

**Removal of the Embarcadero Freeway**  
Spatial Analysis of Land Use, Public Space, and Transit

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## Introduction

The Embarcadero Freeway was an elevated double-decker freeway that was intended to connect the Bay Bridge and Golden Gate Bridge in San Francisco. While its first portion opened in 1959, freeway revolts halted the completion of many freeways in the city, including the Embarcadero Freeway. After the 1989 Loma Prieta earthquake, the Embarcadero Freeway was badly damaged and closed to traffic. The closure did not significantly affect traffic congestion, and this, in conjunction with ongoing freeway revolts and a high cost of reconstruction, led to the demolition of the Embarcadero Freeway starting in 1991.



Figure 1. Embarcadero Freeway.



Figure 2. The Embarcadero Freeway ran adjacent to the Ferry Building and cut off access to the waterfront.

The Embarcadero Freeway was replaced with a boulevard, which has two general travel lanes, a Class II (striped) bike lane, and street parking in either direction. The two directions of travel are also separated by a trolley line that runs through the middle of the street. In this project, we explored how the removal of the Embarcadero Freeway affected land use, open space, active transportation, and transit infrastructure in the area.



Figure 3. Present-day area, with the Ferry Building fully accessible from the neighboring Embarcadero area.

## Methods

Our primary method to assess the impacts of the removal of the Embarcadero Freeway was to compare the Embarcadero area with another neighborhood in San Francisco: Mission Bay. Mission Bay is also a waterfront neighborhood in San Francisco that has a freeway, Interstate 280, running beside it. Figure 4 shows the street network in San Francisco overall as well as in the Embarcadero and Mission Bay areas that we are comparing. We believe that these two areas are comparable because they have shown similar population characteristics over the years, especially in terms of population growth.

### Streets in San Francisco and Project Areas of Interest

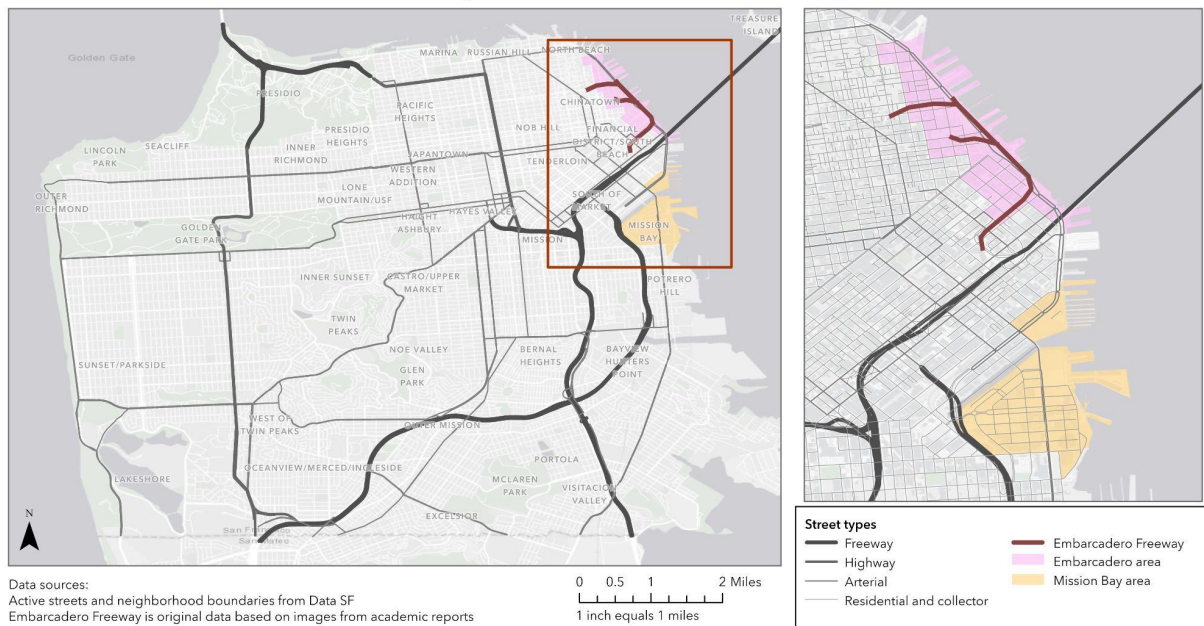


Figure 4. Streets in San Francisco and Project Areas of Interest.

We focused on comparing land uses and transportation access in these two areas to test our hypothesis that removing the Embarcadero Freeway produced an area that was more conducive to public use. To do this, we compared:

- Areas of residential, retail, and open space parcels
- Recreational areas and open spaces
- Bicycle parking and bicycle network facilities
- Transit routes and stations
- Distance between nearest Muni stops
- Number of people taking public transit

Our data primarily comes from DataSF, which is San Francisco's open data portal. Supplemental data was collected from Google Maps for the recreational areas and open spaces as this was missing for the Mission Bay area. This data was then used to create a custom shape layer in ArcGIS

Pro to compare the public spaces available in the Embarcadero and Mission Bay areas. We were also unable to access a geospatial file for the Embarcadero Freeway, so we created this line data manually using Google My Maps, based on images from academic reports.

### Census Data

When comparing Census data between the two neighborhoods, we see that population density was relatively consistent over the years, with increases in both neighborhoods. We utilized population density, rather than total population, as a proxy for development trends (i.e., a more dense population could signify increases in multi-family construction). In some years, population density fluctuates. While further analysis will be needed, this could be due to Census block or tract redistricting. Despite these fluctuations, we have found relative consistency, in that the Embarcadero neighborhood has continued to be a denser area than Mission Bay. This is important, as our findings will show, when considering infrastructural improvements, transportation connections, green space, and other related neighborhood changes.

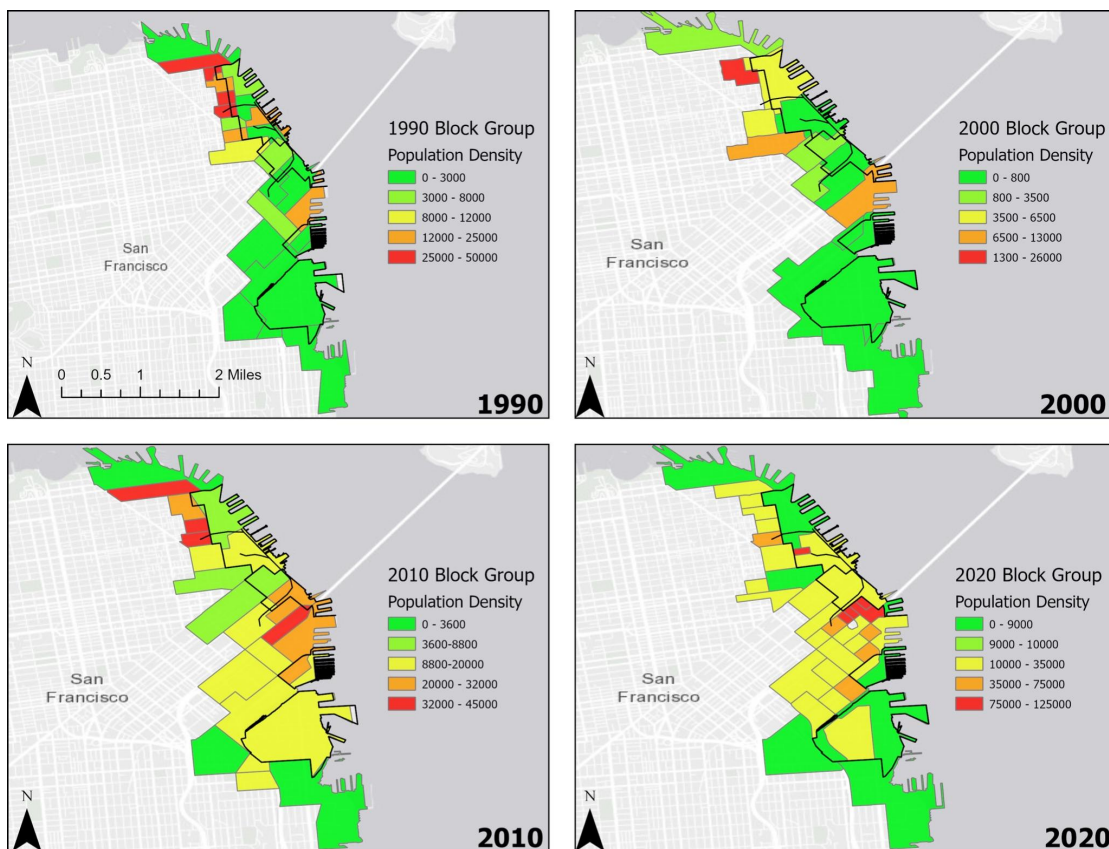


Figure 5. Population Density in the Embarcadero and Mission Bay Neighborhoods (U.S. Census 1990, 2000, 2010, 2020)

# Results

## Land Use

We utilized a model to analyze parcel data for the Embarcadero and Mission Bay neighborhoods. We set up the model to calculate the percentage of individual parcel areas compared to the total area of all parcels in both areas.

The model yielded a parcel-specific percentage, i.e., parcel block lot 0200014 contained 0.013% of the total area of all parcels in the Embarcadero neighborhood. From this model, we were able to calculate the total parcel area percentage in four land use categories: residential use, retail use, open space use, and vacant properties.

This model can act as a proxy for the “presence” of each use in a specific neighborhood. For example, you would be more likely to encounter a parcel with a residential use in the Embarcadero neighborhood than in Mission Bay.



Figure 6. Model Diagram.

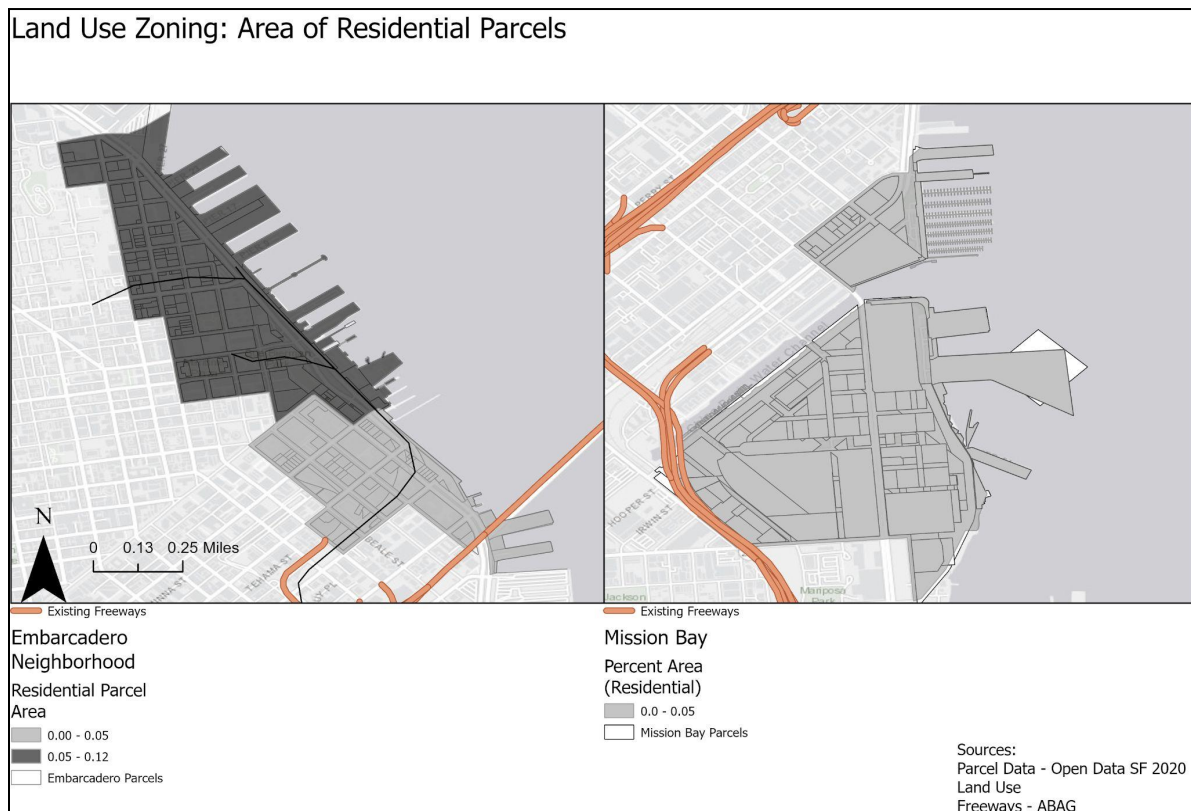


Figure 7. Area of Residential Parcels.

## Land Use Zoning: Area of Retail Parcels

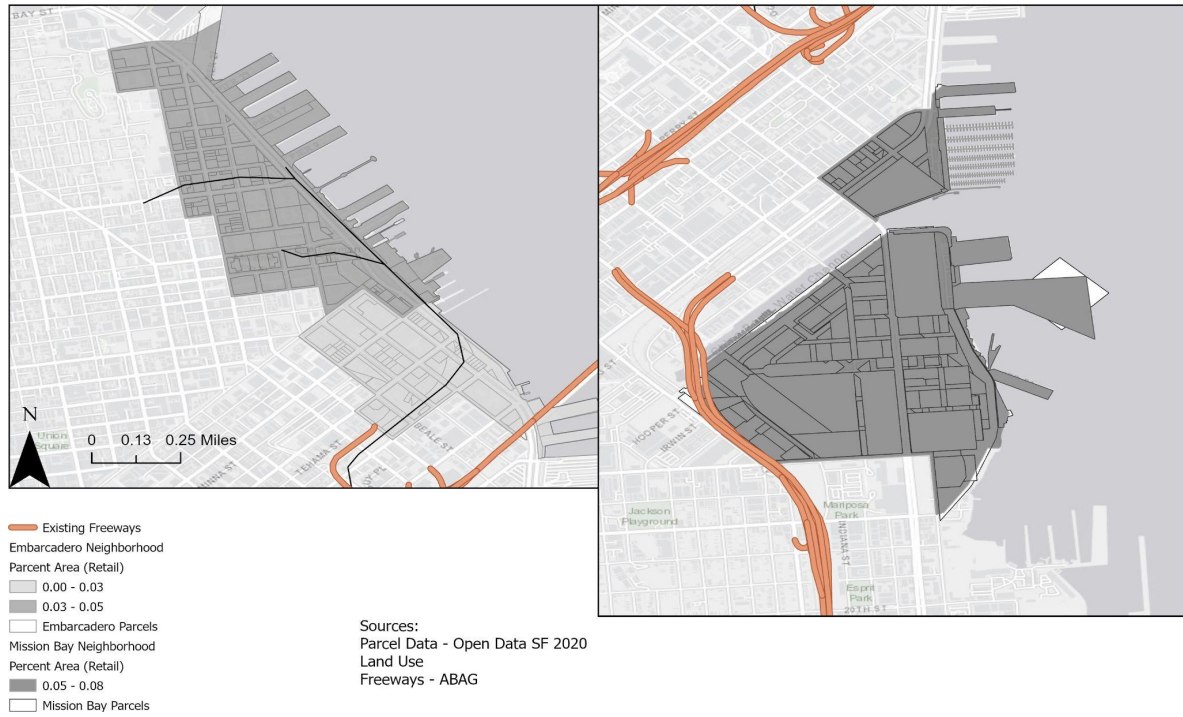


Figure 8. Area of Retail Parcels.

## Land Use Zoning: Area of Open Space Parcels



Figure 9. Area of Open Space Parcels.

While not statistically proven, there could be a correlation between the likelihood of encountering different land uses (retail, residential, open space) and the parcel value in the two neighborhoods. For example, in Figure 7, we see in the north section of the Embarcadero area that residential uses can be up to 12% of total space in the neighborhood. As the northern portion of the Embarcadero has a high likelihood of residential uses, there is a much higher parcel value. Likewise, in Figures 8 and 9, the increased presence of retail or open-space in Mission Bay could signify lower parcel values. However, further research would be needed regarding broader city real estate trends to support this conclusion.

We then considered recreational areas and open spaces in both neighborhoods. As we can see from the maps in Figures 10, 11, and 12, the Embarcadero area has several recreational areas that have sprung up since the removal of the freeway. Many of these spaces reside within 1,000 feet of the route of the Embarcadero Freeway, with several of these parks occupying space that used to be taken up by one of the former legs of the freeway. These public spaces include Sue Bierman Park by the Ferry Building and Maritime Plaza immediately west of that park. In comparison, parks in the Mission Bay area all reside farther than 1,000 feet from the I-280, with the exception of a park that borders the Mission Creek Channel, suggesting that the presence of a freeway may have had an impact on the availability of green spaces in nearby areas.



Figures 10 and 11. Maritime Plaza (left) and Sue Bierman Park (right) are two green spaces that have since occupied the space of one of the former legs of the Embarcadero Freeway. Photos from Google Maps.

We can also see that many facilities — such as benches, lamp posts, and public bathrooms — have been added to the park and plaza since the removal of the freeway. These facilities have not only improved the appearance of the area, but they have also provided useful amenities for those walking or biking around the Embarcadero area.



## Recreational Areas and Open Spaces in Project Areas of Interest



Figure 12. Recreational Areas and Open Spaces in Project Areas of Interest.

## Transportation

To explore changes in transportation, we began by looking at bike infrastructure in the two areas. Both have Class IV bike lanes, also known as separated or protected bike lanes, running along the waterfront portions of the neighborhoods. The Embarcadero area also has more protected bike lanes that connect to other neighborhoods in San Francisco. Most notably, the purple-colored Class III bike lane on Market Street, a corridor that constitutes major retail and office districts of the city, is safer than what a shared bike lane usually offers: Market Street has become car-free in recent years, making the area much more accessible for bicyclists and pedestrians. Both areas also have several bicycle parking locations, although Embarcadero has more, with 71 locations compared to Mission Bay’s 45 locations.

To evaluate the safety of biking in these areas, we mapped the speed limits per street segment. This data was missing for numerous streets, especially for those in Mission Bay. Of the streets that do have data, we see that the Embarcadero has speed limits between 25 and 45 mph, which is lower than the original speed limits on the prior Embarcadero Freeway. These streets have protected bike lanes; meanwhile, in the Mission Bay Area, the streets that lie near I-280 only have striped bike lanes (Class II) or shared bike lanes (Class III), with the protected bike lane in the neighborhood likely on a street with a significantly lower speed limit, as it is not included in the data.

## Biking In and Near Project Areas of Interest

Bike Parking and Bike Network

Speed Limits per Street Segment

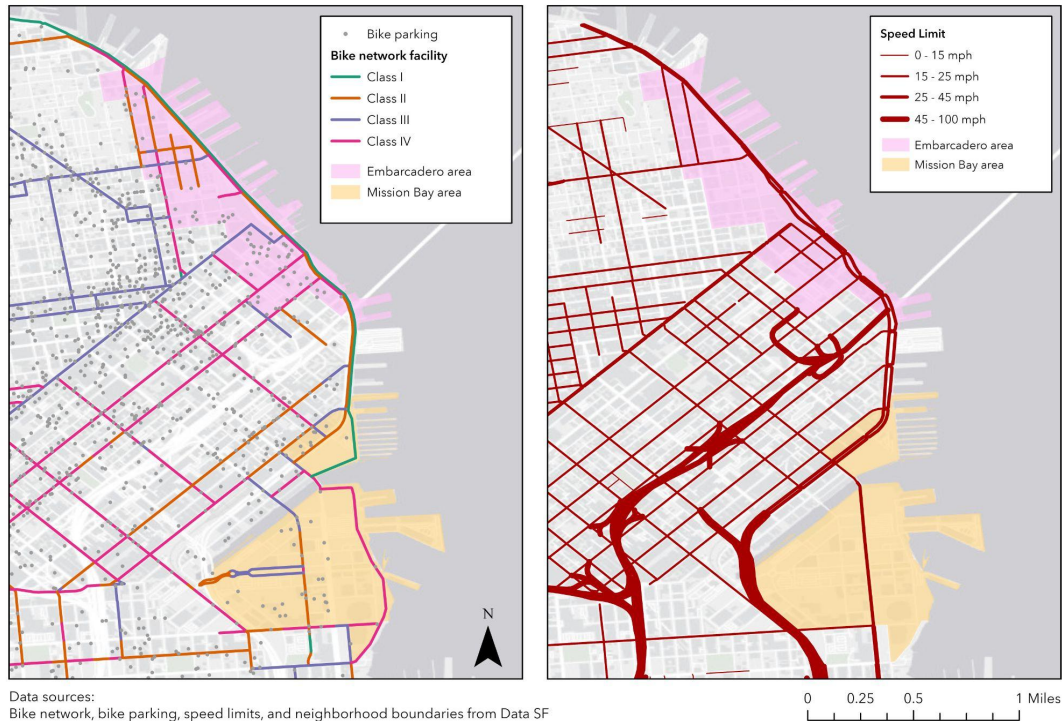


Figure 13. Biking in and near project areas of interest.

The other components of transportation we considered were Muni transit routes, stations, and commuter mode choice. Muni stands for San Francisco Municipal Railway, and is the public transit system for the City and County of San Francisco. We evaluated transit coverage and access by analyzing Muni stops and routes in each neighborhood. Figure 14 shows the routes overlayed on top of the Embarcadero area. There are 17 bus and rail lines intersecting or passing through the neighborhood and 45 stations. The inset map shows 5-minute walksheds covering 0.25 miles from each stop in the Embarcadero area. These walksheds cover the entire Embarcadero area, indicating that the area allows for more seamless multimodal transportation usage.

# Transit Routes and Stations in Embarcadero, San Francisco

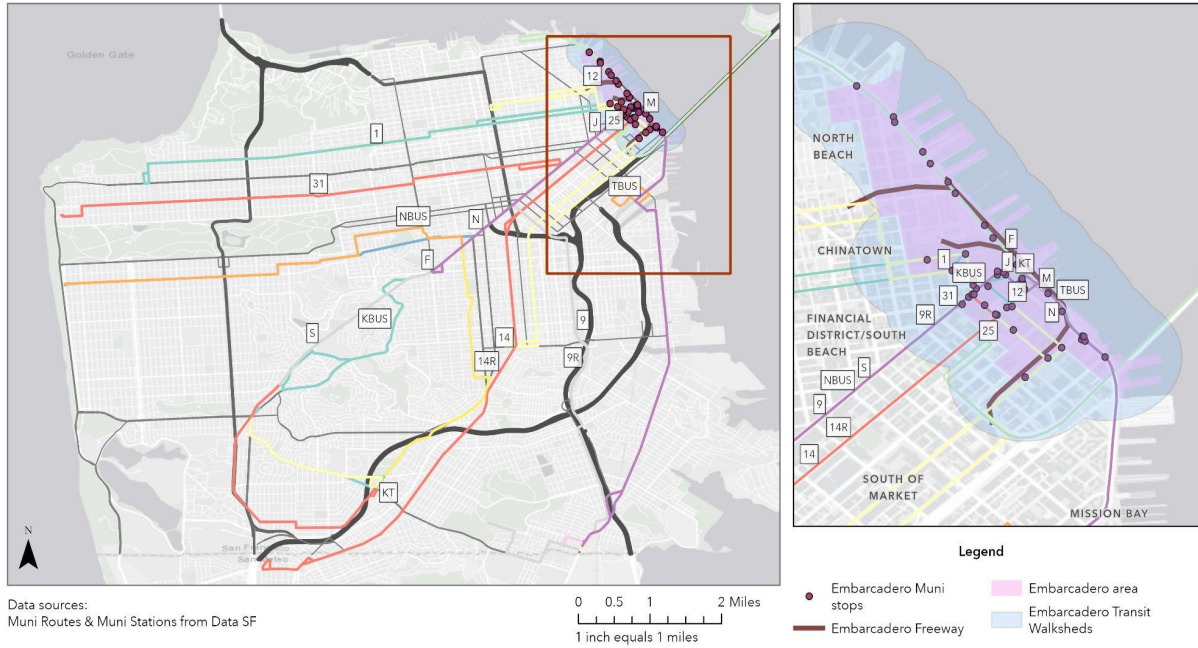


Figure 14. Transit routes and stations in Embarcadero, San Francisco

The analysis for Mission Bay indicates there are fewer transit routes and stops compared to those in Embarcadero. In Mission Bay, there are 8 transit routes and 17 Muni stops. This can be explained by the fact that Mission Bay was developed in 1998, much later than the Embarcadero area, which was built in 1918. In addition, the Embarcadero has always been a hub for transportation: when the Embarcadero Freeway existed, it improved automobile access to the Bay Bridge, and after the clearing of the freeway, major redevelopment began and rail lines were extended to run along the waterfront. The walkshed shown on the inset map actually does not cover the whole Mission Bay area, meaning that the entire area is not as walkable as the Embarcadero. Furthermore, compared to Mission Bay, Embarcadero has more arterial streets which actually allows more coverage of bus lines.

## Transit Routes and Stations in Mission Bay, San Francisco

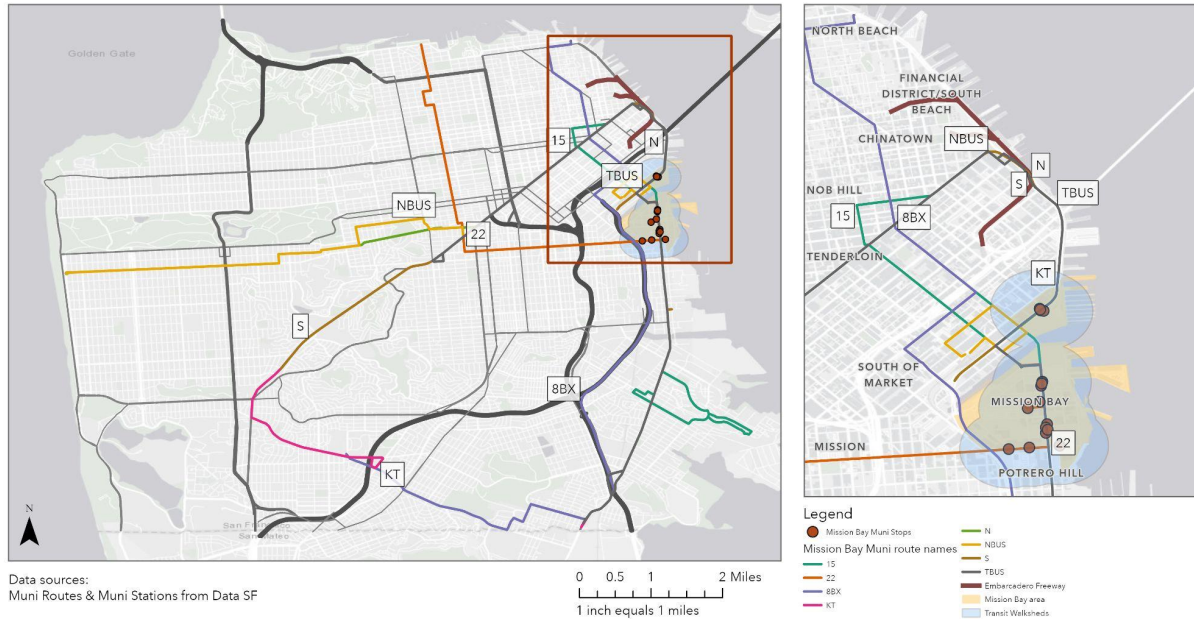


Figure 15. Transit routes and stations in Mission Bay, San Francisco

Our additional analysis on public transit in the two regions focuses on finding the nearest distance between Muni stops in miles. This gives an idea of the ease of transferring between different transit modes or lines. The figure below shows that the Embarcadero has many more transit stops that are closer to one another than the stops in Mission Bay. Most of the stops that are the closest to each other are on Market Street, which can be explained by the fact that it is the major arterial street in San Francisco.

We also looked at the distance between Muni stops without shelters to the surrounding stops that had shelters. This gives us an estimate of how far someone would have to travel to wait more comfortably at a stop with a shelter. Embarcadero has six stops with shelters, and Mission Bay has none. The stops with shelters and close to those with shelters are clustered on Market Street. The stops further away from Market Street are also further from shelters. Given how the Embarcadero area has greater access to transit, it is evident that there is accessible transportation infrastructure that offers more amenities, such as these bus shelters. These distances are shown in Figure 16 below.

## Nearest neighbor distance between Muni stops

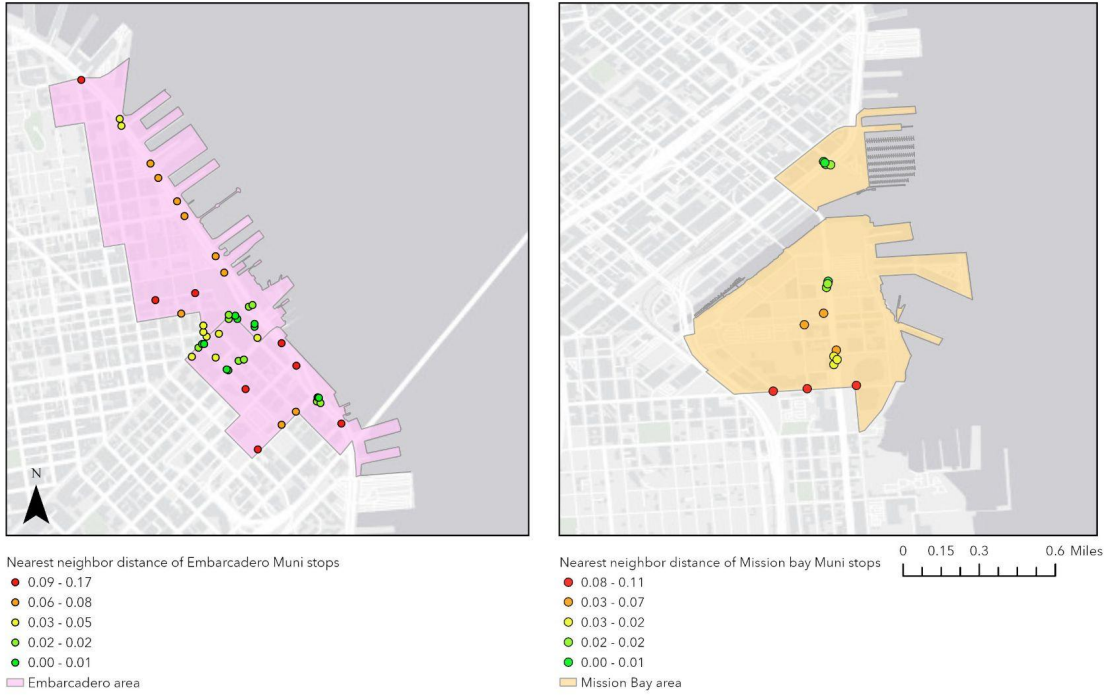


Figure 16: Nearest neighbor distance between Muni stops

## Distance between Muni stops with shelters and without shelters



Figure 17. Distance between Muni stops with shelters and without shelters

We also wanted to determine how many transit stops were created after the closure of the Embarcadero Freeway. The Embarcadero has three lanes in each direction, spanning a total width of 104 feet. By creating a buffer of 52 feet on both sides of the freeway, we estimated how many transit stops fall within the buffer, understanding how accessible the Embarcadero neighborhood has become after the freeway removal. We found that 8 out of 45 total stops fall in the buffer zone.

### Embarcadero Highway Transit Access

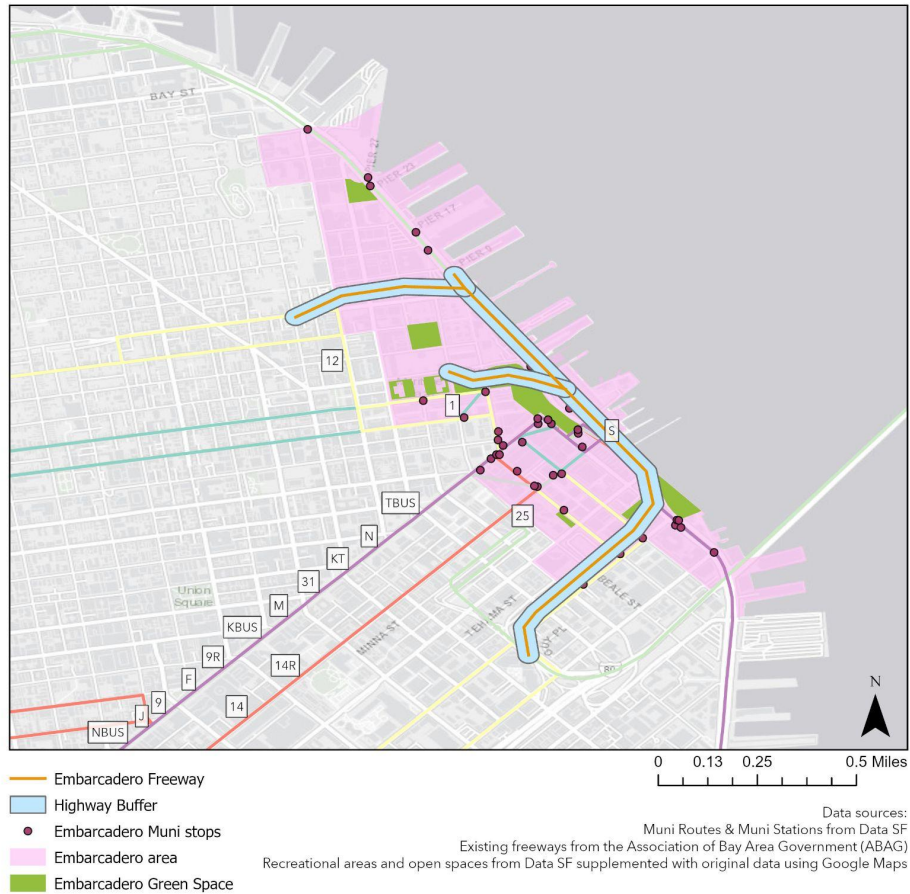


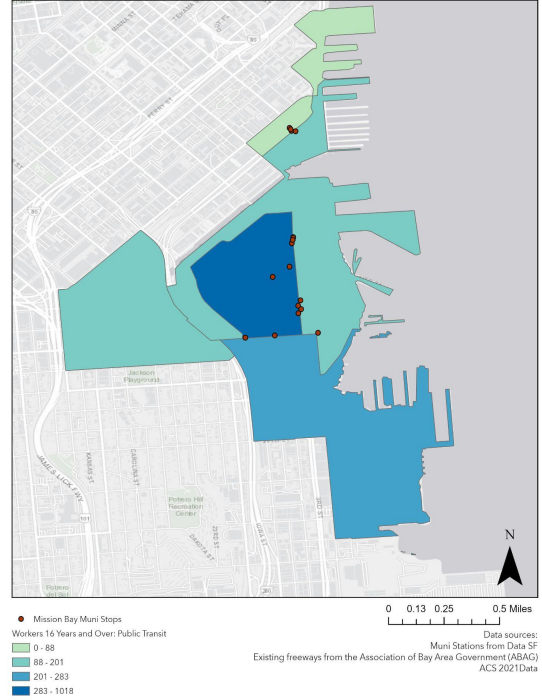
Figure 18: Embarcadero highway transit access

The last component of transportation we evaluated was commuter mode choice, using Census data to determine how many people take transit to work. For both neighborhoods, the highest density of people who take public transit to commute to work also live nearby transit stops. We also see that in the densest Census tract of people commuting to work, Mission Bay has more people commuting through public transit compared to the Embarcadero.

People Taking Public Transit to Work in Embarcadero



People Taking Public Transit to Work in Mission Bay



Figures 19 and 20: People taking public transit to work

## Challenges and Limitations

To analyze the effect that the removal of the Embarcadero Freeway had, our initial idea was to compare the land use and transportation of the area before and after the removal of the freeway. This would have produced results that showed the direct impact that the freeway removal had on the area. However, we were unable to find land use and transportation data in the Embarcadero area prior to 1990. In fact, we were unable to find geospatial data on the route of the former freeway, prompting us to generate our own data on the freeway's extent using images from academic reports and with the help of Google My Maps.

As a result, we decided to instead compare the Embarcadero area to another area that we believed had also undergone significant changes to its land use and transportation since 1989. However, in comparing the two areas, we also came across the issue of obtaining data for the two study areas. For example, the recreational areas and park facilities data we obtained from DataSF was missing data in the Mission Bay area, despite a note suggesting that the data was updated recently. Several parks were also missing in the Embarcadero study area. Thus, we had to generate our own data once again (entirely for the Mission Bay area and to supplement the available data from DataSF for the Embarcadero area) using Google Maps aerials of the neighborhoods. Similarly, the speeds per street segment data were missing for many streets with speed limits below 25 mph. This made some of the analysis challenging as we were unable to easily identify the speed limits of streets that had bike lanes, to be able to evaluate the safety of biking in both neighborhoods.



## Conclusion

Overall, we found there to be an increase in development and value of land uses and greater open space within 1,000 feet of the former Embarcadero Freeway in the Embarcadero area compared to the Mission Bay area after the removal of the freeway. Additionally, changes in the bike network coverage between the two neighborhoods has been comparable, although there is a greater presence of protected bike lanes and bike parking infrastructure in Embarcadero. Embarcadero also has a greater number of transit routes and stations that are in close proximity to each other and easily accessible via walking within the area. The transit stations in Embarcadero are also more likely to contain amenities for passengers such as bus shelters.

Our use of geospatial data analysis and mapping within ArcGIS allowed us to visualize the extent of several land use and transportation changes that have transpired since the removal of the freeway. We were able to contextualize the magnitude of the freeway's removal by directly comparing development in the Embarcadero area with Mission Bay, a neighborhood that also experienced significant growth in recent years but that currently has the I-280 running through it.

From this analysis, we found that despite having similar characteristics, the Embarcadero area affords greater access to public spaces and amenities, as well as greater transportation accessibility and mobility, compared to the Mission Bay neighborhood. Some of these changes can also be linked to the removal of the freeway – for instance, new bus stops and parks have been built in the area, and land values have increased at greater rates compared to Mission Bay. This indicates that the removal of the Embarcadero Freeway has had a positive impact on the value and quality of properties, pedestrian and bicycle access, transportation safety, and overall comfort and livability of the area.

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