Appendix G:
Rail Relocation Land Use Analysis

RAIL RELOCATION LAND USE ANALYSIS

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ch2m

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1 EXISTING CONDITIONS

JOBS AND HOUSING CONCENTRATION

Key findings of a network demographics analysis of jobs and housing near current rail stations include the following:

- There are currently about 10,700 residents and 28,000 jobs within a half-mile of 4th/King station.
- There are currently about 8,000 residents and 7,400 jobs within a half-mile of 22nd Street station.

Analysis

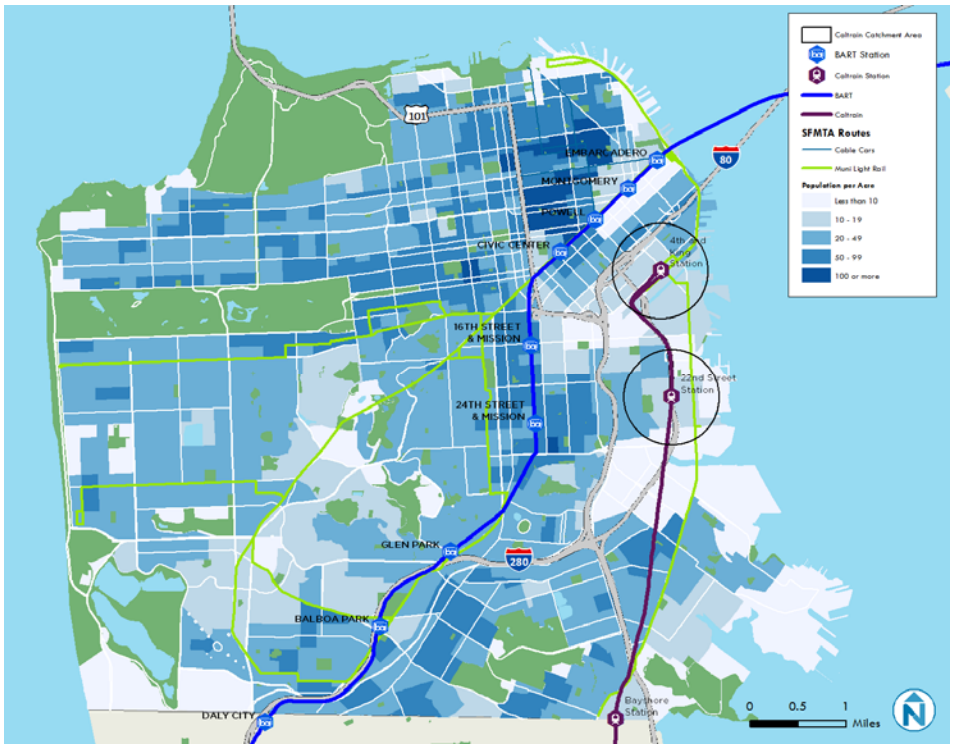
Caltrain's existing service corridor in San Francisco cuts through the southeastern quadrant of the city and avoids some of the city's more densely populated neighborhoods (e.g. Mission District, Tenderloin, or the Western Addition). There are two Caltrain stations in San Francisco, 22nd Street in Potrero Hill, and the terminus at 4th/King in SoMa. A third station, Bayshore, is located on the San Francisco/San Mateo county line, with half of the station in San Francisco and half in Brisbane. These neighborhoods generally have gross population densities of less than 50 residents per acre, as shown in Figure 1. There are currently 10,700 residents living within 0.5 miles from 4th/King station and 8,000 residents in a similar catchment area from 22nd Street station.

San Francisco's employment is mostly concentrated in the city's northeastern quadrant, east of Van Ness Avenue and north of 16th Street, bisected by the Market Street corridor. This quadrant has employment densities of over 100 jobs per acre in many areas. Caltrain's 4th/King Station lies within ½ mile of the eastern side of this employment agglomeration in SoMa. Employment density across the city is shown in

Figure 2. There are currently 28,000 jobs located within 0.5 miles from 4th/King station and 7,400 jobs in a similar catchment area from 22nd St station.[1]

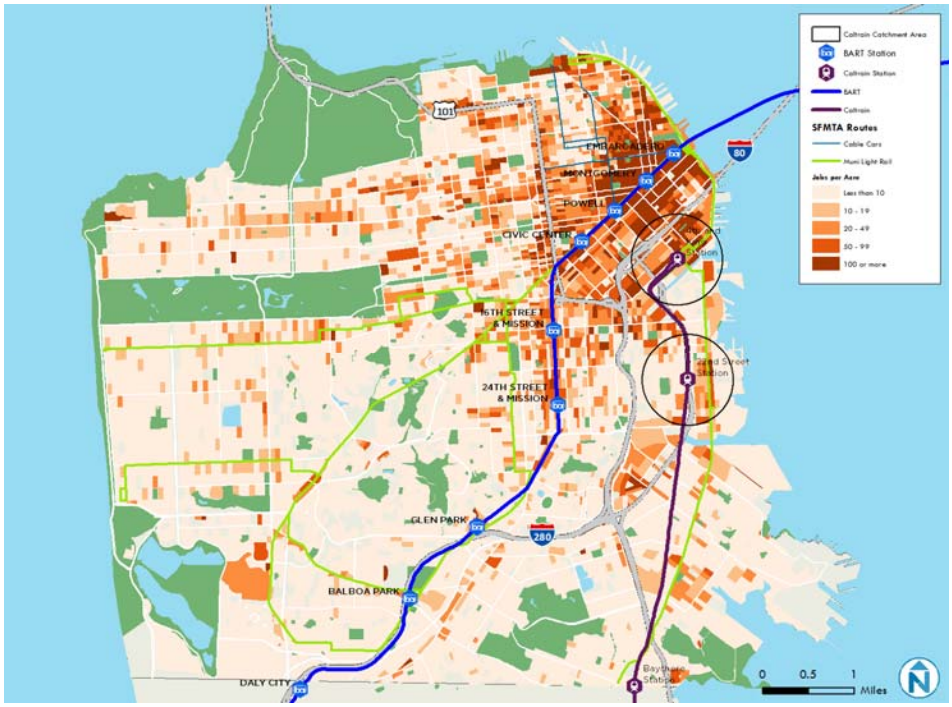
[1] Census Longitudinal Employer-Household Dynamics, 2014. Retrieved from https://onthemap.ces.census.gov/

Figure 1 Existing Population Density



Source: ACS 2011-2015 5-Year Estimates, Table B01001

Figure 2 Existing Employment Density



Source: Census Longitudinal Employer-Household Dynamics Tables, 2014

RAIL RIDERSHIP

Key findings of the existing Caltrain rail ridership analysis include the following:

- The average Caltrain weekday ridership is about 62,000 passengers
- 4th/King station has by far the highest demand of all Caltrain stations
- 22nd Street station only sees about 10% of the demand of 4th/King station
- Less than 1% of commute trips within the city and 1.5% of commute trips from the city are by Caltrain
- 3% of commute trips to the city are by Caltrain
- About 7,000 San Francisco residents commute using this operator (mostly peak riders, accounting for over 14,000 daily trips), and about 10% of these commuters reside within a half-mile radius from 4th/King station

Analysis

Caltrain ridership on an average weekday was 62,000 passengers/day in 2016. San Francisco Station (4th/King) is the Caltrain station with the highest demand, with 14,800 southbound boardings (which corresponds with to-work trips of San Francisco residents and return trips of non-residents), and 14,600 daily alighting (which follows the same pattern). 22nd Street station has less activity, with 1,700 passengers/day alighting northbound, and the same amount of boarding southbound. (Figure 3)

The on board passenger loads between stations is 16,200 passengers/day per direction between Bayshore and 22nd Street, and 14,600 passengers/day between 22nd St and 4th/King stations, as shown in Figure 3.

Figure 3 Caltrain Passenger Activity (Average Weekday, 2016)

	NORTHBOUND		SOUTHBOUND		TOTAL	
STATION	On	Off	On	Off	On	Off
San Francisco	0	14,582	14,769	0	14,769	14,582
22nd Street	47	1,686	1,668	31	1,715	1,717
Bayshore	41	205	212	40	253	245
South SF	183	294	288	189	471	483
San Bruno	306	448	411	310	717	759
Millbrae	610	3,107	2,995	620	3,606	3,727
Burlingame	552	508	502	547	1,054	1,055
San Mateo	1,069	1,040	1,110	1,103	2,179	2,143
Hayward Park	220	204	207	214	427	419
Hillsdale	1,803	1,114	1,155	1,782	2,958	2,896
Belmont	350	304	315	317	664	621
San Carlos	779	714	695	734	1,475	1,447
Redwood City	2,314	1,431	1,500	2,300	3,814	3,731
Menlo Park	1,070	709	725	1,108	1,796	1,817
Palo Alto	4,663	2,818	2,761	4,933	7,424	7,751
California Ave.	1,102	502	526	1,062	1,628	1,564
San Antonio	758	156	184	710	942	866
Mountain View	4,075	497	584	4,132	4,659	4,629
Sunnyvale	2,888	247	302	2,970	3,190	3,217
Lawrence	744	142	157	762	901	904
Santa Clara	1,025	65	68	1,036	1,093	1,102
College Park	25	42	32	132	56	175
San Jose Diridon	4,524	49	188	4,719	4,712	4,768
Tamien	1,268	166	15	1,050	1,283	1,216
Capitol	62	2	3	57	64	58
Blossom Hill	123	6	4	109	127	114
Morgan Hill	182	0	1	163	183	163
San Martin	77	0	0	68	77	68
Gilroy	178	0	0	178	178	178
TOTAL	31,039	31,039	31,377	31,377	62,416	62,416

Source: Caltrain, 2016

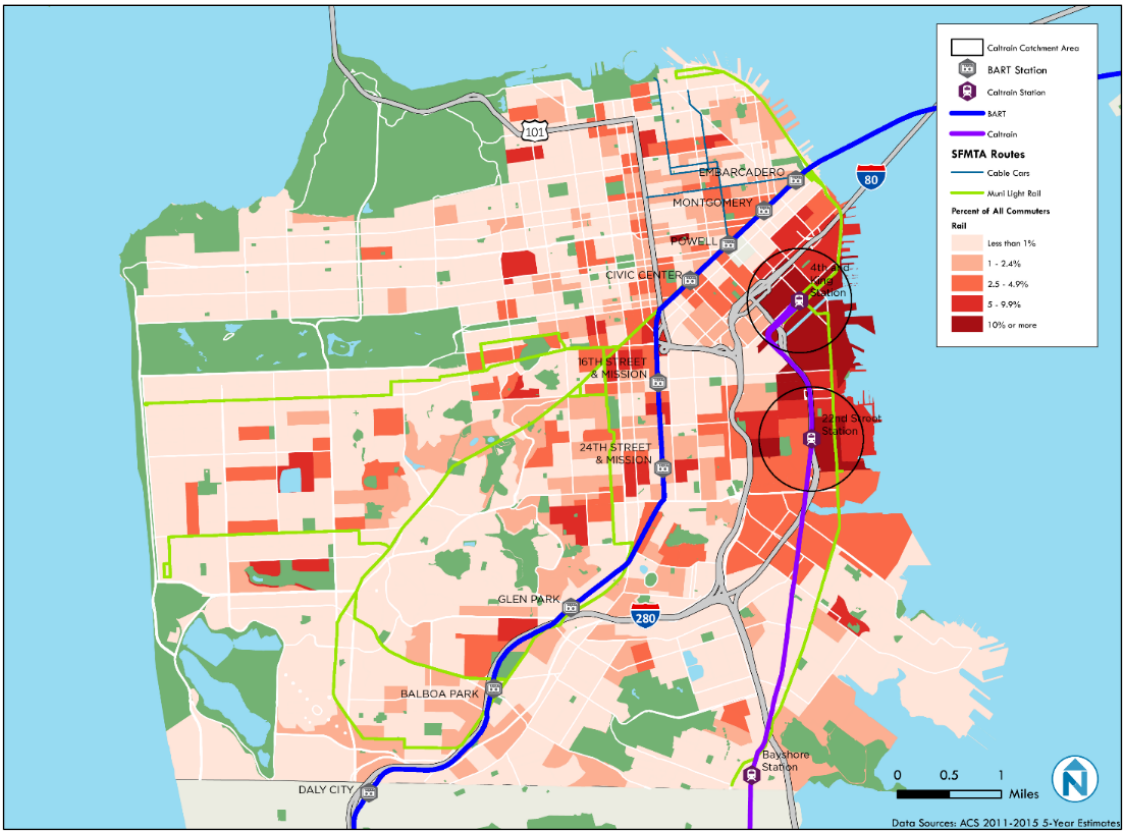
Commute Flows

Caltrain Commuters

San Francisco residents who commute by Caltrain go south to jobs in San Mateo and Santa Clara counties along the Caltrain corridor that parallels US 101. According to ACS 2011-2015 Five Year Estimates, about 7,000 San Francisco residents commute by Caltrain, compared to 104,000 by bus, 34,000 by BART and 10,000 by MUNI light rail. Caltrain commuters in San Francisco live predominantly in three neighborhoods closest to Caltrain stations: SoMa, Potrero Hill, and Dogpatch. The density of rail commuters is shown in Figure 4.

Approximately 700 of San Francisco residents commuting by Caltrain (about 10% of the city's total Caltrain commuters) live within a half-mile radius from 4th/King station, and half of those in a similar catchment area from the 22nd Street station. Northbound, the trip destinations (i.e. place of employment) of about 10% of commuters traveling to San Francisco by rail is within in the half-mile catchment area of the existing Caltrain stations.

Figure 4 Current Caltrain Commuters



Source: ACS 2011-2015 5-Year Estimates, Table B08301

The most common commute destinations of San Francisco residents that commute by rail are Palo Alto, San Mateo and Sunnyvale.

Mode share

Only 1% of commute trips within San Francisco trips are taken by Caltrain, a figure that increases to 3-5% if origins and/or destinations are within walking distance to Caltrain. Similarly, Caltrain commute share is 2% for all trips commuting to San Francisco, but is 4-8% if origins and/or destinations are within walking distance to Caltrain. (Figure 5, Figure 6)

While Caltrain is not a dominant travel mode for most San Francisco commute trips, it is clear that proximity to a Caltrain station, at a trip's origin, destination, or both, increases the share of Caltrain trips. As employment density is expected to increase (relative to citywide growth) near San Francisco's Caltrain stations through 2065, Caltrain mode share is likely to experience corresponding growth. Caltrain could see its mode share increase even further with additional planned train capacity improvements.

Figure 5 Commute Trips from San Francisco to Destinations Outside of San Francisco

Commute mode	Overall	Commutes to destinations near Caltrain Stations	Commutes between areas near Caltrain Stations
SOV	38%	44%	39%
Carpool	8%	8%	5%
Bus	23%	20%	8%
Streetcar	2%	3%	1%
Subway	7%	8%	1%
Rail	1%	3%	5%
Ferry	0%	0%	0%
Bike	3%	3%	2%
Walk	10%	7%	18%
Taxi	0%	0%	1%
Motorcycle	1%	1%	1%
Other	1%	1%	1%
WFH	7%	2%	19%

Figure 6 Commute Trips to San Francisco from Origins outside of San Francisco

Commute mode	Overall	Commutes to destinations near Caltrain Stations	Commutes between areas near Caltrain Stations
SOV	36%	33%	36%
Carpool	10%	11%	7%
Bus	20%	19%	8%
Streetcar	2%	2%	1%
Subway	13%	19%	5%
Rail	2%	4%	8%
Ferry	1%	1%	0%
Bike	2%	2%	2%
Walk	7%	5%	15%
Taxi	0%	0%	0%
Motorcycle	1%	1%	1%
Other	1%	1%	1%
WFH	5%	2%	16%

Source: Census Transportation Planning Package, 2006-2010, Table A302103

Current mode share of current commute trips to/from the half-mile catchment area of the future Transit Center (0.5 mile) is shown in the table below. Rail share is higher when trips are between this catchment area and an origin/destination near another Caltrain station.

Figure 7 Mode Share of Commute Trips from Proposed Rail Stations (0.5 Mile Catchment)

Trips from Transit Center			Trips to Transit Center		
Commute mode	All trips	Workplace near a Caltrain Station	Commute mode	All trips	Residence near a Caltrain Station
SOV	27%	63%	SOV	24%	34%
Carpool	4%	5%	Carpool	8%	6%
Bus	9%	7%	Bus	25%	18%
Streetcar	2%	0%	Streetcar	3%	2%
Subway	5%	8%	Subway	24%	9%
Rail	3%	17%	Rail	4%	11%
Ferry	0%	0%	Ferry	2%	0%
Bike	2%	0%	Bike	2%	2%
Walk	38%	0%	Walk	6%	12%
Taxi	1%	0%	Taxi	0%	1%
Motorcycle	0%	0%	Motorcycle	1%	1%
Other	0%	2%	Other	1%	0%
WFH	10%	0%	WFH	0%	5%

Source: Census Transportation Planning Package, 2006-2010, Table A302103

FIRST/LAST MILE CONNECTIONS

Key findings of the network demographics analysis include the following:

- Each alignment is generally well served by pedestrian facilities, but the Mission Bay alignment is currently slightly better connected to bicycle facilities.
- The Pennsylvania Avenue alignment currently has many more residents and jobs within a 15-minute walk of the 4th/Townsend stations than the Mission Bay alignment and its new station.
- As anticipated, the areas along the Baseline and Pennsylvania Avenue alignments are currently much better served by transit than the Mission Bay alignment. If the Mission Bay alignment were to move forward, transit currently serving 4th/King would likely be extended to serve the Mission Bay station increasing transit run times and operations costs.

Analysis

The study area for this task is drawn from a preliminary options analysis[2]. The area is roughly bounded by 22nd Street to the south, Potrero Avenue to the west, and Mission Street to the north. This area contains the new Transit Center and the existing Caltrain stations at 4th/King Streets as well as 22nd Street.

The emphasis of this transit network analysis is the last mile connection for Caltrain commuters arriving at one of two proposed intermediate stations. The first and previously environmentally cleared station location option involves an underground station at 4th and Townsend Streets, immediately adjacent to the current 4th/King location (Baseline and Pennsylvania Avenue options). The other station location option, part of a Mission Bay alignment option featuring a tunnel under 3rd Street, would be centered roughly at 3rd and China Basin Streets.[3]

Facility and access diagrams displayed later in this memo are designed to compare the relative performance of these two station locations. The impact of the new Transit Center and potential relocations of the 22nd Street station are analyzed separately but are taken into consideration when calculating performance metrics and developing system recommendations.

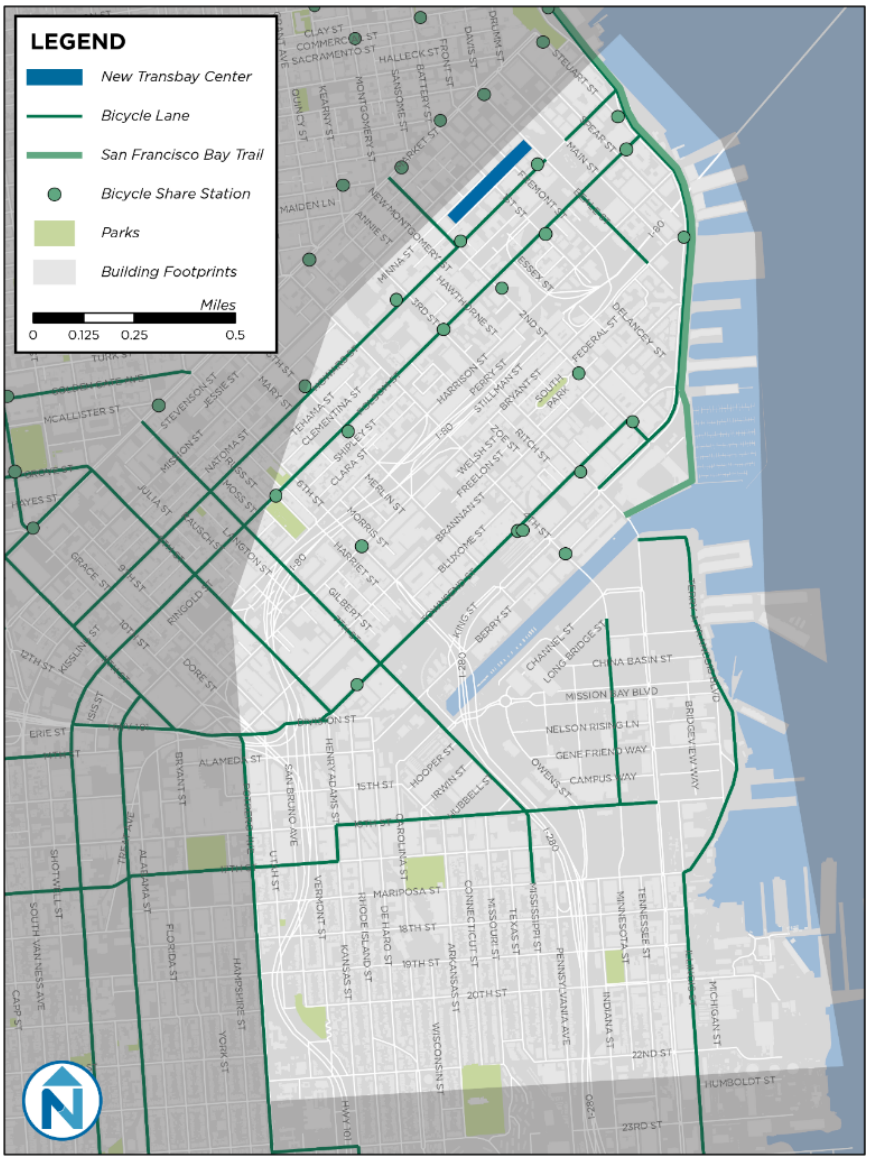
[2] Railyard Alternatives & i-280 Boulevard Feasibility Study Phase I: Preliminary Options Analysis

[3] There has not yet been any work to site the station at 3rd and China Basin Streets. As such, this location is considered the approximate, general place where the station may be placed.

Non-Motorized Last Mile Facilities

Existing non-motorized facilities within the study area consist of a complete sidewalk network as well as bicycle lanes along portions of Terry Francois Boulevard, the Embarcadero, Howard, Folsom, Townsend, 4th, 7th, 16th, 17th, and Illinois Streets. Additionally, the San Francisco Bay Trail parallels the Embarcadero for its entire length within the study area and functions as a shared use pathway for cyclists and pedestrians. Bay Area Bike Share stations are interspersed within the northern half of the study area, though none are currently located south of Mission Creek Channel. With bikeshare becoming more prevalent, as the need occurs, it is anticipated that facilities will be made available.

Figure 8 Existing Non-Motorized Facilities



Existing Transit Service

The existing station location at 4th/King/Townsend Streets is served by a number of SFMTA transit routes. Local buses 10, 30, 45, and 47 along with express buses 81X and 82X take Caltrain riders to locations throughout the downtown during the morning commute. The current station is also served by the E Streetcar and MUNI Metro N, and T/Third Line service during peak ingress to the central business district.

If the Mission Bay alignment moves forward, additional transit service will be necessary. It is likely that many of the existing routes would be lengthened or re-routed to serve the new Mission Bay station. This would result in longer run times and/or likely higher operational costs.

Figure 9 Existing Transit Service near Baseline and Pennsylvania Avenue Alignments

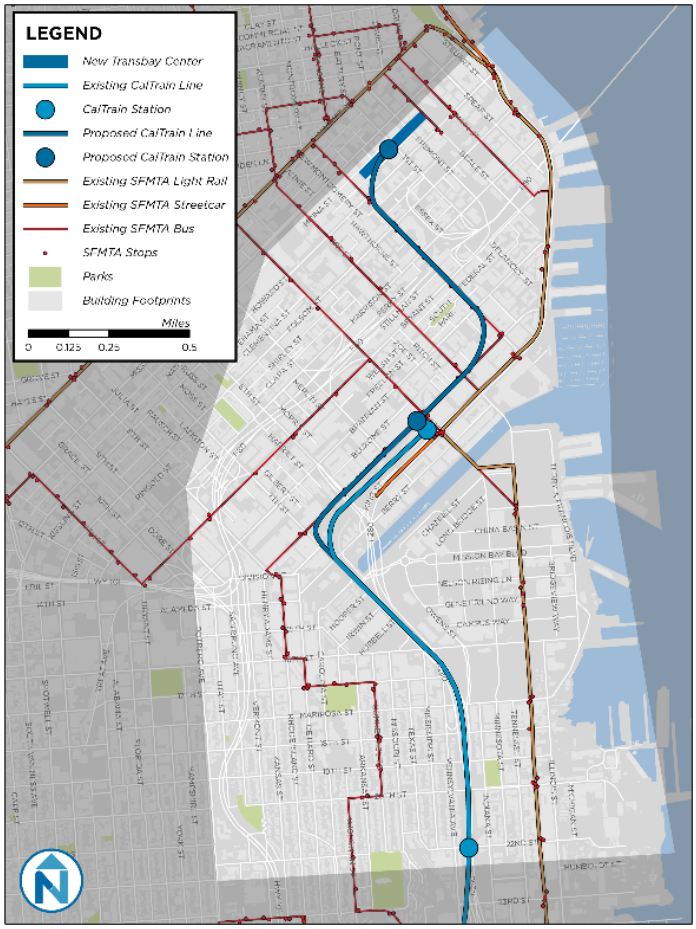
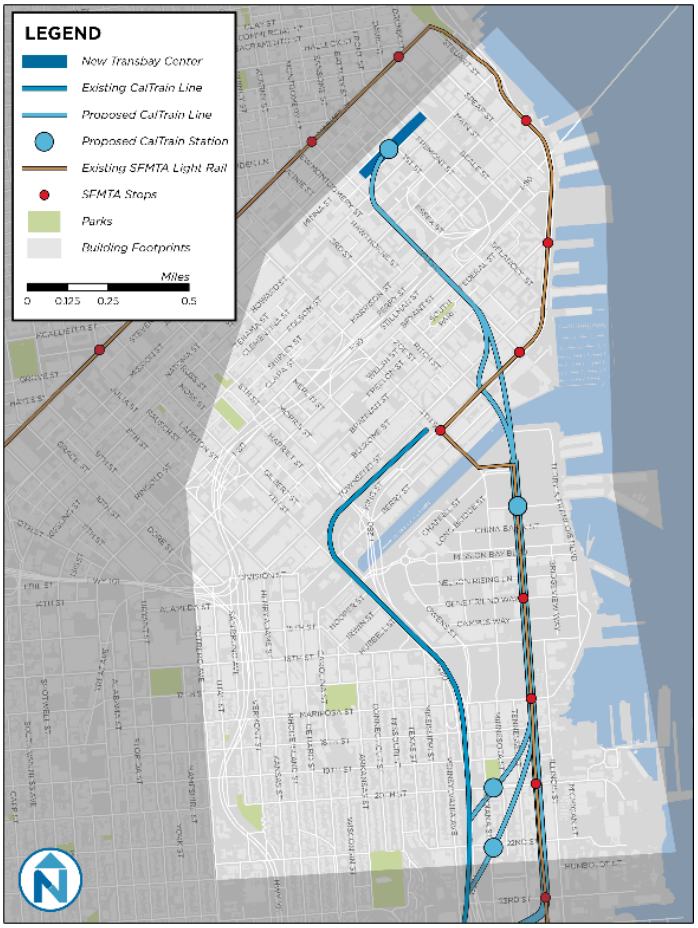


Figure 10 Existing Transit Service near Mission Bay Alignment



Planned Investments

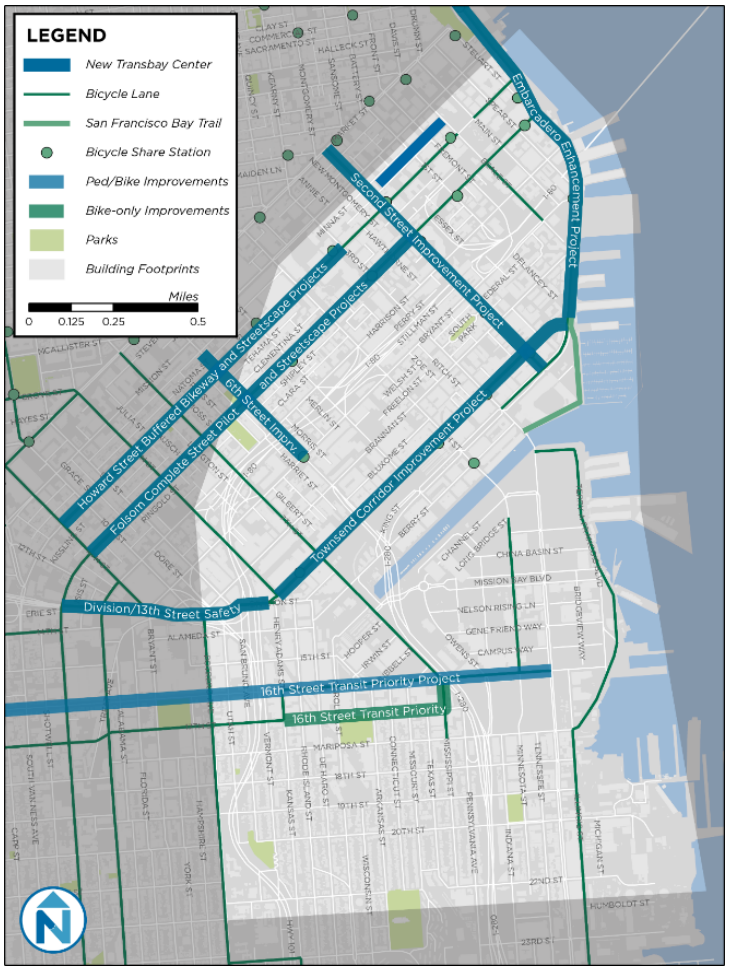
SFMTA touts many multimodal and complete streets initiatives among its planned list of system improvements. A major initiative within the study area, the 16th Street Multimodal Corridor, impacts all travel modes and both proposed station locations. A list of these improvements is identified and analyzed for their ability to contribute to last-mile access from each proposed alignment as an intermediate step before final recommendations can be made.

Non-Motorized Last Mile Investments

SFMTA's planned non-motorized last mile investments generally focus on complete streets principles to improve safety for bicyclists and walkers along major corridors. They achieve this through the addition or greater protection of bicycle facilities as well as crosswalk and signalization reconfiguration. The following projects contain both pedestrian and cyclist safety improvements:

- Embarcadero Enhancement Project
- Second Street Improvement Project
- Townsend Corridor Improvement Project
- Folsom-Howard Streetscape Project
- Folsom Complete Street Pilot Project
- Division/13th Street Safety Project
- 6th Street Improvement Project
- 16th Street Transit Priority Project

Figure 11 Planned Non-Motorized Investments

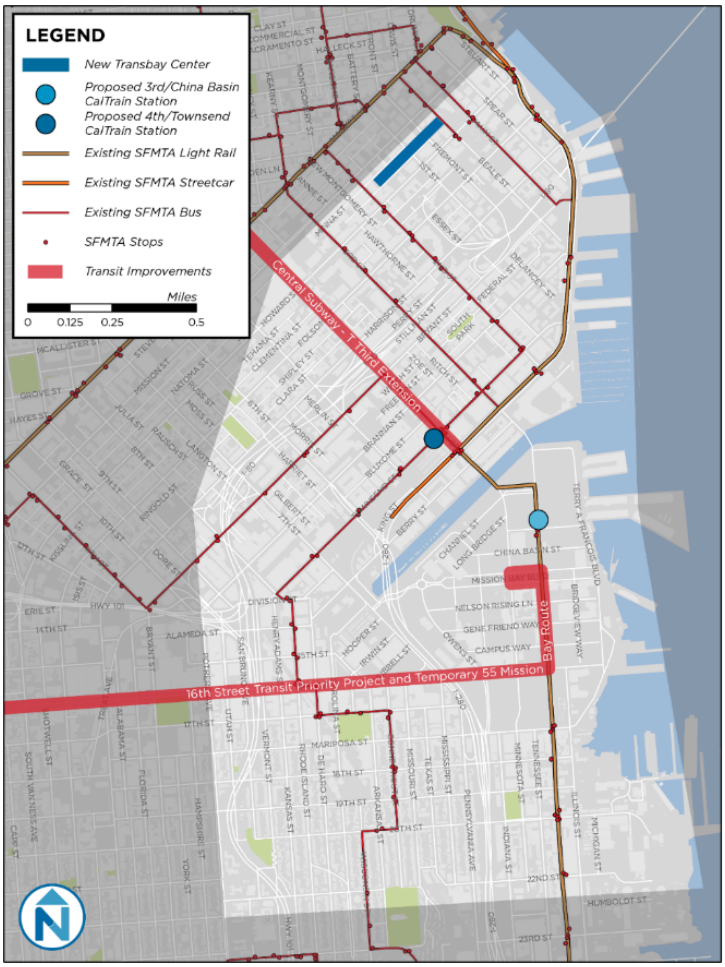


The 16th Street Transit Priority Project also includes an extension of the 17th Street bicycle facility in order to allow for a safe and attractive parallel east-west connection.

Transit Investments

A pair of transit investments currently underway are poised to have a major impact on the study area and greatly affect the operational viability of the two proposed Caltrain station locations. The 16th Street Transit Priority Project aims to improve travel time and reliability for the 22 Fillmore route through a mixture of new dedicated transit lanes, bus bulbs and boarding islands, traffic signals, and increased peak period bus frequency. This initiative includes the implementation of an interim bus route along 16th Street and 3rd Street in Mission Bay, which greatly improves transit access to the proposed Mission Bay station. The Central Subway project improves intermodal connections at both stations by extending the MUNI Metro T Third Line to provide a direct link between the Bayshore and Mission Bay areas to SoMa, downtown, and Chinatown.

Figure 12 Planned Transit Investments



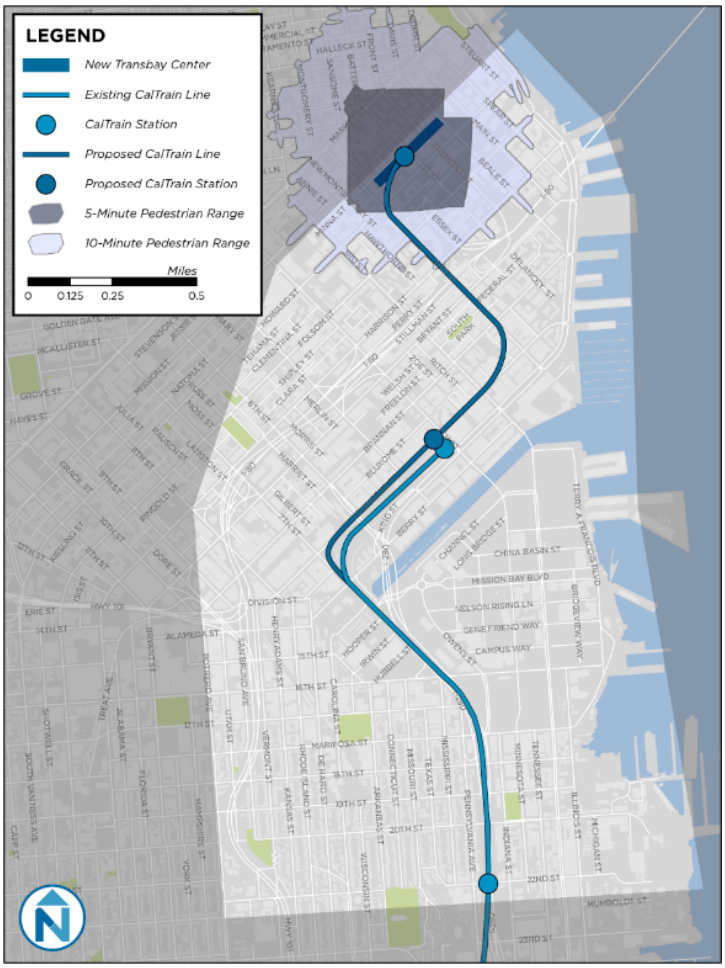
Caltrain Station Last Mile Reach

In an effort to compare the ability of Caltrain riders to access final destinations from each of the proposed station locations, isochrones are created representing the access range associated with different modes. Five and ten minute pedestrian and cyclist ranges as well as 10 and 15 minute single-seat transit ranges (including subsequent walking from transit stops) are modeled, including elevation effects on walking and bicycling.[4]

Transit Center

The five and ten minute pedestrian walksheds from the new Transit Center should be understood in order to properly calculate performance metrics for the transit system. As mentioned in the introduction, this is done separately, but the results are referenced in the subsequent sections and included in final employment access metrics.

Figure 13 Pedestrian Access Shed Range – Transit Center



[4] For the purposes of this study it was assumed that the 5th Street pedestrian Bridge at Mission Creek would be completed. As such, each of the analyses in Figure 13-Figure 23 include the 5th Street pedestrian Bridge.

4th Street /Townsend Street Station & 3rd Street/China Basin Station Locations

Considering existing and planned improvements, the proposed 4th and Townsend Caltrain station is well-connected to adjacent districts. As concentration of employment is currently arranged, five, ten, and fifteen minute pedestrian, bicycle, and planned transit access exceeds that of the Mission Bay Station (See Figure 49 and Figure 51)

As it exists today, the Mission Bay station location is less connected to adjacent districts. This is mainly due to the physical barrier and bottlenecks created by the Mission Creek Channel and the surface Caltrain tracks. Legacy transit system configuration also plays a role, though this is already recognized and has been partially improved through temporary measures. Referencing Figure 49 and Figure 51 once more, employment access is diminished compared with the 4th and Townsend station location.

Non-Motorized

A five-minute pedestrian range from the 4th and Townsend location extends as far as Bryant Street to the northwest and reaches 3rd and 5th Streets along Townsend Street. Access to Mission Bay is limited to the intersection of 4th and Channel Streets. Given ten minutes, pedestrians can find themselves as far away as Folsom Street, the southern end of the Embarcadero, and Mission Bay Boulevard. Bicycling expands this range significantly. Most of the study area is accessible within ten minutes while the primary limitation is the topography of Potrero Hill.

Compared with the 4th Street /Townsend Street station location, pedestrian access at Mission Bay is focused almost completely south of Mission Creek Channel. The five-minute range includes Nelson Rising Lane in the south, Merrimac Street to the west, and Terry Francois Boulevard to the east. Ten minutes on foot, approximately one half mile, allows for pedestrian access to Townsend and 3rd, Townsend and 4th, 16th Street, and Owens Street at Mission Bay Boulevard. Ten-minute bicycle access differs minimally from that of the other proposed station. Five-minute access is shifted south to reflect the more easily accessible areas from that origin point.

Pedestrian and Bicycle Shed Visualization

The following figures 16-25 visualize the pedestrian and bicycle shed areas for the Pennsylvania Avenue alignment and the Mission Bay alignment. Figures 16-19 focus on the shed areas around the 4th/Townsend and Mission Bay stations only. The other figures illustrate the shed areas for all three stations located within the boundaries of San Francisco. For this illustration, the 22nd Street station location has been adjusted slightly to suggest how catchment might be expanded with future alignment refinements. However, the study has no specific recommendations for moving 22nd Street station.

Figure 14 Pedestrian Shed of 4th & Townsend (Pennsylvania Ave Alignment)

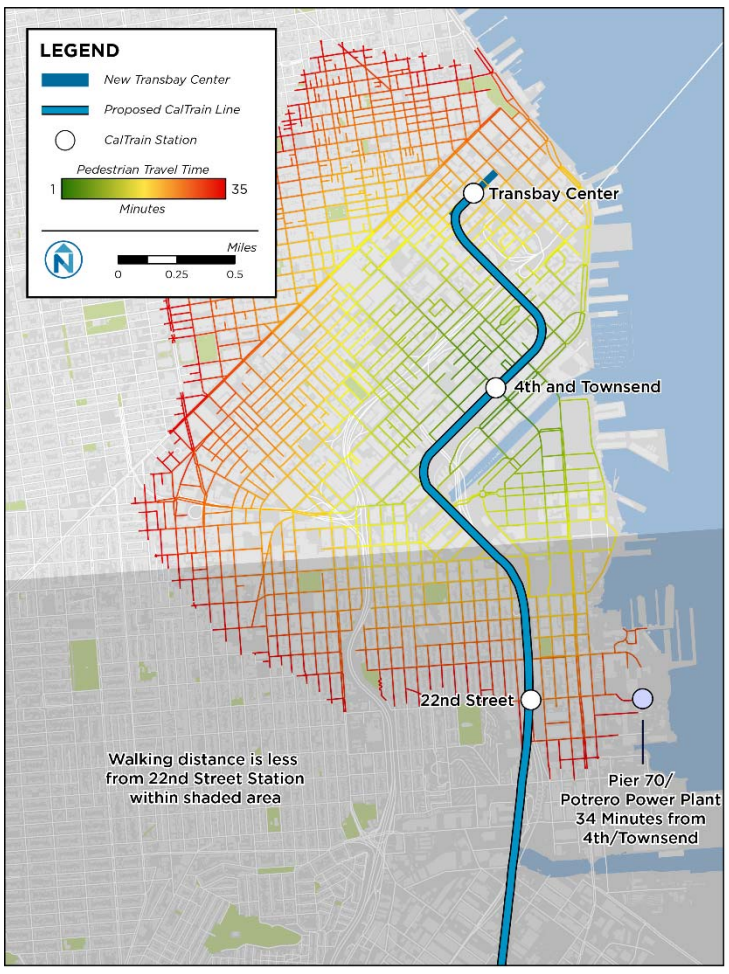


Figure 15 Pedestrian Shed of 3rd & China Basin (Mission Bay Alignment)

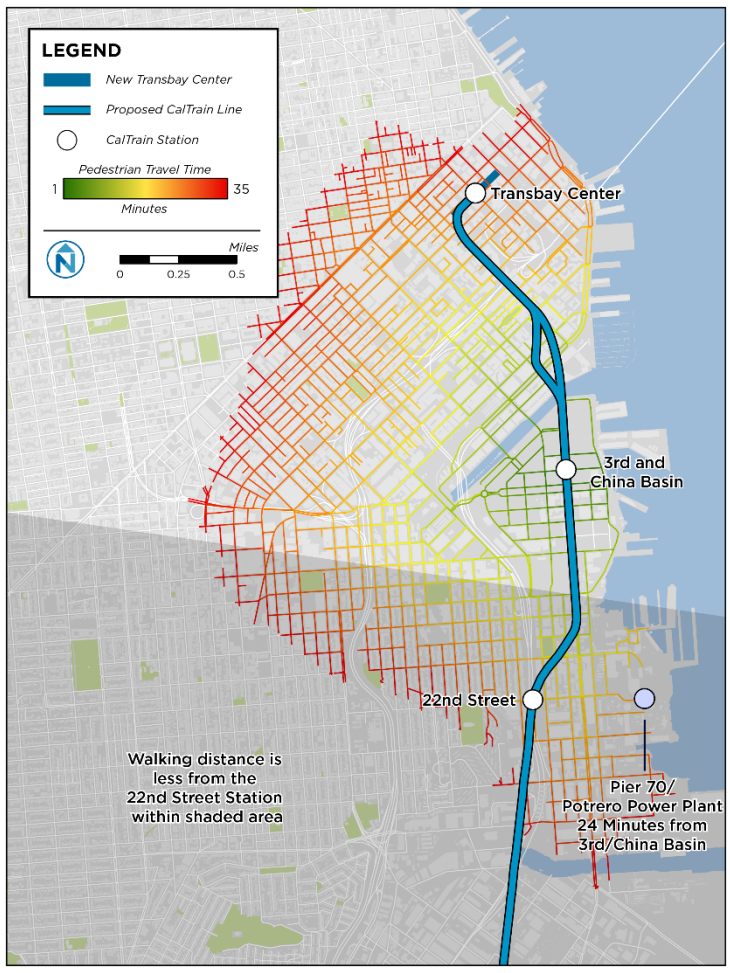


Figure 16 Bicycle Shed of 4th & Townsend (Pennsylvania Ave Alignment)

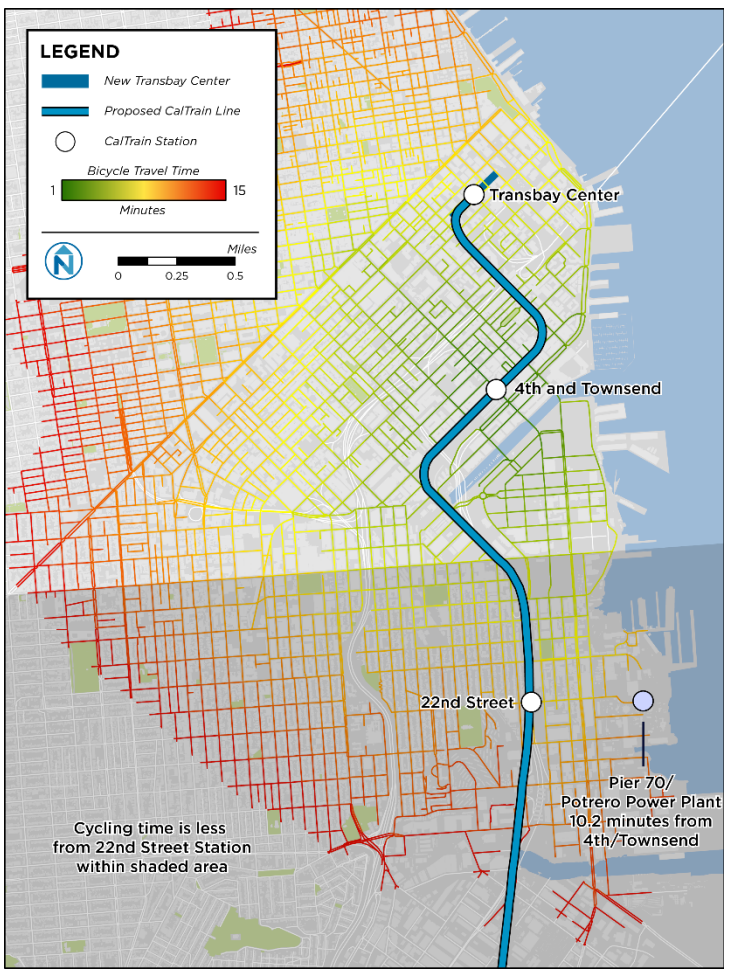


Figure 17 Bicycle Shed of 3rd & China Basin Mission Bay Alignment)

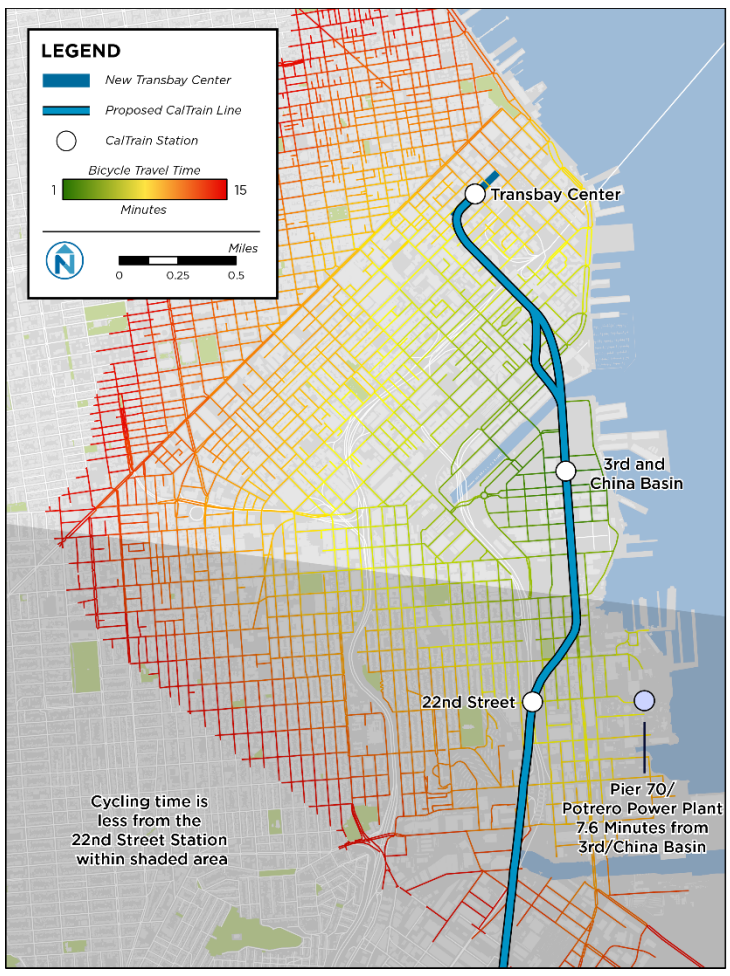


Figure 18 Pedestrian Access Shed Range – Baseline/Existing Alignment

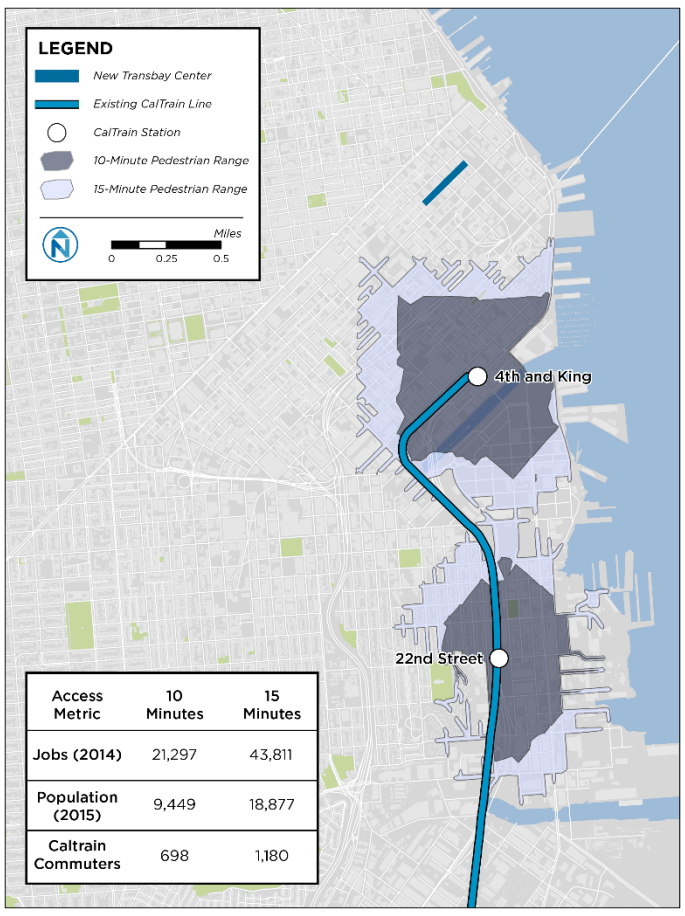


Figure 19 Pedestrian Shed Walk Times – Baseline/Existing Alignment

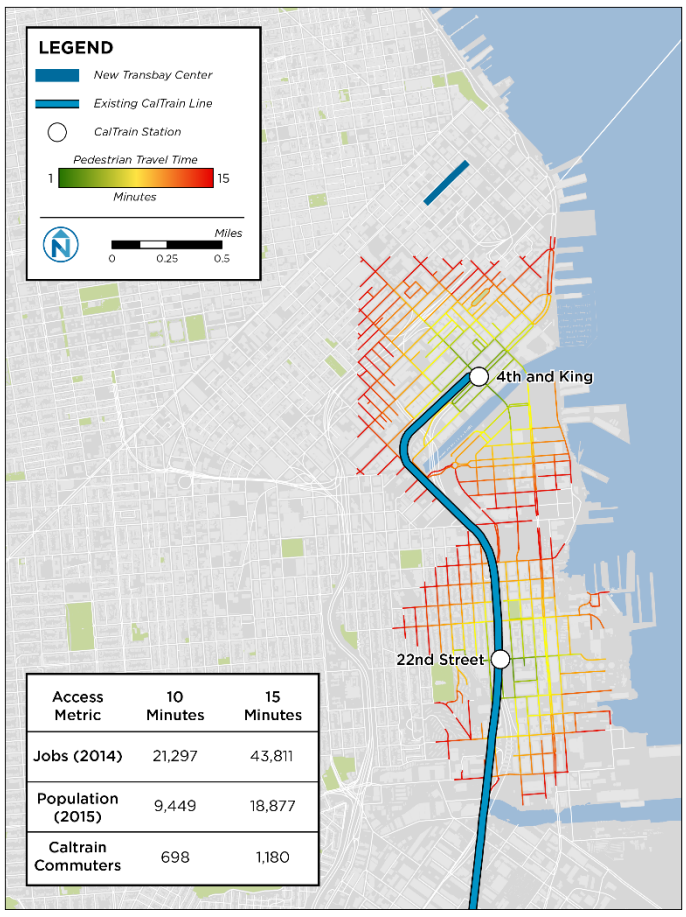


Figure 20 Pedestrian Access Shed – Pennsylvania Avenue Alignment

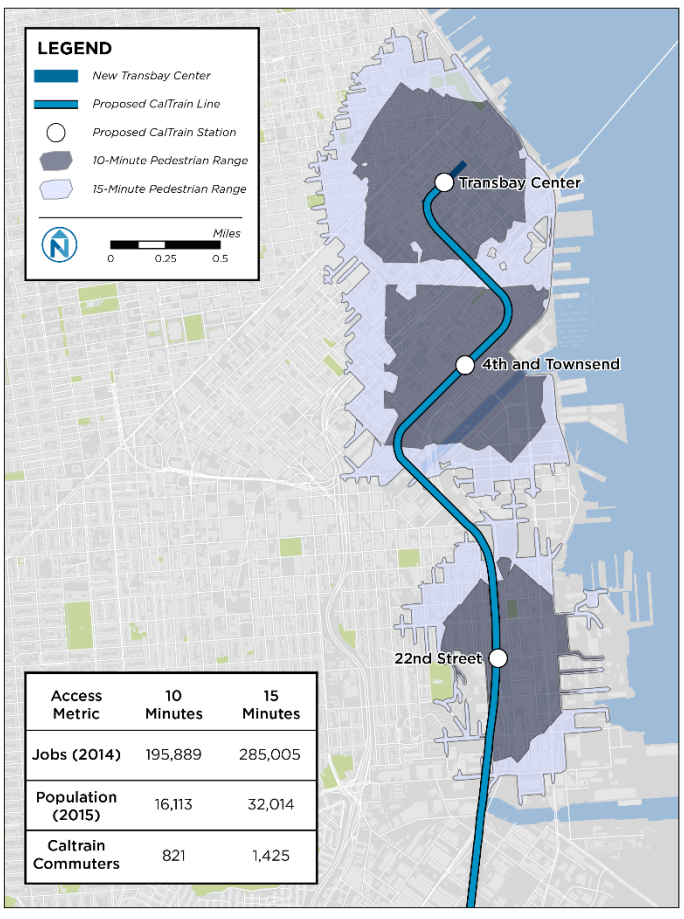


Figure 21 Pedestrian Shed Walk Times – Pennsylvania Avenue Alignment

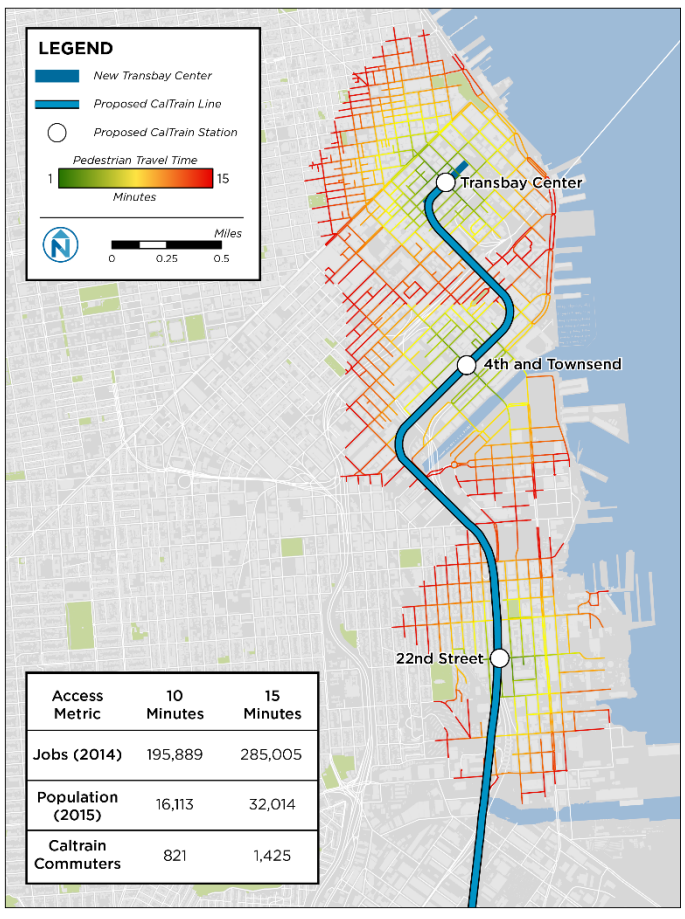


Figure 22 Pedestrian Access Shed – Mission Bay Alignment

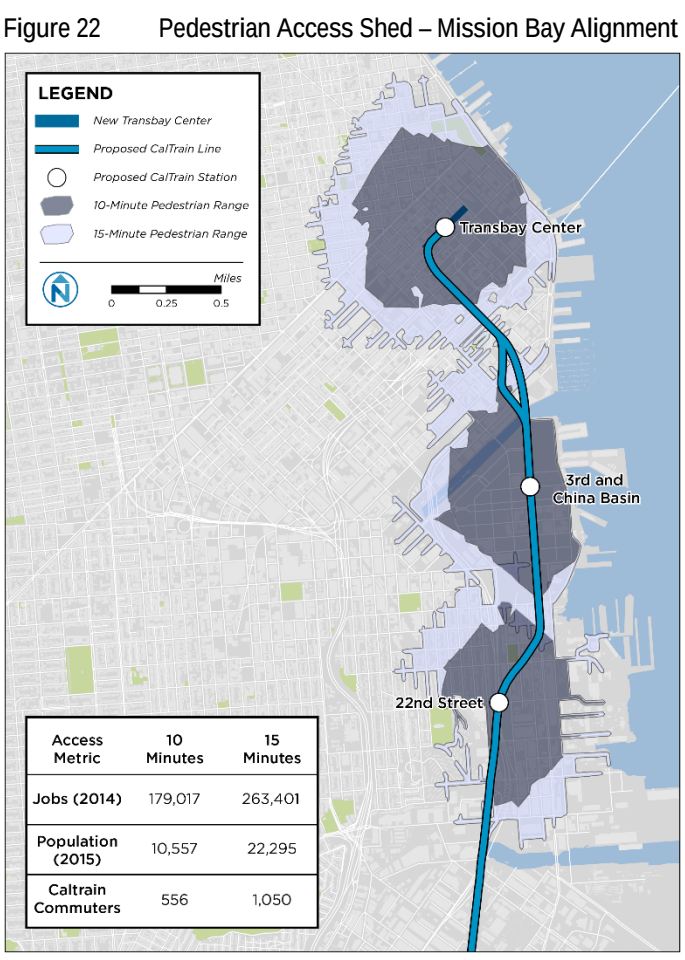
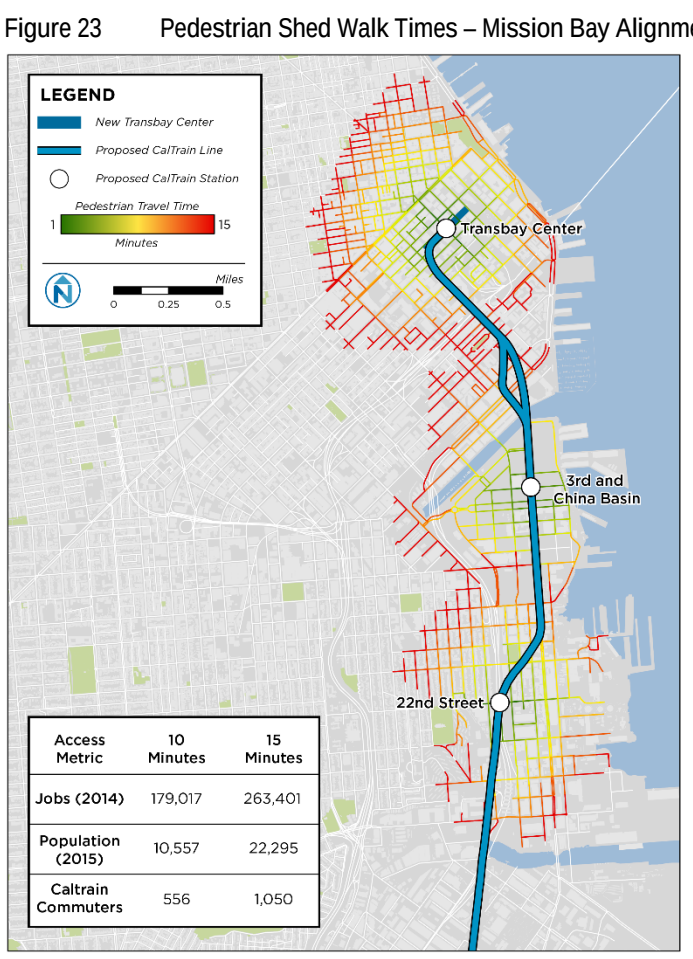


Figure 23 Pedestrian Shed Walk Times – Mission Bay Alignment



Transit

The wide variety of transit options currently serving the proposed 4th and Townsend Street station location provide a large fifteen-minute range to those commuters who must continue their trip via transit. Only residential neighborhoods in the southwest corner of the study area are not accessible via a transit trip.

Many destinations within the study area are served by a transit + pedestrian trip of ten minutes or less. Notable exceptions include locations where riders would likely benefit from taking Caltrain directly to other stations such as the new Transit Center or 22nd Street Station.

The largest gain from planned transit improvements serving the 4th and Townsend location is 10-minute range extensions north of Market Street. As seen in the following figures, Union Square and Chinatown become accessible within 10 minutes from a single transit transfer thanks to the extension of the MUNI Metro T Line through the Central Subway Project.

As the MUNI Metro T/3rd Line is the only transit permanently serving the Mission Bay area, transit commute range is confined to the eastern portion of the study area. Aside from Mission Bay destinations, the ten-minute transit + pedestrian range only reaches small segments of Harrison and Bryant Streets on the other side of the channel. Again in the future, riding directly to the new Transit Center would fill in transit accessibility gaps in the north end of the study area.

The T Line extension and temporary 55 bus route along 16th Street (intended to be replaced permanently by the 22 Fillmore route with transit priority) helps to fill in access gaps along the 4th Street corridor and through the Design District. Access gaps remain in the southwest areas of the South of Market district.

Figure 24 Existing Transit Shed of Pennsylvania Ave Alignment

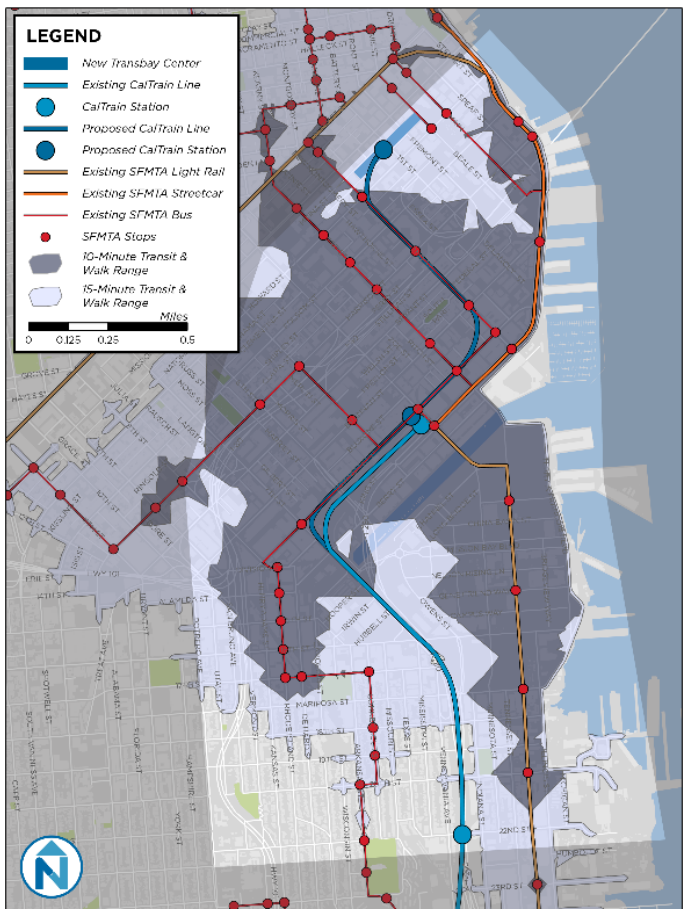


Figure 25 Existing Transit Shed of Mission Bay Alignment

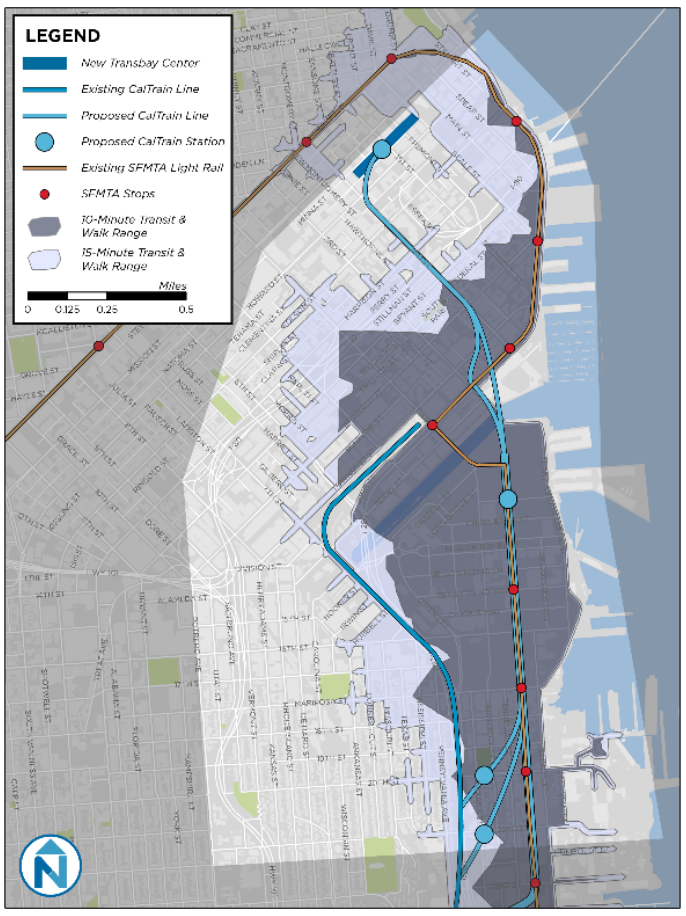


Figure 26 Existing Transit-Leg Travel Times of Penn Ave Alignment

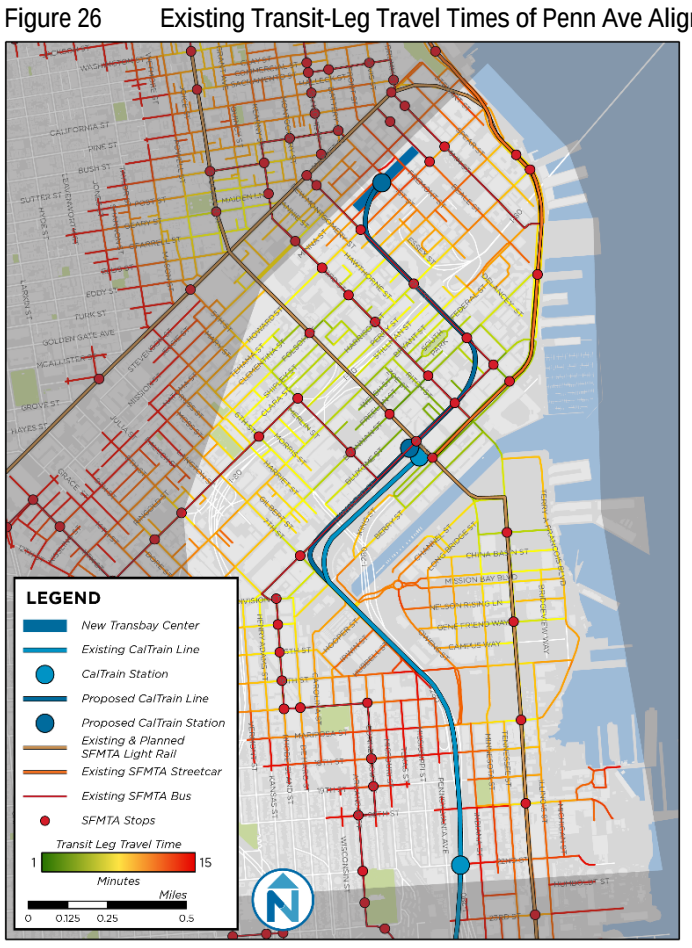


Figure 27 Existing Transit-Leg Travel Times of Mission Bay Alignment

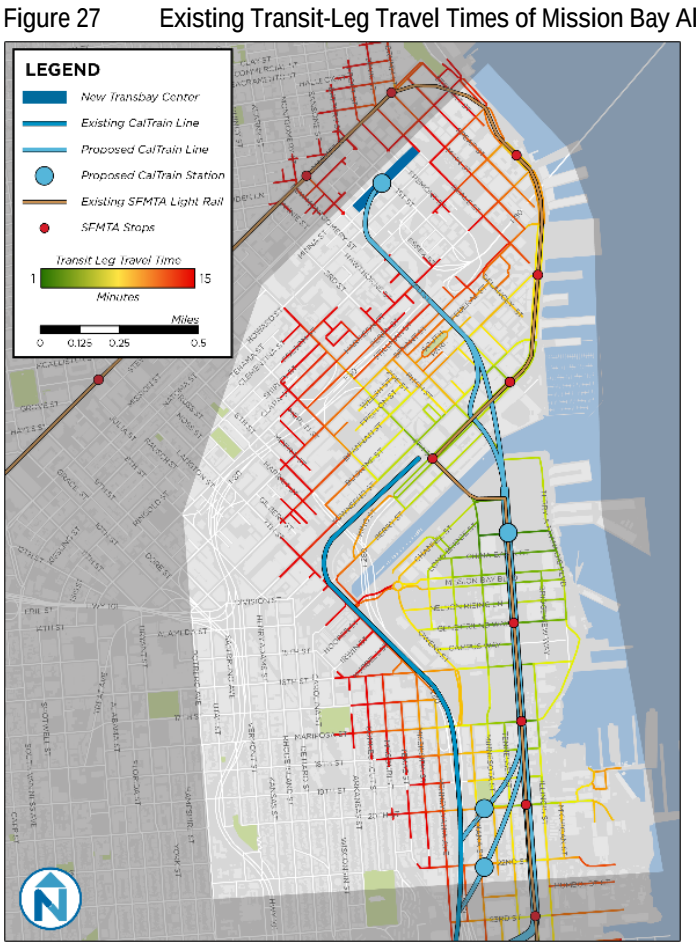


Figure 28 Anticipated Transit Shed of 4th & Townsend

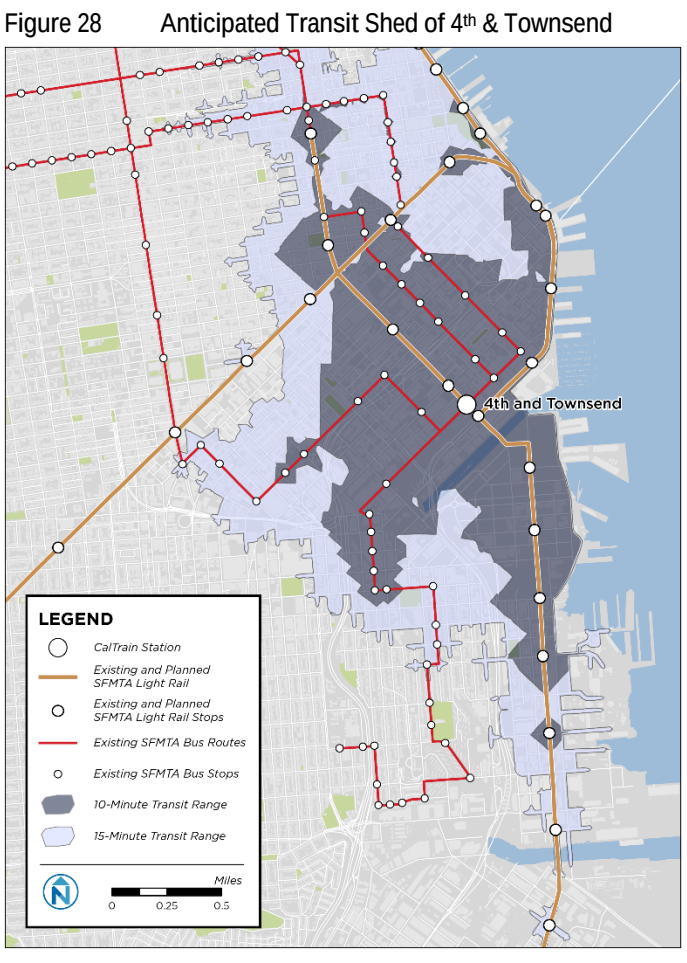
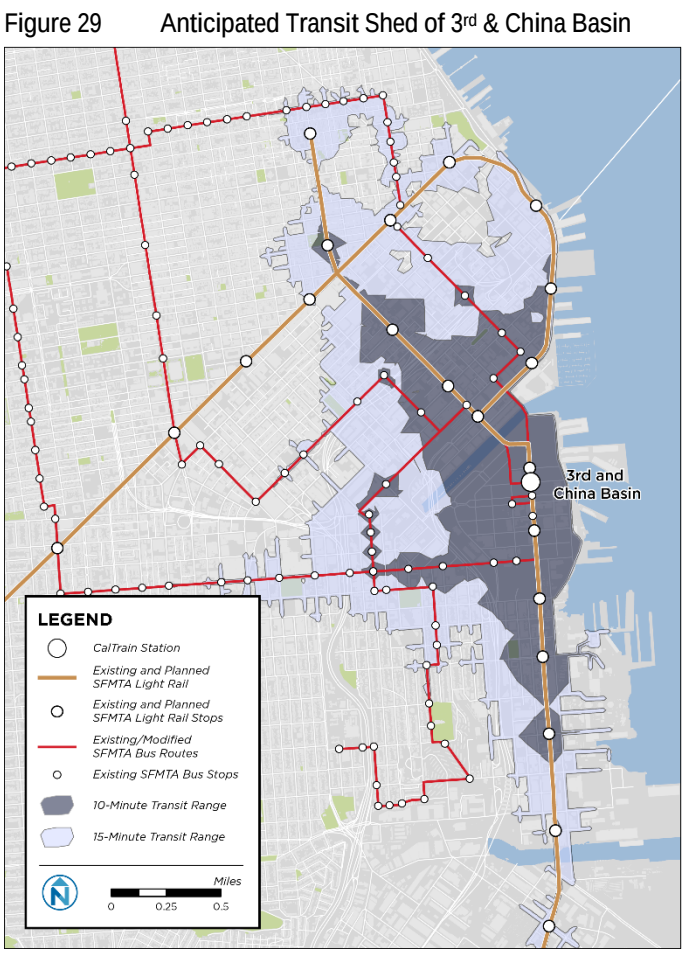


Figure 29 Anticipated Transit Shed of 3rd & China Basin



2 REALIGNMENT CHARACTERISTICS

RIDERSHIP

Key Findings

The results of the ridership analyses contained in the following sections are mixed in terms of their support for proximity to the closest Caltrain station, and the impact of the current rail commuters as well as the commuters that could be captured by Caltrain due to the extension.

The findings related to impacts on station proximity are as follows:

- The Baseline and Pennsylvania Avenue alignments (Figure 30) result in improved access across the city due to the addition of the Transit Center. Because these alignments do not involve relocating existing stations (other than the surface portion of 4th/King), there is no degradation of access to any existing location. The addition of Transit Center brings benefits to the city's northern tier.
- The Mission Bay alignment (Figure 31) results in improved Caltrain access for the northern tier of the city due to the addition of the Transit Center (as do the Baseline and Pennsylvania Avenue alternatives), but also limits access for areas of SoMa, the inner Mission, and Duboce Triangle due to the relocation of the 4th St and King Caltrain station further east.
- The Baseline and Pennsylvania Avenue Alignments, have the greatest population and employment concentrations within their stations' catchment areas of 10 minute walk in all scenarios. Mission Bay area forecasted population and jobs are high, but lower in total concentration. (Figure 40 and Figure 41) as much of the catchment area is in the San Francisco Bay.

The following findings are related to ridership increase of commute riders and the relative time savings.

- On average, commuters on the Mission Bay alignment will save slightly more time per trip (1.5 minutes) than those on the Baseline and Pennsylvania Avenue alignments (1.2 minutes), considering both in-rail travel time and accessibility time to the closest station.
- Consequently, the Mission Bay alignment shows the highest increment of rail mode share due to the improvement of accessibility to Caltrain in an area that is currently not served by this mode. However, it is anticipated that the Mission Bay alignment will serve less population and employment within its immediate catchment area than that of the Baseline and Pennsylvania Avenue alignments because much of its catchment area is in the San Francisco Bay.

Analysis

This section shows the detailed results of evaluations into how the future alignments could impact the current Caltrain ridership in terms of the shortest distance to a Caltrain station and travel time of current commute riders, as well as population and jobs in future scenarios in the station catchment areas:

- Jobs and Population Accessibility Impact: Impact on station proximity of existing and forecasted jobs and population to the closest Caltrain station
- Captured commute demand from other transportation modes

Jobs and Population Accessibility Impact (Caltrain)

Population and employment are expected to increase significantly within the catchment areas of Caltrain stations in relation to existing conditions. The increase is higher in the Mission Bay alignment than in the Baseline and Pennsylvania alignments, but the absolute totals of population and employment served are higher in the Baseline and Pennsylvania alignments.

Existing population and jobs

Certain geographic areas of the City would be slightly closer or farther away from Caltrain access depending on future stations' location. As Figure 1 and

Figure 2 (on page 1-2) demonstrate, population and employment densities are highest in the northeastern quadrant of San Francisco, particularly near 4th/King station and the Transit Center, and lowest in the western half of the city. Because the nearest Caltrain station is more than three miles away, residents or jobs located to the west of Divisadero/Castro Street are unlikely to take Caltrain for trips ending in the South Bay. For the western half of the city, Peninsula-bound buses such as SFMTA Route 28, with a connection at the Daly City BART station, provide faster travel times to destinations in the South Bay than trips departing from any of the existing or proposed Caltrain stations.

As a result, it is necessary to evaluate the population and employment that would be affected by changes in Caltrain service alignments. The next step of the analysis evaluates the percentage of San Francisco (SF) jobs and residents (from 2014 and 2015, respectively) in each of the Census Block Groups reviewed above with improved, diminished or unchanged accessibility to Caltrain in each of the alignments.

The results of this analysis show that the percentage of people and jobs benefiting is greater for the Mission Bay alignment, where 37% of residents within one mile see accessibility improvements, while only 17% of residents do so in the Baseline and Pennsylvania alignments. However, the Mission Bay alignment also has a significant share of residents within one mile who would see diminished accessibility, about 27%. This is a result of the relocation of the 4th/King station to 3rd/China Basin. No residents would see diminished accessibility under the Baseline and Pennsylvania alignments, as these alignments do not involve the relocation of any Caltrain stations.

Figure 30 Change to Shortest Distance of Closest Caltrain Station (% of 2015 Population Living Within 1 Mile of Existing Caltrain Stations)

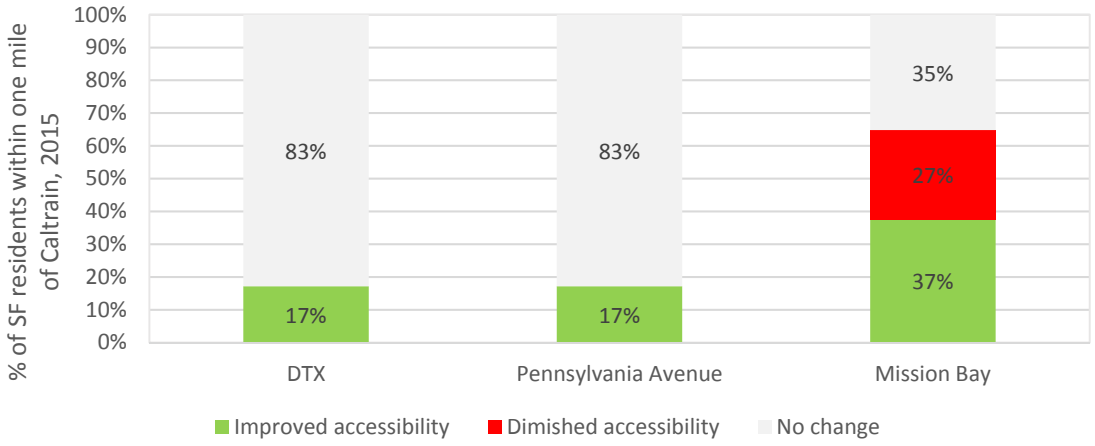
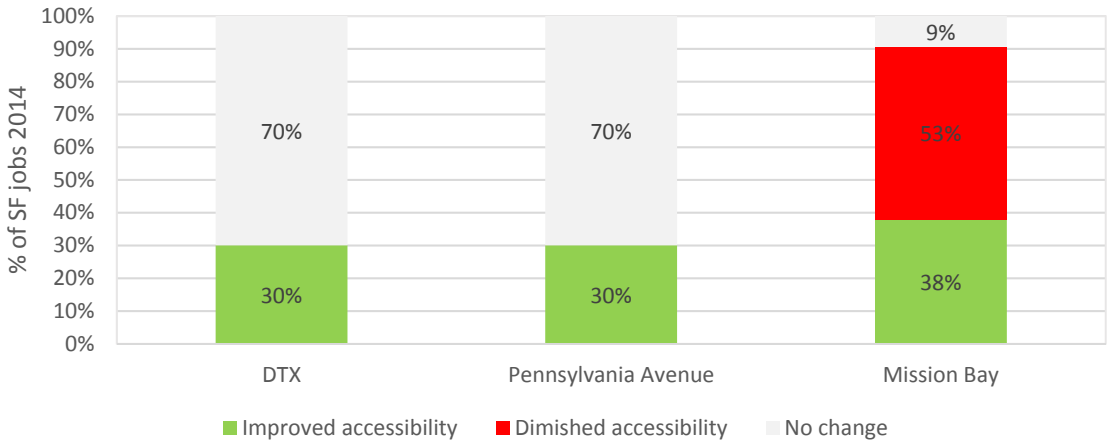


Figure 31 Change to Shortest Distance of Closest Caltrain Station (% of 2014 Jobs Located Within 1 Mile of Existing Caltrain Stations)



Future Population and Jobs

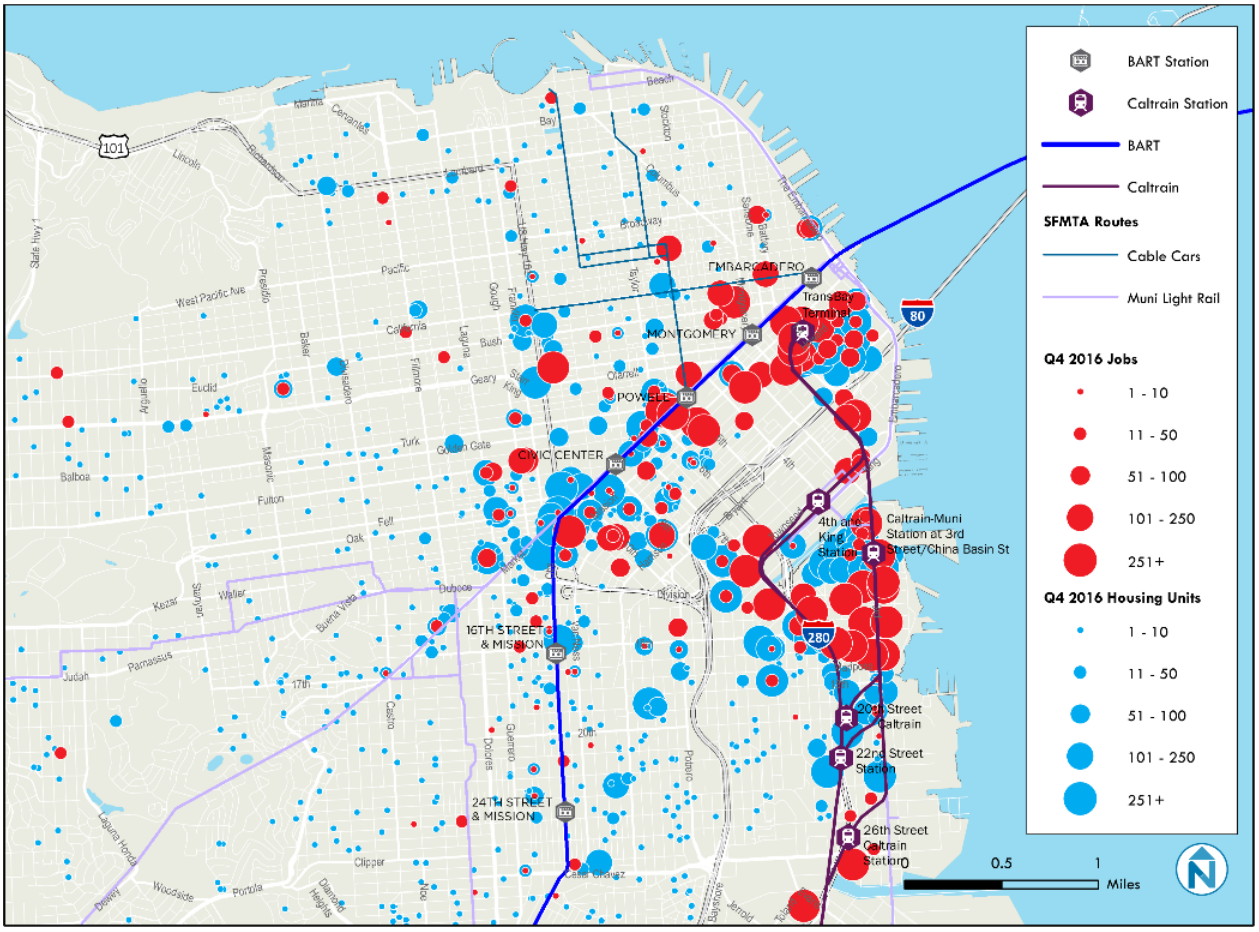
The same analysis was repeated for future development scenarios to evaluate the capacity to attract new riders of each alignment. For that purpose, the catchment areas surrounding the alignments' stations were examined and the current and projected population and employment contained within each were analyzed. The existing scenario plus four future population and employment scenarios envisioned by the consulting team based on the potential for development estimated from available San Francisco Planning Department land use data:

- Existing: population and employment totals from the American Community Survey (2011-2015 5-Year Estimates) and the Census LEHD
- 2016 Q4 Pipeline: Existing + projects under construction or approved for the 2016 development pipeline
- 2040: 2016 Q4 Pipeline + potential projects possible by 2040
- 2065: 2040 + potential projects possible by 2065

- Soft sites: 2065 + parcels identified as "future soft sites" that are likely to be redeveloped at significantly higher densities

Scenario parcel-level forecasts were joined to Census Block Groups in ArcGIS to calculate the population and employment within 10 and 15 minute walk catchment areas under each scenario.[5] See Figure 32-Figure 35.

Figure 32 Housing and Jobs Forecast (Q4, 2016)



[5] This method uses proportional allocations to calculate the population/employment shares of Block Groups that lie only partially within the ½ mile catchment radius.

Figure 33 Housing and Jobs Forecast (2040)

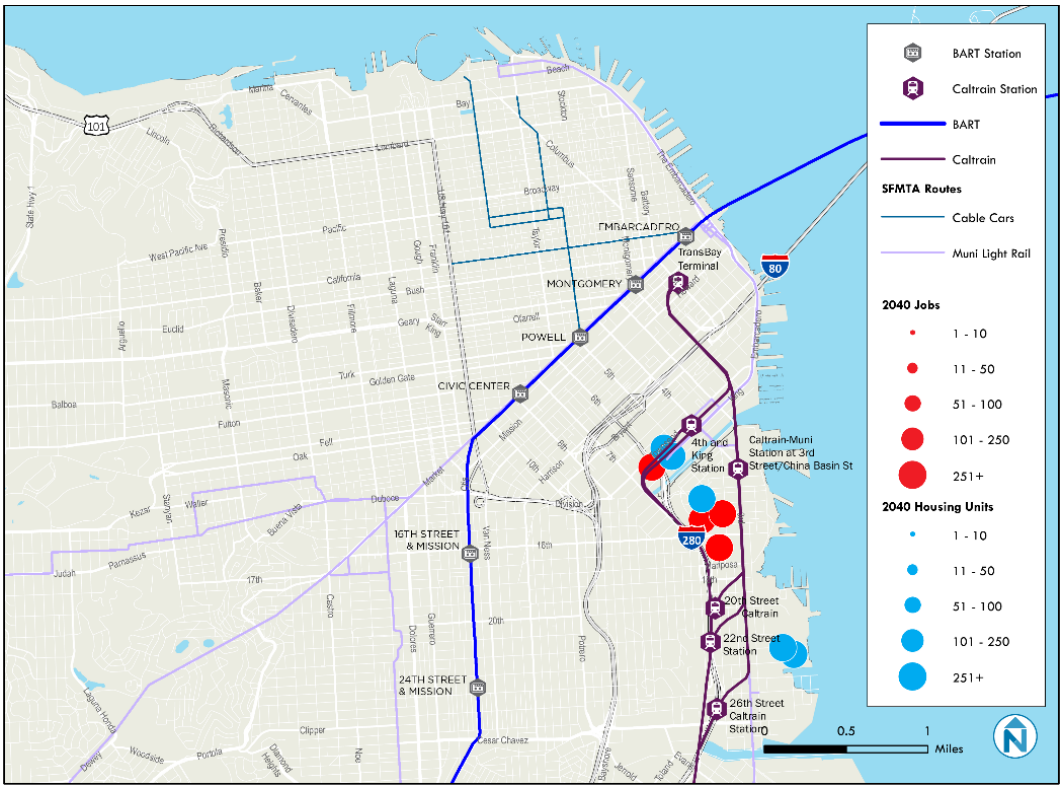


Figure 34 Housing and Jobs Forecast (2065)

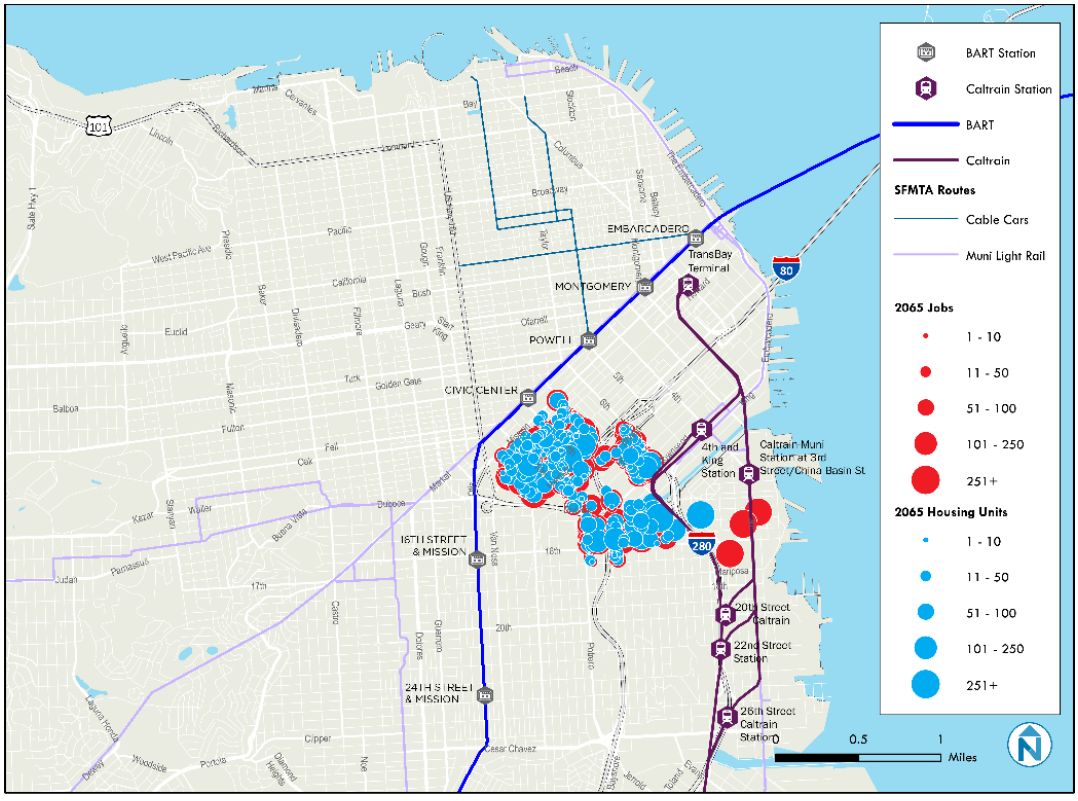
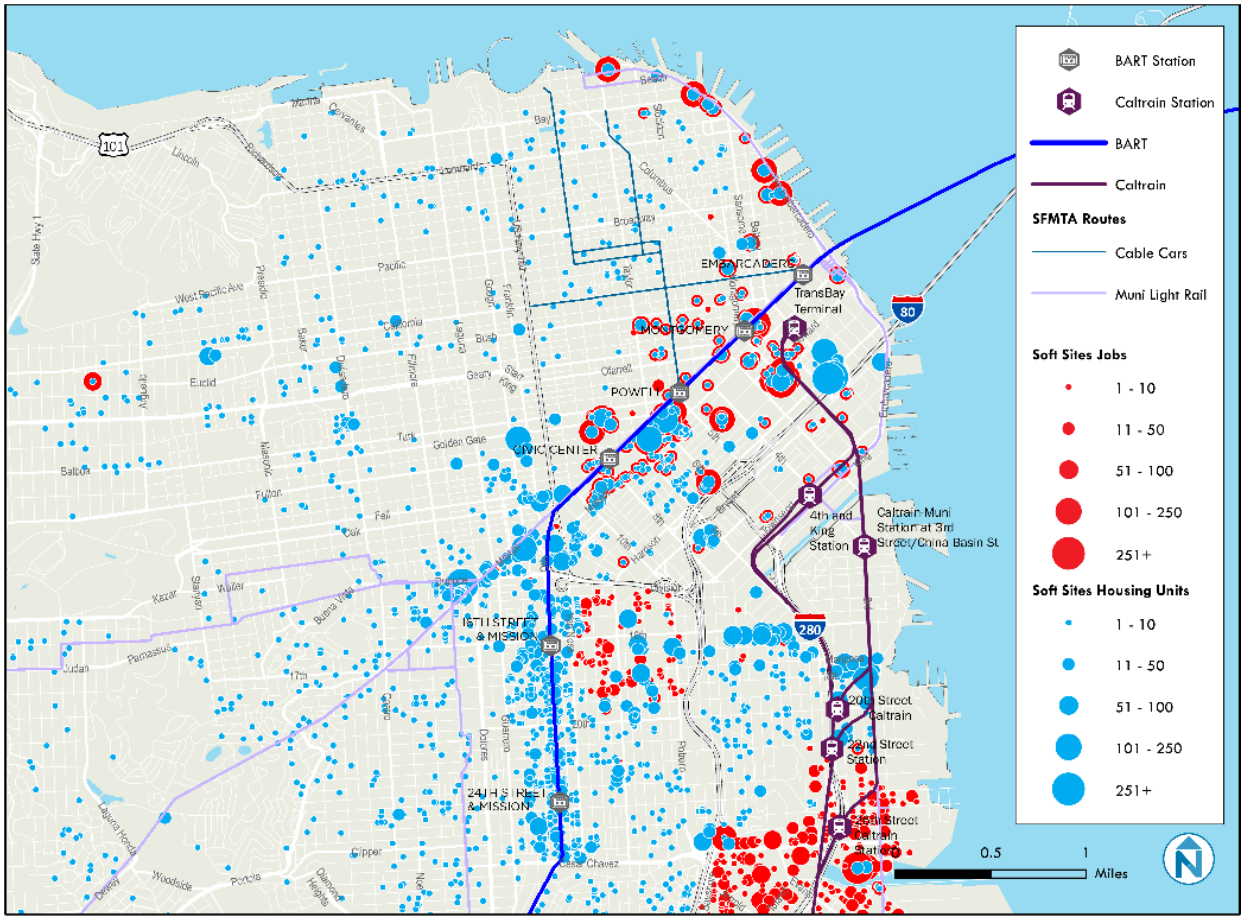


Figure 35 Housing and Jobs Forecast (Soft Sites[6])



According to the development forecast scenarios proposed in this analysis, population and employment along each alignment are expected to increase significantly within the catchment areas of Caltrain stations in relation to existing conditions. Results shown in Figure 36 and Figure 37 indicate that the Mission Bay alignment experiences a greater increase in population and employment in the catchment areas of the stations in relation to existing conditions for both the 10-minute and 15-minute catchment areas (around 32%). However, despite lower population and job growth projections in future scenarios, the Baseline and Pennsylvania Avenue Alignments have the greatest population and employment concentrations within their stations' catchment areas of 10 minute walk in all scenarios, due to part of the catchment area for Mission Bay being located within San Francisco Bay.

[6] Soft sites are defined as sites that are not built out to their maximum allowed extent

Figure 36 Population and Jobs within 10 Minute Walk of Caltrain Stations (From 22nd St Station to Transit Center)

Alignment	Existing			2016			2040			2065			Soft sites		
	Pop.	Jobs	Jobs + Pop	Pop.	Jobs	Jobs + Pop	Pop.	Jobs	Jobs + Pop	Pop.	Jobs	Jobs + Pop	Pop.	Jobs	Jobs + Pop
Baseline Alignment	16,113	195,889	212,002	33,017	218,463	251,480	38,811	228,369	267,180	39,267	229,344	268,611	42,352	232,852	275,204
Pennsylvania Ave Alignment	16,113	195,889	212,002	33,017	218,463	251,480	38,811	228,369	267,180	39,267	229,344	268,611	42,352	232,852	275,204
Mission Bay Alignment 22nd St	13,662	179,087	192,749	33,447	210,176	243,623	34,416	219,937	254,352	35,374	229,528	264,902	38,058	232,762	270,820

Sources: San Francisco Department of Planning, ACS 2011-2015 5-Year Estimates, Table B01001; LEHD, 2014

Figure 37 Population and Jobs within 15 Minute Walk of Caltrain Stations (From 22nd St Station to Transit Center)

Alignment	Existing			2016			2040			2065			Soft sites		
	Pop.	Jobs	Jobs + Pop	Pop.	Jobs	Jobs + Pop	Pop.	Jobs	Jobs + Pop	Pop.	Jobs	Jobs + Pop	Pop.	Jobs	Jobs + Pop
Baseline Alignment	32,014	285,005	317,019	51,772	314,408	366,180	59,080	329,909	388,989	61,351	339,311	400,663	65,972	344,008	409,980
Pennsylvania Ave Alignment	32,014	285,005	317,019	51,772	314,408	366,180	59,080	329,909	388,989	61,351	339,311	400,663	65,972	344,008	409,980
Mission Bay Alignment 22nd St	27,097	263,990	291,087	48,671	302,775	351,446	50,918	317,304	368,222	51,999	330,698	382,697	56,985	335,285	392,270

Sources: San Francisco Department of Planning, ACS 2011-2015 5-Year Estimates, Table B01001; LEHD, 2014

Captured Commute Demand from Other Transportation Modes

Travel-Time Impact (Current Caltrain Commuters)

A parallel analysis evaluates the extent to which each rail alignment would benefit or diminish the travel time of the existing San Francisco residents that commute by rail. Travel time has two components: access time to/from the closest Caltrain Station, and in-rail travel time. Access time is calculated as the walking time to the closest Caltrain rail station through the street network, and in-rail travel time has been estimated on the conservative side using 25 mph as the rail speed, and the distance between stations of the alignments (Figure 38).

Looking at theoretical speed and travel times, the cumulative in-rail travel time between 22nd Street Station and the Transbay Transit Center is not significantly different across the three alignment alternatives. A more detailed operating analysis (conducted separately for this study) considers train scheduling and reveals the potential for one to two minutes of time savings on some trains, and no times savings on most trains.

Figure 38 In-Rail Travel Time Between Stations (minutes)

Origin	Destination	Existing	Baseline Alignment	Pennsylvania Avenue Alignment	Mission Bay Alignment
Bayshore	22nd St	9	9	9	9
Millbrae	4th and Townsend	20*	20	20	n/a
22nd St	Mission Bay	n/a	n/a	n/a	6
Mission Bay	Transit Center	n/a	n/a	n/a	5
22nd St	4th/King	6	n/a	n/a	n/a
4th and Townsend	Transit Center	n/a	4	4	n/a

Although the alignments shorten some of the access/egress times to the closest rail stations, they may also represent a longer in-rail travel time from trips originating on the Peninsula, depending on ultimate ending point along the rail line, due to the added distance to the Transit Center.

1. Baseline and Pennsylvania Avenue alignments: based on current Caltrain riders residents in San Francisco, riders saving total travel time in this alignment will have an additional in-rail travel time of 4 minute per rider-trip and will save an average of 8 minutes in access time per rider-trip.
2. Mission Bay 22nd Street alignment: based on current Caltrain riders residents in San Francisco, riders saving total travel time in this alignment will have an additional in-rail travel time of 1 minute per rider-trip and will save an average of 3.5 minutes in access time per rider-trip.

The following figures shows the total travel time savings derived from each of the alignments. Results show that Mission Bay/26th alternative would represent the highest time savings, with the highest time savings linked to access improvements, and least increase on in-rail travel time. In second position would be the alternative of Mission Bay/22nd St, followed closely by the Baseline and Pennsylvania Avenue alignments.

The average saving per rider (one-way trip) ranges from 1.5 minute/commute rider for the Mission Bay/22nd St alternative, to 1.2 minute/commute rider for the Pennsylvania Avenue (Figure 39).

Figure 39 Time Savings of Existing Caltrain Riders (minutes)

	Baseline Alignment	Pennsylvania Avenue Alignment	Mission Bay Alignment
Access time (one way)	16,162	16,162	17,028
In-rail travel time (one way)	(7,856)	(7,856)	(6,693)
Total time savings	8,306	8,306	10,335
Average savings per rail commuter (one way)	*1.2*	*1.2*	*1.5*

Ridership Capture from Other Modes

The previous chapter denoted that accessibility to the closest Caltrain rail station (shortest walking distance) will improve in certain areas of the city, which could create a mode shift for trips that are currently taken via modes other than Caltrain (see Figure 5 and Figure 6).

Figure 40 shows an estimation of the increment of Caltrain ridership with origin and/or destination in San Francisco for commute purposes per alternative and demographic scenario (variation of population and jobs, as indicated from Figure 32 to Figure 35).

This exercise is based on the assumption that the attractiveness of a mode to capture riders grows when the travel cost decreases, and in this case, that only Caltrain changes in regards to the existing condition. The methodology is a logit model based on access time variation to the closest Caltrain station (access time variation expressed in minutes and lambda equals to 0.05) which has as inputs the current mode share of commute origin-destination pairs, and the variation of rail travel costs for each of the alignments. Note that the lambda coefficient hasn't been calibrated and thus the Figure below needs to be read in terms of the rank among alternatives and not exact forecasted ridership.

While the impact would be the same with the current demographic characteristics, the Mission Bay alignment shows the highest increment of ridership in all future scenarios, as it is the alternative that represents the most time saved (Figure 40). Furthermore, the population is expected to double in future demographic scenarios around the new Mission Bay catchment area (Figure 36).

Figure 40 Estimation of total variation of Caltrain commuters to/from SF*

	Baseline Alignment	Pennsylvania Avenue Alignment	Mission Bay Alignment
Current	+114%	+114%	+114%
2016 pipeline	+135%	+135%	+138%
2040	+140%	+140%	+142%
2065	+143%	+143%	+146%
Soft sites	+154%	+154%	+157%

(*) Based on CTPP 2006-2010 commute flows

Below are two examples of origin-destination pairs that are covered by other modes, but will be covered with Caltrain once the extension is completed, and in consequence, Caltrain mode share might increase at the expense of the decrease of the mode share of the other modes.

Example 1: Millbrae-Embarcadero

The Transit Center will serve the same area as the Montgomery and Embarcadero BART stations, and despite being slightly more expensive some current BART users traveling from Millbrae to these stations might shift to Caltrain as the travel time will be significantly shorter (Figure 41).

According to BART ridership 2016 data, there are approximately 2,500 passengers per day from Millbrae to Montgomery Station or Embarcadero Station, and about equal ridership in the opposite direction. The Caltrain Millbrae station has, on an average weekday, 3,700 boardings and 3,700 alightings, but the information of whether riders transfer from BART and where riders get on/off in Caltrain stations is not available.

The average rail share of commute trips from Millbrae to San Francisco is 2.3%, BART share is 10.8% and bus share is 2.6%. For trips from Millbrae to the Embarcadero area, rail (BART+Caltrain) have a joint share of 60%, though nearly all of this (57% of total trips) are made via BART. With the extension, Caltrain share could double to 6% using the model choice model explained above considering the current commute demand.

Figure 41 Millbrae- Embarcadero/Transit Center Travel Costs

Millbrae-Embarcadero/Transit Center	BART	Caltrain
Travel time (min)	32	24
Fare	$4.65	$5.20*

(*) Current Millbrae-4th St and King Station trip fare; estimated to increase by at least $2.50 with the extension

Sources: BART, Caltrain

Example 2: Mission Bay-Financial District

The Mission Bay alignment would give an alternative to MUNI and bus riders along 3rd St-King St to travel from Mission Bay to Embarcadero areas. According to CTPP 2006-2010 data, bus is used approximately in 40% of the commute trips between these two areas, while streetcar is only used in 6% of these trips.

Below is a comparison of travel time and fare of a trip from UCSF to the Embarcadero Building. In this case, in-rail travel time is less than half with Caltrain than with MUNI, but the fare is significantly higher. In addition, there are other aspects to consider to understand how more attractive could be Caltrain versus MUNI to cover this distance.

- Frequency: three MUNI lines run along this corridor (E, KT, N), with services every 6-8 minutes during peak hours, while current Caltrain services run every 10-15 minute during the same time, and it is projected that 6 trains/hr will run through the new tunnel.
- Reliability (on time performance): Caltrain on-time performance is 92%[7], MUNI (E, KT and N lines) is 50%[8]
- Comfort to get to the platform: MUNI runs at grade level while Caltrain will be below street level.
- Destination: Caltrain will attract those going near the Transit Center, while MUNI will attract those going to the shore line or Financial District from Mission Bay.

Figure 42 UCSF-Bank of the West Travel Costs

UCSF Mission Bay-Embarcadero Ferry Building	MUNI	Caltrain
In-rail Travel time (min)	19'	5'
Fare one-way	$2.75	$3.75*
Fare monthly pass	$75	$84.80

(*) Current one-way fare for Zone 1; estimated to increase by at least $2.50 with the extension

Sources: BART, Caltrain

[7] https://twitter.com/caltrain/status/771404510866477058

[8] https://www.sfmta.com/about-sfmta/reports/performance-metrics/goal-2-preferred-means-travel/percentage-time-performance

CORE CAPACITY AND RESILIENCE

Key Findings

The resilience analyses contained in the following sections reveal that each alignment is potentially compatible with the Core Capacity Transit Study (CCTS). Key findings of the analysis related to consistency with the CCTS include the following:

- Overall, each alignment has potential connections with at least one CCTS package in Southern SoMa or Mission Bay.
- Outside of direct connections with CCTS packages that would serve the Transbay Transit Center, a combination of the 3rd Street Caltrain/HSR alignment and a CCTS package that would bring a new rail alignment through the heart of Mission Bay would offer the closest connection, albeit with the potential for significant vertical circulation requirements.
- The Pennsylvania Avenue and baseline Caltrain/HSR alignments offer some consistency with CCTS packages that would bring new rail service to Brannan Street.

Key findings of the analysis related to impacts on and from AT&T Park and the new Warriors Arena include the following:

- During peak demand periods, SFMTA services are likely to be delayed by loading and surface traffic, resulting in walking being the most efficient way of accessing either station location immediately after an event.
- The Mission Bay station location is within a four- to five-minute walk of the new Warriors arena, and the 4th/Townsend station location is within the 15-minute walk of that new arena.
- In terms of facilitating connections to BART/MUNI Metro the Mission Bay station location is advantageous due to its proximity to the new Warriors arena.
- Neither station location offers advantages with respect to mitigating other arena transit demand such as westbound bus service or the southbound T Third MUNI Metro.
- With respect to AT&T Park, the Mission Bay station location increases pedestrian access time to Caltrain from 3 ½ minutes to almost 9 minutes, representing some loss of convenience for southbound Caltrain riders.

Analysis

Consistency with Core Capacity Transit Study Transbay Tube Alignment Options

This portion of the analysis identifies areas of consistency between The Core Capacity Transit Study (CCTS)[9] transbay crossing alignments and the three Caltrain/High Speed Rail alignments that are under consideration as part of the RAB. Nelson\Nygaard evaluated the likely proximity of potential station locations for alignments in both studies. The analysis assumed that passenger access/egress locations would be at intersections near either end of the roughly 600-foot-long train boxes needed to accommodate BART, Caltrain, and High Speed Rail trains.

Key takeaways:

[9] A description and map of each of the proposed CCTS alignments can be found in Appendix C on page XIII

1. Outside of direct connections with CCTS packages that would serve the Transit Center, a combination of the 3rd Street Caltrain/HSR alignment and a CCTS package that would bring a new rail alignment through the heart of Mission Bay would offer the closest connection, albeit with the potential for vertical circulation requirements.
2. The Pennsylvania Avenue and baseline Caltrain/HSR alignments offer some consistency with CCTS packages that would bring new rail service to Brannan Street.

Detailed Findings

Figure 43 notes each Caltrain/HSR alignment's closest connection with the CCTS alignments' potential station locations. The Mission Bay alignment creates the most direct potential connection in this area, with CCTS Package 5. While Package 2 would also have a landing in Mission Bay, the location of a potential first San Francisco station around 3rd and King streets would mean connections to Southern SoMa/Mission Bay stations along any of the RAB alignments would likely require a short walk. CCTS Package 4 is oriented toward 4th and Townsend and syncs better with the Baseline or Pennsylvania Avenue alignments. Two CCTS packages (3 and 6) are oriented to the Transit Center, without stations in the areas in Southern SoMa or Mission Bay. Therefore, they work equally well with all alignments and are not analyzed further in this section.

The CCTS concluded without identifying a single preferred bay-crossing alternative. Therefore, the CCTS provides no clear direction for the RAB study. Identifying a preferred RAB alignment is likely to happen first, and the outcomes of this study could be an important input to a potential successor study to CCTS that aims to narrow in on a preferred bay crossing alignment.

Note that the station locations assumed in this analysis are likely to shift as the City and region narrow in on preferred Baseline and bay crossing alignments. If the two preferred alignments end up creating a potential transfer opportunity, station location decisions for each alignment should facilitate easy transfers. As such, the walk distances estimated in Figure 43 should be considered preliminary and illustrative.

Mission Bay Alignment

The Mission Bay station in CCTS Package 5 could have a direct connection to a Mission Bay Station, with a transfer facility somewhere in the vicinity of the intersection of 3rd Street and Mission Bay Boulevard. The AT&T Park station in CCTS Package 2 would be a short walk north of a potential Caltrain/HSR station in northern Mission Bay, several hundred feet south of the southern bank of Mission Creek.

The alignments studied in CCTS Packages 2 and 5 would both enter San Francisco far underground to tunnel underneath deep bay mud near the landing locations.[10] Deep building piles associated with AT&T Park and the planned Mission Rock development would reinforce the need for a deep entry into San Francisco for Package 2. Given the easternmost stations' proximity to the shoreline in both packages, train boxes for these stations would also need to be far underground, creating a need for complex vertical circulation infrastructure to facilitate a transfer to a potential Mission Bay station nearby.

[10] http://mtc.ca.gov/sites/default/files/CCTS_InitialEngineeringStudy_Memo_Nov2015.pdf, pages 11-14.

Pennsylvania Avenue and Baseline Alignments

Package 4 would offer the closest potential connection with the Pennsylvania Avenue and Baseline alignments, with a potential station near the intersection of 4th and Brannan streets that would be a short walk from the location of the current Caltrain terminal. The Pennsylvania Avenue and Baseline alignments would create slightly longer transfer opportunities with the Package 2 station near AT&T Park and the Package 5 station on Brannan Street between 6th and 7th streets. Given the potential Brannan Street stations' locations away from the package 4 and 5 alignments' landing points, the station would not need to be as deep as those associated with the stations closest to the Mission Bay alignment stations.

Figure 43 Assessment of Approximate Proximity to Potential Transbay Alignments

Caltrain Alignment	CCTS Package	Closest CCTS Station	Closest Caltrain/HSR Station	Approximate Distance from One End of Train Box (feet)
Mission Bay	Package 2	AT&T Park (3rd/King-3rd/Berry)	3rd/Mission Rock-3rd/China Basin	1,400 to 1,600
	Package 4	4th/Brannan	3rd/Mission Rock-3rd/China Basin	2,000
	Package 5	3rd/Mission Bay Boulevard	3rd/Mission Rock-3rd/China Basin	0 to 200
Baseline/ Pennsylvania	Package 2	AT&T Park (3rd/King-3rd/Berry)	4th/Townsend	800
	Package 4	4th/Brannan	4th/Townsend	600
	Package 5	6th/Brannan	4th/Townsend	1,600

Figure 44 Railyard and Boulevard Study Alignments + Potential Station Locations and CCTS Transbay Crossing Alignments + Potential Station Locations

Arena and Stadium Impacts

The new Warriors arena is an 18,000 seat arena currently under construction at Third and South Streets (Lot E) in Mission Bay. The project includes a multi-purpose area that includes a theater configuration, 580,000 square feet of office and lab space, and have 100,000 square feet of retail space, and a parking facility containing roughly 950 spaces.

As public transit accessibility is touted as a key feature of the development, this memo attempts to briefly quantify peak demand characteristics for each mode and compare them to supply. Demand characteristics are estimated based on other nearby large event mode share profiles.

Interestingly, the most concerning surge load is that which is likely to travel northbound on an enhanced T Third MUNI Metro line north to connect with BART. Regardless of the chosen Caltrain station location, the level of demand for northbound travel far exceeds projected system upgrades.

The Mission Bay station shows potential to contribute to an easing of northbound MUNI Metro demand if certain Caltrain scheduling and routing techniques are employed. Other modes such as westbound bus service and southbound MUNI Metro trains do not realize a significant advantage from either proposed station location.

In terms of facilitating connections to BART/MUNI Metro by easing the demand load, the Mission Bay station location becomes advantageous due to its proximity to the arena compared with the ¾ mile walk to 4th and Townsend Streets. Neither station location offers advantages with

respect to mitigating other arena transit demand such as westbound bus service or the southbound T Third MUNI Metro.

As seen previously in the planned pedestrian access graphic, both proposed Caltrain station locations are within 15 minutes on foot from the new Warriors arena and AT&T Park. During peak demand periods, SFMTA services are likely to be delayed by loading and surface traffic, resulting in walking being the most efficient way of accessing either station location immediately after an event. With respect to AT&T Park, the Mission Bay station location increases pedestrian access time to Caltrain from 3 ½ minutes to almost 9 minutes, representing some loss of convenience for southbound Caltrain riders, but also allows for platooning of pedestrians and Caltrain riders which would help in loading Caltrain trains at a Mission Bay Station from both the AT&T Park as well as the Warriors Stadium. Conversely, the 4th/Townsend station is a longer walk from Warriors Arena.

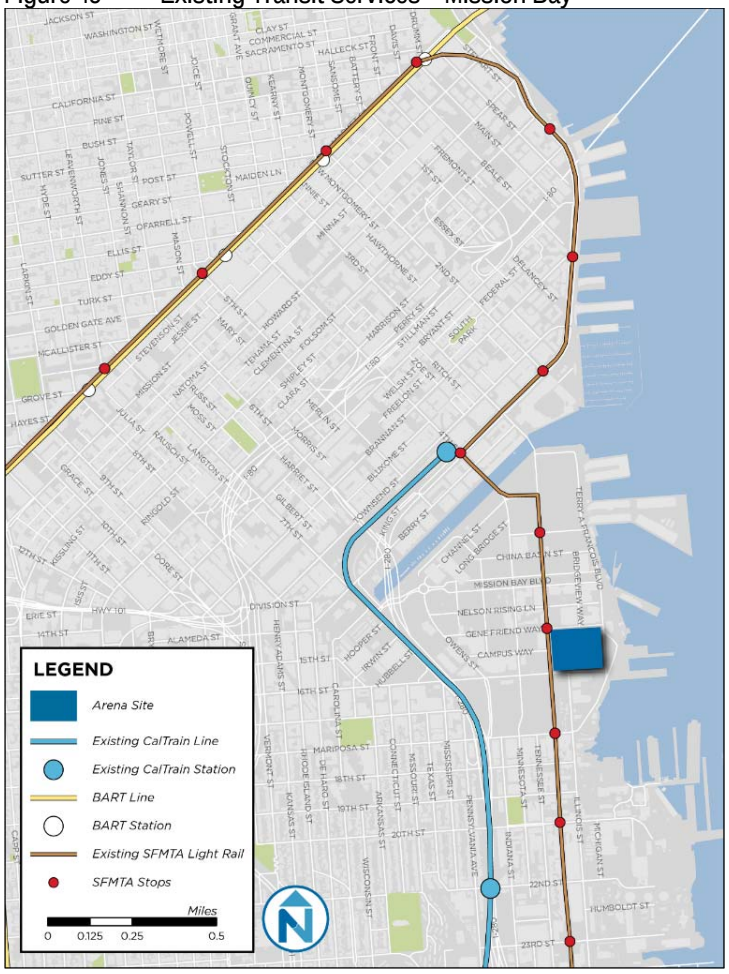
Existing and Planned Transit Networks

In order to evaluate transit load demand and the impacts of Caltrain alignment, existing transit networks and planned network improvements should be inventoried. This section lists current service routes and large capital projects that will fundamentally alter the reach of service in the coming years.

Existing Transit Service

Currently, the nearest Caltrain station to the arena site is located at 4th/King Streets on the opposite side of Mission Creek Channel from the Warriors Arena. The MUNI Metro KT Line is the only existing SFMTA service that currently directly serves the arena site. A temporary bus service exists along 16th and 3rd Streets as part of the 16th Street Multimodal Corridor project – part of a planned set of area transit improvements that will be included in the transit inventory as understood at the time of arena completion. In the future, the 22-Fillmore (BRT Light) will run on 16th Street and replace the Route 55 MUNI Bus line.

Figure 45 Existing Transit Services – Mission Bay



Planned Network Investments

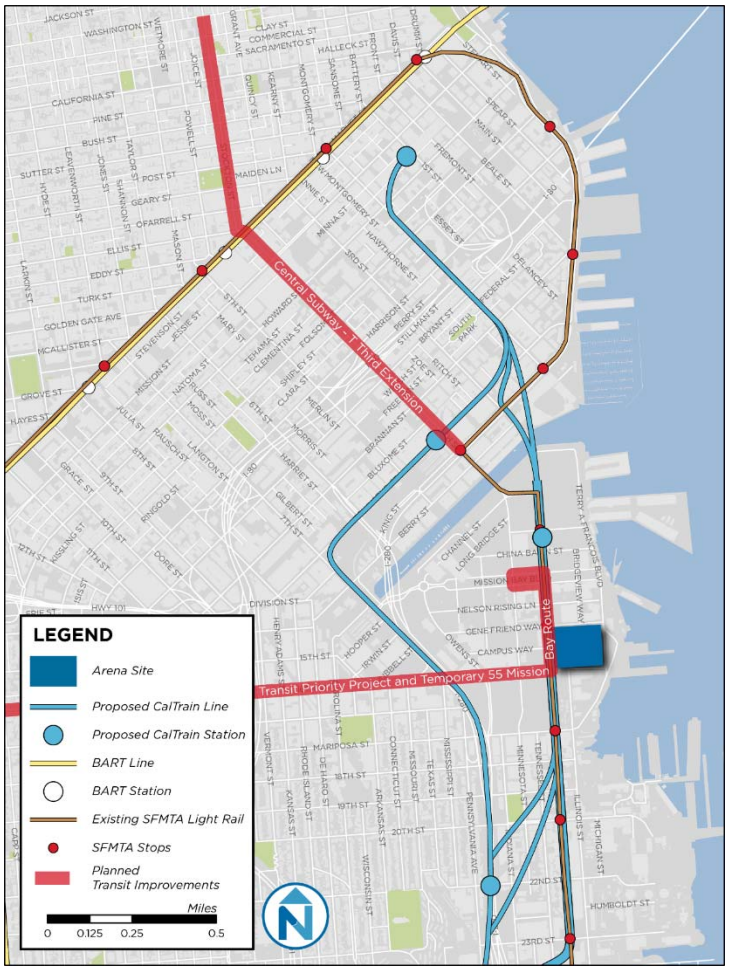
With respect to potential Caltrain stations proximately located to the arena site, there are two:

- Baseline and Pennsylvania Avenue alignment – contains the previously environmentally cleared option (located underground in the DTX) involves at station at 4th/Townsend Streets, at the northwest corner of the current rail station at 4th/King.
- Mission Bay alignment features a tunnel under 3rd Street, would be somewhere along 3rd Street at a location yet to be determined. For the purpose of this initial analysis it is considered to be between China Basin and Mission Rock Streets.

There are a pair of large SFMTA network enhancements currently under construction that will improve access to and from the Mission Bay neighborhood. The largest, the Central Subway project, improves intermodal connections at both stations by extending the MUNI Metro T Third Line underground in its own right-of-way, providing a direct link between the Bayshore and Mission Bay areas to SoMa, downtown, Chinatown, and the Powell Street BART Station.

The 16th Street Multimodal Corridor Project will impact all travel modes and includes an interim bus route (Route 55) along 16th Street and 3rd Street in Mission Bay. This route will provide a bus link to the 16th/Mission BART station until the 22 Fillmore route is instituted permanently through the 16th Street transit priority corridor.

Figure 46 Planned Transit Facilities – Mission Bay

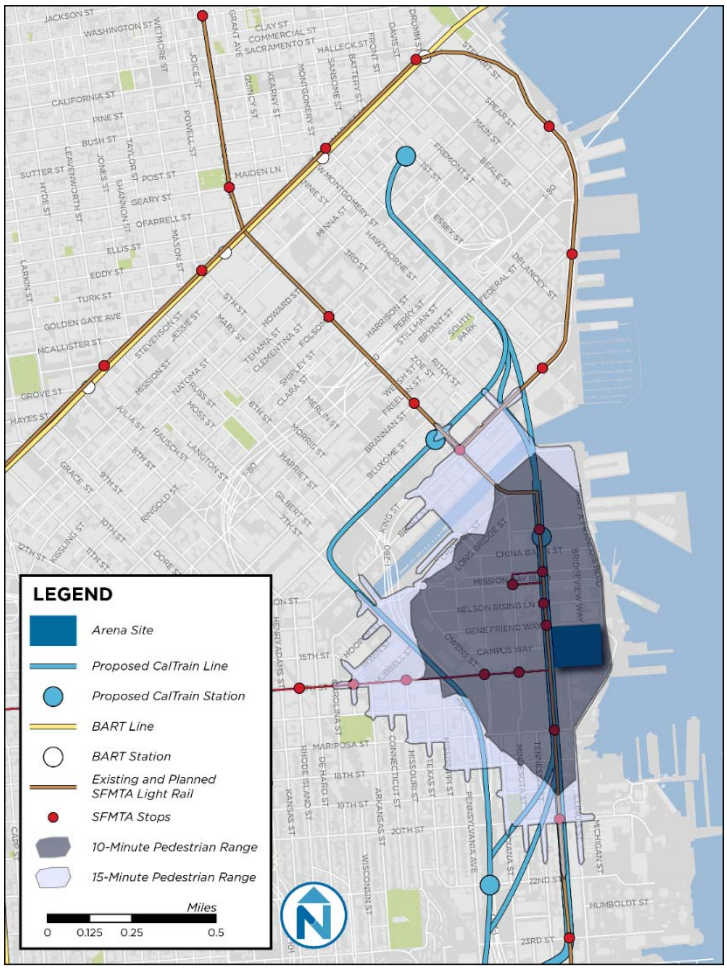


Access from Arenas to Final Transit Mode

Should the Caltrain station be relocated to Mission Bay, the station would find itself well within a 10 minute walking distance of the future Warriors arena, while the walking distance from AT&T Park will be extended from 3 ½ minutes to almost 9 minutes, though still within a ten minute walkshed. If Caltrain continues to be located at 4th/King or 4th/Townsend, on the opposite side of Mission Creek Channel, it will be able to be reached from the Warriors Arena in 15 minutes on foot, assuming that a pedestrian bridge is constructed across the channel at 5th Street.

In either scenario, the future arena will have immediate pedestrian access to the T Third Light Rail extended through the central subway to BART on Market Street. Likewise the finalized 22-Fillmore bus will depart from the area and utilize transit lanes on 16th Street to shuttle eventgoers to another BART station.

Figure 47 Pedestrian Access Shed of New Arena



Surge Demand and Capacity[11]

Demand

To better understand peak period demand. It is instructive to look to another nearby sports venue. Since 2000, the San Francisco Giants have made their home a 42,000 seat ballpark at 3rd and King Streets, just across Mission Creek Channel from the Warriors Area location. In August, 2007 the team conducted a survey of ticket buyers at the request of the Port of San Francisco[12] to better understand the transportation habits of spectators. Ticket buyers were surveyed across various days of the week and game times.

Overall, 41% of buyers used some form of public transportation to arrive at the ballpark. Within this cohort, 27% use Caltrain, 16% take a ferry to another location on the Bay, 28% strictly use MUNI bus or light rail, and 31% plurality use BART. Data disaggregated by day of the week and event start time does not waver significantly from the aggregate transit rider data.

[11] See Appendix C for a full description of the definitions and requirement assumptions for demand and capacity that were used in this analysis.

[12] http://www.sfport.com/ftp/uploadedfiles/port_commission/RFP%20Appendix%20H.pdf

The destination distribution of BART riders suggests that a vast majority come from the East Bay (approximately 85%). This reinforces the concept of the Central Subway as the link to BART which would see the most use under event surge conditions compared with bus lines to stations further west.

Current capacity of the planned basketball arena is listed at 18,000. A scenario is developed in the tables below to represent a high volume transit load desiring to depart simultaneously from the arena site via MUNI Light Rail and Bus. Due to the need to connect to BART via transit – the nearest BART station is 33 to 34 minutes from the arena by foot, whereas the Montgomery Street BART station is 21 minutes from AT&T Park – the T Third Line through the Central Subway may be asked to accommodate over 2,750 patrons in a short time frame. Almost 2,000 of those patrons are anticipated to be connecting to eastbound BART trains.

Figure 48 Anticipated Future Mode Share to Warriors Arena

	Car/Charter	Public Transit/Taxi	Walk/Bike	Other	
Total – 18,000	9,540	7,380	900	360	
	BART	MUNI	Caltrain	Ferry	Taxi
Total – 7,380	2,288	2,066	1,993	1,181	221
	320 – West	821 – North			
	1,968 – East	413 – West			
		826 – South			

Bus West	T Third LRT North	T Third LRT South
733	2,789	826

Demand Differences

Caltrain demand is unlikely to fluctuate for events at AT&T Park or the new arena regardless of the final Caltrain location. In all options Caltrain patrons walk less than 15 minutes to a station.

Local bus service, as both a final transit mode, and a means to access westbound BART service, can be configured to handle demand from either facility. Bus options are more robust nearer AT&T park, which compensates for the larger average crowd size.

Southbound MUNI Metro is certain to serve each arena equally well, though northbound activity is likely to differ. Northbound traffic from the arena is higher as a share of total event attendance due to the significantly longer walking distance to connections on Market Street. This scenario would benefit greatly from a relief component, such as using the Downtown Extension as a northbound shuttle.

Relative Benefit of Caltrain Station Locations

From the arena standpoint, the most pressing concern to come from this analysis is the ability to handle surge ridership northbound on the T Third Line connecting to BART at a rate double that

of the most aggressive planned capacity upgrades. While the possibility exists that some BART users will walk over half-an-hour (over 1.5 miles) to the nearest BART station, other means will need to be considered to help accommodate these passengers in a reasonable timeframe. MUNI Metro may be able to briefly exceed the long-term planned capacity to mitigate some of the demand pressure.

As no other bus routes head north from the arena site currently, careful coordination and scheduling of special Caltrain service can help alleviate some of the demand pressure. At the same time as Caltrain trains load southbound passengers, trains bound for the new Transit Center couldbe utilized by northbound Arena patrons to access both BART and other MUNI connections on Market Street. These empty trains would then return to the proposed station and pick up any remaining passengers still waiting for southbound Caltrain service. This arrangement would allow commuter-rail train movements to be better synchronized to ensure available platform space for arriving trains, which would help to avoid on-track delays.

As stated previously, for the Arena, a China Basin station is preferable for a connection to BART and the 4th/Townsend station is approximately ¾ mile in distance which is at the limit of a walkshed distance. It should be noted that because of the close proximity to Caltrain's 4th/King station (and 4th/Townsend proposed station), there is a "crush" loading situation after each game. If the station was slightly further, the natural platooning of persons could actually result in better arrival patterns and served better with regular operations for Caltrain over the load-and-go operations that are provided at the 4th/King station currently.

NETWORK OPTIMIZATION

Key Findings

The analyses contained in the following sections reveal that the optimization of complete streets networks and transit access better supports the Baseline and Pennsylvania Avenue alignments. Key findings of the analysis that lead to this conclusion include the following:

- The 4th/Townsend Street (Baseline and Pennsylvania Avenue alignments) location is already situated within a robust last-mile transit network.
- Transit improvements are necessary for the 3rd/China Basin station to be viable from an employment access standpoint, but even with improvements employment access would not exceed that of the 4th/Townsend Street location.

Analysis

Non-Motorized

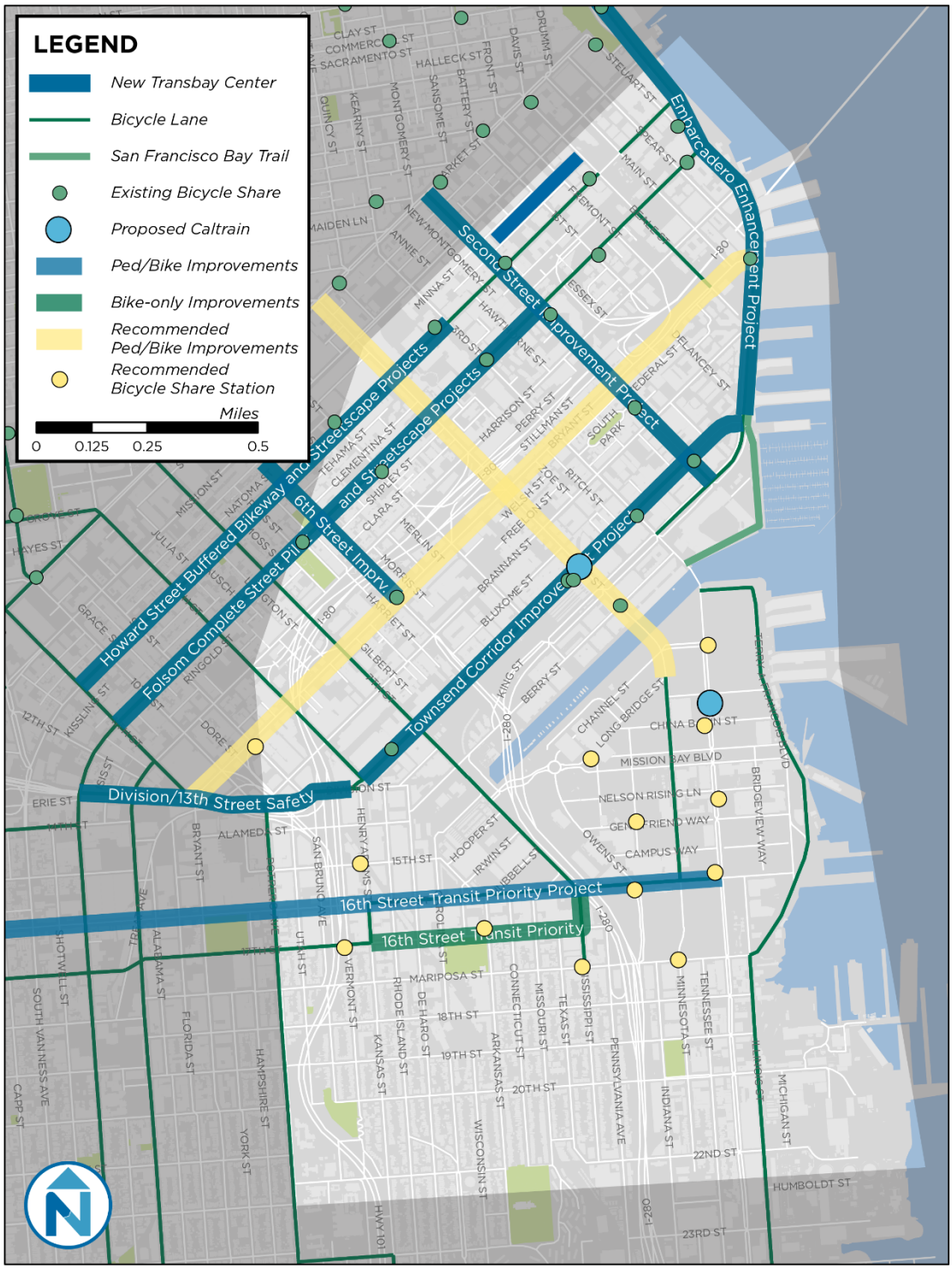
Recommendations to the non-motorized transportation network focus on completing a sub-network that emphasizes pedestrian and bicycle safety. The recommendations are made based on the understanding of projects in progress and the availability of bicycles to rail commuters at each proposed station location. Range of access to destinations is unlikely to increase appreciably because of these recommendations as the non-motorized network is already complete for pedestrians and confident cyclists.

The program of complete streets investments should be continued to include Bryant Street from Division Street to the Embarcadero and 4th Street from Market Street to the beginning of bicycle facilities in Mission Bay. These initiatives complement existing corridor improvement projects and create significant coverage of complete streets in the northern half of the study area while linking to initiatives in the newly developing southern half. The bicycle share network should be expanded south of Mission Creek Channel, especially near the proposed Caltrain station location, in order to provide easier multimodal access to long-range rail commuters.

Figure 49 Non-Motorized Last Mile Access

Access Shed	Employment Access		Recommendation	Cost Impact
	5-Minute	10-Minute		
Pedestrian – Transit Center	41,124	156,268		
Pedestrian – 4th/Townsend	6,325	18,562	Complete Streets Program Additions	Medium
Pedestrian – 3rd/China Basin	916	5,913	Minimal Complete Streets Extensions	Low
Bicycle – 4th/Townsend	49,865	341,883	Complete Streets Program Additions	Medium
Bicycle – 3rd/China Basin	20,629	226,251	Significant Bicycle Share Expansion	Medium

Figure 50 Recommended Non-Motorized Investments



Transit

There is little that can be done to further enhance access via single seat transit from the proposed 4th/Townsend Street station location. Once the Central Subway is complete, the transit network

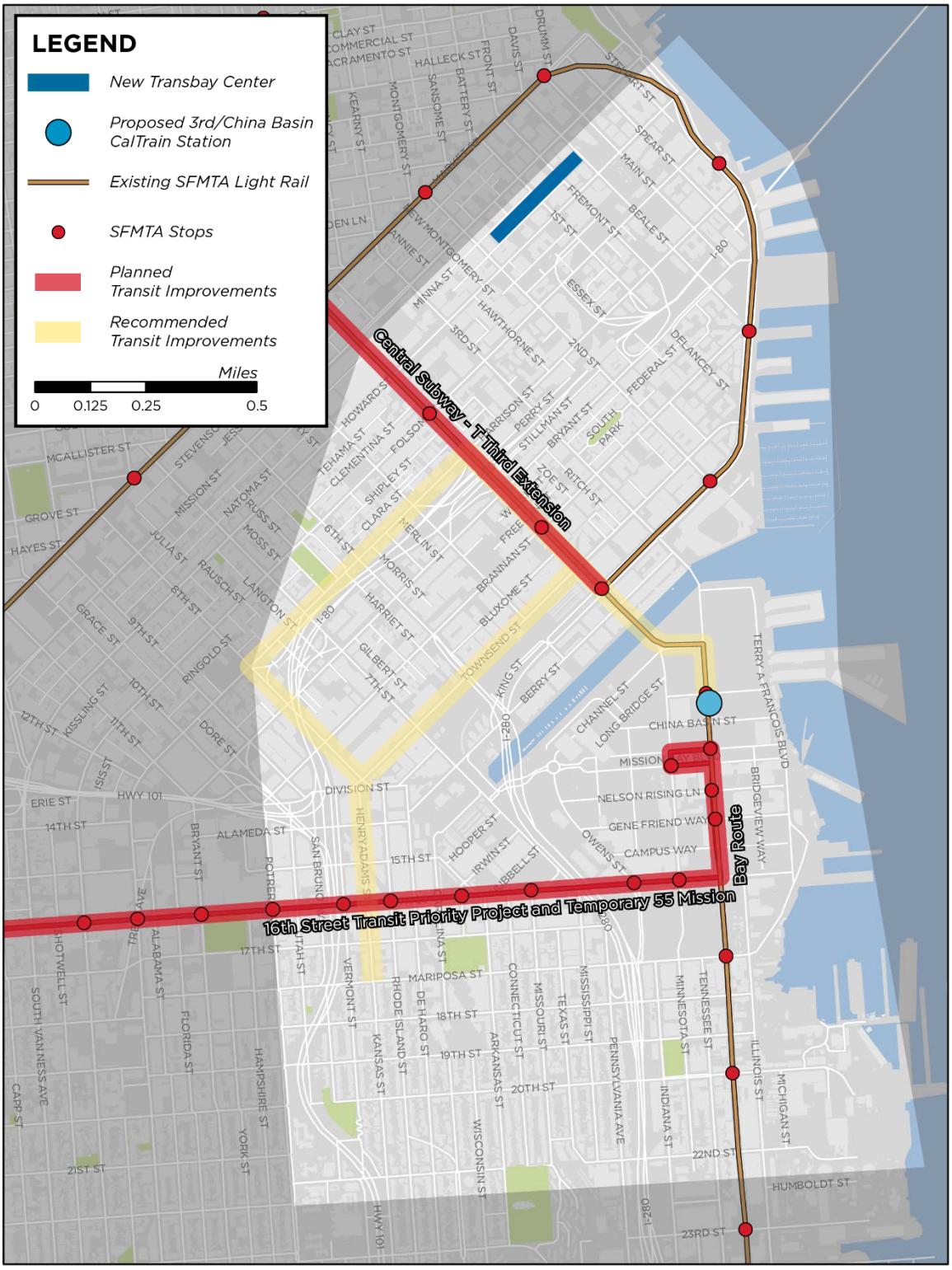
emanating from the existing station is a high-reach access scheme that covers all employment centers within the study area. The 4th/Townsend Street station location represents more robust access to employment, and a better opportunity to minimize additional needed investment, compared with the proposed Mission Bay location.

The Mission Bay currently features significant transit network gaps in the western portion of the study area that would need to be filled in. Unlike gaps in the north, these areas would not directly benefit from the Caltrain extension to the new Transit Center. Potential solutions include express buses which originate at the new Caltrain station and approximate existing portions of the 10 and 47 bus routes. The buses would make no stops on 4th Street to expedite arrival in their intended service areas similar to current routes 81X and 82X. While these services would improve 10 and 15-minute access to the western portion of the study area, access to employment would only marginally improve. By this metric, improving transit options from a Mission Bay station location would not make that location as or more attractive than the 4th/Townsend Street location.

Figure 51 Existing and Planned Transit Last Mile Access

Station Location	Employment Access		Recommendation	Cost Impact
	10-Minute	15-Minute		
4th/Townsend	164,676	373,471	None	Minimal
3rd/China Basin	41,696	168,630	Express Bus Routes	Medium
3rd/China Basin w Improvements	42,311	173,232		

Figure 52 Recommended Transit Investments – Mission Bay



3 DECISION MATRIX

Figure 53 Decision Matrix

Category	Criteria	Metric, Description	Baseline and Pennslyvania Avenue Alignments	Mission Bay Alignment
Market Demand/Marketability	Existing transit demand impact	Expected change in demand from SF Caltrain	1%	2%
	Total Caltrain time savings	Average one-way time savings per rail commuter (existing Caltrain riders), in minutes	1.2	1.5
	Current rail commuters	Within 1/2 mile of existing Caltrain stations (excluding Transbay)	1,134	1,116
	Connectivity to stations, future*	Improved street connectivity at 16th Street	0	1
	Jobs within 15 minute walk of Caltrain stations in San Francisco	Current	285,005	263,990
		Projection 2016	303,406	267,861
		Projection 2040	307,121	276,974
		Projection 2065	316,527	290,015
		Projection softsites	342,619	316,882
	Population within 15 minute walk of Caltrain stations in San Francisco	Current	32,014	27,097
		Projection 2016	37,330	37,199
		Projection 2040	38,656	38,584
		Projection 2065	40,930	39,665
		Projection softsites	45,351	43,903
Consistency with other Plans	Consistency with Core Capacity Package Alternatives**	Package 1	0	0
		Package 2	1	0.5
		Package 3	1.5	1.5
		Package 4	1	0
		Package 5	0	1.5
		Package 6	2	1.5
	Connectivity to major events	Distance from AT&T Park (miles)	0.2	0.3
		Distance from new arena (miles)	0.4	0.3
	Opportunity to mitigate overcrowding after new arena events***	Facilitating connections to BART and Muni T-Third	0.5	1

* Qualitative, based on SF Planning criteria of future street grid changes if the train goes underground. 0 = no change, 1 = Improved street connectivity

** Scoring: 2= two Caltrain stations connecting to BART stations, 1.5= one Caltrain station connecting to BART stations, 1= close walk to two Caltrain stations from BART, 0.5= close walk to one Caltrain station from BART, 0= no Caltrain stations close to BART stations

*** Scoring: 0.5= walkable, but not intuitive; 1= walkable, and intuitive

Appendix A Methodology – Assumptions and Parameters

Existing Conditions - Network and Demographics

Data Sources

- Population: American Community Survey 2011-2015 5-Year Estimates, Table B01001: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml (Accessed March 24, 2017)
- Employment: Census Longitudinal Employer-Household Dynamics (LEHD), 2014 dataset. https://onthemap.ces.census.gov/ (Accessed March 24, 2017)

Analytical Assumptions

- Population densities shown are gross population densities per acre and are not adjusted for land uses or built floor area.

Population and employment densities (Figure 1 and

- Figure 2) use ACS and LEHD data, respectively, to show the number of residents and jobs per acre. Population density is shown at the Block Group level, while employment density is shown at the Block level.
- A method of fractional allocation was used to calculate the population and employment in Census Block Groups or Blocks that fall only partially within a Euclidean ½ mile buffer of the existing Caltrain stations. A Block or Block Group with 60% of its area lying within the ½ mile buffer of a Caltrain station would have 60% of its total employment or population counted as lying within the buffer.

Parameters

Figure	Data	Data Source	Parameter
Figure 1	Existing Population Density	ACS 2011-2015 5-Year Estimates, Table B01001	Residents per acre
Figure 2	Existing Employment Density	Census Longitudinal Employer-Household Dynamics Tables, 2014	Total jobs per acre

Existing Conditions - Ridership

Data Sources

- Caltrain ridership: Caltrain 2016 Annual Passenger Count, p. 30. http://www.caltrain.com/Assets/__Marketing/caltrain/pdf/2016/2016Annual+Passenger+Counts.pdf (Accessed March 22, 2017)
- Mode share, Figure 5-Figure 7: Census Transportation Planning Package, 2006-2010. Table A302103. Means of Transportation, Workers 16 Years and Over. http://data5.ctpp.transportation.org/ctpp/Browse/browsetables.aspx (Accessed March 27, 2017)
- Rail commuters, Figure 4: American Community Survey 2011-2015 5-Year Estimates, Table B08301: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml (Accessed March 24, 2017)

Analytical Assumptions

- A method of fractional allocation was used to calculate the rail commuters living in Census Block Groups that fall only partially within a Euclidean ½ mile buffer of the existing Caltrain stations. A Block Group with 60% of its area lying within the ½ mile buffer of a Caltrain station would have 60% of its total rail commuters counted as lying within the buffer.
- In Figure 4, Census Tract destinations provided in the CTPP dataset are intersected with local municipal boundaries to reveal overall commuter totals for each municipality.
- In Figure 5 and Figure 6, the columns “commutes to destinations near Caltrain stations” and “commutes between areas near Caltrain stations” use a Euclidean distance buffer of ½ mile to define the Caltrain station catchment areas.
- The Census Transportation Planning Package (CTPP) collects data that estimates the number of commutes that occur between various Census Tract origin/destination pairs and provides commute subtotals by travel mode. In Figure 5, this data is used to estimate the commute mode share of all commutes between San Francisco and all other Bay Area destinations, by dividing the commute subtotals by mode by the total number of commuters in each origin/destination pair. The results show that rail commute mode share increases when origins and destinations fall within Caltrain catchment areas. In all commutes starting in San Francisco and ending in non-SF Bay Area commute locations, the rail mode share is 1%. However, this mode share rises to 3% among all SF--> non-SF Caltrain-accessible Bay Area commute locations, and 5% between SF and non-SF Bay Area pairs where both origin and destination are Caltrain-accessible. Figure 6 shows a similar analysis in the reverse direction, with commutes starting in non-SF Bay Area origins and ending in San Francisco. Rail commute mode share increases from 2% among all origin/destination pairs to 4% among commutes with a Caltrain-accessible destination and 8% among commutes with Caltrain-accessible origin and destination.
- CTPP data is used in a similar analysis shown in Figure 7. This analysis uses CTPP data to calculate the number of commutes that have origins in Census Tracts within ½ mile of future Transit Center and the Mission Bay station. If these commutes have work destinations outside San Francisco that are Caltrain-accessible, the rail commute mode share rises significantly, from 3% of all commutes beginning near Transit Center to 17%

of all commutes with Caltrain-accessible workplaces, and from 10% of all commutes originating near Mission Bay station to 39% if the workplace is Caltrain-accessible.

- Please note that ACS commute mode share data uses slightly different names for travel modes than the final report. These data refer to Caltrain commuters as "Rail" commuters, BART commuters as "Subway" commuters, and to MUNI light rail commuters as "Streetcar" commuters

Parameters

Figure(s)	Data	Data Source	Parameter
Figure 5	Commute Trips from San Francisco to Destinations Outside of San Francisco	Census Transportation Planning Package, 2006-2010, Table A302103	Commute mode share, by Census Tract
Figure 6	Commute Trips to San Francisco from origins outside of San Francisco	Census Transportation Planning Package, 2006-2010, Table A302103	Commute mode share, by Census Tract
Figure 7	Mode Share of Commute Trips from New Rail Stations (0.5 Mile Catchment)	Census Transportation Planning Package, 2006-2010, Table A302103	Commute mode share, by Census Tract
Figure 4	Current Caltrain Commuters	ACS 2011-2015 5-Year Estimates, Table B08301	Percent of all commuters, by Census Block Group

Existing Conditions – First/Last Mile Connections

Data Sources

- Roadway network: https://data.sfgov.org/Geographic-Locations-and-Boundaries/San-Francisco-Basemap-Street-Centerlines/7hfy-8sz8 (Accessed March 22, 2017)
- Existing Non-Motorized Facilities: https://data.sfgov.org/Transportation/SFMTA-Bikeway-Network/x3cv-qums (Accessed March 14, 2017)
- Bike Share Stations: https://data.sfgov.org/Transportation/Bike-Share-Stations/gtyg-jpkj (Accessed March 14, 2017, then updated manually)
- Existing Transit Service: https://data.sfgov.org/Transportation/SFMTA-routes-and-stops-for-March-2012/f5c3-8kkj (Accessed March 14, 2017)
- Existing Caltrain and BART: http://www.dot.ca.gov/hq/tsip/gis/datalibrary/ (Accessed March 14, 2017)
- Planned Non-Motorized Investments: https://www.sfmta.com/projects-planning

Analytical Assumptions

- An existing transit line serves a Caltrain station if there is a stop within one block.
- Pedestrian speed = 5 km/h on flat ground, uses Tobler's Hiking Function to change speed and range based on grade https://en.wikipedia.org/wiki/Tobler%27s_hiking_function
- Bicycle speed = 16 km/h on flat ground. Uses a variant of Tobler's Hiking Function designed especially for bicycles (Speed=32*e^(-3*|Slope+0.23|)
- Five and ten-minute isochrones calculated in this analysis are roughly equivalent to ¼ mile and ½ mile network distance buffers from the station locations.
- In Figure 18-Figure 23, the jobs, population, and Caltrain commuter totals shown use a fractional allocation method to calculate the totals in Census Block Groups or Blocks that fall only partially within the 10- and 15-minute isochrones. A Block or Block Group with 60% of its area lying within the five-minute walkshed of a Caltrain station would have 60% of its total employment or population counted as lying within the buffer.
- The analysis in this section assumes a pedestrian/bike-only bridge over China Basin at 5th Street is built and part of the street network.

Parameters

Figure	Data	Data Source	Parameter
Figure 13, Figure 18, Figure 20, Figure 22	Pedestrian Access Shed – Transit Center, Baseline/Existing Alignment, Pennsylvania Ave Alignment, Mission Bay Alignment	Jobs: Census Longitudinal Employer-Household Dynamics Tables, 2014 Population: ACS 2011-2015 5-Year Estimates, Table B01001 Caltrain Commuters: ACS 2011-2015 5-Year Estimates, Table B08301 Roadway network: City of SF Open Data	Jobs, population, and Caltrain commuters within 10- and 15-minute access sheds
Figure 19, Figure 21, Figure 23	Pedestrian Access Walk Times – Baseline/Existing Alignment, Pennsylvania Ave Alignment, Mission Bay Alignment		
Figure 14, Figure 15	Pedestrian Shed of Pennsylvania Ave Alignment, Mission Bay Alignment		
Figure 16, Figure 17	Bicycle Shed of Pennsylvania Ave Alignment, Mission Bay Alignment		
Figure 24, Figure 25	Transit Shed of Pennsylvania Ave Alignment, Mission Bay Alignment	Transit network: City of SF Open Data	Transit Access Shed within 10- and 15-minutes
Figure 26, Figure 27	Transit-Leg Travel Times of Pennsylvania Ave Alignment, Mission Bay Alignment		

Realignment characteristics - Ridership

Data Sources

- Time savings (**Error! Reference source not found.**-Figure 39):
  - Census Transportation Planning Package, 2006-2010. Table A302103. Means of Transportation, Workers 16 Years and Over. http://data5.ctpp.transportation.org/ctpp/Browse/browsetables.aspx (Accessed March 22, 2017)
- Caltrain Stations Catchment (Figure 32-Figure 37)
  - Existing population: American Community Survey 2011-2015 5-Year Estimates, Table B01001: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml (Accessed March 24, 2017)
  - Existing employment: Census Longitudinal Employer-Household Dynamics (LEHD), 2014 dataset. https://onthemap.ces.census.gov/ (Accessed March 24, 2017)
  - Future population and employment (Q4 2016, 2040, 2065, and soft sites forecasts): SF Planning Department
  - Average household size: American Community Survey 2011-2015 5-Year Estimates, Table B25010: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml (Accessed March 24, 2017)
- Ridership Capture from other modes (Figure 40)
  - Census Transportation Planning Package, 2006-2010. Table A302103. Means of Transportation, Workers 16 Years and Over. http://data5.ctpp.transportation.org/ctpp/Browse/browsetables.aspx (Accessed March 22, 2017)

Analytical Assumptions

- Roadway network includes a bike/ped-only bridge over China Basin at 5th Street.
- The proposed Caltrain station referenced as "26th Street" in the final report has the center of its platform at 25th Street & Minnesota Avenue.
- In the Q4 2016 development pipeline forecasts provided to the Project Team by the SF Planning Department, housing units are converted to population with two assumptions. First, to convert from housing units to households the analysis assumes a housing vacancy rate of 2.5%, which matches the projected vacancy rate in other SF Planning forecasts. Second, to convert between households and population the number of households is multiplied by the average household size of the corresponding Census Block Group, from the American Community Survey data.
- In the Q4 2016 forecast, the number of jobs at each development is imputed from the square footage of each land use category (e.g. commercial, retail, industrial). The average number of square feet per job is given by the 2040 and 2065 SF Planning Department forecasts. These conversions are 309 square feet per employee for general office uses, 276 square feet per employee for management/professional/scientific uses, 350 square feet per employee for medical and retail uses, and 568 square feet per employee for industrial uses.

- In Figure 30-Figure 31, the changes in accessibility – defined as the minimum distance from each Census Block Group's centroid to the nearest Caltrain station – are shown as net changes from existing conditions. Baseline and Pennsylvania Alignments do not result in any loss in accessibility because they do not involve the loss or relocation of any existing stations, only the addition of Transit Center. These figures focus on the proportion of population and jobs within one mile of an existing Caltrain station. This one-mile-buffer selection is based on network distance from the centroid of the Census Block Group to the nearest Caltrain station.
- The origin-destination cost matrix assumes a walking speed of 3 miles per hour and ***does not*** consider roadway slope in its calculations.
- In Figure 32-Figure 35, sites with zero net housing units or jobs added are not shown.
- The population and jobs within the 10- and 15-minute walksheds are based on the isochrones calculated in the previous chapter. Catchments use fractional allocation method described previously when calculating population or employment totals in Blocks or Block Groups that lie only partially within each isochrones. The Caltrain catchment areas used in Figure 36 and Figure 37 assume a walking speed of 3 miles per hour and uses Tobler's Hiking Function to change speed and range based on grade https://en.wikipedia.org/wiki/Tobler%27s_hiking_function.
- Figure 38 assumes a train travel speed of 25 mph (from Caltrain current schedule) and a walking speed of 3 mph in its travel time analysis.
- Figure 39 shows the average one-way time savings per rail commuter, in minutes, which uses the ACS figure of 6,722 existing rail commuters as its denominator.

Parameters

Figure	Data	Data Source	Parameter
Figure 30, Figure 31	Change to Shortest Distance of Closest Caltrain Station (% of 2015 Population, % of 2014 Jobs)	Jobs: Census Longitudinal Employer-Household Dynamics Tables, 2014 Population: ACS 2011-2015 5-Year Estimates, Table B01001	Percent of San Francisco population and jobs located in Census Block Groups where shortest distance to Caltrain station increases, decreases, or remains the same.
Figure 32-Figure 35	Housing and Jobs Forecast (Q4 2016, 2040, 2065, and soft sites)	SF Planning Department files	Locations of net housing units and net jobs in each forecast period
Figure 36, Figure 37	Population and Jobs within 10 minute walk of Caltrain stations (From 22nd St Station to Transit Center)	Jobs: Census Longitudinal Employer-Household Dynamics Tables, 2014 Population: ACS 2011-2015 5-Year Estimates, Table B01001	Population and jobs within 10- and 15-minute pedestrian access sheds of each scenario, existing conditions through 2065 and soft sites scenarios
Figure 38	In-Rail Travel Time Between Stations (minutes)	Caltrain, 2016	Travel times to new stations along Pennsylvania, Baseline, and Mission Bay Alignments
Error! Reference source not found.Figure 39	Time Savings of Existing Caltrain Riders, in Minutes per Average Weekday	Caltrain Commuters: ACS 2011-2015 5-Year Estimates, Table B08301	Minutes of travel time added or reduced in each Alignment, per average weekday trip Average one-way time savings per rail commuter, in minutes (divides total travel time savings by # of existing rail commuters living in San Francisco)

Realignment characteristics - Resilience

Data Sources

- Connections with CCTS:
  - CCTS Alignments: http://mtc.ca.gov/sites/default/files/CCTS_FebWorkshop_BreakoutHandout_LongTerm_Transbay_FINAL.pdf

Analytical Assumptions/Parameters

- Connections with CCTS:
  - Train boxes for BART, Caltrain, and High Speed Rail will be 600 feet long
  - Passenger Access Points: Located at the intersections nearest each end of each train box

Parameters

Figure	Data	Data Source	Parameter
Figure 43	Assessment of Approximate Proximity to Potential Transbay Alignments	Core Capacity Transit Study (February 2017)	Walking Distance from One End of Train Box (feet), between most proximate CCTS and Caltrain station pairs

Realignment characteristics – Network Optimization

Data Sources

- Employment: Census Longitudinal Employer-Household Dynamics (LEHD), 2014 dataset. https://onthemap.ces.census.gov/ (Accessed March 24, 2017)

Analytical Assumptions/Parameters

- Pedestrian speed = 5 km/h on flat ground, uses Tobler's Hiking Function to change speed and range based on grade https://en.wikipedia.org/wiki/Tobler%27s_hiking_function
- Bicycle speed = 16 km/h on flat ground. Uses a variant of Tobler's Hiking Function designed especially for bicycles.

$$Speed = 32 * e^{-3*|Slope+0.23|}$$

- In Figure 56, the jobs totals shown use a fractional allocation method to calculate the totals in Census Block Groups or Blocks that fall only partially within the five- and ten-minute isochrones. A Block or with 60% of its area lying within the five-minute walkshed of a Caltrain station would have 60% of its total employment or population counted as lying within the buffer.
- The analysis in this section assumes a pedestrian/bike-only bridge over China Basin at 5th Street is built and part of the street network.

Parameters

Figure	Data	Data Source	Parameter
Figure 49	Non-Motorized Last Mile Access	Jobs: Census Longitudinal Employer-Household Dynamics Tables, 2014	Jobs within five- and ten-minute pedestrian access sheds

Appendix B Sensitivity Analysis – Mission Bay Station

Category	Criteria	Metric, Description	Mission Bay 20th Street Alignment	Mission Bay 22nd Street Alignment	Mission Bay 26th Street Alignment
Market Demand/ Marketability	Existing transit demand impact	Expected change in demand from SF Caltrain	4%	2%	3%
	Total Caltrain time savings	Average one-way time savings per rail commuter (existing Caltrain riders), in minutes	0.9	1.5	1.8
	Current rail commuters	Within 1/2 mile of existing Caltrain stations (excluding Transbay)	1,109	1,116	830
	Connectivity to stations, future*	Improved street connectivity at 16th Street	1	1	1
	Jobs within 15 minute walk of Caltrain stations in San Francisco	Current	263,500	263,990	263,350
		Projection 2016	266,935	267,861	267,811
		Projection 2040	283,736	276,974	276,878
		Projection 2065	307,307	290,015	289,857
		Projection softsites	320,287	316,882	324,328
	Population within 15 minute walk of Caltrain stations in San Francisco	Current	27,365	27,097	24,269
		Projection 2016	34,294	37,199	27,914
		Projection 2040	35,869	38,584	29,225
		Projection 2065	37,976	39,665	30,012
		Projection softsites	42,326	43,903	31,919
Consistency with other Plans	Consistency with Core Capacity Package Alternatives**	Package 1	0	0	0
		Package 2	0.5	0.5	0.5
		Package 3	1.5	1.5	1.5
		Package 4	0	0	0
		Package 5	1.5	1.5	1.5
		Package 6	1.5	1.5	1.5
	Connectivity to major events	Distance from AT&T Park (miles)	0.3	0.3	0.3
		Distance from new arena (miles)	0.3	0.3	0.3
	Opportunity to mitigate overcrowding after new arena events***	Facilitating connections to BART and Muni T-Third	1	1	1

* Qualitative, based on SF Planning criteria of future street grid changes if the train goes underground. 0 = no change, 1 = Improved street connectivity

** Scoring: 2= two Caltrain stations connecting to BART stations, 1.5= one Caltrain station connecting to BART stations, 1= close walk to two Caltrain stations from BART, 0.5= close walk to one Caltrain station from BART, 0= no Caltrain stations close to BART stations

*** Scoring: 0.5= walkable, but not intuitive; 1= walkable, and intuitive

Appendix C Core Capacity Transit Study Alignments

The Core Capacity Transit Study (CCTS) is a collaborative effort among five transit operators and two regional transportation planning agencies to identify short, medium, and long-term investments that would alleviate existing overcrowding on key lines and meet projected future transit demand into a cluster of job-rich San Francisco neighborhoods (the Financial District, South of Market, Mission Bay, Showplace Square, and Civic Center). CCTS did not identify a preferred long-term package. BART is likely to lead a follow-up study, to further refine the options and narrow in on a preferred alignment.

Figure 54 shows the five transbay crossing alignments included in the CCTS long-term packages. A brief description of each package:

2. Package 2: A new underground transbay crossing would land in San Francisco around Mission Creek and continue to Market on 3rd Street, running out of the CCTS study area along the Geary corridor. Relevant potential station locations include AT&T Park (along 3rd Street around Townsend, King, and Berry streets) and Yerba Buena (along 3rd Street near Howard and Mission streets).

3. Package 3: A new underground transbay crossing would land in San Francisco around the Ferry Building, running along Mission Street toward western San Francisco. Relevant potential station locations include Transbay Transit Center (near Mission and Beale streets and/or Mission and New Montgomery streets).

4. Package 4: A new underground transbay crossing would land in San Francisco around Pier 30/32, running along Brannan Street to the Showplace Square area, then turning up Division Street to meet the existing BART alignment. Relevant potential station locations include Brannan Street between 3rd and 4th streets and Brannan between 6th and 7th streets.

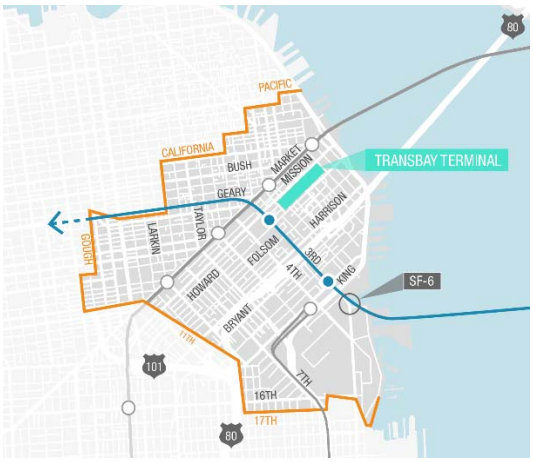
5. Package 5: A new underground transbay crossing would land in San Francisco just south of Pier 50, running through Mission Bay along Mission Bay Boulevard and 5th Street, and then along Brannan and Division streets in western SoMa. Relevant potential station locations include Mission Bay (near Mission Bay Boulevard and 3rd Street) and Brannan between 6th and 7th streets.

6. Package 6: A new underground transbay crossing using conventional rail technology that would land in San Francisco near Pier 30/32 and run through Eastern SoMa to the Transbay Transit Center, where it would join the Caltrain/HSR alignment.

Package 1 (a collection of improvements to existing infrastructure and transit service, including capacity-enhancing investments in Montgomery and Embarcadero stations, AC Transit transbay bus service, and the Water Emergency Transportation Authority's ferry service) does not include a new transbay crossing and is therefore *not* shown in Figure 54.

Figure 54 Core Capacity Transit Study New Transbay Crossing Alignment Options

Package 2

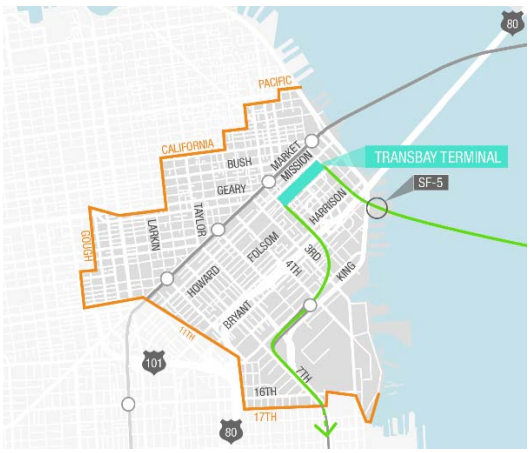


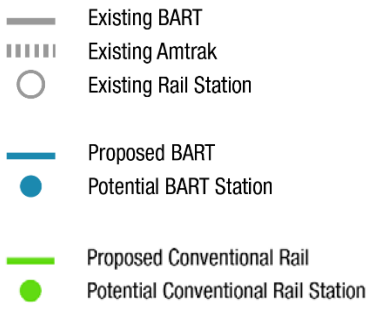
Package 3

Package 4

Package 5

Package 6





Source: Core Capacity Transit Study (February 2017)

Appendix D Transit Capacity and Demand – Definitions & Requirements

Defining Capacity

Transit operators define a planning capacity, or 85% of full potential capacity. At loads beyond 85% of capacity, rider comfort can be compromised and pass-ups may occur during peak and surge periods. All SFMTA capacity numbers in this section represent planning capacities. Caltrain capacities are absolute seated capacity. The full handling capability of various services will be compared with demand in a subsequent section.

Caltrain

Caltrain is currently attempting to address crowded conditions through planned additions of a 6th car to regular train consists and an electrification project which will allow more frequent service including one additional train in each direction during the peak hour(s). Full implementation of the plans would more than double capacity from 3,250 passengers per hour to almost 7,000 per hour. This last figure includes high speed rail express trains to San Jose. Electrification and train size increases alone may accommodate up to 4,500 passengers per hour.

These solutions to increase capacity are independent of alignment. The longer trains could be accommodated at either 4th/King, 4th/Townsend, or a Mission Bay station.

Local Bus

SFMTA MUNI planning capacities for local bus are 54-feet for standard buses and 80-feet for articulated buses.[13] Currently the 55 Mission Bay route only runs 4 buses per hour during peak periods and 3 buses per hour in the late evening when events can be anticipated to conclude. As a result the current line capacity ranges from 162 to 320 passengers per hour dependent on time of day and vehicle allocation.

MUNI Metro

SFMTA's 2014 Fleet Plan lays out expansion needs for time horizons in 2020 and 2040. According to the 2015 Waterfront Transportation Assessment, the capacity of the T Third line will more than double from the current level of roughly 600 passengers per hour to more than 1,400 passengers per hour when the Central Subway opens. This capacity increases to more than 3,000 passengers per hour in 2040. Functionally, the increases represent upgrades from single car KT trains operating every 9 minutes (planning capacity: 101) to a two-car train departing ever eight minutes upon the opening of the subway and improving to 5-minute intervals by 2040.

[13] https://www.sfmta.com/sites/default/files/projects/2015/WTA_Phase2-FinalReport-reduced.pdf

Demand Handling Requirements

The immediately preceding capacities offer some guidance with respect to the ability to handle forecast passenger loads at new arena events. An hour, however, is longer than individuals are likely willing to wait for a transit vehicle. With this in mind, each mode is assessed based on absolute capacity figures and service periods lasting 20 and 30 minutes.

Caltrain

Caltrain will be able to handle its demand provided sufficient resources are directed to post-event peaks. Given its large train capacity, regardless of whether the consist includes diesel or electrical units, four trains are required to move the anticipated 2,000 post-event customers. Five or seven-and-a-half minute intervals would successfully handle surge conditions within 20 and 30 minutes respectively.

Demand	5-Car DMU Train Capacity	5-Car DMU Trains Required	Required Interval (sec) – 20 Minutes	Required Interval (sec) – 30 Minutes
1993	650	4	300	450
Demand	**6-Car EMU Train Capacity**	**6-Car EMU Trains Required**	**Required Interval (sec) – 20 Minutes**	**Required Interval (sec) – 30 Minutes**
1993	600	4	300	450

Local Bus

Assuming that 733 riders will attempt to use buses on the 16th Street corridor to BART and points beyond, 12 regular buses would be required to accommodate those riders under maximum capacity conditions. This can be accomplished with buses every 1 minute and 40 seconds for 20 minutes or every 2 minutes and 30 seconds for 30 minutes. In reality, loading times are likely to be longer and not supportive of such headways. Articulated buses can handle the same load at 2 minute and 30 second intervals for 20 minutes or 3 minute and 45 second intervals for 30 minutes.

Demand	Standard Bus Planning Capacity	Standard Bus Absolute Capacity	Standard Buses Required	Required Interval (sec) – 20 Minutes	Required Interval (sec) – 30 Minutes
733	54	80	12	100	150
Demand	**Articulated Bus Planning Capacity**	**Articulated Bus Absolute Capacity**	**Articulated Buses Required**	**Required Interval (sec) – 20 Minutes**	**Required Interval (sec) – 30 Minutes**
733	63	94	8	150	225

MUNI Metro

The passengers that would use the T Third Line north to BART and beyond is the largest anticipated transit travel group. Even two-car trains packed to full capacity would need to leave the nearest stop every one minute and forty seconds in order to remove all passengers from the area in 20 minutes. To handle the entire demand in 30 minutes would require 2 minute and 30 second headways, which is twice as fast as the anticipated operating characteristics in 2040.

By contrast, four two-car trains will be able to accommodate the expected southbound load in 20 minutes with 5 minute spacing between vehicles.

NORTHBOUND T THIRD LINE					
Demand	Single Car Planning Capacity	Single Car Absolute Capacity	Single Car Trains Required	Required Interval (sec) – 20 Minutes	Required Interval (sec) – 30 Minutes
2,789	101	118	24	50	75
Demand	2-Car Train Planning Capacity	2-Car Train Absolute Capacity	2-Car Trains Required	Required Interval (sec) – 20 Minutes	Required Interval (sec) – 30 Minutes
2,789	202	236	12	100	150

SOUTHBOUND T THIRD LINE					
Demand	Single Car Planning Capacity	Single Car Absolute Capacity	Single Car Trains Required	Required Interval (sec) – 20 Minutes	Required Interval (sec) – 30 Minutes
826	101	118	7	171	257
Demand	2-Car Train Planning Capacity	2-Car Train Absolute Capacity	2-Car Trains Required	Required Interval (sec) – 20 Minutes	Required Interval (sec) – 30 Minutes
826	202	236	4	300	450