a parcel tax levied on a special district comprising all property in the nine-county Bay Area (see Table 11). Land values for 2010 were used due to the wide range of possibilities for 2035 scenarios. As such, the total revenue generation listed below represents a lower bound of potential revenue.

This scenario offers more flexibility in where and how the funding is spent, as it is not dependent on value added from a new crossing. It could be structured as a perpetual fund for infrastructure, or it might sunset with the completion of the project. It might also be structured to apply to projects across the nine-county region, or to projects beyond transportation infrastructure. This tax would be more politically challenging to implement, requiring two-thirds-voter approval in areas where voters may not feel they are receiving direct benefits.

We draw the conservative (0.004%) land value tax rate from 2016's nine-county Measure AA. The measure, which passed with 70% support, imposes a $12 annual parcel tax across the nine-county Bay Area through 2037. The funds pay for environmental protection of the San Francisco Bay. Based on our land use model, the roughly $25 million Measure AA generates per year could have been achieved with a property tax rate of approximately 0.002%. Because the total Bay Area land value is just under half of the total property value, we chose double the rate (0.004%). For the sake of comparison, we also chose a more "aggressive" land value tax rate of 0.025% to see how much money would be generated.

*Table 11: Nine-county land value tax*

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| | Land Value, 2010 | Property Value (land + improvements) | Conservative Land Value Tax, 0.004% | Aggressive Land Value Tax, .025% |
|---|---|---|---|---|
| **Residential** | $337,000,000,000 | $746,000,000,000 | $13,480,000 | $84,250,000 |
| **All other non-tax-exempt parcels** | $121,882,386,452 | $309,599,670,737 | $4,875,296 | $30,470,597 |
| **Total** | $458,882,386,452 | $1,055,599,670,737 | $18,355,296 | $114,720,597 |

*Source: Produced by students in the Fall 2016 Transportation Planning Studio using UrbanSim data.*

**Community Grant Program**

With the establishment of an EIFD and/or land value tax district, a community grant program focused on improving social equity in the region should be created from a dedicated portion of the revenue. The principle is similar to SB 535 (2006), which requires that 25% of cap-and-trade proceeds be spent on projects that benefit disadvantaged communities. The Community Advisory Board discussed in the Governance section would administer the grant program.

## Regional Measure 3

### Both Scenarios

Regional Measure 2, approved by voters in 2004, increased bridge tolls by $1 on seven of the region's state-owned bridges. In addition to supporting operations, revenue from this toll increase also supports capital projects across the region, including the Transbay Transit Center, the Oakland Airport Connector, and the Warm Springs BART extension (Metropolitan Transportation Commission, 2012). MTC has proposed sponsoring Regional Measure 3 to raise the tolls on state-owned bridges in order to fund bridge corridor transportation, and it plans to put it on the ballot in 2018 (Metropolitan Transportation Commission, 2015). The state legislature will determine the amount of the toll increase and where and how the revenues will be spent. Based on past bridge toll increases, a $1-$2 boost is most likely, with a percentage dedicated to fund major future capital projects and operations.

## Congestion Pricing & Regional Measure 4

### Ideal Scenario

We expect the region and state to develop an additional Regional Measure to generate revenue in the transbay corridor between now and project execution. The revenue generated by this toll would go directly towards programs that aim to decrease congestion across the region. We estimate that an additional $1 toll on the Bay Bridge could generate $57 million annually. This could be used towards backing a bond, and over 35 years could amount to nearly $2 billion.

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In addition to this $1 increase, we propose expanding the peak period variable pricing scheme. This recommendation builds on the Bay Area Toll Authority and State's efforts to increase tolls in 2010 to fund seismic safety projects on the bridges and implement a peak period variable pricing scheme along the Bay Bridge (Deakin et al., 2011). As a result of these efforts, the Bay Bridge has a peak period toll of $6 and an off peak toll of $4. The ideal scenario would involve implementing peak pricing along the six other state-owned bridges. These bridges would also ideally experience overall toll increases, with a pricing formula dependent demand increasing with inflation. The automation of toll collection with FasTrak will eliminate concerns of less-than-one-dollar increases. Pricing should also account for the potential need for a toll discount for low-income riders, seniors, veterans and students as well as a discount for carpooling and high-occupancy vehicles.

## BART Fare Structure Changes

### Ideal Scenario

We recommend a change in BART fare structures to include an increased peak period fare, an additional Bay crossing surcharge, and a subsidized fare program for low-income riders. An increase in peak period fares would help solve capacity concerns by encouraging those with flexibility to travel off-peak. An additional transbay surcharge in addition to the current $0.94 would likewise address capacity in the tube and provide a nexus between those who cross the Bay and a new crossing.

However, these fare increases would place a greater burden on low-income riders, making a subsidized fare program even more important. Los Angeles Metro's Rider Relief Program offers fare subsidy coupons, and Muni's Lifeline Pass offers a 50% discount on standard adult monthly passes for riders within certain income brackets (Los Angeles County Metropolitan Transportation Authority, n.d., San Francisco Municipal Transportation Agency, 2013). Income eligibility for the Lifeline Pass can be verified through tax returns, an award letter for CalWORKS, CAAP, CalFresh, or Medi-Cal, two State Disability of Social Security check stubs, or a Government Housing Assistance Program Contract (San Francisco Municipal Transportation Agency, n.d.). BART currently offers discounts for people with disabilities, veterans, Medicare card holders, seniors, and DMV placard identification holders through the Regional Transit Connection Discount card (BART, 2016). We propose expanding this to include Medi-Cal card holders, as well as an additional option for people to apply for a subsidized pass that is based not on income but on occupation. This would allow people who are undocumented or wary of sharing personal income information to apply for a discounted pass.

The Federal Transportation Administration (FTA) requires all transportation agencies to adopt a "Disparate Impacts and Disproportionate Burden Policy" under Title VI (Federal Transit Administration, 2012). This policy applies when there is a change of service or a change in fares and requires separate analysis for minority and low-income populations, and a fare change related to a third crossing would most likely be subject to both fare and service equity analyses. This type of analysis is important but needs improvement to more equitably address the needs of disadvantaged populations. While this basic formula may be necessary for federal approvals, the region should hold itself to higher and stricter standards and impose additional procedural and analytical requirements including vulnerability assessments and a range of impact rather than average threshold.

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## Accessory Funding: Naming, Advertising, and Fiber Optics

### Both Scenarios

Additional funding could come from selling advertising and naming rights and offering fiber optic access to riders. While these funding mechanisms have been utilized in metro areas as diverse as New York City and Dallas (Metropolitan Transportation Authority, n.d., North Central Texas Council of Governments, 2011), there may be significant public concern in the Bay Area regarding the encroachment of the private sector in this area. Furthermore, the controversy surrounding related contracts could increase legal fees and public relations costs. Hospitals and other commercial sites have historically had greater success with selling naming rights, and in 2015, the Transbay Transit Center issued a sponsorship/naming rights offer. However, as of 2016, there has not been any public release of any contract (Transbay Transit Center, 2015).

## Cost Option Not Included: Cap-and-Trade

Cap-and-trade funding is not included in either scenario despite the fact that it has sponsored transportation projects in the past. California High Speed Rail (HSR) received $250 million in cap-and-trade auction proceeds in 2015, and a quarter of cap-and-trade revenue is reserved for HSR each year through that project's Phase 1 (California Legislative Analyst's Office, 2016). Additionally, Senate Bill 535 requires a quarter of the funds raised to be spent on projects that provide direct benefits to disadvantaged communities. Such projects have included replacement of high-polluting vehicles with low-emission electric vehicles and offering van pool commute options (Alvaro S. Sanchez, 2015). However, the cap-and-trade revenue stream is unpredictable. In May 2016, only 7 million of the offered 68 million allowances were sold (California Air Resources Board, 2016), due in part to concerns about the legality of cap-and-trade. The court ruling on whether cap-and-trade is an illegal tax is likely to be handed down within the next year. Although auction sales rebounded in November 2016 (California Air Resources Board, 2016), the fundamental uncertainty of the program makes it inappropriate to rely on it for funding.

# Case Studies

## Case Study: São Paulo "Certificates of Additional Potential for Construction"

In 2001, the Brazilian government passed the Statute of the City, federal legislation designed to assist local governments in addressing the country's patterns of urbanization (Mathur, 2016).[181] The statute gives local authorities the right to capture property value increases and to sell development rights that go beyond what is permitted by zoning regulations through changing uses, footprints, and floor area ratios (Sandroni, 2010). These rights are sold as "Certificates of Additional Potential for Construction" (CEPACs) on the Brazilian Stock Exchange (Mathur, 2016). A version of this system has been in place in Sao Paolo since the 1980s, with the goal of increasing the overall housing stock and decreasing the use

[181] The Federal City Statute serves in part to maximize the public benefit of land use. Other components of the statute relate to the use of vacant lots. If a lot is vacant, owners are taxed at higher rates for a maximum of five years, at which point the government dedicates the land to a state-managed land bank to provide public services such as housing.

of informal settlements (Siqueira, 2012). The CEPAC system has been credited for quickly generating a lot of money with relatively low risk. However, its implementation raises social equity concerns, and a federal investigation committee questioned the extent to which they truly serve as an instrument for the public good.

CEPACs have focused primarily on districts that the City designates for growth and redevelopment, called Urban Operations (UO) areas. The City first makes a determination of how much additional housing stock they wish to add in the UO and how much money would be required to fund the required infrastructure improvements to accommodate that level of growth. The City then puts up for auction enough CEPACs to allow for that additional growth and sets a minimum price that ensures they raise enough money for the required infrastructure, while also factoring in the estimated increase in property values that the increased density will unlock. (Mathur, 2016). The revenue generated from CEPACs must be used within the district and is linked to objectives of the UOs (discussed below).

## CEPACS as a Fundraising Mechanism

São Paulo has issued CEPACs for two UOs, Faria Lima and Agua Espraiada, which generated US$812 million between 2004 and 2009. Annual citywide property tax revenue with $1.4 billion in 2007, as a point of comparison (Sandroni, 2010). In 2004, the first 100,000 CEPACs for UO Agua Espraiada's were auctioned for US$150 million. Each CEPAC represented additional allowable building area of 1-3 square meters depending on land values, and the resulting sales quickly raised US$15 million for infrastructure projects (Sandroni, 2010).

The money raised from sales of the CEPACs were directed towards transportation infrastructure, compensation for displaced populations, construction of public housing for people living in informal settlements, and overall quality-of-life improvements for local residents. There were three informal settlements in the area, and 10% of the urban operation funding was to be spent on public housing for people that were displaced as a result of the UO (Siqueira, 2012). The Faria Lima UO CEPAC auction offered 90,000 CEPACs at a minimum of US$550 each, with a spatial range of 0.8 square meters to 2.8 square meters per stock. However, only 9,091 CEPACs were sold at auction. The poor auction results were in part due to the fact that the price of CEPACs was higher than what developers could obtain on the market for development licenses from Sao Paolo's' pre-CEPAC regime (Sandroni, 2010). A third public auction in 2007 had more success, as 156,730 CEPACs were auctioned, all sold at higher than the minimum asking price. This success was likely due an improved real estate market and the suspension the trading of the pre-CEPAC licenses (Sandroni, 2010). The lack of predictability in the market is one major drawback of the CEPACs, and while the stocks are linked to the development of specific public housing and infrastructure projects, there is no obligation for the administration to complete the projects if the associated CEPACs are not all sold (Sandroni, 2010).

## Main Benefits & Challenges of CEPACs

CEPACs have the potential to offer quick funding for public projects. However, they lack predictability and come with significant social equity concerns.

**Benefits of CEPACs**

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- CEPACs offer infrastructure funds prior to development without any issuance of public debt. Overall, there is little public risk, as the only cost to the public is planning district objective, calculating CEPAC minimums, and organizing the auction (Mathur, 2016).
- The districts can be drawn so as to avoid negative impacts from gentrification. In São Paulo, there are areas designated for affordable housing called Zonas Especiais de Interesse Social / Special Zones of Social Interest (Sandroni, 2010).
- The competitive process in theory results in the highest bids permissible by the market; if the market bids are higher than anticipated, they generate extra revenue for project spending (Walls, 2010).
- CEPACs can be used at any time, allowing developers to invest in a good market. They can also be used anywhere in the UO; developers are not tied to parcels until they specify (Mathur, 2016).

**Challenges of CEPACs**

- Revenue from CEPACs can only be spent in the district from which they are issued, raising the possibility of a geographically inequitable distribution of resources. This issue is exacerbated by the lack of public participation in the district planning process and the reality that the UO designation can be driven by private interests. The Faria Lima district, for instance, is a more affluent area of the city with high-rise office towers, luxury apartment buildings, and some of São Paulo's most expensive shopping malls (Siqueira, 2012). One way to at least partially address this concern would be to allow CEPAC funds to be applied to neighboring areas that might experience negative externalities due to increased development in the UO.
- The original process did not include any accountability, which led to prioritizing increasing property values in the Faria Lima district over social benefit objectives. While public housing was built, there was not a one-to-one replacement of the housing provided by the informal settlements (Siqueira, 2012). Issues in execution led to a federal investigation, which found that the 10% dedication of funds to public housing was not occurring and that more was built than approved. The federal government has imposed new legislation since their investigation that requires specific accountability measures and increased documentation (Siqueira, 2012).
- Once rights are sold, CEPAC revenue stops (Mathur, 2016). While the administration has the authority to auction more CEPACs, doing so could decrease existing CEPAC prices. As holders of CEPACs not associated with a parcel do not have a right to recover financial damages, this investor uncertainty could undermine the market (Sandroni, 2010).
- To the extent that zoning helps promote general public welfare, CEPACs subvert that process.
- The fundraising mechanism is still in its infancy, and it will take time for both public and private actors to fully understand its implications. For instance, it is unclear what would happen if there is a default and a developer cannot finish a project that is linked to CEPACs (Sandroni, 2010).

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### Adoption of CEPAC Mechanism

The CEPAC model has the potential to raise a significant amount of funds quickly and with low public risk, but with significant potential social equity concerns. Any adoption of a similar mechanism would require adaptation to address issues of displacement, process, transparency and accountability.

California has extensive experience with similar fundraising mechanisms. Tax increment financing and special assessment districts such as Mello-Roos are commonly used to repay bonds for infrastructure projects. Development impact fees require developers to pay specific funds to public projects that support the infrastructure needed for the density expected by their development. Transferrable development rights permit developers to build beyond their zoning allocation in exchange for the purchase of rights on another property. Density bonuses permit developers to build increased floors in exchange for the inclusion of affordable housing.

The key distinction between these funding and incentive mechanisms and the CEPAC model is that the government plays a key role in each transaction. Whereas density bonuses and impact fees are limited to a set price, with CEPACs, the government can realize upside if the auction pushes the price above the minimum. With transferrable development rights, while private entities negotiate the price of a transferrable development rights agreement, the subsequent developments are still bounded by zoning restrictions, unlike with CEPACs (Walls, 2010). Establishing districts where density is determined more by market demands than by public regulations will likely result in increased housing and jobs near transit. However, it is important to maintain zones dedicated to affordable housing in order to prevent the displacement of low-income populations from these areas (note *Urban Displacement Project*, Chapple).

The California legislature has the ability to implement a funding model that associates value to future building stock. Outside of the state's extensive experience with land use regulation, the cap-and-trade for carbon dioxide offers a similar platform. If California were to implement a mechanism similar to CEPACs, however, it is necessary to improve upon the model. There would need to be significant accountability and transparency measures on both the public and private side, and strict requirements for public involvement at every step of the process–from drawing the district lines to determining district objectives and ensuring successful prioritization and implementation.

## Case Study: Denver

The Denver Eagle and Union Station projects provide an example of how complex projects can be delivered with a mix of funding sources and extensive use of financing. Leveraging these tools can help agencies provide public benefit by delivering projects that are otherwise too expensive. Public-private partnerships like the Denver Eagle offload some risk, but this transfer comes with financing and transaction costs. This project benefited from participation as a "demonstration" public-private partnership and received over $1 billion in federal funding—a windfall a new crossing would be unlikely to enjoy, possibly amplifying the hazards of private engagement.

### Denver Regional Transit District

The Denver area Regional Transit District (RTD) provides transit service for an eight-county region encompassing Denver and a surrounding regional population of 2.8 million people. It is one of only

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three elected transit boards in the country. In 2001, the district began planning for an overhaul to the regional transit system with large-scale investment in light rail, commuter rail, and bus rapid transit. After a 3-year planning process that included a 96-member advisory committee (DUS - RTD presentation), RTD released plans for its FasTracks initiative—a 12-year, $4.7 billion plan.

Half of the project funding would come from a sales tax measure approved in 2004 that allocated an additional 0.4% on top of RTD's existing 0.6% sales tax revenue. The district's sales tax growth projections predicted approximately 6% sales tax revenue growth through 2025 (2003 FasTracks plan).

### Rising Costs and Falling Revenues Imperil Project

In the ensuing years, two important trends changed the nature of planning for FasTracks. First, the sales tax revenue did not generate the anticipated annual 6% growth (see FIGURES XX below). Second, commodity and material price increases drove cost estimates up dramatically (transportation.gov project profile). With rising costs and falling revenues impacting the project's feasibility, RTD needed another way to fund and deliver the project.

RTD chose to utilize the Federal Transit Administration's public private partnership pilot program (Penta-P), authorized by 2005's federal transportation authorization legislation SAFETEA-LU. In 2007, the FTA chose three FasTracks pilot projects to demonstrate the potential for agencies to use public-private partnerships to finance and deliver projects. These three projects came to be known as the Denver Eagle:

- The East Corridor (a 23-mile commuter rail line from Denver Union Station to the airport)
- The Gold Line (an 11-mile commuter rail line)
- The commuter rail maintenance facility

### Denver Eagle: Public-Private Partnerships

The shortage in anticipated revenues and the spike in costs were contributing factors to the project's turning to a public-private partnership. Participation in the Penta-P program came with an approximate $1 billion grant from FTA, slightly more than 50% of the project's total revenues, with the sales tax revenue providing local match. The use of a bidding process also drove down costs, as the winning bid came in at $300 million below RTD's internal estimates. The contracting structure established a 34-year design-build-finance-operate-maintain agreement with the Denver Transit Partners (DTP) consortium. A $3.4 million monthly payment from RTD to DTP for fulfillment of contractual duties ensures quality service even in the event of low ridership, as payment deductions for any poor performance would reduce the consortium's profitability.

The resulting revenue sources put together by the consortium are given below in Table 12. The private bonds and private equity together combine for 22% of project revenue. Private equity investors typically expect a higher return, so their inclusion drives the project's cost up. The private activity bonds are publicly issued (and therefore tax free for investors) but backed by the concessionaire's revenue stream. Some of this repayment revenue comes from fares on the lines the concessionaire has built, and the 2016 FasTracks budget shows a projected increase in farebox revenue of 565%—from $4.031 million to $26.797 million (2016 budget). This increase is attributable to the opening of new services, but regardless, the ridership forecast risk is with the agency. The $1 billion grant money from FTA New

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Starts helped ensure that this "demonstration project" would be delivered. Short of this grant money, more equity investment would have to make up the shortfall.

*Table 12: Revenue sources used for Denver Eagle project*

| Source | Amount ($ Thousands) | Percent |
|---|---|---|
| **FTA New Starts** | $1,030,400 | 51% |
| **Private Activity Bonds** | $396,100 | 19% |
| **TIFIA loan** | $280,000 | 14% |
| **Other federal grants** | $57,000 | 3% |
| **RTD sales tax revenue** | $128,100 | 6% |
| **Revenue bond proceeds** | $56,800 | 3% |
| **Local contributions** | $40,300 | 20% |
| **Equity** | $54,300 | 3% |
| **Total** | $2,043,000 | 100% |

*Source: Comprehensive Financial Annual Report*

### Allocating Risk

The contracting structure has the effect of insulating RTD from fears of material or labor cost increases and passing those costs onto the concessionaire. The monthly performance payments keep the risk of low ridership with the transit district, and financial incentives and poor performance penalties ensure the concessionaire adequately builds, operates, and maintains the transit lines.

RTD has imposed these penalties multiple times, as in one example where the safety gates at at-grade crossings failed to come down. The result has been increased personnel costs to DTP to pay for round-the-clock traffic flaggers and $1.1 million in performance penalties (Denver Post 10/2016). Until the problem is addressed, RTD will continue to withhold $250,000 per month, or 7% of the monthly scheduled availability payments. Regarding the penalties, DTP's project director John Thompson said, "For us to get to 100 percent of our [debt servicing] payment, we have to be north of 95 percent on availability [payments]—and we're not there."

In May 2016, a lightning strike caused the train to stall, forcing the evacuation of approximately 80 passengers. RTD and DTP disagree on the cause of the breakdown, but potential lightning strikes had been a controversial subject during the design phase. DTP has filed a "force majeure" claim, essentially arguing that the incident was an "act of God" and beyond their control. A dispute is currently being worked out, and harsh financial penalties are expected.

In one sense, these penalties are a public-private partnership process at work—presumably a private entity with debt and equity investors has as much or more incentive to rectify such problems than would a public agency, lest they go bankrupt. But a problem with offloading those risk to the concessionaire is if the transit system is not properly maintained or operated, the public suffers. Financial penalties align incentives but do not by themselves create better outcomes. At the same time, the dispute resolution process increases the transaction costs of a P3.

## Conclusion: Funding & Financing Key Recommendations

A new crossing project will require a very large amount of funds. We identified possible funding sources available in constrained and an ideal scenarios and highlighted potential opportunities and challenges. A summary of our key recommendations is below.

1) **Project leaders must go beyond a "do no harm" philosophy of social equity.** Regional inequality is a persistent and wide-ranging problem, and a new crossing represents a huge opportunity to generate equitable outcomes. Every step in the funding and financing process must ensure that certain populations are not being disproportionately burdened by the project. Furthermore, any project must incorporate specific mechanisms for meaningful community engagement, such as a transparent public involvement process, accurate cost and timeline estimates, and a long-term Community Grant Program.
2) **Utilize reference-class forecasting to budget for the unexpected.** This project will necessarily be complicated, and the planning and construction process will span many years. Use some of the methods discussed in this report and avoiding the everything-goes-according-to-plan approach to planning and budgeting.
3) **Revenue sources should be broad and stable while minimizing regressivity.** The more stable the funding source, the higher the bond rating and lower the debt risk. Half-mile catchment areas around new stations is the most obvious and politically salient funding mechanism, but a project of this magnitude should not rely on simply what is most politically expedient. Regional, or at least multicounty, support will be necessary. Chosen funding mechanisms must also make sure to limit regressivity.
4) **Funding from existing crossings should come primarily from drivers.** The BART system already has relatively high fares and a transbay surcharge in place. While increasing fares adheres to the "user pays" principle, it also makes a service that should be available to all prohibitively expensive for low-income riders. As Bay Bridge drivers also benefit from more people taking transit across the bridge, toll revenue is a sound option.
5) **Engagement with the private sector must proceed with caution.** Private equity investment can increase financing costs, and ensuring proper risk transfer in contracting can increase transaction costs. Instead, lean heavily on low-cost public financing mechanisms like TIFIA loans and municipal bonds as much as possible.

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# Conclusion

This report sought to consider the implications and possibilities of a third bay crossing. With mounting policymaker and public attention, we had the unique and timely opportunity to weigh in on potential alternatives, evaluation metrics, governance structures, and funding and financing challenges. Each of these questions revealed critical tradeoffs and highlighted the many decisions that will need to be made if the region is to move forward with this project.

Social equity, accessibility and connectivity, land use planning coordination, climate change mitigation, and resilience and adaptation guided our analysis of a new transbay crossing. These considerations were critical for framing the problem, outlining potential alternatives to address these concerns, and developing a methodology for evaluating alternatives. We chose to consider two BART alternatives, one standard rail alternative, and one performance pricing alternative. We evaluated each of these alternatives both qualitatively and quantitatively using the performance metrics and travel and land use models. While these models have clear limitations, they provided quantitative insights that informed meaningful comparisons across alternatives and pointed to areas worthy of future investigation.

Knowing that it would be impossible to evaluate all viable alternatives, we developed our performance metrics to allow governing bodies and independent groups to decide whether to move forward with the project, compare between project alternatives, allocate resources and funding sources developed from the project, and monitor and evaluate the selected project throughout its planning, financing, building, operating, maintenance and governing phases. It is intended that this framework for alternative evaluation will be of value even as the potential alternatives evolve over time.

There are a variety of strategies available for project delivery of megaprojects like a third crossing, including private involvement, management by an existing agency, and a joint powers authority. We found that the ideal governance scenario would involve an integrated multi-modal authority that merges major existing transbay operators. This multi-modal entity would be capable of managing travel demand in a megaregion, but would still continue to provide existing services through modal agencies. To complement the governance structure responsible for carrying out the third crossing, we recommended the formation of a Community Advisory Board in an effort to ensure positive outcomes for vulnerable communities. In addition, we recommend that external independent oversight should be formed from the early stage to minimize unexpected risks and poor communication.

A third crossing will require an innovative funding and financing framework due to the project's complexity and the uncertain future of federal and state support. To address issues like cost estimate shortfalls, we propose several risk management techniques, including reference class forecasting, which adjusts cost estimates to align with comparable completed projects. We also identified potential funding sources, including loans, grants, user fees, special assessment districts, and value capture mechanisms.

Ultimately the third crossing has the potential to be a galvanizing project for the Bay Area and the Northern California megaregion. It will undoubtedly require significant regional cooperation between stakeholders and community members. This report offered our team the opportunity to explore this project from a variety of angles and it is our hope that the analysis conducted will provide a viable framework should the region and State move forward with a plan to build a third crossing.

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# Appendices

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# Appendix A: Current Conditions - Annotated Bibliography

The following section summarizes current resources that address a second transbay crossing or are relevant to the current conditions for a third crossing. These resources from federal and state documents, regional and local public agencies, non-profit and for-profit organizations, and academic research.

## Annotated Bibliography Contents

### Federal and State Documents

- State Rail Plan (2013), *Caltrans*
- Title VI Circular to 4702.1B (2012), *Federal Transit Administration*
- Vulnerability Assessment Scoring Tool (2015) *US Department of Transportation*

### Regional and Local Public Agency Documents

- 2015 State of the Region, *ABAG*
- San Francisco Bay Area Rapid Transit District (BART) Climate Change Adaptation Assessment Pilot (2013), *Federal Transit Administration*
- Bay Area Regional Rail Plan (2007), *MTC*, *BART*, *Caltrain* and *California High Speed Rail Authority*
- Bay Bridge Corridor Congestion Study, (October 2010 draft), *AC Transit*
- Bay Bridge Forward Initiative (2016), *Partnership MTC, Caltrans, AC Transit, WestCat, and WETA*
- Building a Better BART (2014), *BART*
- Capitol Corridor Vision Plan (2014) *Capitol Corridor*
- Core Capacity Transit Study (CCTS) (2016), *Metropolitan Transportation Commission*
- Disparate Impact and Disproportionate Burden Policy (adopted 2013), *BART*
- Plan Bay Area (2013), *MTC and ABAG*
- Plan Bay Area, "Equity Analysis" (2013), *MTC and ABAG*
- San Francisco Bay Crossings Study (2000), *Metropolitan Transportation Commission*
- WETA 2016 Strategic Plan (the San Francisco Bay Ferry)

### Non-Profit and For Profit Organization Documents

- ConnectOakland Vision
- Designing the Bay Area's Second Transbay Rail Crossing (2016), *SPUR*
- Equity Considerations for a Second Transbay Crossing - Executive Summary (2015; full report forthcoming), *TransForm*
- SPUR "New Transbay Transit Crossing" Event: Hosted by SPUR (April 2016)
- The Case for a Second Transbay Crossing (2016). Bay Area Council Economic Institute Global Infrastructure Initiative 2015: Post-event summary. McKinsey & Company

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- The Northern California Megaregion: Innovative, Connected, Growing (2016), Bay Area Council Economic Institute
  The Northern California Megaregion (2007), SPUR

### Academic and Other Research, Selected

- E. Deakin, K. Trapenberg Fick, R. Cervero et. al.: *Bay Bridge Toll Evaluation Final Report* (2011)
- Heller, Jeffrey (February 15, 2014). "2nd BART tube under the bay would serve region well" *San Francisco Chronicle*.
- Barnes, K. Trapenberg Frick, E. Deakin, and A. Skarbardonis: *Impact of Peak and Off-Peak Tolls on Traffic in San Francisco-Oakland Bay Bridge Corridor in California* (2012)
  K. Trapenberg Frick, S. Heminger, and H. Dittmar: *Bay Bridge Congestion-Pricing Project: Lessons Learned to Date* (1996)
- R. Cervero: *Traffic Impacts of Variable Pricing on the San Francisco-Oakland Bay Bridge, California* (2014)
- Trapenberg Frick, K.: *Remaking the San Francisco-Oakland Bay Bridge: A Case of Shadowboxing with Nature* (Routledge, 2016)

### Federal and State Documents

**State Rail Plan (2013), *Caltrans*.** Federal regulations require that states produce a state rail plan at least every five years to receive funding for traditional passenger rail and high speed rail. The 2013 State Rail Plan is the most recent update for California. It is a wide ranging document that covers current conditions, customer and public outreach, and future plans for state rail. The 2018 plan currently is in development and discussion with individuals aware of the process indicate that a transbay crossing will be discussed in the updated plan. Available from:
http://www.dot.ca.gov/californiarail/docs/Final_Copy_2013_CSRP.pdf

**Title VI Circular to 4702.1B (2012), *Federal Transit Administration*.** This Circular outlines instructions for recipients of Federal Transit Administration transportation funding to comply with the U.S. Department of Transportation's Title VI requirements, as outlined in 49 CFR Part 21. Transit agencies that have operations of greater than 50 fixed route vehicles during peak period and operate in urbanized areas with a population greater than 200,000 must continually monitor and evaluate their transit service to understand if minority populations are receiving equal transit service as non-minority populations. Furthermore, whenever there is a proposed change of service or fares, agencies must first conduct equity analyses to ensure that minority populations are not disparately impacted. This type of analysis would most likely be required for any third crossing project. Available from:
https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Title_VI_FINAL.pdf

**Vulnerability Assessment Scoring Tool (2015), *US Department of Transportation*.** Guide and instrument for a tool created by DOT to help transportation agencies assess vulnerability of assets. Vulnerability is measured in terms of exposure, sensitivity and adaptive capacity for individual assets. Includes an application to infrastructure in the Gulf Coast region around Mobile, AL. Available from:
http://www.fhwa.dot.gov/environment/climate_change/adaptation/adaptation_framework/modules/scoring_tools_guide/vast_users_guide.pdf

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## Regional and Local Public Agency Documents

**2015 State of the Region, *ABAG*.** This report was prepared by the Association of Bay Area governments to build on other resources tracking trends and regional conditions on the topics of the economy, population and demographics, as well as housing. The report was intended to identify how effectively state and regional planning strategies have been leading regional growth and change. A major theme in the report is the strong economic recovery that the Bay Area has experienced since the Great Recession, along with slow steady population growth. The report identifies challenges such as reduced financing availability for new residential construction, uncertain continued availability of affordable housing for residents of all incomes, and whether new growth will be transit-oriented and transit-accessible. The report touches on the ongoing challenge for the region to meet growing housing demands. Available from: http://reports.abag.ca.gov/sotr/2015/executive-summary.php

**BART Climate Change Adaptation Pilot Study (2013)**. Pilot study funded by FTA to determine climate change related risk and potential adaptation strategies for BART assets. Frameworks were developed to address climate change adaptation, including understanding climate change scenarios, accessing vulnerability, asset management and potential adaptation strategies. The report recommends as a next step that BART devise a funding plan for a system-wide vulnerability and risk review of the operating system and assets. Available from: https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0074.pdf

**Bay Area Regional Rail Plan (2007), *MTC, BART, Caltrain and California High Speed Rail Authority (CHSRA)***. The Bay Area Regional Rail Plan is the first comprehensive, regional rail plan in over 50 years that describes a long-range vision for passenger rail in the Bay Area. In addition to addressing transportation improvements needed, the report describes the value of rail in addressing issues such as environmental goals, economic development and compact, dense development. The vision describes the potential of high speed rail to support regional travel improvements, particularly in light of the Bay Area as part of an emerging megaregion. The plan describes the need for a new governance structure to deliver high-speed infrastructure and service, including a discussion of several different governance structures types. The plan includes a series of alternatives, one of which addresses in part the need to provide another transbay tube to relieve congestion. The vision also includes a description of supportive land use strategies needed in tandem with rail investments. Available from: http://mtc.ca.gov/sites/default/files/BARegionalRailReport-ExSum.pdf

**Bay Bridge Corridor Congestion Study, (October 2010 draft), *AC Transit*** – The report evaluates future performance of bus service on the Bay Bridge and evaluates employing altered metering or physical improvements for improving service. The physical improvements include extending the HOV system further east into Oakland and addition of a contra flow lane. Extending the HOV network is critical for addressing the concern that queues at the Bay Bridge toll plaza on the east side will extend far enough to HOV bypass lanes preventing efficient running of bus service. Available from: http://www.actransit.org/wp-content/uploads/2010_10_14_bay_bridge_report_v5d.pdf

**Bay Bridge Forward Initiative (2016), *Partnership MTC, Caltrans, AC Transit, WestCat, and Water Emergency Transit Agency*** – The initiative is a series of strategic investments ($40 million) for

the next ten years to increase the number of people moving across the Bay Bridge during peak commute hours. Projects include integration of traffic management systems at all bridge entrances, improvements to HOV and bus only on-ramps in Oakland, transit signal priority for buses, higher frequency ferry service, and support for casual carpool. Initiative projects are included in the MTC Core Capacity study capacity estimates and listed in more detail in press release included below. Available from: http://mtc.ca.gov/whats-happening/news/bay-bridge-forward-deliver-congestion-relief-san-francisco-oaklan d-bay-bridge

**Building a Better BART** – Report specifies two primary challenges: maintaining and upgrading existing infrastructure; and, increasing capacity to meet growing ridership during peak periods. The report does not specifically address a potential future transbay crossing, However, the report considers three methods for increasing peak capacity: 1) Increasing capacity at Embarcadero and Montgomery stations in Downtown San Francisco; 2) Creating track redundancy to ensure trains can bypass broken down trains or other obstructions, and 3) Creating new turnarounds that allow trains to be more efficiently redeployed. Available from: https://www.bart.gov/sites/default/files/docs/Executive%20Summary%20Building%20a%20Better%20BART.pdf

**Capitol Corridor Vision Plan (2014), *Capitol Corridor*** - The 2014 Capitol Corridor Vision Plan describes the plan for the regional rail system, including short and medium term plans over the next 10 years and a longer term vision over the next 40 to 50 years. Capitol Corridor, overseen by the Capitol Corridor Joint Powers Authority (CCJPA), operates between Sacramento and the Bay Area and BART provides staff support. The Plan describes how it will benefit from new revenues from the state Cap and Trade program, which will allow for expanded investments in services, as well as federal funding for high-speed rail. The Plan is intended to build on other existing plans, including the California High Speed Rail planning efforts, the Bay Area Regional Rail Plan and the Northern California Emerging Megaregion Plan. In terms of the transbay corridor, the short and medium term plans focus on increasing service frequency and travel times between Oakland and San Jose. The longer term vision focuses on the service as a "transit spine" for the megaregion. Key principles in the plan include integrating service connections, schedules and fares across providers and developing redundancy to protect against system vulnerabilities from seal-level rise. The Plan discusses how some alternatives for future development would be considered based on a potential new third crossing, including connections to a potential future station in West Oakland or Jack London Square. Available from: http://www.capitolcorridor.org/downloads/CCJPAVisionPlanFinal.pdf

**Core Capacity Transit Study (CCTS) (2016), *Metropolitan Transportation Commission*.** The study, slated for completion in Spring 2017, provides a comprehensive review of demand and capacity across the Transbay Corridor and the San Francisco Metro Corridor. The Metro Corridor refers to the BART, Caltrain and MUNI transit networks in San Francisco. Materials developed include a Transbay problem statement, a capacity and demand summary, and an initial engineering study for a future crossing. The report is framed within the context of building transit capacity to serve morning peak demand on the corridor for entering the San Francisco core. MTC argues that the Bay Bridge currently is filled at vehicle capacity during the morning commute and thus in the absence of significant increase in average vehicle occupancy, any increase in capacity will need to come from additional transit provision. Proposed short-term and mid-term projects will increase capacity on transit to meet near-term increases in demand. The projects include, but are not limited to new BART cars, BART train control

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modernization, new Transbay bus terminal, bus only lanes on approach to Bay Bridge, expansion of ferry service. Still, transit will be unable to meet long-term demand under all but the most conservative estimates. The study includes an engineering study of Transbay crossing that identifies promising alignments; however, the report does not recommend a crossing as a long-term solution but instead recommends further study of a crossing. Available from: http://mtc.ca.gov/our-work/plans-projects/other-plans/core-capacity-transit-study

**Disparate Impact and Disproportionate Burden Policy (adopted 2013), *BART*** - This policy outlines BART's thresholds for disparate impacts and disproportionate burden as required by the Federal Transit Administration's Title VI Circular 4702.1B. For fare and service changes, BART determines "disproportionate impact" by assessing how the change would impact "protected" versus "non-protected" riders, with "protected riders" defined as minority or low-income populations. A third crossing would most likely be subject to both fare and service equity analyses. Available from: https://www.bart.gov/sites/default/files/docs/Final%20DI.DB%20Policy.pdf

**Plan Bay Area (2013), *MTC and ABAG*.** As the regional transportation and land use agencies, MTC and ABAG developed the Bay Area's regional Sustainable Communities Strategy (SCS) to comply with SB 375. The plan focuses 78% of the region's planned new housing and 62% of the region's planned new jobs in Priority Development Areas (PDAs) near transportation facilities. This concentration of housing and jobs near transportation options is intended to help the region reduce its greenhouse gas emissions by 15% by 2035. The plan is currently being updated and as part of the update MTC is evaluating a new preferred scenario that incorporates feedback from the public and policy makers (the draft of the preferred alternative is available online now). Available from: http://planbayarea.org/plan-bay-area.html

**Plan Bay Area, "Equity Analysis" (2013), *MTC and ABAG*** – This report provides a framework for the regional plan's land use and transportation strategies and policies for advancing opportunity for communities of concern in the region. The report includes baseline data for communities of concern, as well as an analysis on Title VI requirements, and environmental justice analysis and an equity analysis. Available from: http://planbayarea.org/the-plan/plan- details/equity-analysis.html

**San Francisco Bay Crossings Study (2002, updated in 2012), *Metropolitan Transportation Commission*.** This study, prompted by Senator Dianne Feinstein's request of Governor Gray Davis, investigates the current and forecast transbay travel conditions, as of 2000. The study found that such a crossing was not appropriate at the time, given constraints of cost and the performance of models used by MTC to simulate one. While it did not rule out the possibility circumstances changing, they recommended a number of lower-cost measures be carried out in the near term. Summary available from: http://www.baycrossings.com/Archives/2002/06_July/mtc_bay_brossings_study.htm; 2012 update of study available from: www.mtc.ca.gov/sites/default/files/BC_Study_Update_May_2012.pdf

**Water Emergency Transportation Authority (WETA) 2016 Strategic Plan (the San Francisco Bay Ferry)** – The plan provides the agency's 20-year vision for providing ferry service to the Bay Area. The document describes WETA's work to develop new services and ferry network. The plan also describes WETA's role in providing alternative transportation service during emergencies or disruptions to other transportation services. Available from: http://sanfranciscobayferry.com/weta/strategic-plan

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## Non-Profit and For Profit Organization Documents

**ConnectOakland Vision -** ConnectOakland is a plan developed an advocacy group made up of volunteers including residents and professional in the design and planning fields to transform the Interstate 980 corridor from a freeway to an at-grade boulevard that would reconnect West Oakland and Downtown. The vision discusses the possibility of using the suppressed land beneath the existing interstate to run a rail tunnel that could serve either BART or Standard Rail. Their proposal would create 21 blocks of new and revitalized land for development or parkspace. Available at http://www.connectoakland.org/

**Designing the Bay Area's Second Transbay Rail Crossing (2016), *SPUR***. This white paper provides SPUR's case for a second bay crossing and argues that planning should start now and provides recommendations for how to proceed with planning and design processes. SPUR, the San Francisco Bay Area Planning and Urban Research Association, is a non-profit civic planning organization. In this white paper, SPUR emphasizes that a third crossing is needed to add to transit capacity, enable rail maintenance necessary for transit redundancy, and support mobility and access for the region's projected population and employment growth. The white paper describes many important planning and design decisions need to be made, such as which transit service providers would be involved, what the alignment of the proposed crossing would be, what infrastructure is needed, and how the construction could be phased. SPUR then makes recommendations for next steps, such as funding, prioritization and governance structures. These recommendations emphasize building on existing projects and plans, such as ongoing proposals for tearing down I-980 that runs between West Oakland and Downtown Oakland. Available from: http://www.spur.org/publications/white-paper/2016-02-10/designing-bay-areas-second-transbay-rail-crossing

**Equity Considerations for a Second Transbay Crossing - Executive Summary (2015; full report forthcoming), *TransForm*.** TransForm is in the process of releasing a white paper that focuses on social equity issues that the region and state should address during planning for a third crossing. Transform is a non-profit advocacy organization focused on transportation in the Bay Area and California. While the paper has not yet been released, Transform has made available an executive summary with brief highlights. The executive summary describes potential equity benefits, including improved transit service for low income communities, and reduced air pollution associated with regional increases in transit ridership. The summary describes that the paper will address key issues around equity in major infrastructure projects, such as who benefits and who pays, and who is involved in the decision making process. A series of recommendations are included, such as seeking anti-displacement measures, improving current issues in transit service, and seeking out equitable financing. The final report is expected to be released in the coming months. The Executive Summary is available from: http://www.transformca.org/transform-report/second-transbay-crossing

**SPUR "New Transbay Transit Crossing" Event: Hosted by SPUR (April 2016)** - This event was held in SPUR's Oakland office and served as an opportunity to bring a wide range of stakeholders into the same room to discuss a new transbay crossing. The event was open to the public, moderated by the San Francisco County Transportation Authority, and began with presentations from representatives from non-profits SPUR and Transform and also representatives from the private sector, specifically the Bay Area Council and McKinsey & Company. The focus of these presentations included speaker perspectives on why a new crossing is needed (SPUR and Bay Area Council Economic Institute),

recommendations for how to promote social equity within the transbay transportation system (Transform), and recommendations for how a project of this scale could be delivered (McKinsey & Company and Bay Area Council Economic Institute). Following the presentations, representatives from the public agencies - Metropolitan Transportation Commission, BART, California State Transportation Agency, and the City of Oakland - spoke about what a new transbay crossing could potentially mean at the local, regional, interregional, and state levels. The non-profit, private sector, and public agency representatives then fielded audience questions. A video of the event is available at: https://www.youtube.com/watch?list=PLT3WgisWww_-kIqM0YVMgUGmh6r2GWFAA&params=OAFIAVgI&v=jXzXiCwOBBU&mode=NORMAL&app=desktop.

**The Case for a Second Transbay Crossing (2015), *Bay Area Council Economic Institute*.** This report analyzes the current transbay travel constraints, focusing on the corridor between San Francisco and Oakland. The report argues that the current systems create an economic drag on the Bay Area, analyzes several options for an additional transbay rail crossing, identifies the benefits of such a crossing, and provides some examples of various contracting and funding models that might lead to a transit crossing projected being built efficiently and effectively. The report identifies the challenges of capacity and congestion on the rail and highway systems, as well as the challenge of resiliency in this critical transportation link in general. The report has description and diagrams depicting specific design elements and alignments of a possible new rail line. Available from: http://www.bayareaeconomy.org/report/the-case-for-a-second-transbay-transit-crossing/.

**Global Infrastructure Initiative 2015: Post-event summary. *McKinsey & Company*.** This report was issued following the Global Infrastructure Initiative event that was held in San Francisco in 2015. The event and the report explored how innovation and technology can improve infrastructure delivery. The event convened experts and officials to discuss a key focus project: a new transbay transit tunnel between San Francisco and Oakland. The report summarizes themes and ideas that could be applied to major infrastructure projects around the world based on discussions and learning at the event. It describes specific strategies related to project planning, finance, construction, and operations. On the transbay tunnel project in particular, the report sets three primary recommendations: defining the problem, involving a wide variety of stakeholders, and determining and ownership structure and governance model to cover all stages of the project. Available from: http://www.globalinfrastructureinitiative.com/downloads/GII-2015-Post-event-Summary.pdf.

**The Northern California Megaregion: Innovative, Connected, Growing (2016), *Bay Area Council Economic Institute*.** This report analyzes conditions of the larger megaregion that includes the traditional nine-county Bay Area as well as six counties in the Sacramento metropolitan area, three counties in the northern San Joaquin Valley, and the Monterey Bay Area. The report identifies the extent to which these areas have grown and begun to interact across regional boundaries. based on population and employment growth patterns, as well as commuter travel across regional boundaries, the report argues that planning at the megaregional level is necessary, especially for improved transportation connections. It suggests economic development structures that cross county lines, statewide tax credit programs, and expanded service on interregional rail lines. Additionally, the report touches on opportunities for leveraging the innovation system of companies and universities, as well as improving the efficiency and sustainability of goods movement in the megaregion. Available from: http://www.bayareaeconomy.org/report/the-northern-california-megaregion/.

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**The Northern California Megaregion (2007), *SPUR*.** This report argues that the Bay Area is part of a larger megaregion of Northern California by analyzing data on land consumption, transportation flows and commute patterns, economic integration, and cultural integration. Based on the analysis, the report proposes several different ways to define a megaregional boundary. The report finally argues that several important problems could be addressed at this scale: a northern California rail network, landscape preservation in the Central Valley, and a megaregional equity agenda. Available from: https://www.spur.org/sites/default/files/publications_pdfs/SPUR_The_Northern_California_Megaregion.pdf.

### Academic and Other Research, Selected:

**E. Deakin, K. Trapenberg Fick, R. Cervero et. al.: *Bay Bridge Toll Evaluation Final Report* (2011).** This report is an independent study by the University of California, Berkeley on the effects of the toll structure changes made in 2010 for the Bay Bridge. The new toll structure created higher tolls during weekday peak-periods (5-10am and 3-7pm) and instituted a toll for carpoolers who had previously traveled for free. The goal of the new toll policy was to finance earthquake retrofits, but also to encourage off-peak travel and switching to other modes. The study evaluates a series of questions, including the effects of the tolls on traffic volumes, the impact on carpooling and transit ridership, and public perceptions of the toll changes. The study found that traffic volumes overall decreased by 1% during the first year, and that shifts occurred from peak to off-peak times. There was a 26% decrease in carpoolers, many of whom switched to other modes. The results of the public perception surveys indicated a "resigned acceptance." These findings provide valuable insights for consideration as part of a Performance Pricing alternative for a third crossing. Available from: http://apps.mtc.ca.gov/meeting_packet_documents/agenda_1764/Bay_Bridge_Toll_Evaluation_Final_Report_final.pdf

**Heller, Jeffrey (February 15, 2014). "2nd BART tube under the bay would serve region well" *San Francisco Chronicle*.** Bay area architect and Bay Area Council Board Director Jeffrey Heller proposes a second BART tube. it would connect in Oakland at MacArthur BART and run though Jack London Square and Alameda. It would cross the bay to San Francisco with a stop at the AT&T ball park and continue through San Francisco's Dogpatch and Bayview-Hunter's Point to the San Francisco Airport. An alignment image and Opinion piece published in the San Francisco Chronicle are available at: http://www.sfgate.com/opinion/article/2nd-BART-tube-under-the-bay-would-serve-region-5236682.php

**I. Barnes, K. Trapenberg Frick, E. Deakin, and A. Skarbardonis: *Impact of Peak and Off-Peak Tolls on Traffic in San Francisco-Oakland Bay Bridge Corridor in California* (2012)** – Report is a study of the impact of toll changes on bridge traffic. The report finds that carpool rates decreased significantly after the institution of toll of carpool users (it previously had been free for carpool vehicles). The findings have applications for considering the possibility of increasing capacity on the Bay Bridge through more aggressive carpool / non-carpool tolling differences.

**K. Trapenberg Frick, S. Heminger, and H. Dittmar: *Bay Bridge Congestion-Pricing Project: Lessons Learned to Date* (1996) –** The paper discusses an early unsuccessful attempt to apply congestion pricing—varying the toll with the time of day and level of congestion—to the Bay Bridge. It provides a series of lessons learned for future consideration of congestion pricing and reported on

public perception of using pricing to improve capacity on the Bay Bridge, including recommendations for providing a toll discount to low-income drivers.

**R. Cervero: *Traffic Impacts of Variable Pricing on the San Francisco-Oakland Bay Bridge, California* (2014).** This study considers how the new tolling structure introduced in 2010 for the Bay Bridge impacted travel behaviors. The analysis found that the toll increase on carpoolers resulted in more significant travel changes than the peak pricing for regular (non-HOV) traffic. This indicates that peak trips may be nondiscretionary. Carpoolers did not become single occupant vehicle (SOV) drivers, rather switched modes to transit or chose off-peak travel times. The paper raises questions around how equity issues associated with peak-pricing can be resolved. Some recommendations that are described include reinvesting toll revenue into BART service improvements or partial toll vouchers for lower income populations. Available from: http://trrjournalonline.trb.org/doi/abs/10.3141/2278-16

**Trapenberg Frick, K.: *Remaking the San Francisco-Oakland Bay Bridge: A Case of Shadowboxing with Nature* (Routledge, 2016)** – This book details the history of the development of the Bay Bridge's new east span. The book is framed within megaproject and other literature and concludes with recommendations for improving megaproject planning and implementation. The book also includes the history of the original San Francisco-Oakland Bay Bridge in 1936 as prologue to a discussion of the bridge's ultimate (and fraught) renovation and East Span replacement. It also discusses the history of the "Second Crossing." Since the completion of the first bridge, many proposals and plans were made for subsequent crossings within the core of the Bay Area. Trapenberg Frick discusses the wartime concern for the security of the region, the proposals through which BART's tunnel was ultimately created, and post-BART revivals of "Southern Crossing" proposals connecting Alameda County with Southern parts of San Francisco and the SF Peninsula.

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# Appendix B: MTC's Communities of Concern definition for Plan Bay Area 2040[182]

| *Disadvantage Factor* | *% Regional Population* | *Concentration Threshold* |
|---|---|---|
| **1. Minority** | 58% | 70% |
| **2. Low Income (<200% Federal Poverty Level - FPL)** | 25% | 30% |
| **3. Limited English Proficiency** | 9% | 20% |
| **4. Zero-Vehicle Household** | 10% | 10% |
| **5. Seniors 75 Years and Over** | 6% | 10% |
| **6. People with Disability** | 9% | 25% |
| **7. Single-Parent Family** | 14% | 20% |
| **8. Severely Rent-Burdened Household** | 11% | 15% |
| Definition – census tracts that have a concentration of BOTH minority AND low-income households, OR that have a concentration of 3 or more of the remaining 6 factors (#3 to #8) but only IF they also have a concentration of low-income households. | | |

[182] Metropolitan Transportation Commission Deputy Executive Director, Policy. (2015, December 31). MTC Resolution No. 4217: Equity Framework for Plan Bay Area 2040. Memorandum. Retrieved from https://mtc.legistar.com/LegislationDetail.aspx?ID=2542165&GUID=D89FCABA-8814-4F0C-990D-B6803291A4D5&Options=&Search=

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# Appendix C: Transbay Travel Patterns

*Transbay Corridor 2015 Peak Hour Occupancy Levels by Mode*

| | 2015 Morning Peak-Hour Westbound Travel (Person-trips) | | |
|---|---|---|---|
| | Trips | Capacity | Occupancy |
| **Total All Modes** | **38,800** | **37,100** | **105%** |
| **Auto** | 9,900 | 9,900* | 100% |
| **BART** | 25,000 | 22,700 | 110% |
| **Bus** | 2,700 | 2,900 | 93% |
| **Ferry** | 1,300 | 1,650 | 77% |

*Assumes existing vehicle occupancy.

*Source: MTC http://mtc.ca.gov/sites/default/files/CCTS_TransbayCapacityandDemandSummary_FINAL.pdf*

*Change in Peak Hour, Peak Direction Demand Transbay Transit, 2010-2015*

| | 2010 | 2015 | Change | |
|---|---|---|---|---|
| | AM Demand | AM Demand | Number | Percent |
| AC Transit | 1,984 | 2,531 | + 547 | +28% |
| BART[8] | 17,406 | 24,986 | + 7,580 | +44% |
| SF Bay Ferry | 765 | 1,271 | + 506 | +66% |
| Other bus[9] | 180 | 180 | 0 | 0% |
| **Total** | **20,335** | **28,968** | **+8,633** | **+42%** |

*Source: MTC http://mtc.ca.gov/sites/default/files/CCTS_TransbayCapacityandDemandSummary_FINAL.pdf*

*Peak Hour, Peak Direction Occupancy for Transbay Corridor - All Modes, 2010-2015*

| | 2010 | | | 2015 | | |
|---|---|---|---|---|---|---|
| | AM Capacity | AM Demand | Occupancy | AM Capacity | AM Demand | Occupancy |
| **Transbay Corridor – Total** | 38,045 | 31,569 | 82% | 36,773 | 38,834 | 106% |

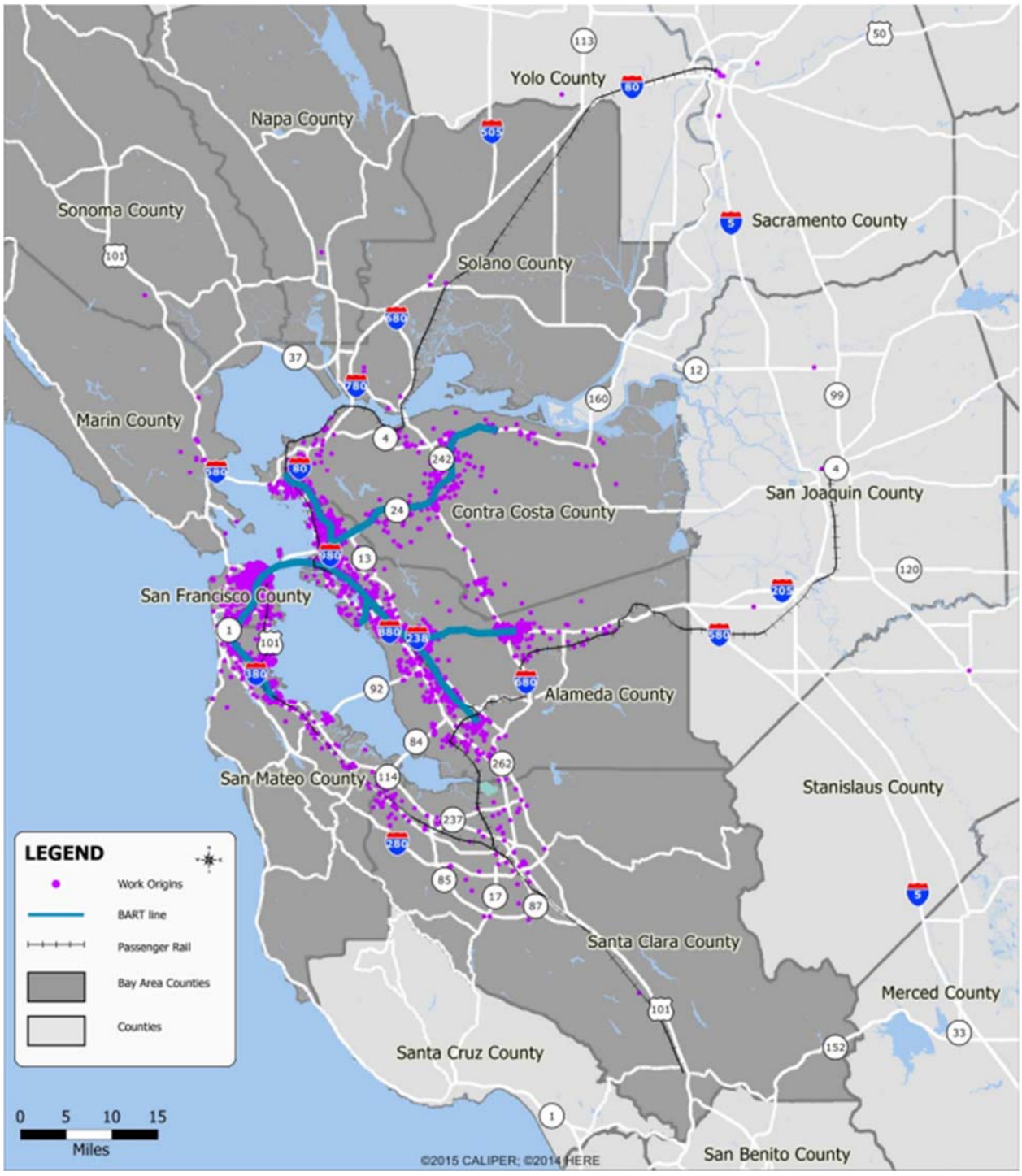
*Source: MTC http://mtc.ca.gov/sites/default/files/CCTS_TransbayCapacityandDemandSummary_FINAL.pdf*

*2015 Peak Hour, Peak Direction Transit Capacity by Time Period & Operator*

| | AM Services Vehicles at Screenline | AM Passenger Capacity | PM Services Vehicles at Screenline | PM Passenger Capacity |
|---|---|---|---|---|
| AC Transit | 63 buses | 2,730 [18] | 89 buses | 3,666 |
| BART | 212 cars<br>23 trains | 22,684 | 212 cars<br>23 trains | 22,684 |
| SF Bay Ferry | 5 ferries | 1,322 | 5 ferries | 1,522[19] |
| Other bus | 3 buses | 171 | 3 buses | 171 |
| **Total** | | **26,907** | | **28,043** |

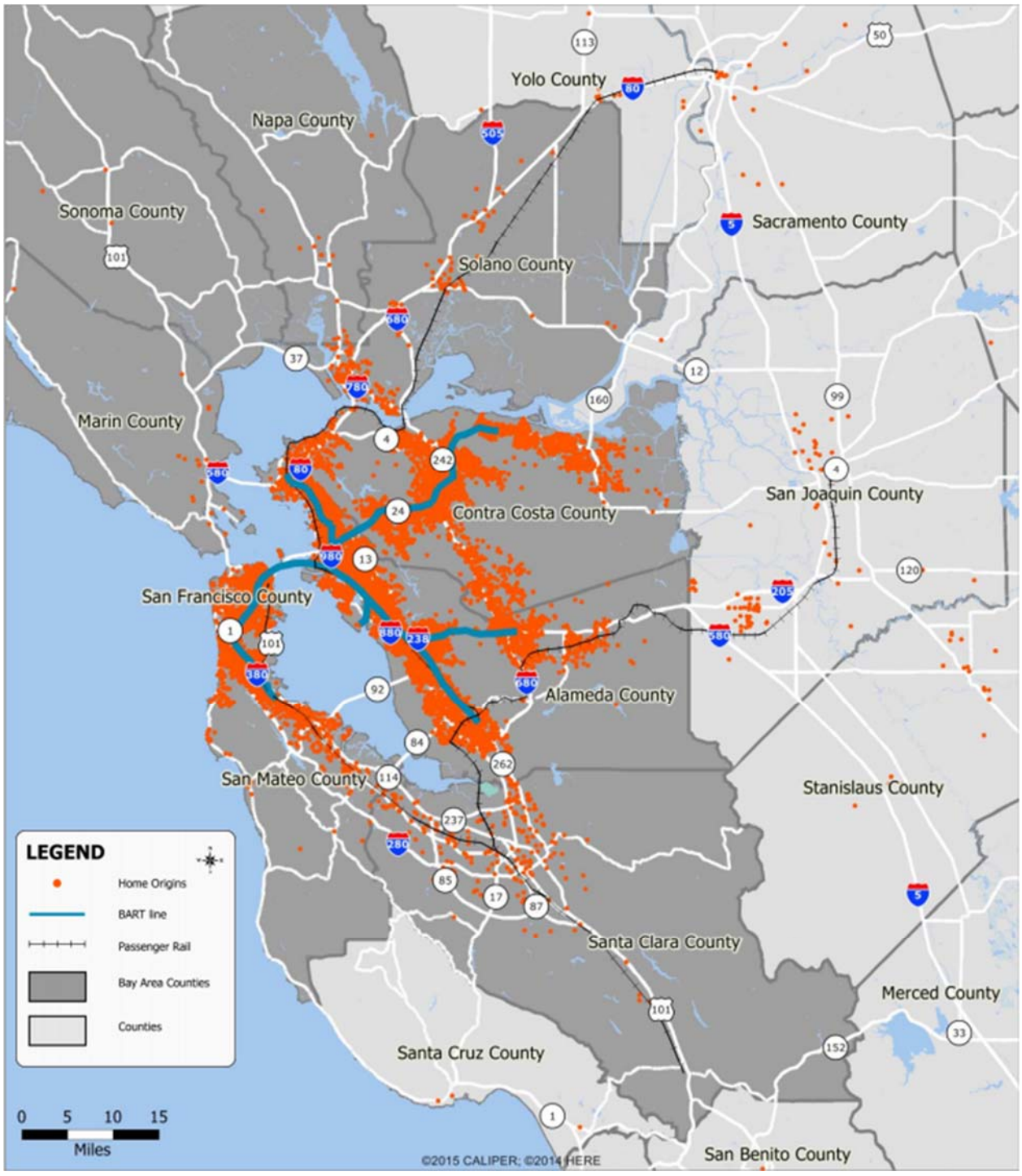
*Source: MTC http://mtc.ca.gov/sites/default/files/CCTS_TransbayCapacityandDemandSummary_FINAL.pdf*

*Work Locations of BART Riders, 2015 BART Station Profile Survey*




*Source: http://www.bart.gov/about/reports/profile*

*Home Locations of BART Riders, 2015 BART Station Profile Survey*




*Source: http://www.bart.gov/about/reports/profile*

# Appendix D: Performance Metric Sources & Methodology

| Problem Category | Metric | Methodology | Data Sources |
|---|---|---|---|
| **Social Equity** | Health Metric | Using forecasted traffic volumes from SFCTA SF-CHAMP 4 travel model, tools were used in a 2011 HIA by SFDPH to estimate future walk and bike trips and burdens of traffic collisions and emissions. | Travel Model One for traffic volumes; May not have access to other predictive tools. |
| **Social Equity** | Displacement Metric | Use current available data on housing and transportation costs as a % of income.<br>Use of inventories of households, businesses, and non-profits. | Housing and Transportation Affordability Index (for current data)<br>ACS, Census, transit service inventories, business, household and service inventories, surveys. Some possible data gaps. |
| **Accessibility and Connectivity** | Transit Access | Use land use model or GIS | Land use model or GIS |
| **Accessibility and Connectivity** | Jobs Access | Use BLS job statistics on location of jobs and expected education needs to see where transportation could connect residents with job centers. | BLS job statistics, land use model |
| **Accessibility and Connectivity** | Healthcare Access | Use location of primary care doctors within ¼ mile of transit stop | InfoUSA for location of primary care doctors |
| **Accessibility and Connectivity** | Recreational Access | Use GIS layers from SF Open Data to identify open space and park locations to create a buffer of sites within ¼ mile of transit; geocode parks outside SF to add to layers | SF Open Data and geocoded data from other city parks departments |
| **Accessibility and Connectivity** | Intermodal Connectivity | Manual count of service connections and description of whether overnight service is included; service includes transit and bikeshare | Service provider schedules and maps |
| **Resilience and Adaptation** | Redundancy | Passenger capacity for alternatives compared to capacity for network in partial shutdown. | Capacity expectations for alternatives. Existing capacity for transbay crossing. |
| **Resilience and Adaptation** | Sea Level Rise and Flooding | Comparing location of facilities to projected sea level rise and flooding. | ABAG: SLR and flooding projections. |

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| | | | |
|---|---|---|---|
| **Resilience and Adaptation** | Seismic vulnerability | Comparing location of facilities to liquefaction risk. | ABAG: liquefaction hazard by fault. |
| **Climate Change Mitigation** | Transportation related CO2 Mitigation | Analyze CO2 emission data outputs from transportation demand models for all transportation modes in the region for a given time period | Travel Model One, Plan Bay Area Model |
| **Climate Change Mitigation** | Land use related CO2 Mitigation | Analyze CO2 emission data outputs from land use models for all changes in land use within ¼ mile buffer of new transbay transit stations | UrbanSim land use model, Plan Bay Area Model |
| **Land Use/Economic Growth** | Population Growth | Change in population by geographic location within the Bay Area and within transit station areas | Travel model or data from the American Community Survey and/or Census with geographic transit location data |
| **Land Use/Economic Growth** | Job Growth | Change in employment by geographic location within the Bay Area and within transit station areas | Travel model or LEHD employment data with geographic transit location data |
| **Land Use/Economic Growth** | Land Development Opportunities Adjacent to Stations | Amount/area of prime developable land (low intensity uses) within ½ mile of transit station | UrbanSim land use model or analysis of satellite imagery to identify vacant parcels and surface parking lots |
| **System Performance** | Time Periods that Demand Exceeds Capacity | Specific hours of the day when ridership or use of facilities exceeds official capacity on each transportation link | Travel Model One, MTC data, and BART Operations Planning data (not currently available publicly). |
| **System Performance** | Westbound to Eastbound Person Trip Balance | Westbound to eastbound ratio of morning peak trips in transbay corridor | Travel Model One, data from BART, BATA, WETA and MTC. |
| **System Performance** | Net Investment Cost of Alternative | A net present value analysis of upfront costs, operating losses or revenues (for increased tolling), and long-run maintenance cost. | Travel Model One, existing data or estimates of revenue and capital operating costs from MTC, BART, BATA, Caltrans, and other transit operators |

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# Appendix E: Land Use Scenario Outputs for Various Model Runs compared to Control Run

*Difference in non-residential square footage within ½ mile of stations for various model runs compared to control run.*

| | Business-as-usual Land Use Scenario | | | Preferred Land Use Scenario | | |
|---|---|---|---|---|---|---|
| **Station** | **BART 1** | **BART 2** | **Standard Rail** | **BART 1** | **BART 2** | **Standard Rail** |
| **11th/Broadway** | -61,410 | -253,116 | -156,248 | 254,096 | 252,455 | 174,143 |
| **14th Street** | 575,207 | 5,636 | 140,222 | 644,361 | 120,298 | 121,121 |
| **15th/Franklin** | -132,217 | -136,604 | -91,522 | 293,578 | 134,302 | 127,533 |
| **3rd/Mission** | 135,748 | 51,258 | 5,760 | 321,462 | 318,398 | 321,462 |
| **4th/Brannan** | -2,774 | 6,035 | 6,035 | 9,852 | -45,013 | -27,588 |
| **6th/Brannan** | 20,567 | 21,004 | -18,315 | 78,406 | 13,546 | 59,591 |
| **Alameda** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Ballpark** | 6,894 | 6,894 | -355 | -43,290 | -43,290 | -43,290 |
| **Berkeley (standard rail, existing)** | 531,942 | 23,227 | 36,226 | -5,320 | -33,020 | 19,798 |
| **Eastlake** | 9,610 | -15,515 | -42,396 | 64,596 | -52,574 | 230,754 |
| **Emeryville (standard rail, existing)** | 28,342 | 2,225 | 2,225 | -362,581 | -394,970 | -421,751 |
| **Fillmore** | 198,589 | 12,351 | -4,200 | 80,435 | 92,720 | -63,713 |
| **8th/Howard** | 109,493 | 114,838 | 100,294 | 193,987 | 198,301 | 171,561 |
| **Howard Terminal** | 49,697 | 52,029 | 400,587 | 335,980 | 851,465 | 513,489 |
| **Hyde/McAllister** | -2,325 | -51,643 | -11,335 | 103,138 | 80,601 | 103,904 |
| **Jack London Square** | -69,666 | -249,726 | 52,191 | -73,909 | -12,726 | 64,117 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **Mission Rock** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Richmond (standard rail, existing)** | -15,992 | -16,437 | -14,639 | -34,635 | 47,052 | -69,861 |
| **Transbay Transit Center (standard rail, exists in baseline)** | 3,371 | -17,816 | 4,989 | 96,040 | 97,105 | 97,105 |
| **Union Square** | 3,550 | 5,550 | 135 | -3,849 | -21,868 | -11,043 |
| **Van Ness** | 14,160 | 13,095 | -3,720 | -26,709 | -54,038 | -27,016 |
| **Total** | 1,402,786 | -426,716 | 405,935 | 1,925,637 | 1,548,745 | 1,340,316 |

*Note: Control run is business-as-usual land use scenario with no crossing alternative in 2035.*

*Difference in residential units within ½ mile of stations for various model runs compared to control run.*

| | **No-Project Land Use Scenario** | | | **Preferred Land Use Scenario** | | |
|---|---|---|---|---|---|---|
| **Station** | **BART 1** | **BART 2** | **Standard Rail** | **BART 1** | **BART 2** | **Standard Rail** |
| **11th/Broadway** | -296 | 141 | -112 | -669 | -606 | -339 |
| **14th Street** | 378 | 455 | 431 | -214 | -229 | -183 |
| **15th/Franklin** | -553 | -229 | -233 | -873 | -1,105 | -761 |
| **3rd/Mission** | -1,024 | -250 | -55 | -1,676 | -1,619 | -1,663 |
| **4th/Brannan** | 40 | -37 | -38 | -65 | 536 | -17 |
| **6th/Brannan** | -38 | -13 | 83 | -267 | -61 | 101 |
| **Alameda** | 39 | 12 | 10 | 13 | 8 | 9 |
| **Ballpark** | -154 | -155 | -45 | -2 | -6 | 1 |
| **Berkeley (standard rail, existing)** | 36 | -41 | -1 | 10 | 52 | -2 |
| **Eastlake** | -67 | -32 | 34 | 221 | 330 | 186 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **Emeryville (standard rail, existing)** | -77 | -55 | -52 | 429 | 508 | 958 |
| **Fillmore** | -71 | -74 | -22 | 2,173 | 2,135 | 1,506 |
| **8th/Howard** | -442 | -409 | -236 | -803 | -757 | -778 |
| **Howard Terminal** | -199 | -188 | -167 | -324 | -454 | -708 |
| **Hyde/McAllister** | 83 | 334 | 36 | -393 | -134 | -439 |
| **Jack London Square** | -33 | 110 | -97 | -350 | -158 | -509 |
| **Mission Rock** | 379 | -4 | -3 | -1 | -3 | -2 |
| **Richmond (standard rail, existing)** | 6 | 5 | 27 | 5,241 | 5,189 | 5,715 |
| **Transbay Transit Center (standard rail, exists in baseline)** | -245 | -43 | -206 | -256 | -444 | -444 |
| **Union Square** | 100 | -23 | 12 | 14 | 165 | 101 |
| **Van Ness** | -10 | -25 | 52 | 485 | 621 | 477 |
| **Total** | -2,148 | -521 | -582 | 2,693 | 3,968 | 3,209 |

*Note: Control run is no-project land use scenario with no crossing alternative in 2035.*

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