DESIGNING THE BAY AREA'S SECOND TRANSBAY RAIL CROSSING

How to ensure reliable transit and a connected region

SPUR WHITE PAPER

Released on February 10, 2016

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Thank you to the transportation agency staff members, technical experts and policy makers who provided information and reviewed drafts of this white paper. SPUR's Transportation Policy Board, Regional Planning Board, San Francisco City Board and Oakland City Board reviewed and debated the policy issues discussed in this white paper.

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INTRODUCTION

In the 1950s and 1960s the San Francisco Bay Area completed transformational projects, building both a freeway network and the Bay Area Rapid Transit system, including the visionary Transbay Tube, the underwater tunnel that carries BART passengers across the San Francisco Bay. This bold investment has paid for itself many times over.

Our region has benefited tremendously from the transportation investments of the previous generation. But at some point we stopped investing in the future, and now we are paying the price. Since the BART crossing opened in 1974, the Bay Area has grown from 4.3 million to 7.6 million people, yet we have added no new capacity in the heart of the BART system: the transbay link that connects the East Bay to San Francisco and the Peninsula. Nor have we added new capacity on the Bay Bridge. As a result, it's getting more and more difficult to make trips across the Bay, which threatens the region's quality of life and its ability to grow. We are succeeding in generating transit demand, but we are failing to add new infrastructure to support our success.

SPUR believes we must start planning the region's second transbay rail crossing. There are five key reasons why we must plan now:

- **We're running out of space.** Today, the Transbay Corridor — the travel corridor between San Francisco and Oakland, consisting of the Bay Bridge, the BART Transbay Tube and passenger ferries — is operating over capacity during peak travel hours.[1] Growth projections suggest that, even with new carpools and new bus, BART and ferry service, the transbay crossing will run out of capacity. This could happen as soon as 2024 if the recent travel growth rate continues.[2]
- **Our system is not reliable.** BART's reliability is declining, in part because the Transbay Tube operates near capacity, meaning that small disruptions quickly multiply through the system, and recovering from inevitable incidents requires increasing amounts of time.[3]
- **We are vulnerable to disasters and other disruptions.** Today, the majority of peak-hour transbay trips take place on BART, yet BART provides only a single track in each direction, making travelers highly vulnerable when there is a natural disaster or an unexpected mechanical failure.

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[1] *The Metropolitan Transportation Commission's Bay Area Core Capacity Transit Study estimates that transbay systems (including BART, AC Transit buses and Water Emergency Transportation Agency ferries) are operating at 101 percent of capacity standards during peak hour (27,398 transit trips, 23,664 of which were on BART). Peak-hour transit demand to the downtown core of San Francisco grew by 35 percent from 2010-2014. See: http://mtc.ca.gov/sites/default/files/2015_10-20_CCTS_TAC_meeting.pdf*

[2] *The Bay Area Core Capacity Transit Study estimates that future transit system improvements will provide a morning peak transbay capacity of 51,000 travelers. At the current rate of ridership growth (4.3 percent), transbay ridership will reach 51,000 by 2024. MTC estimates that 23,000 more transit trips can be offered during morning peak hours — if we fund and deliver a large set of transit projects and new transit services. See: http://mtc.ca.gov/sites/default/files/2015_10-20_CCTS_TAC_meeting.pdf*

[3] *For example, on-time performance has dropped to around 91 percent (the agency's goal is 95 percent). BART Quarterly Service Performance Reviews, Fourth Quarter, FY15, Engineering & Operations Committee August 13, 2015. http://www.bart.gov/sites/default/files/docs/QPR_Report_FY2015-q4_FINAL%20r1.pdf*

- **We are failing to meet our policy goals**. Plan Bay Area, our region's long-range plan for how to grow sustainably, sets targets for reducing our greenhouse gas emissions and car use, but we will have difficulty reaching these goals with our existing transit services. [4] Local and regional environmental, social and economic goals will require a different level of investment in our most important transit lines.
- **We don't have all-night rail transit.** People need 24-hour rail service in large cities such as ours, but this is not possible in the Transbay Corridor today because there is no alternate rail available during required nightly maintenance periods.

SPUR believes that the Bay Area's prosperity depends on getting ahead of these transit network challenges. We have called for a second transbay rail crossing in our reports *A Mid-Life Crisis for Regional Rail* (2008),*The Future of Downtown San Francisco* (2009), *After the Disaster: Rebuilding Our Transportation Infrastructure* (2010) and *A Downtown for Everyone* (2015). The Metropolitan Transportation Commission's 2007 Regional Rail Plan for the San Francisco Bay Region also identified a longer-term need for a second transbay crossing between the dense urban markets of San Francisco and the inner East Bay, designed for new regional rail, high-speed rail or possibly BART service. There have also been proposals — dating back to the 1940s, but most recently put forth in 2007 — to develop a southern rail crossing for the Bay. The Regional Rail Plan proposed a rail passenger crossing in the Dumbarton Corridor, connecting Redwood City to Union City BART. This connection, however, would serve far fewer people than a second connection between San Francisco and Oakland.

A second transbay rail crossing is not inevitable; it's a commitment today's leaders must make for the future of the Bay Area. In order to make the best decisions, it's incumbent on our leaders to understand all of the options, opportunities, benefits and costs of a second rail crossing.

We need to make immediate improvements while also planning for the long term.

A second crossing is not a substitute for near-term action to improve how we use our existing bridges, roads and tunnel. We will need to invest in our key transportation systems in the coming years. This includes BART's plans for three-door train cars and a new signal system, Caltrain's modernization program and adding more transbay buses when the new Transbay Transit Center opens in downtown San Francisco in 2017. The Metropolitan Transportation Commission (MTC)'s Bay Area Core Capacity Transit Study, currently underway, identifies actions we have to take in the next few years to move more people across the Bay. (See page 9.) However, transbay transit may still be overwhelmed if travel grows at even half the recent pace. With the growth of jobs and housing near rail stations, the need for reliable transit will continue to increase. It is not a question of if we need a second rail crossing, but rather when.

The Bay Area is capable of addressing the here and now while also preparing for our long-term transportation, housing, environmental and economic needs. More than that, it is our obligation to the generations after us — who will live in an era of climate change and land scarcity — to plan for a future that will rely more on transit and less on cars.

[4] *Plan Bay Area (July 18, 2013). See http://planbayarea.org/plan-bay-area/final-plan-bay-area.html*

We should integrate a second rail crossing into today's planning.

We are making decisions today that will either limit or enhance the performance of a second transbay rail crossing. These include local decisions such as how we design new buildings and their foundations, how we plan and set zoning rules for land use, how we design roads and transit lines, and where we put underground infrastructure (including tunnels, pipes and sea level rise protection). They also include regional and state decisions such as how the Northern California rail network will function and where high-speed rail will operate. Private actors such as employers and investors also need to include a new crossing in their planning.

Ultimately, we don't know how long planning, financing and building a second crossing will take. Business as usual suggests 20 or 30 years — meaning crowded trains, train stoppages and dependence on driving would continue for decades. Some infrastructure experts we interviewed suggested that we could complete it in a 10-year time frame — if the public and political leaders took extraordinary steps to support creative funding, construction and governance solutions. Similar projects are regularly completed in less time in other countries. For example, the Istanbul Marmaray Rail Tunnel Project was completed in nine years, and Madrid's Interconnector is anticipated to open in 2016, eight years after construction began.[5]

Incorporating a potential second rail crossing into planning now — rather than trying to fit all the pieces together after today's planned buildings and transit projects have been built — will add efficiency and opportunities for cost savings.

SPUR researched this white paper on designing a second transbay crossing in order to spark thinking and planning for future transit in the Bay Area's busiest travel corridor. In this paper we will:

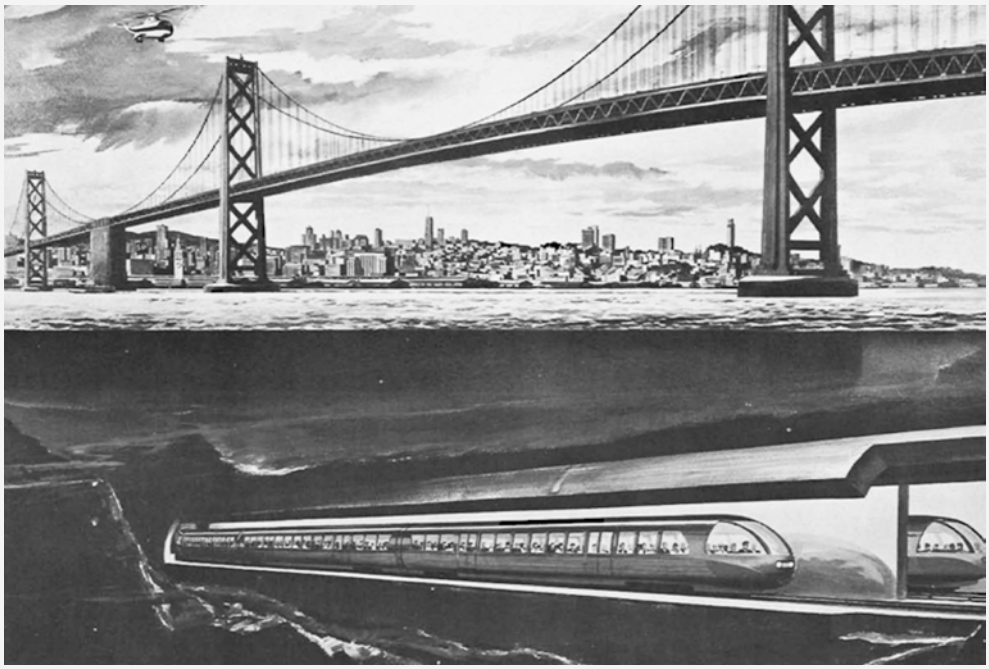
- Explain the purpose of a second transbay rail crossing and why we need to begin an informed conversation today.
- Outline the major design and operations choices that will need to be made.
- Offer recommendations to move forward on planning a second transbay rail tunnel.

[5] *The Madrid Interconnector is a 6.9 kilometer, single-bore, two-track tunnel between two major stations. Contracts were awarded in 2008 and boring was completed in 2011. The Istanbul Marmaray Rail Tunnel project — the first rail crossing of the Bosphorous strait, used by metro and commuter rail — took nine years to construct. Like the Transbay Tube, the Marmaray tunnel is underwater in a congested urban area.*

SPUR's recommendations are:

1. Fund and implement near-term and mid-term transportation solutions to make better use of the bridges, the existing Transbay Tube and the Bay itself.
2. Fund and initiate a planning and design process for a second transbay rail crossing.
3. Define regional priorities and form a state-level task force to secure funding and create an appropriate governance structure.
4. Study both standard gauge rail and BART gauge rail for the second crossing.
5. Begin planning for a second crossing in local plans and projects.
6. Start planning for great stations areas today.
7. Prioritize designs that minimize construction impacts.

Building the First Transbay Rail Tunnel



Source: San Francisco Bay Area Rapid Transit District, *Engineering Report: Rapid Transit for the San Francisco Bay Area*, June 1961, http://libraryarchives.metro.net/DPGTL/bart/1961-parsons-engineering-report-to-sf-bart-district.pdf

The concept of building an underwater tunnel between San Francisco and the East Bay was first explored in 1946, when a joint army-navy board was convened to study the need for more travel capacity across the Bay. This commission found that it would be impossible to continually build new highway crossings and the related parking facilities, and that at some point automotive congestion would become so severe that the area would be forced to provide other options.

In 1951, the San Francisco Bay Area Rapid Transit Commission (BARTC, the precursor to today's BART District) was formed to study the creation of a rapid transit district. BARTC consultants recommended the construction of a rail rapid transit system on the east and west sides of the Bay. It would connect the central business districts of Oakland and San Francisco via an "underwater tube" and would be dramatically cheaper to construct than even the least expensive bridge option. In 1961, Parsons Brinckerhoff Tudor Bechtel, the BART project engineers, issued initial plans and engineering analysis.[1] It would be the longest and deepest underwater transit tube in the world.

The Transbay Tube was an engineering marvel: It was designed as 3.6-mile tunnel composed of 57 binocular-shaped steel segments that would be lowered by barge into a 33- to 133-foot deep trench on the Bay floor. The project took less than four years to complete, and the tube opened for service in 1974. Fifteen years later, the tube (and the entire BART system) withstood the shock of the 7.1-magnitude Loma Prieta Earthquake.

The construction of the Transbay Tube involved groundbreaking engineering and design. Nothing of its kind had ever been built before, and engineering talent from around the country came to the Bay Area to make this project a reality. Funding such a vision took years of persistence and creativity. Of the $1.6 billion spent to build the original BART system, 80 percent came from local and state funding. As we look to a second transbay rail crossing — and the region's next generation of transit investments — a similar level of risk taking and ingenuity may be required.

[1] *The BART district originally comprised five counties: San Francisco, San Mateo, Marin, Alameda, and Contra Costa. However, San Mateo County withdrew in April 1962, and Marin followed suit the next month.*

WHY SHOULD WE PLAN A SECOND TRANSBAY RAIL CROSSING?

A second transbay crossing would serve a broad range of purposes, from meeting fundamental transit needs to directing new growth in the most efficient manner and sustainable places. SPUR suggests four key reasons to plan a second transbay rail crossing.

1. A Second Transbay Rail Crossing Will Add Transit Capacity

During peak periods, BART train cars are packed as they pass through the Transbay Tube, making it impossible for people to board trains at stations close to the tube. Busy peak periods are getting longer. Likewise, the AC Transit transbay bus system, Caltrain and the WETA ferries have experienced more crowding.

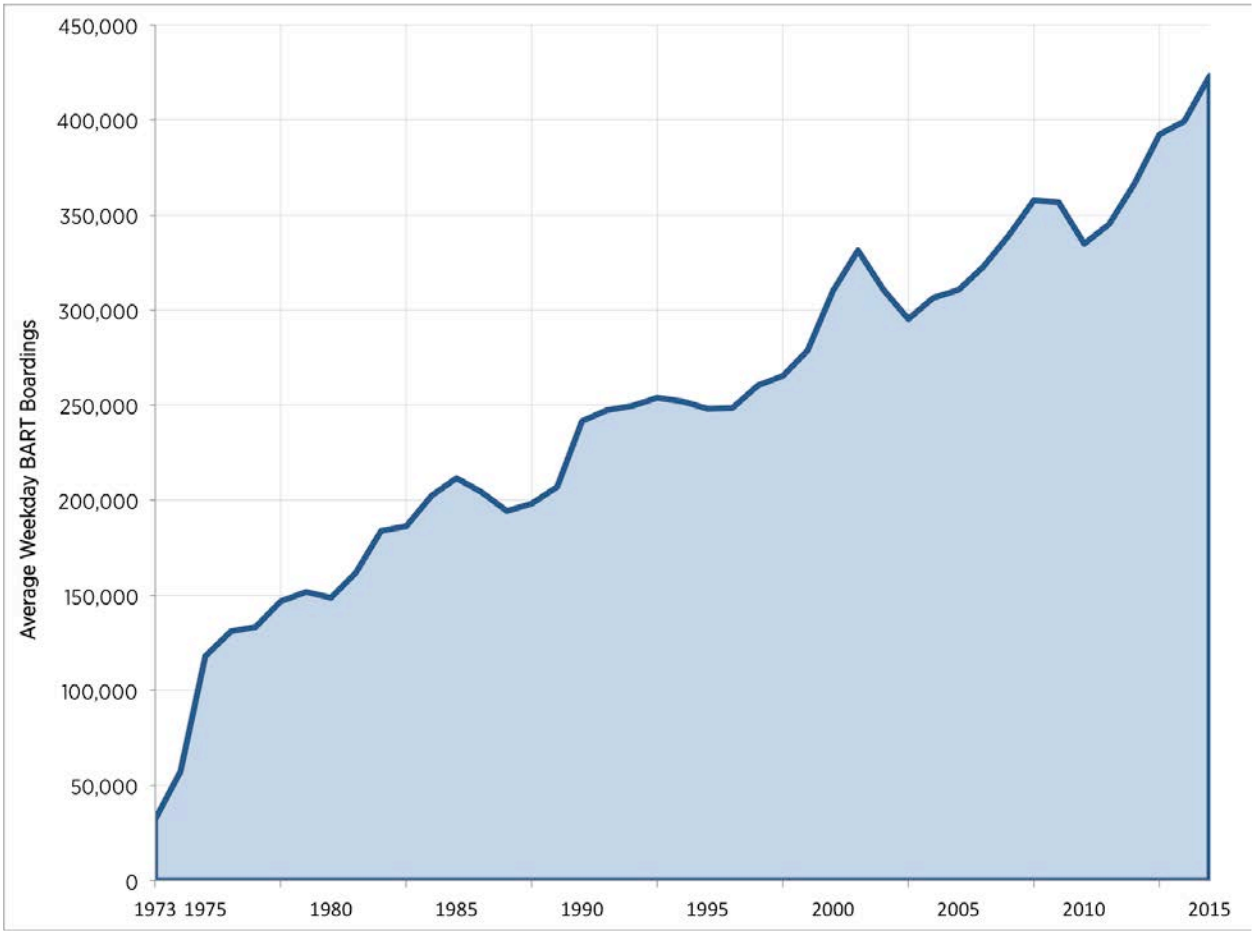
With this ongoing ridership growth in the region's cities, and multiple BART extensions coming online within the next five years (each adding new transit riders to the system), BART is increasingly unable to serve transbay riders with acceptable service.

When we fail to accommodate transit growth, it has broad implications: Highways and local roads become congested; walkable transit-oriented development doesn't get the support it needs to succeed; economic growth and the local economy slow down; and conditions to worsen for existing transit users, particularly those with constrained mobility (such as people in wheelchairs), who are less able to access a packed train.

A series of capacity improvements, small and large, will give breathing space to existing and new riders. However the planned capacity improvements will likely fall short of what is needed to accommodate demand during peak travel hours.[6] Incremental improvements and system optimization will only get us so far; at some point we will need a game-changing capacity project that enables the region to grow.

[6] *Current analysis by MTC estimates that 23,000 more transit trips can be offered during morning peak hours — if we fund and deliver a large set of transit projects and new transit services. Source: Bay Area Core Capacity Study http://mtc.ca.gov/sites/default/files/2015_10-20_CCTS_TAC_meeting.pdf, SPUR Analysis*

Figure 1: The Bay Area Relies More and More on Rail
Ridership on BART is exploding due to growth in jobs and housing, increasing traffic on highways and new and improved ways to get to and from rail stations. This preference for transit may be a fundamental shift for the region, not just a cyclical trend.



Source: BART, Total Annual Exits FY1973 - FY2015, http://www.bart.gov/about/reports/ridership

How Can We Move More People Across the Transbay Corridor in the Short Term?

Multiple studies have investigated what we can do to move more people across the Transbay Corridor before a second rail crossing is completed. We can and should pursue the following projects to provide relief in the next few years. Some are funded and underway, while others will require significant new funding and/or policy change.

1. Add more train, bus and ferry service. BART is already acquiring new trains cars, but as new BART extensions open (for example, service to Warm Springs opens this year) the fleet will also need to serve more stations. More BART service also requires an efficient train control system that will allow trains to run more often, increasing overall train capacity. Other needed BART projects are station improvements, turnbacks that allow trains to reverse direction so BART can run more frequent service in the busiest places, expanded maintenance facilities, and an upgraded power supply. Growing bus service requires replacing aging buses and acquiring additional buses, as well as increased maintenance capability. New ferry boats — especially higher-capacity boats — would enable the addition of more ferry service during peak hours.

2. Increase transbay bus efficiency. Creating a dedicated bus lane on the Bay Bridge would increase bus travel speeds and enable full use of the Transbay Transit Center's bus capacity (300 buses, or 20,000 passengers per hour — as much as a BART station). For East Bay neighborhoods that are not near BART stations, better bus lanes will improve transbay access to and from San Francisco and the Peninsula. As an intermediate step, it may be possible to designate one westbound lane on the bridge as a bus-only lane during morning peak hours, or as a high-occupancy vehicle lane for vehicles carrying four passengers. A contraflow lane — reversing the direction of a lane in the non-peak direction — is another way to add a bus lane. New access ramps currently under construction will provide buses with traffic-free access from the Bay Bridge directly to the Transbay Transit Center, further expediting bus service.

3. Add ferry landings and new bus destinations. Expediting WETA's plans to add more ferry berths at San Francisco's Ferry Building and adding new ferry landings in Richmond and other places where capacity needs are highest would provide new transbay transit alternatives. Adding transbay bus services to new destinations will also reduce demand on train transit. AC Transit's transbay bus service should pilot new service on its busiest lines to job centers in San Francisco, including Mission Bay/4th and King Caltrain, Civic Center and other possible high-demand locations.

4. Manage demand for transit and roads. To reduce crowding, we can encourage travel during non-commute times by increasing prices during peak hours or reducing prices during the "shoulder" times right before or after peak hours. Demand for the Bay Bridge can be affected through tolling and occupancy requirements. We can also incentivize more carpools to form with the designation of more high-occupancy lanes.

The Bay Area Core Capacity Transit Study[1] is identifying reasonable foreseeable projects to handle more travel in the Transbay Corridor, addressing opportunities with autos, rail, bus and ferries. The study is analyzing different solution packages of near-term, medium-term and long term-solutions, which are likely to include some of the solutions listed here.

[1] *The study is collaboration of the San Francisco Municipal Transportation Agency, Water Emergency Transit Authority, AC Transit, BART and Caltrain in coordination with MTC and the San Francisco County Transportation Authority. See: http://www.mtc.ca.gov/our-work/plans-projects/other-plans/core-capacity-transit-study*

2. A Second Transbay Rail Crossing Would Enable Essential Maintenance and Repair

In order to provide the reliable service transit riders depend on, the Bay Area's rail systems have to be in a good state of repair and regularly maintained. The need for maintenance increases with both the age of our system and our heavy use of it.

Today, maintenance crews have a short window of time each night to make both routine and major repairs on the Transbay Tube because it must be reopened a few hours after work begins. With a second transbay crossing, transbay service could use one crossing while the other crossing is shut down for maintenance. With today's single rail link, this level of backup during repairs is not possible.

The current Transbay Tube needs more extensive repairs than can be completed in a few hours, as was indicated by two weekend shutdowns in the summer of 2015. Without a second transbay crossing, maintenance and repairs of the existing Transbay Tube will require more weekend shutdowns, and/or single tracking service, which cuts the throughput of the tunnel by more than half. Ultimately, a second crossing is necessary simply to maintain BART in a state of good repair without causing the very disruptions that a state of good repair seeks to avoid.

An important benefit of having more time for maintenance is that transbay rail service could run 24 hours, providing access to late-night and early morning jobs.

3. A Second Transbay Rail Crossing Will Help Us Manage Breakdowns and Withstand Shocks

Our region's overreliance on a single rail link is risky even under current conditions: More than 70 percent of transbay trips from the East Bay to San Francisco during the morning peak occur on a single set of rail tracks.[7] On multiple occasions BART transbay service has been halted for more than several hours, sometimes with no warning.[8] With plans for the region's future hinging on dramatic growth near transit, our dependence upon a single rail track will introduce even more risk.

The existing transbay transit system is fragile and vulnerable to two kinds of disruptions. The first type is routine disruptions that happen with some regularity: sick passengers requiring urgent medical treatment; mechanical glitches; political protests. When trains are running at or near capacity, these events are disruptive to large numbers of people and take longer to recover from.

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[7] *Bay Area Core Capacity Transit Study. See: http://mtc.ca.gov/sites/default/files/2015_10-20_CCTS_TAC_meeting.pdf*

[8] *October 1989, Loma Prieta Earthquake (11 hours); June 2012, building fire near West Oakland BART (14 hours); October 2012, person entered tunnel (1.5 hours); May 2015, broken rail between Civic Center and 16th St Mission (6.5 hours); July 2013, strike (4 days); October 2013, strike (4 days); November 2014, protest (1.75 min); January 2015, fatality (2 hours); August 2015, planned repairs (2 days); August 2015, fatality (4 hours); September 2015, planned repairs (3 days).*

The second type of disruption we are vulnerable to is a major shock — an earthquake, fire, major mechanical disaster, large accident or act of terrorism — which could shut down the transbay link for months or longer. No other system we have can properly absorb transbay transit riders and allow our region's basic functioning to continue. A major natural or mechanical disaster that put the Transbay Tube out of commission for weeks or months would wreak havoc on the region's economy.

As we make investments to grow the number of travelers using the tube, our over-dependence on it will become even more extreme. Increased bus and ferry service will provide essential new capacity, too, but not on a scale that could manage trips displaced from a Transbay Tube failure.

Having multiple crossings will cushion the region from planned and unplanned repairs and natural disasters, and a wide range of other potential disruptions.

4. A Second Transbay Rail Crossing Will Keep the Bay Area Moving as We Grow

Our region's 2040 transportation and land use plan, Plan Bay Area, and other local plans presume that in the future, more people will live or work near regional transit — especially in San Francisco, the Peninsula and the inner East Bay. For example, Plan Bay Area projects 250,000 new jobs, or a 40 percent increase, in areas adjacent to BART stations.[9] This means that people will rely much more on transit, and transbay rail service, to get around. Plan Bay Area sets important transportation targets, including:[10]

- Boosting the share of trips taken without a car by 10 percent
- Reducing per capita vehicle-miles traveled by 10 percent

We think meeting these targets, or exceeding them, will be difficult with a transbay rail crossing that relies upon a single rail line in each direction. In fact, even the most transit-oriented growth scenarios modeled in Plan Bay Area would fail to meet these targets with our current transportation system. Now is the time to ask ourselves whether we are serious about our regional transportation and land use vision and, if we are, to take the steps to build a transit network that supports those goals.

A new transbay tunnel — with new stations surrounded by transit-friendly neighborhoods — could enable us to meet or exceed our Plan Bay Area goals while accommodating the region's forecasted population growth. Particularly, this effort could succeed when combined with other transportation policy shifts: setting the price of driving and parking closer to their true costs; redesigning streets; coordinating land use planning and creating walkable urban neighborhoods.

For the cities SPUR works in — San Francisco, Oakland and San Jose — and for all of the cities in the Bay Area, reliable transit connections matter. In the future, transit should enable the dense parts of the region to function as a single innovative economy, a single diverse housing market and an integrated job market.

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[9] *See BART Sustainable Comprehensive Operations Analysis https://www.bart.gov/sites/default/files/docs/BART%20SCOA%20Final%20Report%20June%202013.pdf*

[10] *Plan Bay area (July 18, 2013). See: http://planbayarea.org/plan-bay-area/final-plan-bay-area.html*

A second crossing would provide more operational resilience, which translates to a more reliable and a more comfortable ride across the Bay. People would also have more options for how to get around. Finally, it would create a truly strengthened backbone for our region that other new transit services could build on.

How a Second Rail Crossing Can Support Oakland's Growth

Oakland's emergence as a stronger economic hub has critical transportation benefits for the region. It will improve the balance of travel flows (with more commuters traveling the opposite direction of current congestion) and capitalize on substantial existing transportation infrastructure (freeways, ports, railroads, an airport, BART, bus lines, etc.) In the short term, Oakland may experience some spillover benefits from increased transbay congestion and reliability problems: Oakland's easy access to the rest of the East Bay has been a selling point as transbay reliability declines. However, as Oakland's economic importance and regional interdependence grows, transbay reliability and capacity challenges will need to be addressed.

In the long run, Oakland will be a more attractive location for businesses and residents if it is more reliably connected to other regional economic hubs — especially given the network-based nature of the Bay Area's innovation economy. A transbay rail connection could deliver a one-seat ride between Oakland and Silicon Valley; it could even extend high-speed rail service to Oakland. (See map on page 16.) These connections will be the foundations for Oakland's sustained job growth and economic strength.

In other words, the 10 to 20 years required to deliver a second crossing could prove to be good for Oakland's interests. In the near term, businesses will continue to be attracted to Oakland for cost savings and to minimize transbay challenges. But a critical selling point for businesses will be steady progress toward a more reliable transbay network and the sort of inter-regional connections that will take Oakland to the next level as an economic center.

WHAT DESIGN DECISIONS DO WE NEED TO MAKE?

Designing and building a three-mile rail link crossing a wide bay — then connecting it to the existing rail network — is complicated and will require layers of major interrelated design decisions. This section explores the significant planning and design decisions that we will need to make when designing a second transbay rail crossing.

What transit services, and how many tracks, should cross the bay?

We have two types of train systems in the Bay Area: BART gauge and standard gauge rail. ("Gauge" refers to the distance between the two rails of the track.) BART trains run on a wider-gauge rail than standard systems; consequently trains on that system cannot operate on conventional rail tracks. (It is important to note that the BART District runs some services that are not on BART gauge, including the Oakland Airport Connector and the upcoming e-BART extension to Antioch.) Meanwhile, conventional rail systems — such as Caltrain, Capitol Corridor, Amtrak and, in the future, high-speed rail — operate

on a standard-size gauge, and each of these services can run on the same tracks. A second transbay crossing could be built with both track types — including four tracks instead of two — to accommodate many train services.

Figure 2: The Bay Area's Two Types of Rail Systems
The Bay Area has two types of rail systems, BART gauge and standard gauge rail. Riders can connect between the two systems at Millbrae, Richmond and Coliseum stations. Several more connections are planned, at the Transbay Transit Center, San Jose's Diridon Station and Union City.

Map by Brian Stokle

Where should the second Transbay Corridor rail crossing go?

Deciding where the Transbay Corridor rail connection is made — which cities, neighborhoods and transit lines the new transit link would connect — is the most important set of decisions to make. This is a major, one-hundred-year investment decision. It comes down to providing direct redundancy with the existing crossing versus leveraging the new crossing to connect new markets and increase flexibility within the regional rail network. Should downtown San Francisco and downtown Oakland be better linked with a crossing that roughly follows the current Transbay Tube? Or should transit bring people to neighborhoods that are not as well served by transit, such as Mission Bay or Jack London Square?

A second crossing that is very close to the existing crossing could deliver commuters to San Francisco's financial district during a mechanical failure or scheduled maintenance shut-down. In contrast, a second crossing that is further south might better serve developing markets and support the creation of new transit-oriented neighborhoods, while providing less direct redundancy for the existing tube. A hybrid choice could use one of these strategies on one side of the bay, and the other on the other side of the bay.

These considerations will be intertwined with decisions about the number of tracks and types of track that comprise the new transbay rail connection. The principal options are:

- **Strengthen the existing system with a new two-track BART gauge crossing (one track in each direction).** This option would provide greatly needed capacity, maintenance flexibility and reliability for the existing BART system by allowing BART trains to run on either crossing (the current Transbay Tube or the new tunnel). Depending on the routing, this option could also connect some dense and rapidly growing communities, but it would primarily support and leverage additional value for the existing BART system. Connecting the new crossing to the existing BART system would provide BART with much greater service flexibility.

- **Expand to new markets with a two-track standard gauge crossing (one track in each direction)**. This option would add needed transbay rail capacity and would add new regional connections on standard gauge rail systems. For example, Caltrain, Capital Corridor and future high-speed rail could connect across the bay, directly linking Oakland, eastern Contra Costa and Sacramento with San Francisco and the Peninsula. Connecting the Peninsula more directly to Oakland would open up access to Silicon Valley jobs and strengthen Oakland and the East Bay as viable places to open offices, once employers could easily go between the two job centers. Major track improvements on the Capitol Corridor route (electrifying train engines and separating passenger tracks from freight tracks) would be required to increase the level of service on the corridor between Sacramento and the west side of the Bay. A standard gauge crossing would require completion of the extension of Caltrain to downtown San Francisco.
- Combine the two strategies with a four-track crossing that uses both BART and standard gauge rail (two tracks in each direction). This option would provide access to both the BART system and existing standard gauge rail systems and offer the benefits of both of the previous options: redundancy for today's system and service to new markets. The approach would support the long-term needs of a highly transit-oriented and interconnected region, but it would be a much more complex and disruptive transportation project.

Many of the most efficient alignments would run under the City of Alameda, which is on an island. Placing a station there would be logical and have the potential benefits of providing regional rail access to the island, supporting its plan for denser development and reducing dependency on its bridge crossings.

Whatever rail alignment is selected should ensure that:

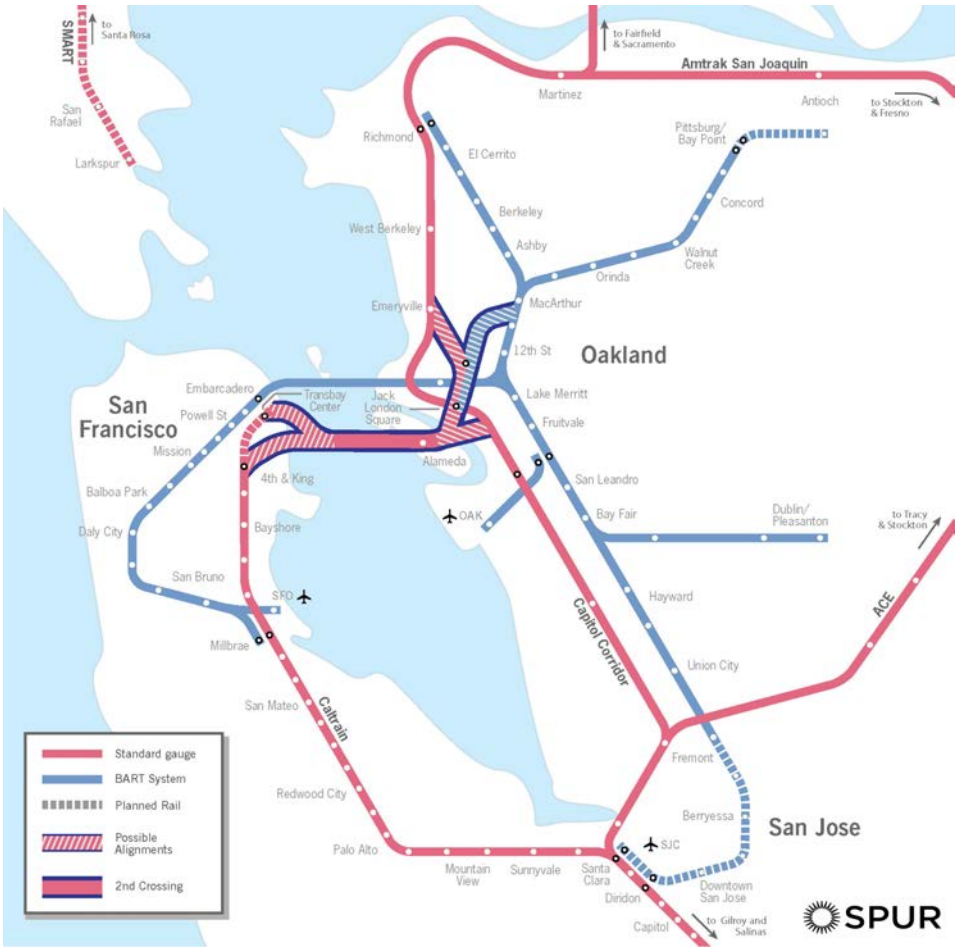
- There is one operational transbay rail crossing at all times to allow for major maintenance of the other crossing, especially the existing Transbay Tube.
- Downtown San Francisco and Oakland transit riders have access to the second transbay crossing directly, or with one transfer, from existing BART and other rail services.
- Train maintenance and storage facilities are designed to be adequate for train operations while not degrading surrounding communities.
- It does no harm to the existing rail systems and infrastructure by introducing new points of failure.
- Local land use and other local policies are leading to the ridership that is anticipated for a new rail crossing.

Figure 3: Three Ways a Second Transbay Rail Crossing Could Connect With Existing Rail

Map 1. A new two-track BART gauge crossing (one track in each direction) would provide redundancy for the existing transbay BART crossing and allow more flexibility with BART service.

Map by Brian Stokle

Map 2. A new two-track standard gauge crossing (one track in each direction) could connect the region's commuter rail systems and create a more direction connection between the East Bay and Silicon Valley. A standard rail crossing could also carry high-speed rail trains.



Map by Brian Stokle

Map 3. A new four-track crossing could carry both BART gauge and standard gauge tracks, providing the benefits of new BART connectivity and new transit connections between the East Bay and Silicon Valley.

Map by Brian Stokle

What type of infrastructure should we use for the crossing?

Deciding on the crossing infrastructure and number of tracks will inform where the crossing can go and how much it will cost. Each infrastructure option has pros and cons in terms of cost, station access and environmental considerations.

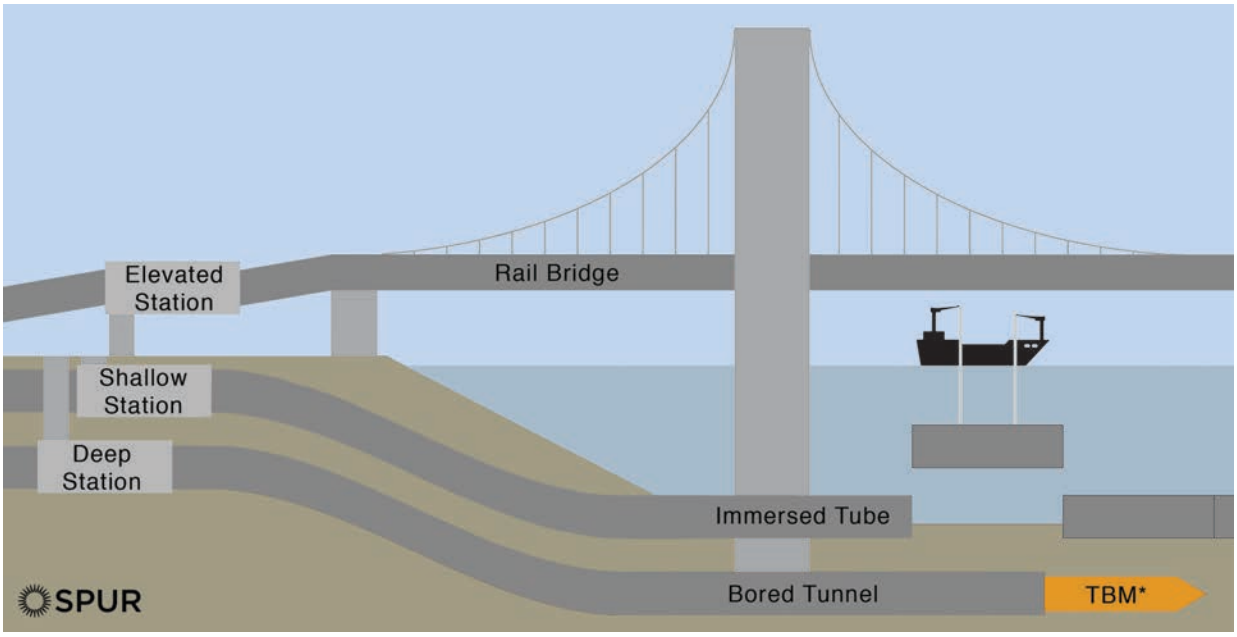
There are several distinct ways that rail can cross the bay, a tunnel being the most likely. The main options are:

- Immersed tube on the bottom of the Bay. This is the design of the current Transbay Tube: a steel tunnel placed on the bay floor in sections, linked together and covered in mud, and consequently not deep underground when it reaches land.
- Bored tunnel beneath the Bay. Tunnel boring calls for digging a deeper tunnel *under* the bay, through rock and earth. The Central Subway in San Francisco is using tunnel-boring technology. Tunnel boring technology has become much cheaper in recent decades. It also allows for deeper

tunnels and stations that do not follow the street grid, and therefore can be less disruptive during construction.

- Rail bridge over the Bay. A rail bridge would have a gently rising approach from each side of the Bay with a high section in the center to allow large ships to pass under it. The width of the San Francisco Bay provides a sufficient span to accommodate rail's required maximum slope. Connecting the rail link from the bridge to elevated rail lines on wide boulevards, and eventually to tunnels, could create new route options.[11]

Figure 4: Infrastructure Options for a Second Transbay Rail Crossing
Rail can cross the Bay in multiple ways: bored tunnel, immersed tube and rail bridge. A bored tunnel is considered a likely choice; this method would require deeper stations than the current BART stations.



*Tunnel Boring Machine
Image by Graham Pugh

[11] *BART's maximum slope for train operations is 4 percent. A high bridge section could be centered south of Yerba Buena Island, with sufficient distance to reach a 35-foot-high elevated rail line somewhere in San Francisco. Wider streets, such as King Street, 16th Street and the Embarcadero, would more easily accommodate an elevated line. Alternatively, a rail bridge could avoid a long landing by entering into a tunnel at a hill such as Potrero or Rincon.*

Construction Impacts from Subways

Construction of the current Transbay Tube had an acute impact, particularly on three major thoroughfares: Market and Mission streets in San Francisco, and Broadway in Oakland. On Market Street, the earliest construction activity began in May 1967 and ended in nine years later, in May 1976. Disruption of Market Street was exacerbated by the Market Street Beautification project, which significantly reconstructed sidewalk areas from 1972 to 1977, extending the public's perception of construction activity in the area. Businesses cited poor pedestrian and vehicular access, sidewalk narrowing, noise and dust as reasons for business decline. Similar conditions occurred on San Francisco's Mission Street. In Oakland, impacts were even more severe, as construction used cut-and-cover methods: digging up the street, laying tracks and then covering them. In Oakland, BART-related disruption was concurrent to significant Redevelopment Agency-led construction. [12]

The magnitude of construction impacts with a second crossing will depend on what construction methods are chosen. Station construction creates the most debilitating impacts on neighborhoods due to the cut-and-cover construction technique that is often used. Construction crews dig a giant trench to reach bored tunnels below, disrupting street traffic and making access to nearby retail businesses difficult. The Union Square Station of the Muni Central Subway, currently under construction, is a useful example. Building a deeper excavated station can have fewer neighborhood impacts, as it can require a smaller access point to reach the station, which is excavated from deep below the city, not from the surface down. However completely tunneling out a deep station may prove more expensive and increases the time passengers must take to reach train platforms.

How do we phase the construction of the crossing?

Given the long time required to deliver a second crossing, it maybe advisable to build smaller projects in advance of constructing the new tunnel. Can we complete smaller rail projects that bring quicker short-term benefits to cities first, then build the crossing afterward? Or is a crossing so important that we need to build it first and phase the connecting projects afterward? In order to plan this kind of phased construction, we will need to have answered all the preceding design questions.

Complete Projects on Land First

Both the east and west sides of the Bay might benefit if new rail subways are phased in before building an actual crossing. Initial projects that could integrate with a second crossing include:

Oakland and the East Bay

- Building the East Bay approach to the second transbay crossing. The I-980 trench has been identified as a promising site for a transfer station between transbay rail lines and East Bay rail lines. A second rail crossing could convert this trench into a major site for new housing and a truly intercity and regional train station in downtown Oakland. An initial phase could bring BART service to downtown Oakland and Howard Terminal, ending at Alameda Point.

[12] *Study of BART's Construction Impacts (1978),* https://archive.org/download/studyofbartscons1978vict/studyofbartscons1978vict.pdf

- Developing rail stations near ferry landings at Jack London Square and in Alameda. This would allow people to transfer from BART to ferries on their way to San Francisco, addressing transbay demand before a second crossing is built.
- Constructing dedicated passenger rail tracks for Amtrak and the Capitol Corridor. These routes could then connect with a new crossing at a hub in Oakland. [13]
- Building a rail yard for passenger rail services in Oakland.
- Upgrading inter-regional rail service from the Central Valley. This would include new and enhanced rail alignments for access to Sacramento, Stockton and Merced with new right-of-ways, including some on new levees to protect low lying East Bay areas from sea level rise. Such enhancements would provide improved access to the East Bay and South Bay from cities to the east.

San Francisco and the Peninsula

- Completing the Caltrain/high-speed tunnel to the new Transbay Transit Center.
- Building a subway from Geary or another neighborhood in western San Francisco to downtown, SoMa and/or Mission Bay.
- Creating a BART spur track off of the Market Street tunnel near Van Ness Avenue, through Showplace Square and into Mission Bay.
- Connecting San Francisco's Richmond and Sunset neighborhoods to Daly City BART with access to points south.
- Upgrading inter-regional rail service from the Central Valley. This would include new and enhanced rail alignments for access to Sacramento, Stockton and Merced with new right-of-ways, including some on new levees to protect low lying East Bay areas from sea level rise. Such enhancements would provide improved access to the East Bay and South Bay from cities to the east.

Complete the Transbay Crossing First

If the second transbay crossing were built first, it would likely need to connect to the nearest regional rail station and job center on either side of the Bay. In San Francisco this would mean either reaching the Market Street station from a new downtown station or merging tracks into the existing Market Street tunnel somewhere between the Civic Center and 16th Street Mission stations. On the East Bay side, it would mean reaching an existing rail station (e.g. West Oakland, Lake Merritt or 19th St BART, or Jack London Amtrak), where second crossing passengers would transfer to the existing rail network. Or, the tracks could merge with existing service, such as BART or Capitol Corridor, on existing tracks and use existing stations.

[13] *The Capitol Corridor 2014 Vision Plan Update explains the steps required to increase the amount of Capitol Corridor Service. See: http://www.capitolcorridor.org/downloads/CCJPAVisionPlanFinal.pdf Service changes could include: new commuter rail service from Oakland to Hercules or even on to Martinez; ACE service to Oakland; and more frequent Capitol Corridor service linking Sacramento and San Jose, especially between Oakland and San Jose.*

Connecting Local Projects With a Second Transbay Tunnel

Oakland's downtown planning process has introduced a new vision to turn Interstate 980 into a boulevard and create a new transbay rail tunnel beneath. Today, 980 functions as a barrier between downtown Oakland and West Oakland. It would be costly to deliver on plans to transform this underutilized freeway into land for affordable housing, new jobs and improved connections between downtown Oakland and surrounding neighborhoods. However, this investment would be more manageable — and more likely to happen — if undertaken as part of a new transbay rail crossing. This new terminal could include the train storage and maintenance that would be required for the increased number of trains, including high-speed rail trains.

Source: Dover, Kohl & Partners

RECOMMENDATIONS

The development of BART's Transbay Tube —— the Bay Area's first modern rail crossing —— transformed our region and has enabled decades of growth on both sides of the Bay. Given the complexity of another project like this, we must allocate ample time for planning, finance early engineering and ensure that the crossing is integrated with other regional transportation projects. With enough time, we can work together to take advantage of opportunities for collaboration, funding and improving the functioning of the entire transit network.

Recommendation 1. Fund and implement near-term and mid-term transportation solutions to make better use of the bridges, the existing Transbay Tube and the Bay itself.

Immediate action is required to address transit crowding and allow more people to get across the Bay. Shorter-term projects are underway including: investments to add new BART cars and increase train frequency; expanded and more efficient transbay bus service; programs to encourage peak transbay travelers to shift their trips to less crowded times; and investments in expanded ferry service. As discussed earlier, these investments cannot solve our transbay crossing challenges, but they are essential stop-gap measures. These projects must advance swiftly in order to manage transbay travel in the coming decade.

Some leaders have expressed concern that planning for a second crossing will displace these essential near-term and mid-term solutions. This is plainly not an option. We needed many of these shorter-term solutions yesterday, and we will continue to need them in the years before a new transbay crossing can be completed. The push to begin planning for a second transbay tunnel is not meant to displace near-term improvements but rather to avoid revisiting our current predicament by mapping out critical new transit links that are reliable and designed for a growing region.

Recommendation 2. Fund and initiate a planning and design process for a second transbay rail crossing.

Playing catch-up on essential regional transportation links is costly, both to people and to our regional economy. We can plan for tomorrow's needs while tackling today's problems. As we see every year with BART, Caltrain and other crowded systems, it is easy to slow down the planning and building of transportation projects — but it's not easy to catch up. Serious planning for the second transbay rail crossing will be costly, and we need to pursue funding today to get started.

BART is likely to present a bond measure on the November 2016 ballot in three counties (San Francisco, Alameda and Contra Costa) to raise needed funds to improve service reliability, increase capacity and elevate the system's state of good repair. This would be the most appropriate and immediate opportunity to fund initial planning and engineering for a second rail crossing. The bond will likely focus on nearer-term maintenance and capacity investments, such as expanding the Hayward Maintenance Complex, installing a new train control system and upgrading power systems. As this report has described, a second transbay crossing is increasingly necessary to deliver the operational flexibility for proper system

maintenance and reliable service. SPUR suggests the BART Bond program including funding for planning the second transbay rail.

BART can be proactive in tackling one of the central challenges for its long-term reliability — and for the growing number of transit riders in the Bay Area. BART, with its regional elected board, can embrace the big picture and lead the planning of this significant project.

As a region, we must also pursue other possible funding sources for the planning of a second crossing, including:

- **State and federal funding.** Given the importance of the Bay Area economy, and the importance of this project to sustain economic growth, this crossing should be a state and regional funding priority. Specific pots of money include cap and trade and high-speed rail.
- **Countywide transportation tax measures.** Both Contra Costa and San Francisco counties may place such measures on the ballot in 2016.
- **Plan Bay Area.** The next Regional Transportation Plan should include planning the next generation of transit projects in the region.
- **Regional Measure.** MTC may place a measure on the ballot in 2018 asking voters to raise bridge tolls to fund infrastructure projects and transit programs in the bridge corridors.

Recommendation 3. Define regional priorities and form a state-level task force to secure funding and create an appropriate governance structure.

The Bay Area has a complex institutional landscape when it comes to transit. A project of this magnitude and importance should not be framed around existing or historic institutions' roles. Delivering a second transbay crossing in the timeframe required will be hard enough without territorial battles and isolated planning. As a region, we should consider what we need (transit capacity, reliability, fiscal sustainability, flexibility in revenue sources, procurement efficiency and operational flexibility) and how it will benefit the people of the Bay Area, then establish the institutional arrangement that can deliver. Ultimately, the governance of the second rail crossing needs to be strong enough to coordinate and deliver the requirements of the many operators and interests, including high-speed rail, BART, local commuter rail operators, MTC, cities and others.

SPUR recommends forming a state-level task force composed of local and state leaders. This group can:

- Lead local planning conversations about a second rail crossing
- Identify economic benefits, risks, and potential state and federal funding
- Examine state legislation that would help us complete this project more quickly, including procurement and accelerated environmental review options.
- Help define the best organizational structure to both deliver and operate the project
- Explore opportunities for public-private partnerships (see sidebar on page 24)

  In the short run, we can use the Bay Area Core Capacity Transit Study to call for a regional task force to help various Bay Area interests speak with one voice.

Using a Public-Private Partnership to Deliver the Second Transbay Tunnel

It will be important to study how to deliver the project in a timely and cost-efficient way, as well as how to best maintain the new crossing over time. Many of our infrastructure projects take decades to complete because of the time it takes to accumulate local, state and federal funding; it took 18 years (1956-1974) to plan for and build the existing Transbay Tube.

A funding and project delivery process that is different from business as usual will be needed to get this infrastructure project built in a reasonable amount of time. One option is a public-private partnership (PPP or P3), an agreement between a government agency and a private sector entity that participates in delivering a public sector project. Contrasted with traditional models (including how the existing BART system was built), the private sector assumes a greater role in the planning, financing, design, construction, operation and maintenance of public facilities. P3s transfer risks to the private sector, reduce costs, increase certainty of execution, accelerate funding and accelerate project completion. While P3s are still emerging in California and the United States, they are increasingly common around the world. A local example is San Francisco's project to replace Doyle Drive with the Presidio Parkway.Pursuing a P3 requires deciding who will fill the roles to design, build, operate and maintain the infrastructure. These roles could include:

> **Project sponsor and builder:** The agency, or consortium of agencies, who lead planning, design, construction and delivery of the project.
>
> **Funder/financier:** Likely a combination of public funders (local, regional, state and federal governments). The financier is the party that takes the commercial or monetary risk associated with the project. The funder/financier may retain an ownership and/or operating role for the tunnel facility.
>
> **Tunnel maintenance/operator:** The agency or private entity responsible for operating the tunnel and maintaining all the systems: ventilation, leakage, power, signals, communications, security, etc. Long-term asset management is a role that could be carved out of this role and filled by a different entity.
>
> **Service operators:** The multiple service providers using this facility, which may include the California High Speed Rail Authority, BART, Caltrain, Amtrak and new public or private operators.
>
> **Service planner:** The party that determines what the actual train routes are, i.e., which providers would service which stops and how frequently.

Recommendation 4. Study both standard gauge rail and BART gauge rail for the second crossing.

Choosing between a second rail crossing with BART technology and one with standard rail technology entails fundamental trade-offs. BART technology offers more direct redundancy for the existing Transbay Tube and maximizes BART's future operational flexibility. Standard rail offers greater opportunities to connect with other regional systems and reach new markets. (See page 14.) The choice between these technologies directly impacts where any future stations could be located. Deeper analysis with a broad group of people is needed to weigh these trade-offs. Factors to consider in choosing a rail type and siting stations include:

- Locations of future dense job growth
- Potential future extensions and other rail and transit expansion (new metro lines, light rail lines, bus centers, etc.), as well as their phasing.
- Efficiency, impact and costs of construction
- Capacity to deliver seamless transfers between services with minimal walking and to coordinate schedules between train services
- Opportunities for improving local connections to transit, including feeder transit services and complete streets with strong pedestrian and bike infrastructure.

Recommendation 5: Begin incorporating a second crossing in local plans and projects.

The second transbay crossing is a game-changing infrastructure project that should inform decision-making for numerous ongoing or soon-to-begin transportation studies, land use plans and major development projects. These plans could be prematurely obsolete if they fail to consider a potential second transbay crossing. Examples include: the San Francisco Subway Master Plan, Railyard Alternatives and I-280 Boulevard Feasibility; Downtown Oakland Specific Plan; Alameda County Countywide Transit Plan; Alameda Point Redevelopment and others.

Integrated Transit Services

Developing plans for a second crossing today allows us to make sure that current transit investments work toward a coherent future network. Regional rail (BART or commuter rail) can only thrive so long as local bus systems reliably, quickly and efficiently get travelers to the rail stations. Light-rail service will have to grow, bus routes will need to be added or changed. In addition, any new station would be an attractor for new bus rapid transit or streetcar rail service.

Service improvements to connecting rail and bus services should continue, and be built upon, in the coming years. Caltrain Modernization, Muni Forward, and bus rapid transit projects from AC Transit, VTA and Muni should move forward, as should more frequent service for the Capitol Corridor and ACE rail lines. We should also keep working on solutions to make our multiple operators function more like one system, including integrated fare products and shared transit maps and information programs.

Recommendation 6: Start planning for great stations areas today.

While the primary purpose of a second crossing is to address serious transit reliability and capacity problems, new transit access must be leveraged to deliver much-needed new urban places.

A second transbay crossing will likely lead to the creation of new or enlarged transit stations. Planning and zoning for the areas surrounding these stations must acknowledge their regional role. Density minimums, parking maximums and other complimentary policies should be adopted in station areas. Neighborhoods around transit should not only benefit those who can afford market-rate real estate, they should also be built and financed in a way that guarantees significant affordable housing near stations.

Figure 5: Transit-friendly Neighborhoods Lead to Transit Usage
More than 70 percent of people arriving to downtown San Francisco arrive on transit, thanks to a high concentration of jobs in walking distance from rail stations. When considering where new rail stations should go, we should ensure that there are plentiful workplaces and other destinations nearby.

Photo by Sergio Ruiz

Recommendation 7: Prioritize designs that minimize construction impacts.

We want new stations to be surrounding by pleasant and thriving community hubs. Our first step must not be to cause a major setback with a multi-year, multi-city construction zone. With new tunneling techniques, wise use of existing streets and careful timing, we can minimize impacts on functioning communities. Alternately, if we plan ahead, we can hold currently vacant or available land for future transit stations or for construction activities, which would minimize impact on busy streets.

The sooner we can determine the route and design of a second crossing, the better we can coordinate adjacent projects to reduce their impacts. Station design, access planning and architecture are all decisions that can either enhance or detract from neighborhood vitality.

Some construction impacts to nearby building occupants should be expected, and they will need to be mitigated to the extent possible. Construction of the existing Transbay Tube had lasting impacts, which should be avoided when building a second crossing.

CONCLUSION

Today the Bay Area lacks a comprehensive regional transit plan for a 21st-century network that can fully cope with earthquakes, service disruptions, population growth and the increasing interest in using transit rather than driving. When we look this far forward, we are looking beyond economic cycles and political cycles, beyond the problems of today or this year. We must look at how our growing region will be able to thrive in a world of warmer temperatures and higher sea level, with several million more residents. We must take the long view on transportation and imagine a region with high-speed rail, autonomous vehicles and the continued transformation of Bay Area cities to denser, more walkable places.

The BART plan drafted in 1961 imagined something that didn't exist anywhere: hundreds of miles of grade-separated transit; an automated train-control system; automated fare payment; futuristic, airline-style train cars. It was a courageous and creative vision. The Bay Area needs a bold vision today for a much more robust transportation network. A second transbay rail crossing is one essential piece of the Bay Area's future, one that we might not be able to live without. Let's get to work on it.

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