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## WALKING AND CYCLING IN SAN FRANCISCO: IDENTIFYING UNDERSERVED LOCATIONS THAT ARE PARTICULARLY RECEPTIVE TO NON-MOTORIZED TRANSPORT VIA THE PEDESTRIAN AND BICYCLING SURVEY

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by

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Walking and Cycling in San Francisco:  
Identifying Underserved Locations that are Particularly Receptive  
to Non-Motorized Transport via the Pedestrian and Bicycling Survey

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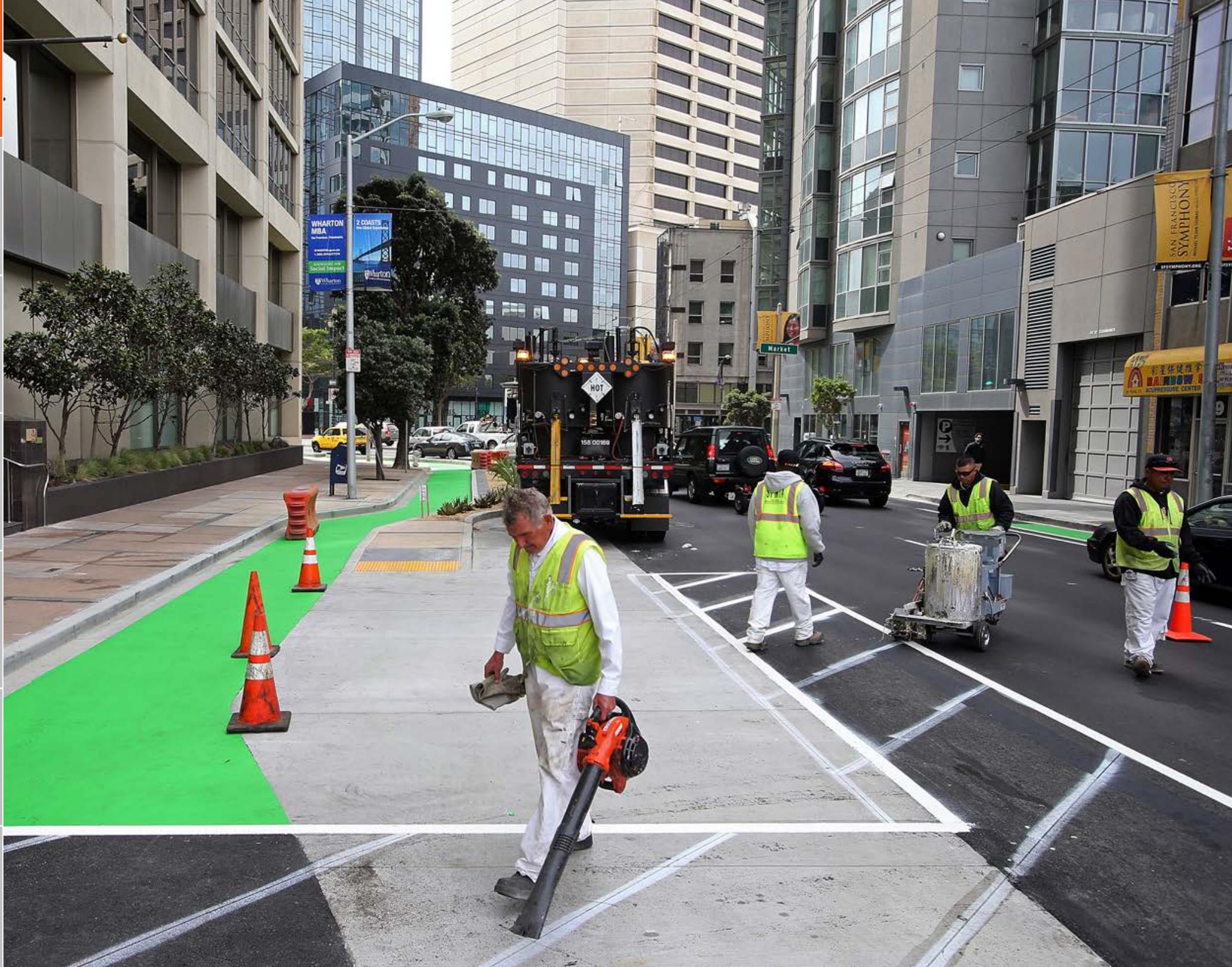


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# EXECUTIVE SUMMARY

## PRIORITIZING NON-MOTORIZED INFRASTRUCTURE IN SAN FRANCISCO

This research pinpoints locations in San Francisco with demographic and environmental characteristics that are particularly well suited to active travel, but which lack basic infrastructure or facilities.

As communities across the nation, including San Francisco, confront the challenging, inter-related issues of climate change, traffic congestion, and obesity, many are adopting policies to increase utility walking and cycling rates.<sup>1</sup> Non-motorized transport (NMT) affords many advantages over other means of transportation: virtually no carbon or greenhouse gasses are emitted from bike or walk trips; capacity and efficiency of existing roads are improved because pedestrians and cyclists require less space than motorists; active travel provides a source of physical activity, improving the public health of residents and preventing chronic disease; and pedestrian and cycling infrastructure improvements are relatively inexpensive and quick to implement, and require less maintenance compared to other modes.<sup>2</sup> Due to these many benefits, over 650 government agencies have adopted Complete Streets policies, which seek to balance the needs of pedestrians, cyclists, and transit users with those of drivers so as to improve the well-being of the entire community.<sup>3</sup>

In order to maximize the impact of available funding, government agencies and officials must prioritize NMT improvements; their short- and long-term economic advantages (easier and cheaper to build and maintain, traffic congestion amelioration, lower community health-care costs, lower environmental harm and thus less future remediation, etc.) are too many to ignore. To optimize use of limited funds and the efficacy of new improvements, these new NMT investments must be targeted—sited in areas with populations and physical characteristics that are particularly conducive to utility walking or cycling.

This approach to targeting new improvements is relevant beyond San Francisco; it allows communities to answer the following questions:

- Which locations have the greatest number of people who are likely to walk or bike?
- Where are the most conducive environments for walking and cycling?
- What underserved locations should be prioritized for immediate infrastructure improvements because they have populations or built environment characteristics that are associated with higher levels of walking and/or cycling?

Three methods were applied to identify places in San Francisco that are conducive to non-motorized travel. First, a literature review was prepared that assessed demographic and built environment correlates to utility walking and cycling. Next, a modified version of the Pedestrian and Bicycling Survey that measured travel patterns and gathered demographic information was mailed to San Francisco residents. Binary logistic regression analysis of responses estimated which populations correlated to increased rates of utility walking or biking. Using GIS, an iterative mapping analysis identified the locations across the city best suited to non-motorized transport.

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1. This report focusses on people and environments that correlate to utility walking and biking trips. The primary purpose of 'utility' trips is to arrive at a destination, rather than to reap health benefits associated with active travel modes or to recreate. Note: Throughout this paper the term "[walking or biking] for transportation" indicates this meaning of 'utility trip.'

2. National Complete Streets Coalition, "Complete Streets: Fundamentals," website accessed November 11, 2014, <http://www.smartgrowthamerica.org/documents/cs/cs-brochure-features.pdf>.

3. National Complete Streets Coalition, "Welcome to the National Complete Streets Coalition," Smart Growth America, website accessed November 11, 2014, <http://www.smartgrowthamerica.org/complete-streets>.

## EXISTING CONDITIONS

In every city, local urban form and geographic features impact travel patterns. San Francisco's natural features, and the existing City policies that promote active travel, both serve to elucidate the context in which (and the foundations upon which) this study was completed. To begin with, the city's unique topography, extraordinary geography and temperate climate can be both a boon and a bane for utility walking and cycling; steep inclines are a major deterrent, as are gaps in the bike network, but the climate is generally favorable. Findings from recent assessments of existing pedestrian and cycling infrastructure are shown to reveal an urgent need for new improvements. A series of existing City policies are supported by this research, including: Vision Zero and WalkFirst policies and projects, and City goals regarding increasing bicycle and pedestrian mode share, improving bike network connectivity, and prioritizing active-travel improvement projects.

## LITERATURE REVIEW: KEY FINDINGS

A literature review was prepared for this study to determine which demographic and environmental characteristics positively influence non-motorized travel behavior, and the results informed the mapping analysis.

### DEMOGRAPHIC CORRELATES FROM THE LITERATURE REVIEW

The literature review identified certain types of people as most likely to walk or bike for utility. The research suggests that people earning a low income and regular public transit users are more likely to walk for transport. Those with a high level of education are associated with biking for utility, as are males, students, and households without children. The attributes of young age, white race, and limited access to a motor vehicle correlate to increased levels of both modes.

### Environmental Correlates from the Literature Review

Environmental conditions also play an important role in the decision to walk or bike, according to the literature review. The presence of bike infrastructure and bike facilities (such as parking, showers, and lockers) has a strong effect on the propensity to bike for utility. Increased residential density is associated with greater odds of walking for transport. The literature review also found considerable support that population density and a land-use mix are related to increased rates of both walking and biking, while residential density is a predictor for utility walking. Steep slopes are an impediment to both modes, especially cycling.

Findings for street connectivity, the presence of pedestrian infrastructure, and proximity to public transit were ambiguous, and thus were omitted from the mapping analysis. All other environmental correlates were mapped.

## PABS ANALYSIS: KEY FINDINGS

The Pedestrian and Bicycling Survey (PABS) was implemented to see if these relationships would prove true in San Francisco. By directly evaluating the population of interest, this research examines potential departures from the literature review due to unique characteristics of the city. Findings from the literature review and binary logistic regression analysis of the PABS data identified the relevant demographic variables that were then mapped across the city.

### PABS KEY FINDINGS: UTILITY WALKING

Almost all residents in the sample (96 percent) had walked for utility in the past week. Few people walked for their entire commute to work or school, yet most respondents walked to transit and walks to other destinations were common. Discovering that most residents walk for utility is an important finding that provides support for additional pedestrian infrastructure throughout the city.

Only 47 percent of San Franciscans who are employed or students walked for their entire commute to work or school in a typical week. Of those residents who regularly commuted solely on foot, 30 percent did so at least five days a week. These findings demonstrate an opportunity to increase the walk mode share of commute trips.

The most surprising result was in the gender variable correlation; though gender was not identified by the literature review as a correlate to utility walking, the PABS found that females are approximately twice (1.96 times) as likely as males to walk to work or school in a typical week. Policies that target females may be an effective means for increasing pedestrian mode share of commute trips.

### PABS KEY FINDINGS: UTILITY BIKING

A small percentage of San Franciscans biked for utility. Just 18 percent of residents had cycled for transport in the past week. A total of 11 percent of residents rode to work or school, while 6 percent cycled to transit and 13 percent biked to other destinations. In a typical week, only 13 percent of the sample commuted to work or school via bike.

One correlate from the literature review was confirmed: young age was associated with increased utility biking. Young adults were 3.8 times more likely than seniors to bike for transport. Middle aged adults were 3.3 times more apt to bike for utility than their senior counterparts.

## MAPPING ANALYSIS

### OVERVIEW AND METHODS

Mapping analysis identified locations across the city that have many predictors of non-motorized transport. This information will help city officials target improvements in places where they are likely to be well used because they comprise populations and physical characteristics that are particularly receptive to utility walking or biking.

For each mode (walking and biking), demographic maps were created out of data from the *2010 Census* and from the *2008-2012 American Community Survey* five-year estimates. Each demographic correlate (for walking, correlates were young age, low income, and regular public transit use; for biking, male gender, educational attainment, young age, and absence of children in household) is mapped by quartile at the level of block group, and each quartile is assigned a score of one to four, four being the densest group of people who are apt to walk (or bike) for transport.

Physical environmental correlates (population density, residential density, land use mix, and percentage slope) are also mapped throughout the city for each mode (using various data from the above sources and the SFMTA) and scored from one to four.

Then, again for each mode, three composite suitability maps (prepared using the Spatial Analyst extension of ArcGIS) combine this information. One weighted overlay unites all demographic variables, another merges all physical characteristics, and the final map for each mode integrates all correlates to utility walking (or biking).

### KEY FINDINGS: UTILITY WALKING

The most suitable locations for pedestrian infrastructure are concentrated in northeast San Francisco and the Mission (see [Figure 21](#)). A total of 18 neighborhoods have ideal conditions for utility walking. All but five of these neighborhoods have more than 100 acres that are particularly conducive to walking.

A few neighborhoods contain large areas with very favorable conditions including the Mission (656 acres), Western Addition (562 acres), and Downtown Civic Center (319 acres). In addition, the Nob Hill, South of Market, and Haight Ashbury areas each contain more than 200 acres well suited to utility walking. Finally, over 75 percent of the Nob Hill, Chinatown, and Downtown Civic Center neighborhoods are well suited for pedestrians.

### KEY FINDINGS: UTILITY BIKING

In 27 out of 37 neighborhoods, at least some portion of the area has optimal conditions for utility biking. Receptive areas for cycling infrastructure are predominately located in northern San Francisco and the Mission (see [Figure 30](#)). Southern San Francisco is largely unsuitable for biking, with a few small exceptions.

A few sizeable areas were discovered that are very conducive to utility biking. The Mission and Western Addition have the greatest amount of land that is well suited for biking, at 729 and 647 acres respectively. Four more neighborhoods include over 200 acres of land with very favorable conditions: South of Market, Downtown Civic Center, Haight Ashbury and the Inner Richmond. Several others contain more than 100 acres of land that is conducive to utility biking. Smaller areas are concentrated in a few places: along parts of Mission Street in Excelsior and northern Bernal heights; along Columbus north of Broadway Street; in the Inner Sunset, adjacent to Golden Gate park; and in South of Market east of 2nd Street.

## RECOMMENDATIONS FOR SPECIFIC IMPROVEMENTS

Over the next five years, the City has allocated \$17 million in funding available for capital improvements to increase walk mode share and reduce pedestrian injuries. Another \$55 million has been budgeted for bicycle improvements over the next two years. To assess the value of a particular project, city officials must gauge how each intervention will impact levels of non-motorized transport. The findings of this study provide an additional metric for prioritizing improvements that this research predicts will increase walking and cycling rates most effectively. Policies that target infrastructure in underserved areas with receptive populations and environments for utility walking and biking are essential for maximizing the impact of available funding and meeting the City's active-travel mode-share goals.

### POLICIES AND IMPROVEMENTS: UTILITY WALKING

To determine which pedestrian improvements should be prioritized for immediate construction, capital projects listed in various policy documents are compared to the utility-walking suitability assessment map (see [Figure 21](#)).

First, pedestrian high-injury streets identified by the San Francisco Department of Public Health are overlaid onto the suitability assessment map.<sup>4</sup> Next, walk improvements listed in the *Vision Zero: Capital Project Implementation in Support of Vision Zero* are evaluated to ascertain which are located in receptive areas for walking.<sup>5</sup> Finally, pedestrian projects from the *Draft SFMTA Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* that occur on streets with very favorable conditions for increasing utility walking rates are presented.<sup>6</sup>

### Priority Pedestrian High-injury Streets

[Figure 31](#) illustrates which pedestrian high-injury corridors should be prioritized for immediate infrastructure improvements because they are surrounded by populations or built environment characteristics associated with higher levels of utility walking. The majority of dangerous streets are concentrated near Downtown Civic Center and southern Nob Hill. Underserved corridors north of Market Street and east of Franklin Street are some of the most ideal and necessary places for new pedestrian improvements. Almost all high-injury streets in the Mission should be given precedence for funding, except for 16th Street east of South Van Ness Avenue. Other roads prone to pedestrian

accidents and fatalities that should be improved in the near term are: Webster Street; Divisadero Street; Masonic Avenue south of Turk Street; Market Street west of 5th Street; and Mission and Howard streets from 5th to 11th.

### Other Areas Receptive to Utility Walking

This research also identifies places that are not pedestrian high-injury streets, but which have ideal conditions for increasing walk mode-share (see [Figure 31](#)). These areas are: Haight Ashbury along the Panhandle, Western Addition south of Eddy Street, the Inner Sunset along Golden Gate Park, and along Van Ness Avenue in Russian Hill and the Marina.

4. San Francisco Department of Public Health Open Data, "Pedestrian High-Injury Corridors, San Francisco, CA," City and County of San Francisco, August 17, 2014, accessed August 20, 2014, <http://ow.ly/FwaKi>; San Francisco Municipal Transportation Agency, *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC)* (San Francisco: SFMTA, March 2014), 7, accessed September 5, 2014, <http://ow.ly/F7iMt>.

5. San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

6. San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 92-108, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

## Priority Vision Zero Pedestrian Projects

*Vision Zero: Capital Project Implementation in Support of Vision Zero* identifies 40 projects totaling over \$20 million, many of which are intended to help reduce pedestrian injuries and deaths.<sup>7</sup> Eight of these projects are already completed, and SFMTA has committed to implementing another 24 Vision Zero projects by 2024.<sup>8</sup> Pedestrian improvements in support of Vision Zero that are expected per the findings of this research to most effectively increase walking rates are catalogued below by Vision Zero project ID number (Table 1).

## Priority Pedestrian Projects from SFMTA's Capital Improvement Program (CIP)

The *Draft SFMTA Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* includes 40 pedestrian projects totaling over \$67 million which are expected to improve: congestion, street design, and the safety of people walking.<sup>9</sup> For some projects listed in this document, specific locations are not provided. Pedestrian improvements proposed in areas that are best suited to utility walking are catalogued below by CIP number (Table 2).

7. San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

8. Ibid.

9. San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 92-108, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

**Table 1. Vision Zero pedestrian improvements in areas best suited to utility walking**

ID#	Project
2	Ellis Street/Eddy Street, from Leavenworth to Mason streets
4	Golden Gate Avenue, from Polk to Jones streets
5a	Howard Street Near-Term A
7	Polk Street, from McAllister to Union streets
10b	Webster Street, from Fulton to Sutter
10c	Webster Street, from Fulton to Sutter streets
16	Irving Street, from Arguello Boulevard to 9th Avenue
19	Mission Street, from 18th to 23rd streets
21	Sutter Street, at Mason, Taylor, and Leavenworth streets
24	Columbus Avenue, Broadway to Union Street
28	Geary Blvd./Leavenworth Street and Eddy Street/Mason Street
33	6th Street at Minna Street
37	Persia Triangle improvements
38	Valencia Street/Duboce Avenue

Source: San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

**Table 2. CIP pedestrian improvement projects in areas best suited to utility walking**

CIP#	Project
PE0109	Columbus Avenue pedestrian improvements
PE0117	Turk Street at Webster Street pedestrian improvements
PE0122	Pedestrian Safety spot improvements within a block radius of Octavia Street
PE0157	Market and Octavia streets intersection improvement project
PE0158	Oak and Octavia streets intersection improvement project

Source: San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 92-108, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

## POLICIES AND IMPROVEMENTS: UTILITY BIKING

To establish which bike improvements should be given precedence for near-term funding, capital projects listed in several policy documents are evaluated using the biking suitability assessment map (see [Figure 30](#)).

First, cyclist high-injury streets presented in the *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee* in March 2014 are superimposed onto the biking suitability assessment map.<sup>10</sup> Next, bike projects enumerated in the *Vision Zero: Capital Project Implementation in Support of Vision Zero* are examined to identify those in areas conducive to utility biking.<sup>11</sup> In addition, bike improvements proposed in the *Draft SFMTA Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* that are found to be surrounded by favorable conditions for increasing biking rates are specified, as are other well-suited areas.<sup>12</sup>

## Priority Cyclist High-injury Streets

Cyclist high-injury corridors that should be prioritized for immediate infrastructure improvements are shown in [Figure 32](#). These underserved streets are clustered in northeastern San Francisco and the Mission. Downtown Civic Center between Eddy and McAllister streets is unsafe for cyclists, though it is surrounded by populations and environmental conditions which are associated with higher levels of cycling; this situation deserves remediation. Polk Street south of Union also has a high rate of severe injuries and fatalities to cyclists in an area that is notably receptive to biking. Additional streets that are dangerous for cyclists and that should be improved in the near-term are located in: Haight Ashbury; southern Western Addition; in the Mission, except in the northeast quadrant; and a few places in South of Market.

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10. San Francisco Municipal Transportation Agency, *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC)* (San Francisco: SFMTA, March 2014), 7, accessed September 5, 2014, <http://ow.ly/F7iMt>.

11. San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

12. San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 42-55, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

### Priority Vision Zero Bicycle Improvements

A few projects listed in *Vision Zero: Capital Project Implementation in Support of Vision Zero* are along bicycle high-injury corridors (see [Figures 9 and 32](#)), making them prime targets for improvements.<sup>13</sup> Improvements in support of Vision Zero that are expected to most effectively increase utility biking rates are catalogued below by Vision Zero project ID number ([Table 3](#)).

13. San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

**Table 3. Vision Zero bicycle improvements in areas best suited to utility biking**

ID#	Project
4	Golden Gate Avenue, from Polk to Jones streets
5a	Howard Street Near-Term A
7	Polk Street, from McAllister to Union streets
10a	Webster Street, from Fulton to Sutter streets
18	Market Street, from Gough to 12th streets
30	King Street bike improvements

Source: San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

### Priority Bicycle Projects from SFMTA’s Capital Improvement Program (CIP)

The *Draft SFMTA Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* includes 49 bicycle-related projects, totaling over \$119 million, that aim to create new bicycle facilities and improve cyclist safety.<sup>14</sup> Many projects itemized in that document do not provide exact locations. Bicycle improvements proposed in areas that are receptive to utility biking are catalogued below by CIP number (Table 4).

### Other Receptive Areas for Utility Biking

The June 2013 *SFMTA Bicycle Strategy Update Needs Assessment* identified strategic gap-closures needed to improve the fragmented bicycle network (see Figure 8).<sup>15</sup> Post and Sutter streets are strategic network gap-closures that are located in places with favorable conditions for increasing bike rates. Additional existing bike routes in areas where improvements are expected to have the largest possible effect are: Columbus Avenue, Taylor Street, California Street, Broadway east of Polk Street, and Webster Street south of Fulton Avenue (see Figure 33).

**Table 4. CIP bicycle projects in areas best suited to utility biking**

CIP#	Project
BI0101	2nd Street bike lanes
BI0102	5th Street bike lanes
BI0103	7th Street streetscape
BI0118	California Pacific Medical Center--26th Street and Cesar Chavez Street corridor evaluation
BI0121	Folsom and Essex streets pilot project
BI0127	Polk Street improvement project
BI0136	Western Addition - downtown bikeway connector
BI0137	Wiggle - neighborhood green corridor
BI0138	Market and Octavia streets - bicycle spot improvements and network upgrades
BI0154	Folsom Street streetscape
BI0155	Masonic Avenue streetscape

Source: San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 42-55, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

14. San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 42-55, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

15. San Francisco Municipal Transit Agency, *SFMTA Bicycle Strategy April 2013* (San Francisco: SFMTA, April 2013), 3, accessed August 31, 2013, <http://ow.ly/F7gu4>.



# INTRODUCTION

## PRIORITIZING NON-MOTORIZED INFRASTRUCTURE IN SAN FRANCISCO

### 1.1 EFFORTS TO INCREASE BIKING AND WALKING RATES

As communities across the nation, including San Francisco, confront the challenging, inter-related issues of climate change, traffic congestion, and obesity, many are adopting policies to increase utility walking and cycling rates.<sup>16</sup> Non-motorized transport (NMT) affords many advantages over other means of transportation: virtually no carbon or greenhouse gasses are emitted from bike or walk trips; capacity and efficiency of existing roads are improved because pedestrians and cyclists require less space than motorists; active travel provides a source of physical activity, improving the public health of residents and preventing chronic disease; and pedestrian and cycling infrastructure improvements are relatively inexpensive and quick to implement, and require less maintenance compared to other modes.<sup>17</sup> Due to these many benefits, over 650 government agencies have adopted Complete Streets policies, which seek to balance the needs of pedestrians, cyclists, and transit users with those of drivers so as to improve the well-being of the entire community.<sup>18</sup>

In order to maximize the impact of available funding, government agencies and officials must

prioritize NMT improvements; their short- and long-term economic advantages (easier and cheaper to build and maintain, traffic congestion amelioration, lower community health-care costs, lower environmental harm and thus less future remediation, etc.) are too many to ignore. To optimize use of limited funds and the efficacy of new improvements, these new NMT investments must be targeted—sited in areas with populations and physical characteristics that are particularly conducive to utility walking or cycling.

This research pinpoints locations in San Francisco with populations and built-environment characteristics that are particularly suited to active travel, but which lack basic infrastructure or facilities. The work presented uses the Pedestrian and Bicycling Survey (PABS) and the thorough review of relevant literature to identify and assess various correlates to utility walking and cycling; these data are plotted to maps presented herein.<sup>19</sup> After mapping all of these elements, three composite suitability maps were prepared to illustrate the most ideal locations for new pedestrian and biking improvements. One such weighted overlay map represents the aggregation of all demographic correlates; another map merges all physical characteristics; and the final map for each mode combines both types of variables.

This approach to targeting new improvements is relevant beyond San Francisco; it allows communities to answer the following questions:

- Which locations have the greatest number of people who are likely to walk or bike?
- Where are the most conducive environments for walking and cycling?
- What underserved locations should be prioritized for immediate infrastructure improvements because they have populations or built environment characteristics that are associated with higher levels of walking and/or cycling?

16. This report focusses on people and environments that correlate to utility walking and biking trips. The primary purpose of ‘utility’ trips is to arrive at a destination, rather than to reap health benefits associated with active travel modes or to recreate. Note: Throughout this paper the term “[walking or biking] for transportation” indicates this meaning of ‘utility trip.’

17. National Complete Streets Coalition, “Complete Streets: Fundamentals,” accessed November 11, 2014, <http://www.smartgrowthamerica.org/documents/cs/cs-brochure-features.pdf>.

18. National Complete Streets Coalition, “Welcome to the National Complete Streets Coalition,” Smart Growth America, accessed November 11, 2014, <http://www.smartgrowthamerica.org/complete-streets>.

19. Ann Forsyth, K. Krizek and A. W. Agrawal, *Measuring Walking and Cycling Using the PABS (Pedestrian and Bicycling Survey) Approach: A Low-Cost Survey Method for Local Communities* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010). Full survey provided as Appendix A.

## 1.2 A GUIDE TO THIS REPORT

**Chapter Two: Walking and Biking in San Francisco: Existing Conditions and Policies** provides an overview of physical characteristics and government policies in San Francisco which impact walking and biking rates. Unique environmental features are described for readers unfamiliar with the city. Existing non-motorized transport policies are reviewed to demonstrate the relevance of this research.

**Chapter Three: The Pedestrian and Bicycling Survey** explains the survey of San Francisco implemented for this report in order to verify predictors of non-motorized transport discovered during the literature review. A summary of the literature review findings introduces the types of people that are expected to positively correlate to walking or biking for utility in San Francisco. Survey administration and data analysis procedures are detailed to clarify the scope of the research effort. Finally, results from binary logistic regression analysis are presented, which inform decisions about which correlates to map in subsequent chapters.

**Chapter Four: Mapping Correlates to Utility Walking** outlines the process of mapping indicators of walking across San Francisco. Findings from the PABS and the literature review are compared to determine which demographic correlates to map. Environmental factors from the literature review are mapped when GIS data is available at block group level geography. From these correlates, a series of suitability assessments are created that establish the most ideal locations for new improvements. This process is repeated in **Chapter Five: Mapping Correlates to Utility Biking**.

**Chapter Six: Recommendations for Specific Improvements** identifies several projects that are expected to increase utility walking or biking rates; that is, this research finds that they comprise populations and environments that are exceptionally well suited to non-motorized transport, thus potentially offering proof of concept. The SFMTA Capital Improvement Program, Vision Zero: Capital Project Implementation in Support of Vision Zero and the SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC) are reviewed to prioritize improvements that fall within the most suitable areas.<sup>20</sup> Additional underserved areas that should be considered for improvements are also presented.

Finally, **Chapter Seven: Conclusions** provides a summary of key findings from each research method employed (the literature review, the Pedestrian and Bicycling Survey, and the mapping analysis). In addition, limitations of this research are described in order to ensure that these findings are interpreted appropriately. To close, the report proposes future research that builds upon the findings herein.

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20. San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 92-108, accessed November 7, 2014, <http://ow.ly/Fw3FT>; San Francisco Municipal Transportation Agency, *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC)* (San Francisco: SFMTA, March 2014), 7, accessed September 5, 2014, <http://ow.ly/F7iMt>; San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.





# CHAPTER TWO

## WALKING AND BIKING IN SAN FRANCISCO: EXISTING CONDITIONS AND POLICIES

In every city, local urban form and geographic features impact travel patterns. The description provided in this chapter of San Francisco's natural features, and the review of existing City policies that promote active travel, both serve to elucidate the context in which (and the foundations upon which) this study was completed. To begin, the city's unique topography, extraordinary geography and temperate climate are explored. Next, findings from recent assessments of existing pedestrian and cycling infrastructure are shown to reveal an urgent need for new improvements. Finally, a series of existing City policies that are supported by this research are summarized, including: increasing bicycle and pedestrian mode share, improving bike network connectivity, and prioritizing active-travel improvement projects.



### 2.1 THE SAN FRANCISCO ENVIRONMENT

#### 2.1.1 NATURAL FEATURES AND CLIMATE

As a result of several geographic constraints, San Francisco has a fairly compact footprint, which can be easily traversed (distance-wise, at least) by bikers and pedestrians. The city is a peninsula surrounded by water on three sides and bordered by Daly City to the south. The Pacific Ocean is the city's western edge, and the San Francisco Bay its eastern shore. San Francisco is approximately a seven-mile-by-seven-mile square, crowned by the iconic Golden Gate Bridge to the north.

The city's distinctive topography comprises many hills (Figure 1), which discourages pedestrians and cyclists.<sup>21</sup> The street pattern imposes a simple grid on these knolls, mostly scaling the hilltops rather than winding around them. A few of these steep inclines exceed elevations of 900 feet.<sup>22</sup>

Generally, the city's Mediterranean climate provides warm, dry summers that support cycling, and wet, cool (but not freezing) winters that discourage it. In the summer, persistent coastal fog keeps temperatures between 50 and 70 degrees Fahrenheit.<sup>23</sup> The rainy season usually begins in October and continues through April, with slightly cooler temperatures ranging from 45 to

60 degrees.<sup>24</sup> Winter rains do act as a deterrent to non-motorized travel, research shows, but many cities around the world with colder, wetter weather have significantly higher rates of utility walking and cycling (such as Copenhagen and Amsterdam, where superior policies and infrastructure seem to have overcome the more severe weather).<sup>25</sup>

21. Kevin J. Krizek, Ann Forsyth and Laura Baum, *Walking and Cycling International Literature Review Final Report* (Melbourne: Department of Transportation Walking and Cycling Branch, 2009) 10.

22. Geographic Names Information System (GNIS), "Query Form For The United States And Its Territories," United States Geological Survey, accessed February 9, 2013, <http://geonames.usgs.gov/apex/f?p=136:1:14777265759326>.

23. Golden Gate Weather Services, "Climate of San Francisco Narrative Description," Golden Gate Weather Services, accessed February 9, 2013, <http://ggweather.com/sf/narrative.html>.

24. Ibid.

25. Eva Heinen, Bert van Wee and Kees Maat, "Commuting by Bicycle: An Overview of the Literature," *Transport Reviews* 30, no. 1 (January 2010): 69, 76, 78; Kevin J. Krizek, Ann Forsyth and Laura Baum, *Walking and Cycling International Literature Review Final Report* (Melbourne, VIC: Department of Transportation Walking and Cycling Branch Melbourne, 2009), 10; John Pucher and Ralph Buehler, "Making Cycling Irresistible: Lessons from the Netherlands, Denmark and Germany," *Transport Reviews* 28, no. 4 (July 2008): 495-528; World Weather & Climate Information, "Average Weather and Climate in Netherlands," accessed December 11, 2014, <http://ow.ly/FOen3>; World Weather Online, "Copenhagen Monthly Climate Average, Denmark," accessed December 11, 2014, <http://ow.ly/FOclh>.



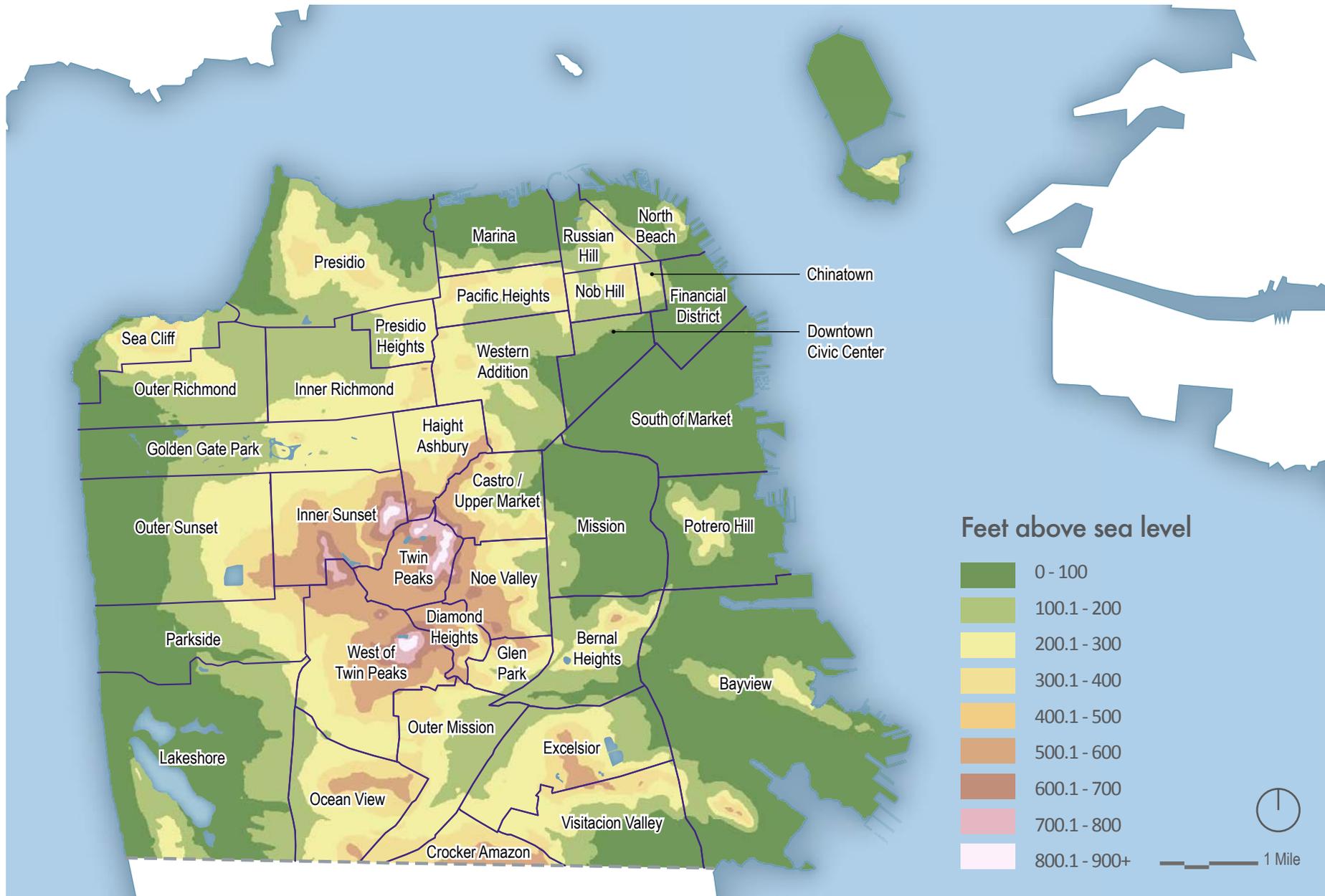


Figure 1. San Francisco topography

Sources: Map created by author. See Appendix D for source information.

### 2.1.2 EXISTING BIKE AND PEDESTRIAN INFRASTRUCTURE

San Francisco’s existing bicycle network is shown in **Figure 2**, and bike-network street typologies in **Figure 3**; these maps and data show the current state of affairs and the jumping-off point for future efforts, and provide the context for researching and assessing San Francisco’s needs and next steps.

Most of the San Francisco bicycle network fails to provide comfortable cycling conditions for average riders.<sup>26</sup> In 2013, the San Francisco Municipal Transportation Agency prepared an assessment of the city’s bicycle network that assigned a stress level to each segment of the network (**Figures 4 and 5**).<sup>27</sup> The study revealed the inadequacy of existing bike infrastructure concluding: “less than ten percent of the network is comfortable for most people.”<sup>28</sup> One reason is a dearth of dedicated bike lanes and paths and a heavy dependence on sharrows, resulting in many unappealing, dangerous, and/or inaccessible areas (**Figures 4 and 6**).<sup>29</sup>

Because sharrows provide no separation from motor vehicle traffic, these bike routes do not accommodate most adult residents; that is, most adults either do not use them in comfort, or do not use them at all.<sup>30</sup> (As shown in **Figure 3**, sharrows are markings in the travel lane alerting motorists that cyclists are allowed to use the full lane.) Clearly, additional infrastructure is needed to bolster cycling rates in the city.

The City has several high-injury corridors that are well utilized, but are obviously dangerous, and appear to have safety needs that may merit prioritization over other projects. According to the San Francisco Department of Public Health (SFDPH), 60 percent of cyclist fatalities and severe injuries occur on four percent of the street network (**Figure 6**).<sup>31</sup> SFDPH also found that 66 percent of severe pedestrian injuries and fatalities occur on only six percent of the city’s street network (**Figure 7**).<sup>32</sup> For the purposes of this research, therefore, the term ‘underserved location’ may indicate a favorable site with inadequate or no walking or cycling infrastructure, or may refer to an unsafe area prone to severe or fatal injuries to pedestrians or cyclists, regardless of infrastructure presence, since these locations also warrant consideration for allocation of improvements.

26. San Francisco Municipal Transportation Agency, “Bicycle Strategy Update Needs Assessment and Next Steps,” June 18, 2013), 5, accessed August 31, 2013, <http://ow.ly/F7dNB>.

27. *Ibid.*, 5.

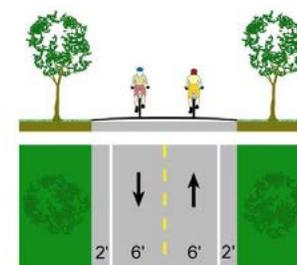
28. *Ibid.*, 5.

29. *Ibid.*, 5.

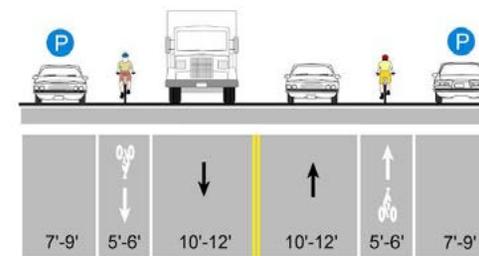
30. *Ibid.*, 3, 5.

31. San Francisco Municipal Transportation Agency, *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC)*, (San Francisco: SFMTA, March 2014), 7, accessed September 5, 2014, <http://ow.ly/F7iMt>.

32. San Francisco County Transportation Authority, San Francisco Department of Public Health and San Francisco Municipal Transportation Agency, “WalkFirst: Safety Streets,” City and County of San Francisco, accessed March 2, 2014, <http://ow.ly/F7ebi>; San Francisco Department of Public Health, “Pedestrian Safety,” Program on Health Equity and Sustainability, accessed March 2, 2014, <http://ow.ly/F7gjcj>.



Typical Class I Facility - Bicycle Path, Multi-Use Path or Multi-Use Trail



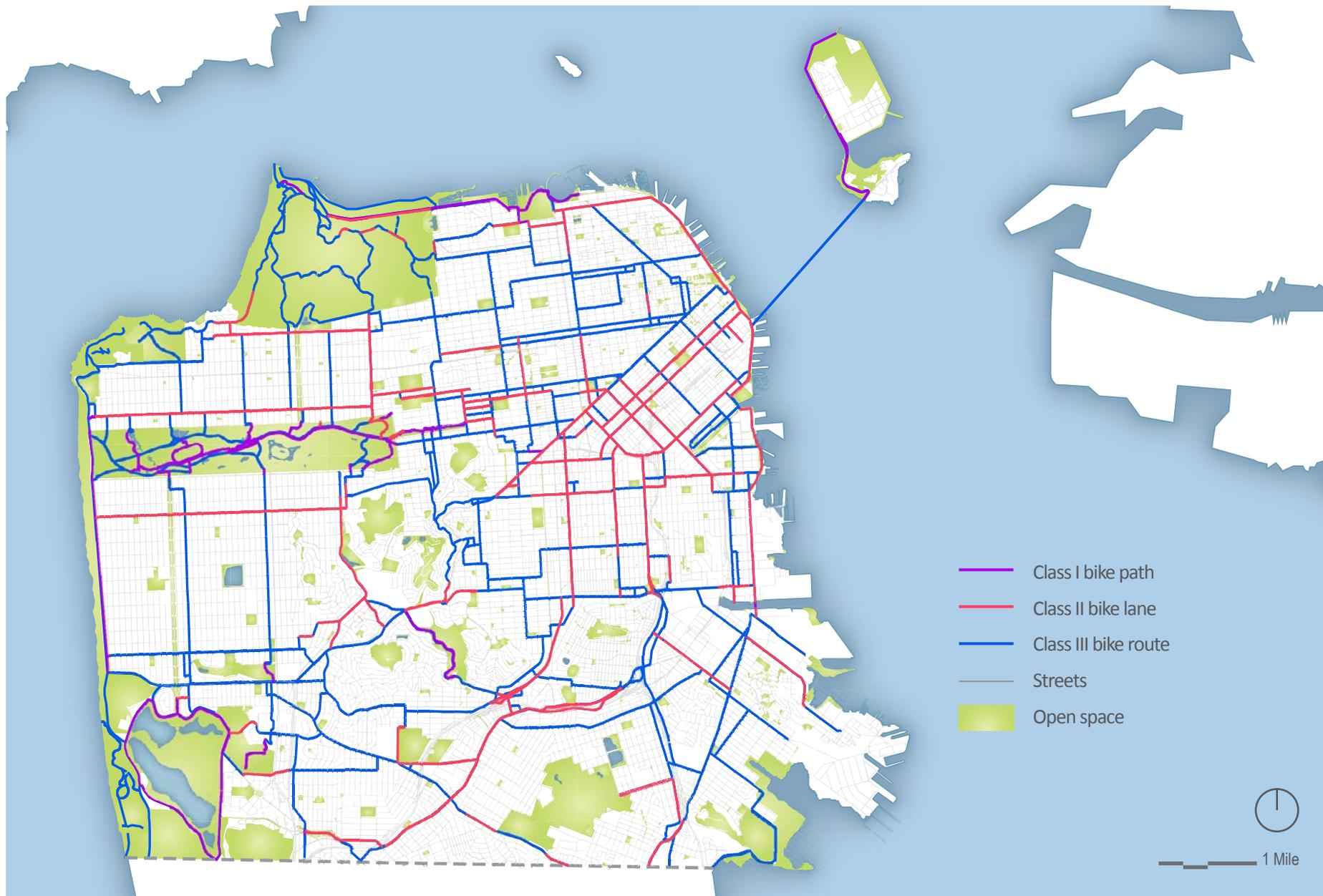
Typical Class II Facility - Bicycle Lane



Typical Class III Facility - Marked Bicycle Route

**Figure 3. Bike infrastructure sections**

Source: See Appendix D for source information.



**Figure 2. Existing bike network**

Sources: Map created by author. See Appendix D for source information.

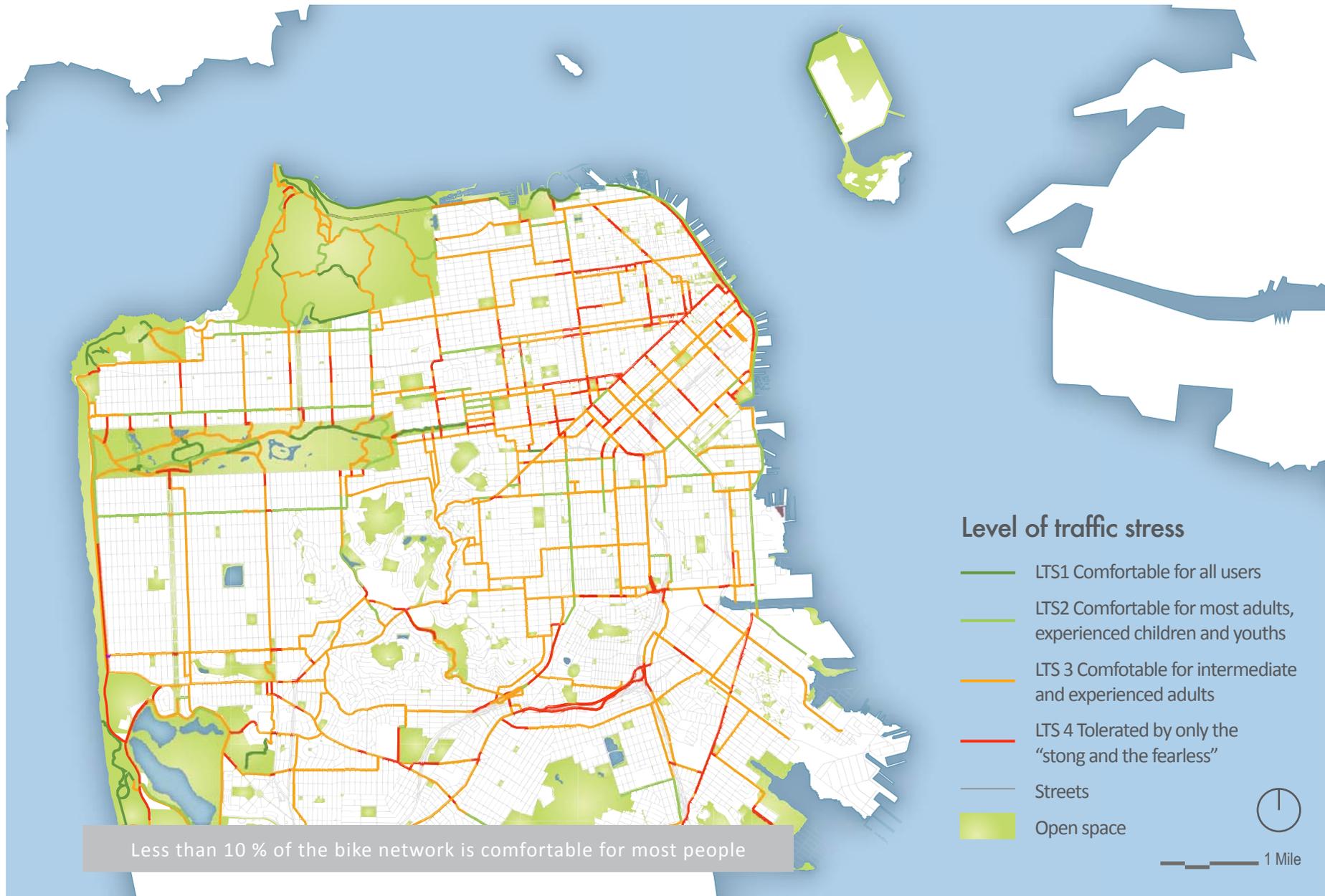


Figure 4. Level of traffic stress (LTS) on the San Francisco bicycle network

Sources: See Appendix D for source information.

LTS 1 Everyone feels comfortable to ride



LTS 2 Adults feel comfortable to ride



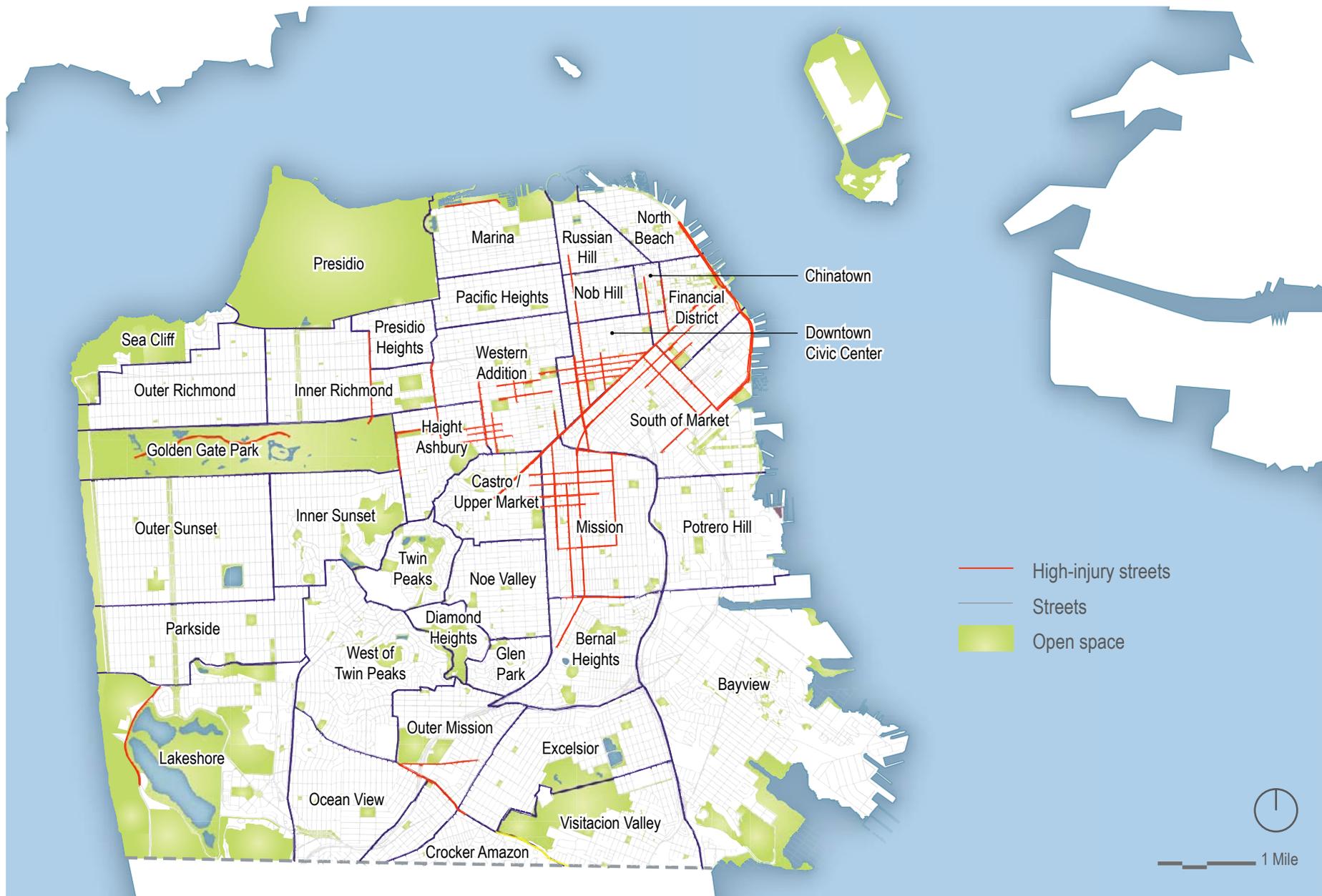
LTS 3 "Enthusied and confident" will ride

**Figure 5. Level of traffic stress 1-4**

Sources: See Appendix D for source information.



LTS 4 Only "Strong and fearless" will ride



**Figure 6. Cyclist high-injury corridors**

Sources: Map created by author. See Appendix D for source information.

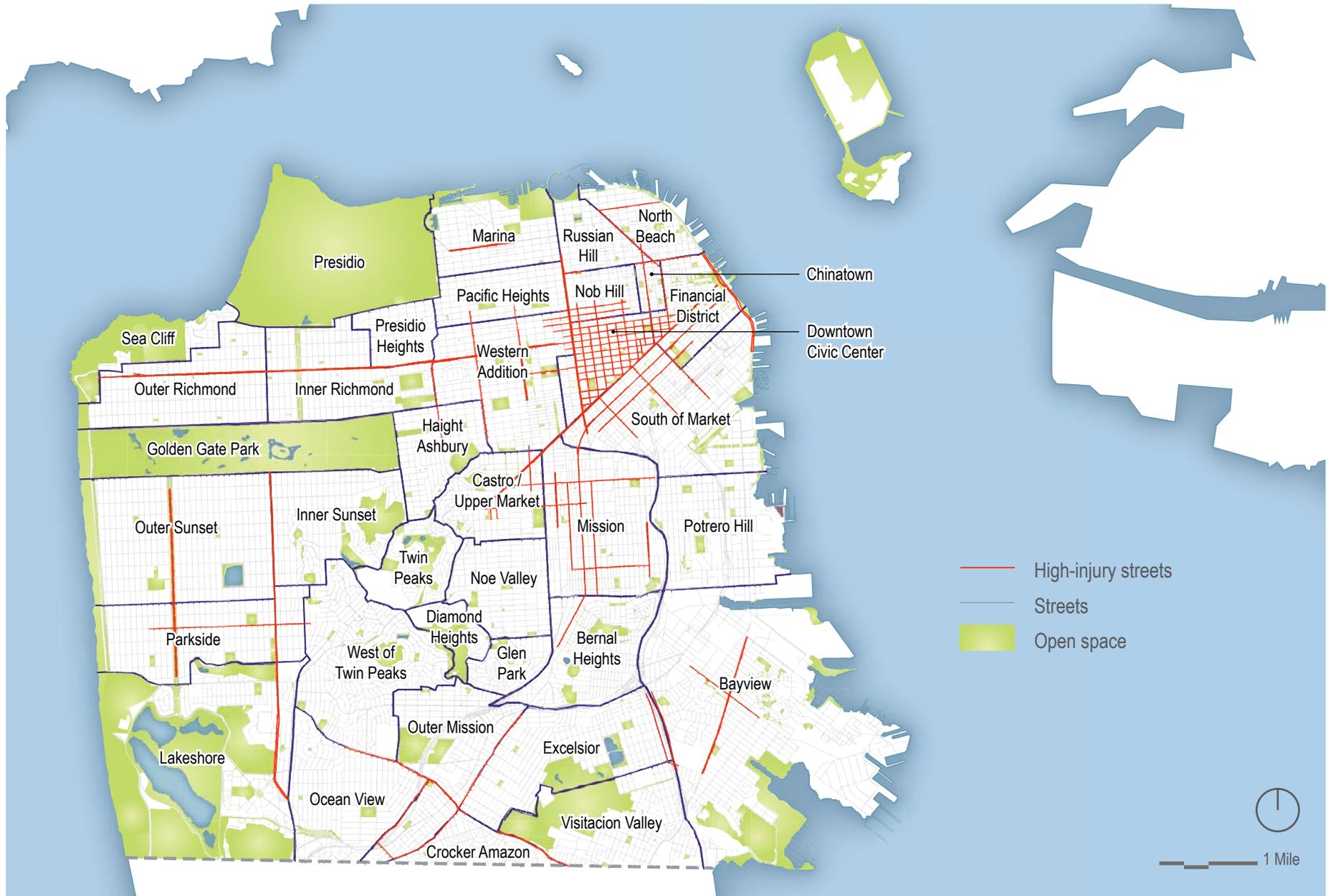


Figure 7. Pedestrian high-injury corridors

Sources: Map created by author. See Appendix D for source information.

## 2.2 EXISTING CITY POLICIES THAT PROMOTE ACTIVE TRAVEL

The City has adopted several policies to encourage walking and cycling, including: increasing bicycle and pedestrian mode share, improving bike network connectivity, and prioritizing active-travel improvement projects. This section provides an overview of each goal or policy and explains how this research reinforces these City goals.

### 2.2.1 INCREASE BICYCLE MODE SHARE

Recently, San Francisco set aggressive goals for increasing bicycle mode share. In 2010, the San Francisco Board of Supervisors passed a resolution which targets 20-percent bike mode share by 2020.<sup>33</sup> To achieve this objective, a substantial 16.5-percent growth rate is required.<sup>34</sup> A staggering increase of 250 percent in bicycle activity is needed to achieve the goal of 50 percent of all trips from sustainable modes, a goal set in the *SFMTA 2013-2018 Strategic Plan*.<sup>35</sup> The research presented herein responds to these policies and supports bike mode share increase by identifying projects located in areas with populations and environments that are associated with higher rates of utility biking.

### 2.2.2 IMPROVE BIKE NETWORK CONNECTIVITY

The June 2013 *SFMTA Bicycle Strategy Update Needs Assessment* exposed a clear need for cycling infrastructure improvements in San Francisco.<sup>36</sup> To address the shortage of dedicated bike lanes and paths, many strategic network gap closures were identified (Figure 8).<sup>37</sup> The connectivity of the bike network may be improved by this study because it provides city officials with information to help facilitate new bike infrastructure projects—identifying the specific sites across the city where new infrastructure might be most advantageously placed.

### 2.2.3 INCREASE PEDESTRIAN MODE SHARE

By 2021, SFMTA seeks to grow the walking mode share to 13 percent of work trips and 23 percent of all trips.<sup>38</sup> This requires an increase to 28 percent total mode share and 44 percent of commute trips over a 2012 baseline.<sup>39</sup> The *SFMTA Pedestrian Strategy April 2013* identifies eight miles of high-injury corridors that require extensive urgent safety improvements to minimize pedestrian injuries and fatalities.<sup>40</sup> Of these, one mile will be redesigned per year with capital-intensive treatments such as sidewalk widening.<sup>41</sup> By locating correlates to utility walking across the city, this project will inform city officials which improvements are likely to raise walking rates most effectively.



*Young bicycle commuter on Market Street*

33. San Francisco Municipal Transportation Agency, *2012 San Francisco State of Cycling Report* (San Francisco: SFMTA, 2012), 7, accessed September 5, 2014, <http://ow.ly/F7gjR>.

34. *Ibid.*, 7.

35. San Francisco Municipal Transit Agency, *SFMTA Bicycle Strategy April 2013* (San Francisco: SFMTA, April 2013), 3, accessed August 31, 2013, <http://ow.ly/F7gu4>.

36. *Ibid.*, 5, 10.

37. *Ibid.*, 10.

38. The Mayor's Pedestrian Safety Task Force, *San Francisco Pedestrian Strategy* (San Francisco: Mayor's Office, April 2013), accessed November 7, 2013, 13, <http://ow.ly/F7gGd>.

39. *Ibid.*, 13.

40. *Ibid.*, 11.

41. *Ibid.*, 11.

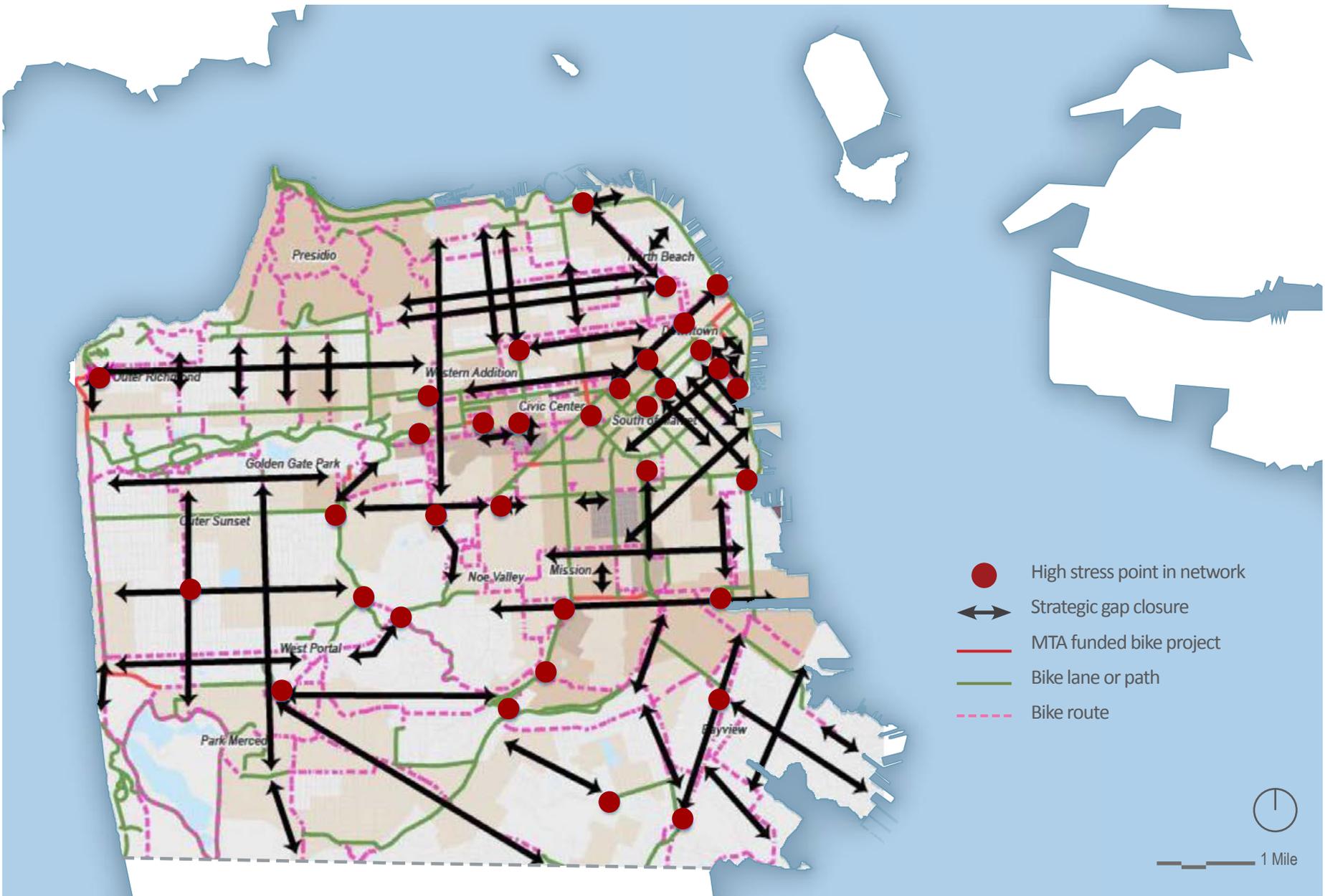


Figure 8. Strategic bike network gap-closure opportunities

Sources: See Appendix D for source information.

## 2.2.4 PRIORITIZE RESOURCES FOR NON-MOTORIZED TRANSPORT IMPROVEMENTS

Careful project prioritization is required to maximize the impact of available funding and achieve the bold mode share targets set by recent SFMTA plans. The City has budgeted \$55 million for new bicycle improvements over the next two years and \$17 million for pedestrian projects facilities over the next five years.<sup>42</sup> Several existing policies establish high-priority improvements to be carried out in the near term, including: Vision Zero, WalkFirst, and the *2009 San Francisco Bicycle Plan*.<sup>43</sup> Additional means of evaluating those City infrastructure priorities are provided by the research presented in this report.

### Vision Zero

Vision Zero is a strategy to eliminate all traffic deaths and reduce severe traffic-related injuries by 2024.<sup>44</sup> To date, eight Vision Zero projects have been completed and SFMTA plans to implement 24 more by January 2016 (Figure 9).<sup>45</sup>

### WalkFirst

WalkFirst is a partnership between various City departments charged with improving pedestrian safety comprising the SFMTA, Planning Department, Department of Public Health, Department of Public Works, and Controller's Office.<sup>46</sup> (Refer to Figure 7 for high-injury corridors prioritized by WalkFirst.)

## 2009 San Francisco Bicycle Plan

The *2009 San Francisco Bicycle Plan* identified 60 long-term improvement projects, 52 of which have been completed.<sup>47</sup> The recent *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC)* outlines six remaining projects as of March 2014 being scheduled for construction:

1. Project 5-13: Bayshore Boulevard (formerly San Bruno Avenue) Class II bike lanes between Paul and Silver avenues.
2. Project 3-4: Polk Street northbound Class II contraflow bike lane from Market Street to McAllister Street.
3. Project 7-1: 7th Avenue at Lincoln Way intersection improvements.
4. Project 3-2: Masonic Avenue Class II bike lane from Fell Street to Geary Boulevard.
5. Project 2-1: 2nd Street Class II bike lanes from King to Market streets
6. Project 2-3: 14th Street eastbound Class II bike lane between Dolores and Market streets – Phase II.<sup>48</sup>

42. Joshua Sabatini, "SF Prepares to Double-down Investment on Bike Safety and Improvement Projects," *The Examiner*, April 28, 2014, accessed July 20, 2014, <http://ow.ly/F7gRh>; San Francisco County Transportation Authority, San Francisco Department of Public Health, San Francisco Municipal Transportation Agency, "WalkFirst: Making San Francisco Safer One Step at a Time," City and County of San Francisco, accessed August 15, 2014, <http://walkfirst.sfplanning.org/>.

43. San Francisco County Transportation Agency, San Francisco Department of Public Health and San Francisco Municipal Transportation Agency, "WalkFirst: Making San Francisco Safer One Step at a Time," City and County of San Francisco, accessed August 15, 2014, <http://walkfirst.sfplanning.org/>; San Francisco Municipal Transportation Agency, *San Francisco Bicycle Plan* (San Francisco: SFMTA, June 26, 2009), 1.11-1.16, accessed September 5, 2014, <http://ow.ly/F7isT>; San Francisco Municipal Transportation Agency, "San Francisco Vision Zero Status Report," September 2014, 1, accessed October 1, 2014, <http://ow.ly/F7h1d>.

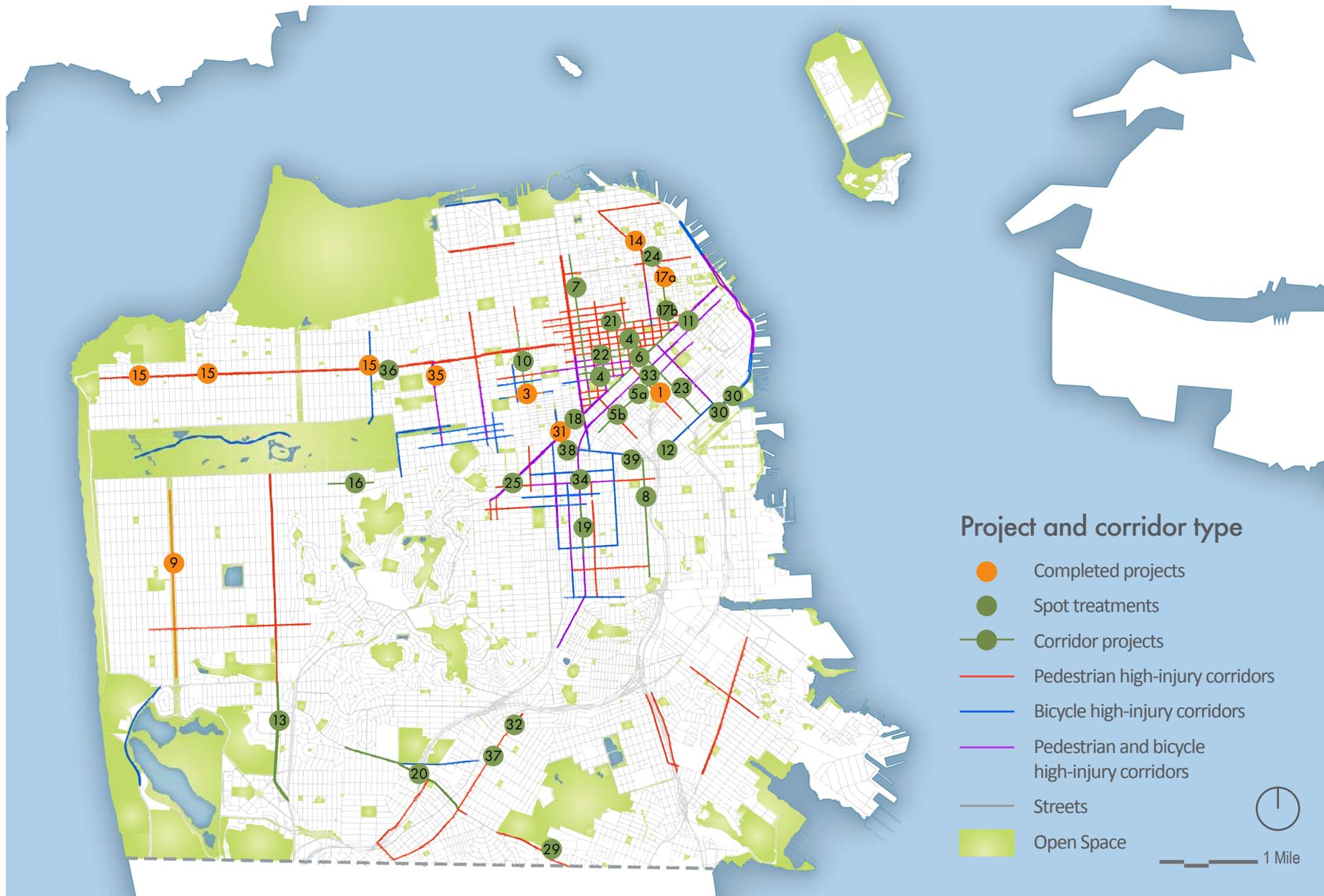
44. San Francisco Municipal Transportation Agency, "San Francisco Vision Zero Status Report," September 2014, 1, accessed October 1, 2014, <http://ow.ly/F7h1d>.

45. *Ibid.*, 1-4.

46. San Francisco County Transportation Agency, San Francisco Department of Public Health and San Francisco Municipal Transportation Agency, "WalkFirst: Making San Francisco Safer One Step at a Time," City and County of San Francisco, accessed August 15, 2014, <http://walkfirst.sfplanning.org/>.

47. San Francisco Municipal Transportation Agency, *San Francisco Bicycle Plan* (San Francisco: SFMTA, June 26, 2009), 1.11-1.16, accessed September 5, 2014, <http://ow.ly/F7isT>.

48. San Francisco Municipal Transportation Agency, *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC)*, (San Francisco: SFMTA, March 2014), 2, accessed September 5, 2014, <http://ow.ly/F7iMt>.



**Figure 9. Capital projects in support of Vision Zero**

Sources: See Appendix D for source information.

Note: Area-wide and city-wide projects without a specific geographic location are not shown on map.



# CHAPTER THREE

## THE PEDESTRIAN AND BICYCLING SURVEY

A literature review conducted for this study identified the types of people most likely to walk or bike for utility. The research suggests that people earning a low income and public transit users are more likely to walk for transport. Those with a high level of education are associated with biking for utility, as are males, students, and households without children. The attributes of young age, white race, and limited access to a motor vehicle correlate to increased levels of both modes. Refer to [Appendix C: Literature Review Sources](#) for a list of research articles consulted for each variable.

The Pedestrian and Bicycling Survey (PABS) allows researchers to determine if these relationships prove true in any locality; it was implemented here to test whether the specified corollaries would hold true for the city of San Francisco. By directly evaluating the population of interest, this research examines potential departures from the literature review due to unique characteristics of the city. Findings from the literature review and binary logistic regression analysis of the PABS data identified the relevant demographic variables mapped in [Chapters Four and Five](#).

This chapter proceeds with an explanation of what the PABS measured and the advantages of implementing this specific survey over others. A thorough methodology follows, which specifies

the process of administering the PABS and preparing the resulting data for analysis. (The authors of the PABS prepared a guide for its implementation, the *Pedestrian and Bicycling Survey PABS User's Manual*.<sup>49</sup> This research was conducted per the process outlined in that report, as discussed in [Section 3.3: Administering the PABS](#).) Generally, the methodology clarifies: how the sample was derived, if the sample was representative of the San Francisco population, definitions for variable classification, and the coding used for regression model inputs. Finally, results from the binary logistic regression models are discussed, along with the limitations of the analysis, including the small sample size; in all, a confidence level of 90% was realized, lower than had been hoped for, due to the sample encompassing only 271 surveys that contained sufficient information for statistical analysis.<sup>50</sup>

### 3.1 WHAT THE PABS MEASURES

The Pedestrian and Bicycling Survey evaluates non-motorized transport behavior for the general population. Demographic data is gathered along with a variety of travel information including: the amount of active travel occurring in a community, which populations walk and cycle, the frequency of non-motorized transport, and general trip purposes.<sup>51</sup> The PABS collects three classes of travel

information: how often one biked or walked last week, how recently one used specific travel modes, and the frequency of mode use in a typical week.

The following demographic variables were assessed by the survey:

- Age;
- Two cross-streets closest to home;
- Residential zip code;
- Gender;
- Race/ethnicity;
- Employment status;
- Educational attainment;
- Number of children per household;
- Number of people per household; and
- Total household income in the past 12 months for all adults in the household.

See [Appendix A: Pedestrian and Bicycling Survey](#) for the complete survey questionnaire used in this research.

49. Kevin J. Krizek, Ann Forsyth, and Asha Weinstein Agrawal, *Pedestrian and Bicycling Survey (PABS): User's Manual* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010), 1-54.

50. McCallum Layton, "Stats Calculator: Sample Size," 2014, accessed September 28, 2014, <https://www.mccallum-layton.co.uk/tools/statistic-calculators/sample-size-calculator/>.

51. Ann Forsyth, K. Krizek and A. W. Agrawal, *Measuring Walking and Cycling Using the PABS (Pedestrian and Bicycling Survey) Approach: A Low-Cost Survey Method for Local Communities* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010) 1.



### 3.2 BENEFITS OF THE PABS

Every type of data collection has advantages and drawbacks. The PABS was designed to balance sufficient sample quality, expense considerations, and likely response rates.<sup>52</sup> The tradeoffs of other methods—intercept surveys, counters, trip diaries, phone surveys, and qualitative methods—are explored in detail by the survey authors in *Measuring Walking and Cycling Using the PABS (Pedestrian and Bicycling Survey) Approach: A Low-Cost Method for Local Communities*.<sup>53</sup>

The PABS was selected for this project because it affords many advantages over other survey instruments. First, the PABS methods produce a random sample, which is necessary if findings are to be generalized to the entire San Francisco population. A mail survey was chosen because internet and phone surveys exclude low-income residents without access to the internet or phone service, thereby precluding the achievement of a true cross-section of the community. Intercept surveys were disregarded because their findings are difficult to apply to the general population.

An important benefit of the PABS is its low-cost approach. Mail surveys can sometimes be prohibitively expensive due to the costs of generating a sample sufficient for a large city, including acquiring addresses, printing

questionnaires, and paying for postage. However, the PABS minimizes some of these expenses. For example, cluster-sampling postal carrier routes reduced the cost of acquiring mailing addresses. (For more detail on the cluster sampling and other methods employed, see *Section 3.3.3: Drawing the Sample*.)

Another key advantage of the PABS over other instruments is its ability to measure trips made in the past month or year, thereby assessing both regular and infrequent use of non-motorized transport.<sup>54</sup> By considering a longer time period than many other surveys do, the PABS provides information that is often absent from other travel diaries and surveys.<sup>55</sup> For example, with the PABS it is possible to account for regular users who did not walk or bike within the last week due to poor weather.

The Pedestrian and Bicycling Survey also offers researchers the unusual benefit of tested reliability; most questions achieved satisfactory to excellent reliability in efficacy assessments.<sup>56</sup> Typically, transportation researchers are unable to determine the likelihood that survey participants would report similar behaviors consistently over time.<sup>57</sup> However, independent testing and subsequent re-testing of each of two iterations of the PABS one week later demonstrated its dependability.<sup>58</sup>

The data collected as part of this research project may prove useful to other researchers for a variety of applications. Travel information for both the last week and a typical week can enable more sophisticated statistical analysis than is encompassed by this investigation. The application of Poisson statistics, i.e., “a discrete probability distribution for the counts of events that occur... in a given interval of time (or space),” may be used to ascertain the likelihood a respondent walked or cycled a specific number of days in the past week.<sup>59</sup> Information regarding other modes of travel – vehicular or public transit – may be useful for future analysis. Studies of non-motorized transport for recreational purposes may also find uses for this data.

52. Ann Forsyth, K. Krizek and A. W. Agrawal, *Measuring Walking and Cycling Using the PABS (Pedestrian and Bicycling Survey) Approach: A Low-Cost Survey Method for Local Communities* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010) 11.

53. *Ibid.*, 7-10.

54. *Ibid.*, 11.

55. *Ibid.*, 10.

56. *Ibid.*, 2.

57. *Ibid.*, 2.

58. Ann Forsyth, Kevin J. Krizek, Asha W. Agrawal and Eric Stonebraker, “Reliability Testing of the Pedestrian and Bicycling Survey (PABS) Method,” *Journal of Physical Activity & Health* 9, no. 5 (July 2012): 677.

59. Jonathan Marchini, “The Poisson Distribution,” (lecture Department of Statistics, University of Oxford, United Kingdom, November 10, 2008) 4, accessed December 12, 2014, <http://ow.ly/FPvNW>.

### 3.3 ADMINISTERING THE PABS

The authors of the Pedestrian and Bicycling Survey prepared a guide for its implementation, the *Pedestrian and Bicycling Survey PABS User's Manual*.<sup>60</sup> This research follows the process outlined in that report. Each step of the data collection procedures is described below.

#### 3.3.1 MODIFICATIONS TO THE PABS QUESTIONNAIRE

The PABS questionnaire was implemented as originally designed by the survey authors, except for a few modifications. When information for a variable was unavailable from the *2010 Census* or the *2012 American Community Survey Five-Year Estimates* at the block group level, the corresponding PABS question was omitted from the survey.<sup>61</sup> One question to measure educational attainment was added, because the literature review found this variable to correlate to utility biking. (See [Appendix A](#) for the complete survey questionnaire used in this research.)

#### 3.3.2 ESTIMATING RESPONSES

One goal of this research is to achieve a confidence level of 95 percent and a confidence interval of five percent, which requires a minimum of 384 completed surveys for a city

with San Francisco's population size. The PABS San Jose field test yielded a return of 16 percent when survey envelopes were hand-addressed, specifying the resident's name in blue ink.<sup>62</sup> Per the recommendations of the field-test authors, this addressing procedure was implemented, and residents were contacted multiple times. In addition to the survey, an advance notice and reminder post card was mailed to each potential respondent. This additional contact justified a modest increase of the estimated response rate to 20 percent. An online sample-size calculator was used to determine that 2,000 potential respondents must be contacted to achieve the minimum target.<sup>63</sup>

#### 3.3.3 DRAWING THE SAMPLE

A cluster sample of postal carrier routes was used to mitigate project costs associated with drawing the sample, in keeping with the recommendations of the survey authors. The city of San Francisco is a large study area, with over 800,000 residents and more than 375,000 housing units.<sup>64</sup> Given this sizeable population, it is prohibitively expensive to obtain addresses that include resident names for every housing unit. To obtain the cluster sample, the entire population was divided into groups and a random sample of these groups was selected. First, a

complete list of all 642 San Francisco postal carrier routes with residential addresses was acquired from *MelissaData*, a commercial mailing lists vendor.<sup>65</sup> A random sample of 65 routes was created using Microsoft Excel's random number generator. The selected routes, including over 27,000 addresses, were then purchased from *MelissaData* for \$321. From a composite list of all purchased addresses, 2,000 were randomly selected, again using Excel's random number generator. The procedure for extracting the cluster sample is detailed in the *Pedestrian and Bicycling Survey PABS User's Manual*.<sup>66</sup>

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60. Kevin J. Krizek, Ann Forsyth, and Asha Weinstein Agrawal, *Pedestrian and Bicycling Survey (PABS): User's Manual* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010), 1-54.

61. United States Census Bureau: American FactFinder, "2012 ACS 5-year estimates," 2008 – 2012 American Community Survey, U.S. Census Bureau's American Community Survey Office, 2012, accessed July 20, 2014, <http://factfinder2.census.gov>; United States Census Bureau: American FactFinder, "2010 SF1 100% Data," 2010 Census, U.S. Census Bureau, 2010, accessed July 20, 2014, <http://factfinder2.census.gov>.

62. Ann Forsyth, K. Krizek, and A. Agrawal, *Measuring Walking and Cycling Using the PABS (Pedestrian and Bicycling Survey) Approach: A Low-Cost Survey Method for Local Communities* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010), 27.

63. Creative Research Systems, "Sample Size Calculator," accessed March 15, 2014, <http://ow.ly/EydDS>.

64. Association of Bay Area Governments and Metropolitan Transportation Committee, "Bay Area Census," accessed February 7, 2014, <http://ow.ly/EydOO>.

65. Melissa Data, "Lookups: Carrier Routes by Zip Code," accessed April 10, 2014, <http://ow.ly/Eye4q>.

66. Kevin J. Krizek, Ann Forsyth, and Asha Weinstein Agrawal, *Pedestrian and Bicycling Survey (PABS): User's Manual* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010), 22-25.

### 3.3.4 TRANSLATING THE SURVEY INTO MULTIPLE LANGUAGES

San Francisco's demographics indicate the likelihood that many potential respondents might be deterred by a survey written only in English. The city's diverse population is 33.3 percent Asian, 6.1 percent Black or African American, and 48.5 percent white, and those with Hispanic or Latino ethnicity comprise 15.1 percent of all residents.<sup>67</sup> To address this concern, the English survey was translated into Spanish and Mandarin, and the survey that was mailed included all three languages.

### 3.3.5 IRB PERMISSION AND PROTECTION OF RESPONDENT PRIVACY

The San Jose State University Institutional Review Board approved this research project. A strategy for safeguarding respondent privacy was devised as a condition of this approval. Specifically, the survey mailing addresses were stored on a hard drive located in a locked filing cabinet, along with the returned and completed hard-copy surveys. Only the author of this report had access to this filing cabinet.

### 3.3.6 MAILING THE SURVEY

Mailings occurred during the school year in order to capture more-typical travel behavior.<sup>68</sup> On May 5th, an advance-notice postcard was sent out that briefly explained the purpose of the study. One week later, the survey, along with a cover letter and a postage-paid return envelope, were mailed first-class in an envelope hand-addressed with blue ink. Finally, a reminder postcard was sent out on May 27th.

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67. Association of Bay Area Governments and Metropolitan Transportation Committee, "Bay Area Census," accessed February 7, 2014, <http://ow.ly/EydOO>.

68. Kevin J. Krizek, Ann Forsyth, and Asha Weinstein Agrawal, *Pedestrian and Bicycling Survey (PABS): User's Manual* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010) 20.

### 3.4 PREPARING COLLECTED DATA FOR ANALYSIS

This section describes the process required to transform the data from the returned surveys into a dataset tailored for use in the logistic regression models in this report. First, descriptive statistics of delivered and returned surveys are provided. Next, the coding process and treatment of incomplete responses is reviewed and explicated; this critical step illustrates how the number of cases for analysis has been determined. Finally, the resulting sample is compared to the San Francisco population to see if it is representative.

#### 3.4.1 DELIVERED AND RETURNED SURVEYS

16.1 percent of mailed surveys (17.1 percent of those delivered) were filled out by respondents and sent in, a response rate lower than the anticipated 20 percent. The PABS was sent to 2,000 San Francisco residents. A total of 121 surveys were returned for incorrect addresses, representing 6.1 percent of mailed surveys (Table 5). Therefore, it is assumed that 1,879 surveys were properly delivered. Of those returned by residents, 321 were at least partially completed.

#### 3.4.2 DATA ENTRY RULES

Guidelines for inputting survey data were developed and followed as explained below and in the following sections.

**Table 5. Delivery and response rates for the PABS (out of 2,000 surveys mailed)**

Delivered and returned surveys	Number	Percentage of mailed surveys	Percentage of delivered surveys
Returned for incorrect address	121	6.1%	...
Delivered	1,879	94.0%	100%
Not returned	1,545	77.3%	82.2%
Returned blank	13	0.7%	0.7%
At least partially completed	321	16.1%	17.1%
Used in analysis samples	271	13.6%	14.4%

Replies were recorded precisely as written on the original, with the following exceptions:

- Where multiple time periods were checked, the most recent was recorded (Question #3). For example, if a resident indicated the most recent time he or she biked to public transit was both in the last 7 days and last month, only the last week was entered.
- If a range of days was provided, the midpoint was used (Questions #4-12).
- If the number of days contained a decimal, it was rounded up (Questions #4-12).
- Where two digits were given for the year born, "19" was added in front of the two digits (Question #13).<sup>69</sup>
- When a written note indicated that a resident did not bike, and the number of days they biked was missing, a "0" was input.
- If "NA or not applicable," was written for the number of days walked or biked, a "0" was coded (Questions #4-12).
- If a written explanation for an "other" response was unclear, a "999" (the code for missing responses) was assigned (Questions #17-19).
- For all other missing or unusable answers, "999" was entered.<sup>70</sup>

69. Kevin J. Krizek, Ann Forsyth and Asha Weinstein Agrawal, *Pedestrian and Bicycling Survey (PABS): User's Manual* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010) 27.

70. *Ibid.*, 27.

### 3.4.3 TREATMENT OF DATA ISSUES

Many returned surveys were incomplete; this section describes how each of the types of incompleteness was treated. Types of incompleteness are as follows: PABS **Question #20** – the number of children in the household – yielded an excessive number of missing responses, and a new approach to coding this question was devised as a result. Largely incomplete surveys required a policy to determine how much missing data was acceptable. Ambiguous data was also a concern; for example, more than 25 percent of respondents indicated that they were out of town at some point in the past seven days. (This is meaningful to the data in that, if a respondent was out of town for any period, their non-motorized transport for that week may not have occurred in San Francisco.) The procedure for addressing each of these issues is described below.

#### Re-Coding the Number of Children and Adults in the Household

Over 40 percent of the sample failed to provide the number of children in their household. A careful review of the responses revealed that the format of the question may have been an issue, because it asked for both the number of children and the number adults in the household (see **Question #20 in Appendix A: The Pedestrian and**

**Bicycling Survey**). Many respondents who omitted the number of children in their household provided the number of adults. Because these people made an effort to complete the question, it is assumed they do not live with children. Therefore, the following procedures were established for re-coding responses to **PABS Question #20**:

- If the number of adults was left blank it was input as “999,” which is the code for missing responses.
- Where the number of adults was written as a “0”, it was re-coded as a “1” to include the respondent.
- When the number of adults was provided and the number of children was missing, a “0” was coded for the number of children.
- If the number of adults was left blank and the number of children was missing, a “999” was entered for the number of children.

#### Removing Surveys with Too Much Missing Data

When a returned survey is predominantly blank, it fails to provide researchers with enough information for statistical analysis. Demographic information is critically important for the logistic regression models because each of these independent variables controls for the others. To

ensure sufficient data for the statistical analysis, surveys were removed from the analysis sample if they met any of the following criteria:

- There were multiple missing responses within the following categories of travel information collected:
  - How often one biked or walked within the last week;
  - How recently one used specific travel modes; and
  - The frequency of mode use in a typical week.
- There were 10 or more missing responses, at least one of which was in each of the travel classes listed above.
- Any demographic question was missing a response.
- Gender was coded as “prefer not to say.”

While it would be interesting to see how people who declined to state their gender correlated to walking and biking for utility, unfortunately it was not possible. Only five people chose not to state their gender, which was an insufficient number to generate meaningful correlations.

### Treatment of Respondents Who Had Travelled Out of Town

If a respondent had travelled out of town in the week prior to filling out the survey, replies for how often he or she walked or biked could have included travel from other locations. This research is strictly concerned with non-motorized transport in San Francisco. However, given the limited size of the dataset, removing all 85 people who were out of town and the five people who left this question blank would have severely impacted the sample. Instead, a different approach was implemented: any resident that walked or biked more days than he or she was out of town remained in the sample. For example, if in the last week a respondent had been out of town for four days, and had walked five days and biked three days, only the walk information would be included in the statistical models. This practice guaranteed that at least some of the reported non-motorized transport occurred in San Francisco.

**Table 6. Sample quantity: cases for statistical analysis**

Survey condition	Number
At least partially completed and returned	321
Discarded for out of town or excessive missing data	14
Discarded due to blank demographic data	36
Deemed “complete” and used for analysis models	271

When the out-of-town threshold was not met, a code of “888” (akin to “999” / missing response) was recorded. Consequently, any survey containing an “888” was re-evaluated to assess the amount of missing or insufficient answers. Surveys meeting the following criteria were eliminated:

- The total number of all “999” and “888” answers was 10 or more.
- A respondent incorrectly indicated that he or she was out of town for more than 7 days in the past week.

### 3.4.4 THE TOTAL NUMBER OF CASES FOR LOGISTIC REGRESSION MODELS

As described above, the sample for analysis was derived by re-coding household size, removing surveys with excessive missing information, and accounting for ambiguous out-of-town responses. Of the original 321 returned surveys, 14 were eliminated due to excessive missing data, and an additional 36 were rejected due to blank demographic responses, leaving 271 for the analysis sample, which represented 14.4 percent of delivered surveys (Table 6).

### 3.4.5 IS THE SAMPLE REPRESENTATIVE OF THE POPULATION OF SAN FRANCISCO?

To apply findings to the general population, the sample must be representative. For example, the percentage of seniors in the sample should align with the percentage of San Franciscans who were reported as seniors in the US Census. However, surveys do not generate perfectly representative samples; for that, a full census would be required.

As laid out in [Table 7](#), the sample obtained was somewhat representative of the population of San Francisco overall. The sample was closely representative (within five percentage points) of the population in terms of gender, presence or absence of children in household, and percentage with an annual income between \$40,000 and \$99,999. Several demographics are under-represented in the sample: young adults, minorities, low-income residents, people who are not in the labor force, and those without a bachelor's degree. Conversely, seniors, middle aged adults, white people, those who earn incomes of \$100,000 or more, those in the labor force, and those who have attained a bachelor's-degree-or-higher level of education are over-represented.

Consult [Section 3.5.1: Independent Demographic Variables](#) for definitions of each cohort in the table.

**Table 7. San Francisco population compared to sample (per 2010 Census and 2008-2012 ACS)**

Demographic	Percent in Sample	Percent in San Francisco	Difference
<i>Representative cohorts</i>			
Males	50.9%	50.7%	0.2%
Females	49.1%	49.3%	-0.2%
Household income from \$40,000 to \$99,999	31.7%	30.7%	1.1%
Households with children under 18	19.9%	18.4%	1.5%
Households without children under 18	80.1%	81.6%	-1.5%
<i>Under-sampled cohorts</i>			
Not in the labor force	21.0%	31.2%	-10.2%
Young adults aged 18 to 34 years	15.9%	30.5%	-14.6%
Household income less than \$40,000	11.1%	30.8%	-19.8%
No bachelor's degree	22.1%	48.0%	-25.9%
Minorities	31.7%	58.1%	-26.4%
<i>Oversampled cohorts</i>			
Seniors 65 and older	22.5%	13.6%	8.9%
In the labor force	79.0%	68.8%	10.2%
Household income from of \$100,000 or more	56.5%	38.5%	17.9%
Middle aged 35 to 64 years	61.6%	42.5%	19.1%
Completion of a bachelor's degree or higher	77.9%	52.0%	25.9%
Whites	68.3%	41.9%	26.4%

Source: United States Census Bureau: American FactFinder, "2008 – 2012 American Community Survey" U.S. Census Bureau's American Community Survey Office, 2012, accessed July 20, 2014, <http://factfinder2.census.gov>; United States Census Bureau: American FactFinder, "2010 Census," U.S. Census Bureau, 2010, accessed July 20, 2014, <http://factfinder2.census.gov>.

Note: Household Income is measured for the past 12 months in 2012 dollars. Education, income and employment data for San Francisco is from the 2008-2012 American Community Survey. All other data for SF is from the 2010 Census.

### 3.5 DEFINITIONS OF DEPENDENT AND INDEPENDENT VARIABLES FOR BINARY CODING

Because binary logistic regression analysis was used to determine which types of people are associated with walking or biking for utility, all demographic and travel variables had to be split into two groups (0, 1) to be coded. Definitions and code assignments for each variable were determined as described in this section.

#### 3.5.1 INDEPENDENT DEMOGRAPHIC VARIABLES: DEFINING GROUPS FOR CODING

Treatment of demographic variables is described here, and the resulting coding is charted in [Table 8](#) in the section that follows.

##### Race and Ethnicity

Race was divided into minorities and whites. A minority is defined as a person who is African American or Black; American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; or any combination of these races. Per the Caltrans Title VI Program definitions, a person who is of Hispanic or Latino origin, regardless of race, is also considered a minority.<sup>71</sup>

##### Gender

Gender was determined by legal gender.

##### Employment Status

Employment status was classified as people in the labor force and those not in the labor force. To be considered part of the labor force, a person must have: worked for pay either from home or

outside the home, been a member of the armed forces, or been looking for employment. All others were not counted as part of the labor force, including students, homemakers, retired people, and the disabled.

##### Presence of Children

Households were split into those with one or more child under the age of 18 and those without children.

##### Educational Attainment

Only two respondents did not have a high school degree. To generate sufficient frequencies for statistical analysis, residents with a bachelor's degree or higher level of educational attainment were separated from those who did not have a bachelor's degree.

##### Age

Prior to being dichotomized, age was broken into three cohorts: young adults aged 18-34, middle aged adults from 35 to 64 years old, and seniors aged 65 or older. Binary coding for each group is explained in [Section 3.5.2: Demographic Variables: Coding](#).

##### Income

Several income variables were tested in the statistical analysis: three measured household income in the past 12 months, and two studied annual per capita income. For the past year's household income, "Income \$60k" split residents into those who earned less than \$60,000 in the last year and those who made \$60,000 or more. This threshold was moved to \$80,000 for "Income \$80k" and to \$120,000 for "Income

\$120k." For per capita income, residents with an income less than \$40,000 per person were separated from those earning \$40,000 or more in "Low Per Capita Income," while "High Per Capita Income" moved the division line to \$100,000.

#### 3.5.2 DEMOGRAPHIC VARIABLES: CODING

In binary logistic regression, each pair of cohorts being analyzed is made of one group that is assigned a code of "1" and another that is coded as "0." An Exp(B) value (odds ratio) greater than one signifies those recorded as "1" have greater odds of using non-motorized transport than those given a "0." For Exp(B) values less than one, the inverse is true: those coded as "0" are more likely. Coding for each variable is listed in [Table 8](#).<sup>72</sup>

*Note:* All regression models incorporated two of the three age classifications. This approach permitted a comparison between age cohorts included in the model and those in the excluded group.

71. Caltrans, "Title VI Program Civil Rights," California Department of Transportation, 2000, accessed September 7, 2014, <http://ow.ly/Eyevr>.

72. James Lee, "Binary Logistic Regression," (lecture presented for JS 203 Seminar in Applied Statistics in Justice, San Jose State University, San Jose, CA) 3, accessed March 7, 2014, <http://ow.ly/EycQu>.

**Table 8. Binary coding of independent demographic variables**

Independent variable	Recorded as “1”	Recorded as “0”
Race	Minorities	Whites
Gender	Males	Females
Employment status	People in the labor force	People not in the labor force
Presence of children	Households with children	Households without children
Educational attainment	Bachelor’s degree or higher	No bachelor’s degree
Young age	Young adults aged 18 to 34 years	All other age groups
Middle age	Middle aged 35 to 64 years	All other age groups
Seniors	65 years and older	All other age groups
Income \$60k	Household Income < \$60,000	Household Income => \$60,000
Income \$80k	Household Income < \$80,000	Household Income => \$80,000
Income \$120k	Household Income < \$120,000	Household Income =>\$120,000
Low Per Capita Income	Per Capita Income < \$40,000	Per Capita Income => \$40,000
High Per Capita Income	Per Capita Income < \$100,000	Per Capita Income => \$100,000

Source: United States Census Bureau: American FactFinder, “2008 – 2012 American Community Survey” U.S. Census Bureau’s American Community Survey Office, 2012, accessed July 20, 2014, <http://factfinder2.census.gov>; United States Census Bureau: American FactFinder, “2010 Census,” U.S. Census Bureau, 2010, accessed July 20, 2014, <http://factfinder2.census.gov>.

**Table 9. Number of cases for dependent travel variables**

Dependent variables	Number of cases
<i>Utility Walking</i>	
In the past week	264
Commute to work or school in a typical week	266
<i>Utility Biking</i>	
In the past week	247
Commute to work or school in a typical week	269

### 3.5.3 NON-MOTORIZED TRANSPORT: DEPENDENT VARIABLES

Two utility variables per mode were analyzed for both walking and biking: one assessed travel within the last week, and the other measured commuting to work or school in a typical week.

### 3.5.4 NMT DEPENDENT VARIABLES: CODING AND SAMPLE SIZES

Each variable dichotomized residents into those who used the mode of transportation being tested and those who did not. People who walked or biked were coded as “1” and all others were assigned a “0”.

In the PABS, San Franciscans were asked both the most recent time they walked or biked and the number of days they did so. Occasionally, inconsistent information was provided. If for any question a resident indicated that he or she used non-motorized transport in the past week, a “1” was coded in the model.

The number of cases for each regression model varied slightly due to missing responses or people who did not meet the out-of-town threshold. The sample size for each dependent variable is listed in [Table 9](#).

### 3.6 BINARY LOGISTIC REGRESSION FINDINGS

There were some predictable and some unexpected findings from the PABS data analysis. It was as expected that a small percentage of people biked, and that young age was positively related to utility biking; it was more surprising that most everyone walked, and that female gender was associated with increased walking to work or school. These findings are described in this section by mode. Descriptive statistics reveal the percentage of residents who walked or biked for utility, as well as the frequency of their trips. Statistically significant correlations between walk or bike trips and socio-demographic variables are also recorded, and include, for example, an unexpected finding regarding gender.

There was very little difference in the number of people who walked or biked in the last week versus the past month. Therefore, logistic regression analysis was only completed for the past-week variables.

Findings for travel that occurred within the past week are presented first because they are most likely to capture regular users. Results for commute trips in a typical week are also explained in order to identify regular users that may have been missed in the past-week data.

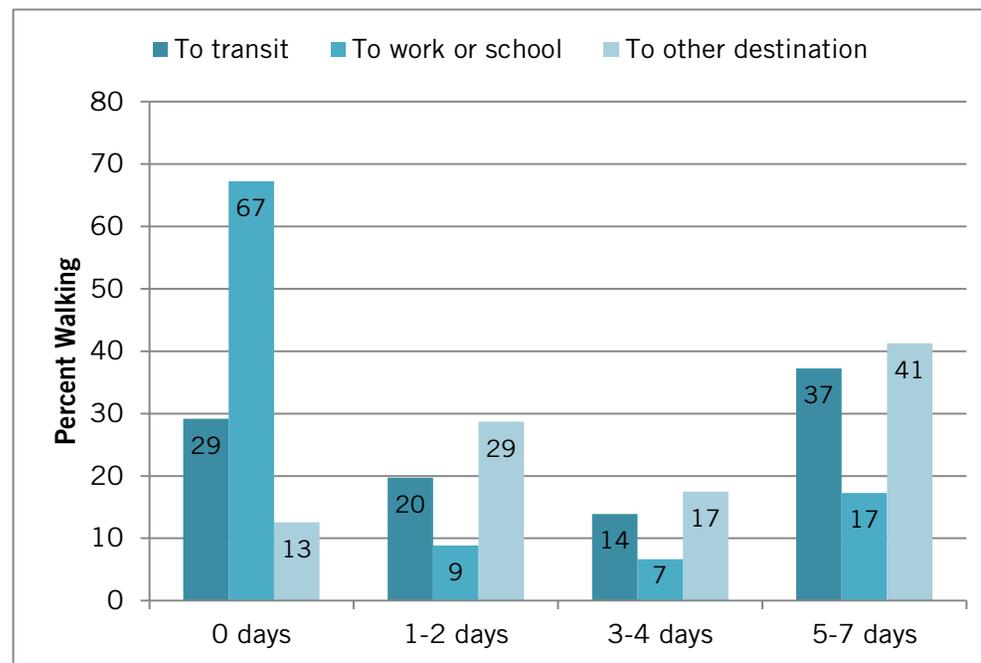
#### 3.6.1 WALKING WITHIN THE LAST SEVEN DAYS

Nearly all San Franciscans sampled – an impressive 96 percent – had walked for utility in the past week. Fewer residents walked to work or school than for other utility purposes (Table

10). Only 32 percent of pedestrians commuted solely on foot, while 68 percent walked to transit and 83 percent walked to other destinations. Regardless of trip purpose, more people walked at least five days out of the week than those who walked 1-2 or 3-4 days (Figure 10).

**Table 10. Percentage of residents who walked in the past 7 days by trip purpose**

Walk trip purpose	Percentage of respondents
To transit	68%
To work or school	32%
Destination other than work, school, or transit	83%



**Figure 10. Percent of sample by number of days walked within past week per trip purpose**

### 3.6.2 WALKING TO WORK OR SCHOOL IN A TYPICAL WEEK

Most San Franciscans walked for utility, yet just 42 percent walked to work or school in a typical week. Of those residents who were employed or students, 47 percent walked for their entire commute and 30 percent did so at least five days (Figure 11).

Gender turned out, surprisingly, to be related to walking to work or school in a normal week (Table 11). In fact, females were 1.96 times more likely to commute via walking than were males. Depending on the income variable tested, gender was significant at a one- or two-percent level. Refer to Table 11 for regression model outcomes.

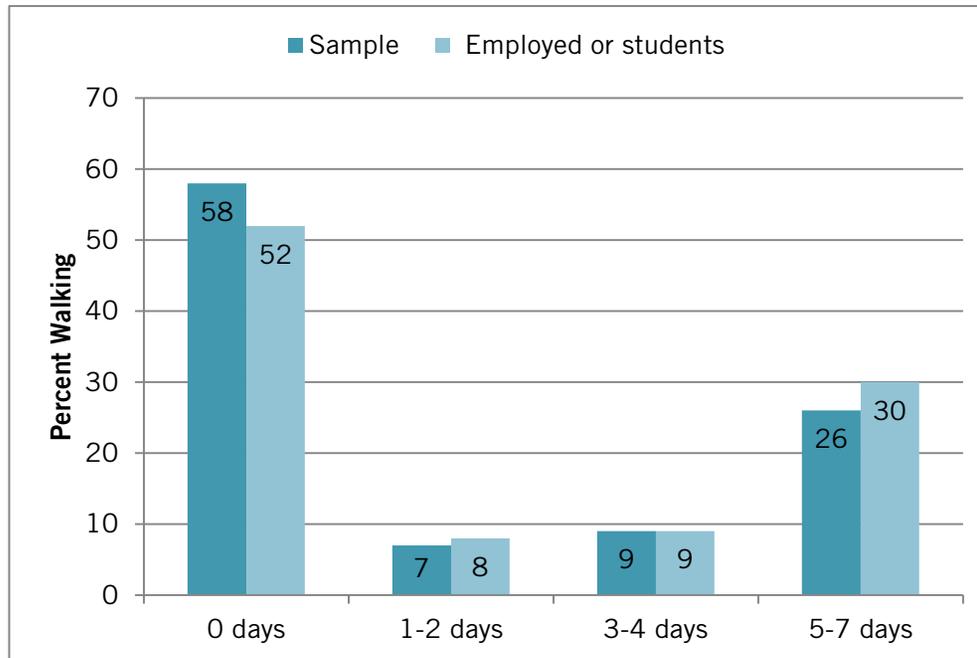


Figure 11. Percent of sample and of employed people/students by number of days walked within past week

Table 11. Binary logistic regression of walking to work or school in a typical week

Independent variables	B	S.E.	Wald	df	Sig.	Exp(B)
Step 1 <sup>a</sup>						
<b>Gender</b>	-.670	.268	6.247	1	<b>.012</b>	<b>.512</b>
Race	.086	.284	.091	1	.763	1.089
Employment	1.118	.433	6.662	1	.010	3.060
Education	.007	.331	.000	1	.983	1.007
Children in household	.064	.343	.035	1	.852	1.066
Middle age	-.059	.367	.026	1	.872	.943
Senior	-.310	.496	.391	1	.532	.733
High per capita income	-.372	.386	.929	1	.335	.689
Constant	-.804	.577	1.943	1	.163	.448

Note: Bold text indicates a demographic variable with a statistically significant correlation.

a. Variables entered on Step 1: Gender, Race, Employment, Education, Children in household, Middle age, Senior status, and High per-capita income.

### 3.6.3 BIKING WITHIN THE LAST WEEK

Relatively few people in the sample biked. Just 18 percent of residents cycled for utility in the past week. More people biked to work or school than to transit. A total of 11 percent of residents rode to work or school, while 6 percent cycled to transit and 13 percent biked to other destinations (Table 12).

Seniors cycled less than all other age groups. Compared to seniors, young adults were 3.8 times more likely to bike for utility, and middle-aged adults were 3.3 times as likely (Table 13). Both of these findings were significant, at a level slightly above 10 percent.

### 3.6.4 BIKING TO WORK OR SCHOOL IN A TYPICAL WEEK

Just 13 percent of the sample normally commuted to work or school via bike. Of those residents who were employed or students, 15 percent regularly biked to work or school.

**Table 12. Percentage of bike trips in the past 7 days by trip purpose**

Bike trip purpose	Percentage of respondents
To transit	6%
To work or school	11%
Destination other than work, school, or transit	13%

**Table 13. Binary logistic regression of utility biking in the past 7 days**

Independent variables	B	S.E.	Wald	df	Sig.	Exp(B)
Step 1 <sup>a</sup> Gender	.271	.360	.568	1	.451	1.312
Race	.061	.381	.026	1	.872	1.063
Employment	.225	.672	.112	1	.737	1.253
Education	.447	.494	.820	1	.365	1.564
Children in household	.324	.407	.630	1	.427	1.382
<b>Young age</b>	1.340	.825	2.640	1	<b>.104</b>	<b>3.820</b>
<b>Middle age</b>	1.199	.746	2.582	1	<b>.108</b>	<b>3.316</b>
High per capita income	-.079	.503	.025	1	.875	.924
Constant	-3.367	.769	19.168	1	.000	.035

Note: Bold text indicates a demographic variable with a statistically significant correlation.

a. Variable(s) entered in Step 1: Gender, Race, Employment, Education, Children in household, Young age, Middle age, and High per capita Income.

### 3.6.5 SUMMARY OF KEY FINDINGS

#### Walk Findings

Almost all residents in the sample walked for utility in the past week. Few people walked for their entire commute to work or school, yet most respondents walked to transit and walks to other destinations were common. These results suggest that San Franciscans are unique in that nearly everyone walks for utility—a happy result, indeed.

The most surprising result was in the gender variable correlation; though gender was not identified by the literature review as a correlate to utility walking, the PABS found that females were 1.96 times more likely to walk to work or school in a typical week than males.

#### Bike Findings

The PABS confirmed that young age was associated with increased utility biking. In this way, San Franciscans validate utility biking research conducted in many other locations: Bangalore, India; Curitiba, Victoria and Recife, Brazil; Adelaide, Austria; and the 2003 national Canadian Community Health Survey.<sup>73</sup>

A small percentage of San Franciscans biked for utility, consistent with research for other

locations. In the past seven days, nearly twice as many people had commuted to work or school by bicycle than to transit. In a typical week, 15 percent of residents who were employed or students commuted to work or school via bike.

### 3.6.6 STUDY LIMITATIONS

All findings must be evaluated within the limitations of the research design. Several issues must be acknowledged to clarify the scope of these findings:

- This research does not prove a causal relationship for specific dependent variables. Instead, it establishes correlation, fulfilling one condition required to prove a causal relationship. Findings from this project provide a starting point from which future studies can establish causation.
- Small sample size is a considerable limitation of this research. A confidence level of 90% was realized because only 271 surveys contained sufficient information for statistical analysis.<sup>74</sup>

- The sample diverged from the full population by 5 percentage points or more along a number of variables: age, race, employment status, educational attainment and those earning a high or low income. Consult [Section 3.4.5: Is the Sample Representative of the Population of San Francisco?](#) for a comparison of specific cohorts.
- Walking and biking trips are frequently overestimated in survey responses because they are “considered to be a virtuous behavior.”<sup>75</sup>

73. Neville Owen, Ilse De Bourdeaudhuij, Takemi Sugiyama, Eva Leslie, Ester Cerin, Delfien Van Dyck and Adrian Bauman, “Bicycle use for Transport in an Australian and a Belgian City: Associations with Built-Environment Attributes,” *Journal of Urban Health* 87, no. 2 (March 2010): 194; Pnina O. Plaut, “Non-Motorized Commuting in the US,” *Transportation Research: Part D* 10, no. 5 (September 2005): 350; Rodrigo S. Reis, Adriano A. F. Hino, Diana C. Parra, Pedro C. Hallal and Ross C. Brownson, “Bicycling and Walking for Transportation in Three Brazilian Cities,” *American Journal of Preventive Medicine* 44, no. 2 (February, 2013): e11; T. M. Rahula and Ashish Vermab, “Study of Impact of various Influencing Factors on NMT Mode Choice,” *Procedia - Social and Behavioral Sciences* 104 (December 2013): 1112, 1115; Meghan Winters, Melissa C. Friesen, Mieke Koehoorn and Kay Teschke, “Utilitarian Bicycling: A Multilevel Analysis of Climate and Personal Influences,” *American Journal of Preventive Medicine* 32, no. 1 (January 2007): 54.

74. McCallum Layton, “Stats Calculator: Sample Size,” 2014, accessed September 28, 2014, <https://www.mccallum-layton.co.uk/tools/statistic-calculators/sample-size-calculator/>.

75. Kevin J. Krizek, Ann Forsyth and Asha Weinstein Agrawal, *Pedestrian and Bicycling Survey (PABS): User’s Manual* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010) 29.



# CHAPTER FOUR

## MAPPING CORRELATES TO UTILITY WALKING

This chapter describes the mapping analysis used to identify locations across the city that have many predictors of non-motorized transport. The results will help city officials target new pedestrian improvements in places where they are likely to be well used because they comprise populations and physical characteristics that are particularly receptive to utility walking.

The chapter begins with an explanation of the demographic and environmental variables known to correlate with walking that were chosen for mapping. The next section describes the procedures for mapping each variable and creating the composite suitability-assessment maps that reflect the sum of all findings. The last section reviews the findings from the mapping analysis to identify those locations where pedestrian improvements are expected to increase walking rates most effectively.

### 4.1 DECIDING WHICH CORRELATES TO MAP

A literature review was prepared for this study to determine which demographic and environmental characteristics positively influence non-motorized travel behavior, and the results informed the mapping analysis described throughout this chapter and [Chapter Five](#). Studies of objective

measures were the focus of this evaluation; research on perceptions of the built environment and other stated preferences was excluded.

The literature review assessed the following themes:

- What demographic and environmental factors are correlated with utility walking?
- What demographic and environmental factors are correlated with utility biking?

The literature review (findings presented in brief in [Table 14](#); sources listed in [Appendix C](#)) revealed substantial evidence that earning a low income and being of young age are strong predictors of the propensity to walk for utility. A few reports suggested white people, residents with limited access to a motor vehicle, and those who take public transit are also more inclined to walk for transport. Findings for gender, education, and marital status were ambiguous.

[Table 14](#) also shows which of these demographic correlates were mapped, and gives the reasons for omitting those variables not mapped. Although females were nearly twice as likely to walk to work as males in the PABS, gender was not mapped because the literature review

findings were inconsistent. Education and marital status were excluded for the same reason. Access to a motor vehicle was left out because this data was unavailable at the block-group level. White race was omitted because intentionally locating non-motorized transport improvements in white areas violates Title VI of the Civil Rights Act of 1964. The density of young people, those earning a low income, and public transit users were mapped across San Francisco to identify places where the population is most likely to walk for utility.

The literature review also found considerable support that population density, residential density, and land-use mix correlated to walking for transport ([Table 15](#)). One investigation in Seattle and a comprehensive literature review of over 300 studies found steep slopes were a deterrent. Findings for street connectivity, the presence of pedestrian infrastructure, and proximity to public transit were ambiguous, and thus were omitted. All other environmental correlates were mapped.

**Table 14. Determining which demographic correlates to utility walking to map**

Correlates	Literature review findings	Relationship found by PABS?	Data available?	If not mapped, why not?
<i>Mapped correlates</i>				
Young age	<ol style="list-style-type: none"> <li>1. Younger people were more likely to walk than their senior counterparts in five studies.</li> <li>2. An inquiry focused on respondent perceptions found young and senior populations walked more for utility than did middle-aged people.</li> </ol>	No	Yes	N/A
Low income	<ol style="list-style-type: none"> <li>1. A significant correlation was found by three studies and an extensive literature review.</li> <li>2. Two additional reports found a correlation with residents who lived in disadvantaged areas.</li> <li>3. No conflicting evidence was discovered.</li> </ol>	No	Yes	N/A
Public transit use	<ol style="list-style-type: none"> <li>1. Two studies found a positive relationship.</li> <li>2. No conflicting evidence was discovered.</li> </ol>	No	Yes	N/A
<i>Unmapped correlates</i>				
Gender	<ol style="list-style-type: none"> <li>1. Findings were ambiguous.</li> </ol>	Yes	Yes	Correlation direction was inconsistent.
Motor vehicle access	<ol style="list-style-type: none"> <li>1. Limited motor vehicle access was positively associated in three investigations.</li> <li>2. A survey in Seattle found conflicting results: an inverse correlation with higher VMT and a positive relationship with the number of cars per household.</li> </ol>	No	No	Data for motor vehicle access was not available at the block group level.
White race	<ol style="list-style-type: none"> <li>1. White people walked less than minorities in two studies.</li> <li>2. Another assessment which included few minorities found race to be insignificant.</li> </ol>	No	Yes	Intentionally locating transportation improvements in predominately white areas violates Title VI of the Civil Rights Act of 1964.
Educational attainment	<ol style="list-style-type: none"> <li>1. Findings were ambiguous.</li> </ol>	No	Yes	Correlation direction was inconsistent.
Marital status	<ol style="list-style-type: none"> <li>1. Findings were ambiguous.</li> </ol>	No	Yes	Correlation direction was inconsistent.

Source: See Appendix C for literature review sources by correlate.

**Table 15. Determining which environmental correlates to utility walking to map**

Correlate	Literature review findings	Data availability	If not mapped, why not?
<i>Mapped correlate</i>			
Population and residential densities	<ol style="list-style-type: none"> <li>1. Research suffers from a lack of common measurement standards.</li> <li>2. Density appears to be the most vital physical factor impacting utility walking rates.</li> <li>3. A total of eight studies and three literature reviews reported a positive association with a density measure. Of these, six measured population density, two studied residential density and three employed a combination.</li> </ol>	Yes	N/A
Land use mix	<ol style="list-style-type: none"> <li>1. Six research projects recognized measures of land-use mix as positively associated.</li> <li>2. Close proximity of destinations was an indicator in seven investigations, but the importance of specific destinations varied.</li> </ol>	Yes	N/A
Topography	<ol style="list-style-type: none"> <li>1. One study and an extensive literature review found steep slopes were a deterrent.</li> </ol>	Yes	N/A
<i>Unmapped correlate</i>			
Connectivity	<ol style="list-style-type: none"> <li>1. Findings were ambiguous.</li> </ol>	Yes	Correlation direction was inconsistent.
Pedestrian infrastructure	<ol style="list-style-type: none"> <li>1. Findings were ambiguous.</li> </ol>	Yes	Correlation direction was inconsistent.
Proximity to public transit	<ol style="list-style-type: none"> <li>1. Findings were ambiguous.</li> </ol>	Yes	Correlation direction was inconsistent.

Source: See Appendix C for literature review sources by correlate.

Note: Population density is defined as the number of people per unit of land. Residential density is the number housing units per unit of land.

## 4.2 MAPPING METHODOLOGY

This section provides insight into the methodology and datasets that inform the mapping analysis for utility walking, with details on each step.

The demographic maps in this chapter were created out of data from the *2010 Census* and from the *2008-2012 American Community Survey* five-year estimates. Each demographic correlate (low income, young age, and public transit use) is mapped by quartile at the level of block group. Each quartile is assigned a score of one to four, four being the densest group of people who are apt to walk for transport. Physical environmental correlates (population density, residential density, land use mix, and percentage slope) are also mapped throughout the city (using various data from the above sources and the SFMTA; citations below) and scored from one to four.

Three composite suitability maps combining this information were then prepared using the Spatial Analyst extension of ArcGIS. One weighted overlay combines all demographic variables, another merges all physical characteristics, and the final map integrates all correlates to utility walking.

*Note:* For all maps, neighborhood boundaries shown are those designed by the Planning Department to notify local groups about certain types of development in their area.

### 4.2.1 MAPPING DEMOGRAPHIC CORRELATES TO UTILITY WALKING: DATA AND DEFINITIONS

This section defines the specific demographic correlates and datasets, citing sources for each. The GIS base-map of San Francisco utilizes data collected from DataSF, the repository for information published by the City and County of San Francisco.<sup>76</sup> Age information was obtained from the *2010 Census*. Data on household income in the past 12 months and data for commuting to work were acquired from the *2008-2012 American Community Survey* five-year estimates.

The following demographic correlates are mapped (as persons with the trait per acre, by block group):

- Low income, defined as households earning less than \$40,000 a year;
- Young age, i.e., adults from 18 to 34 years old; and

- Public transportation use, meaning San Francisco residents whose usual mode of commute to work is a bus or trolley bus, streetcar or trolleybus, subway or elevated train, railroad, or ferryboat.<sup>77</sup>

### 4.2.2 MAPPING ENVIRONMENTAL CORRELATES TO UTILITY WALKING: DATA AND DEFINITIONS

This section defines the specific environmental correlates and datasets, citing sources for each.

#### Population and Residential Densities

Population and residential density datasets are culled from the *2010 Census* and mapped per the steps described in [Section 4.2.1: Mapping Demographic Correlates](#). Population density is defined as the number of residents per unit of land (in this case, acre). Residential density indicates the number of housing units per acre.

76. City and County of San Francisco, "Data SF: Data Catalog," accessed August 20, 2014, <https://data.sfgov.org/>.

77. United States Census Bureau: American FactFinder, "B08301: Means of transportation to work," 2008 – 2012 American Community Survey, U.S. Census Bureau's American Community Survey Office, 2012, accessed July 20, 2014, <http://factfinder2.census.gov>.

### Land Use Mix

Information on existing land uses for all parcels, including parcel area, was provided by the San Francisco Transportation Agency.<sup>78</sup> This dataset included the following categories:

- CIE – cultural, institutional and educational
- MED – medical and health services
- MIPS – management, information and professional services
- MIXED – includes more than one type of business
- MIXEDRES – includes both business and residential uses
- OPENSOURCE
- PDR – production, distribution and repair
- RESIDENT – residential uses
- RETAIL/ENT – retail and entertainment uses
- VACANT – vacant parcels
- VISITOR – Visitor services, including hotels and motels.

To measure land use mix, this dataset was transformed in ArcGIS from parcel-level information to the number of distinct land uses per block group. The first step in creating a land use mix for each block group was to reclassify this information into the following six general uses: commercial, residential, industrial, institutional, open space and mixed use. Vacant lots were excluded from the dataset. Next, all parcels in a specific category were merged into one GIS feature. A spatial join summarized the attributes, and provided a count of distinct land uses in each block group. Finally, the results were again reclassified and scored from one to four (four being the highest outcome possible), and mapped.

### Percentage Slope

The following steps were taken to obtain percent slope throughout the city: Contour elevations were obtained from [DataSF](#).<sup>79</sup> In ArcGIS, a surface was created using the raster interpolation tool of the 3D Analyst extension. Then, a percent-slope map was generated from the surface using Spatial Analyst. The following four slope classifications were produced: zero percent to ten percent, 10.1 percent to 20 percent, 20.1 percent to 30 percent, and greater than 30 percent. Each category was scored from one to four, with four representing the gentlest topography (that is, the lowest gradient / least slope).

### 4.2.3 PREPARATION OF COMPOSITE SUITABILITY MAPS FOR UTILITY WALKING

Three composite suitability maps for utility walking were created, each showing the locations of, respectively:

- high concentrations of receptive populations;
- conducive environments; and
- demographic and environmental suitability combined, each given equal weight.

Composite suitability maps were prepared in ArcGIS using the weighted overlay tool of Spatial Analyst. Each correlate to utility walking was initially translated into a raster, required for the overlay. All rasters were assigned weights and scored from one to four. Several different weighting schemes were tested for the receptive population map and the environmental suitability map, but the variations had little impact on the outcome. Consequently, each input variable was given equal weight.

78. San Francisco Municipal Transportation Agency, “San Francisco Land Use” City and County of San Francisco, March 21, 2014, accessed July 20, 2014, [https://dl.dropboxusercontent.com/u/22763179/For\\_JK.zip](https://dl.dropboxusercontent.com/u/22763179/For_JK.zip).

79. Jeff Johnson, “Elevation Contours (Zipped Shapefile Format)” Data SF: Data Catalog, August 14, 2014, accessed August 20, 2014, <https://data.sfgov.org/Geographic-Locations-and-Boundaries/Elevation-Contours-Zipped-Shapefile-Format-/x467-4ghd>.

### 4.3 MAPPING ANALYSIS FINDINGS FOR UTILITY WALKING

This section describes the mapping analysis process used to identify the locations of populations and environments that are conducive to utility walking, leading up to and including the final composite suitability map presented at the end of the section.

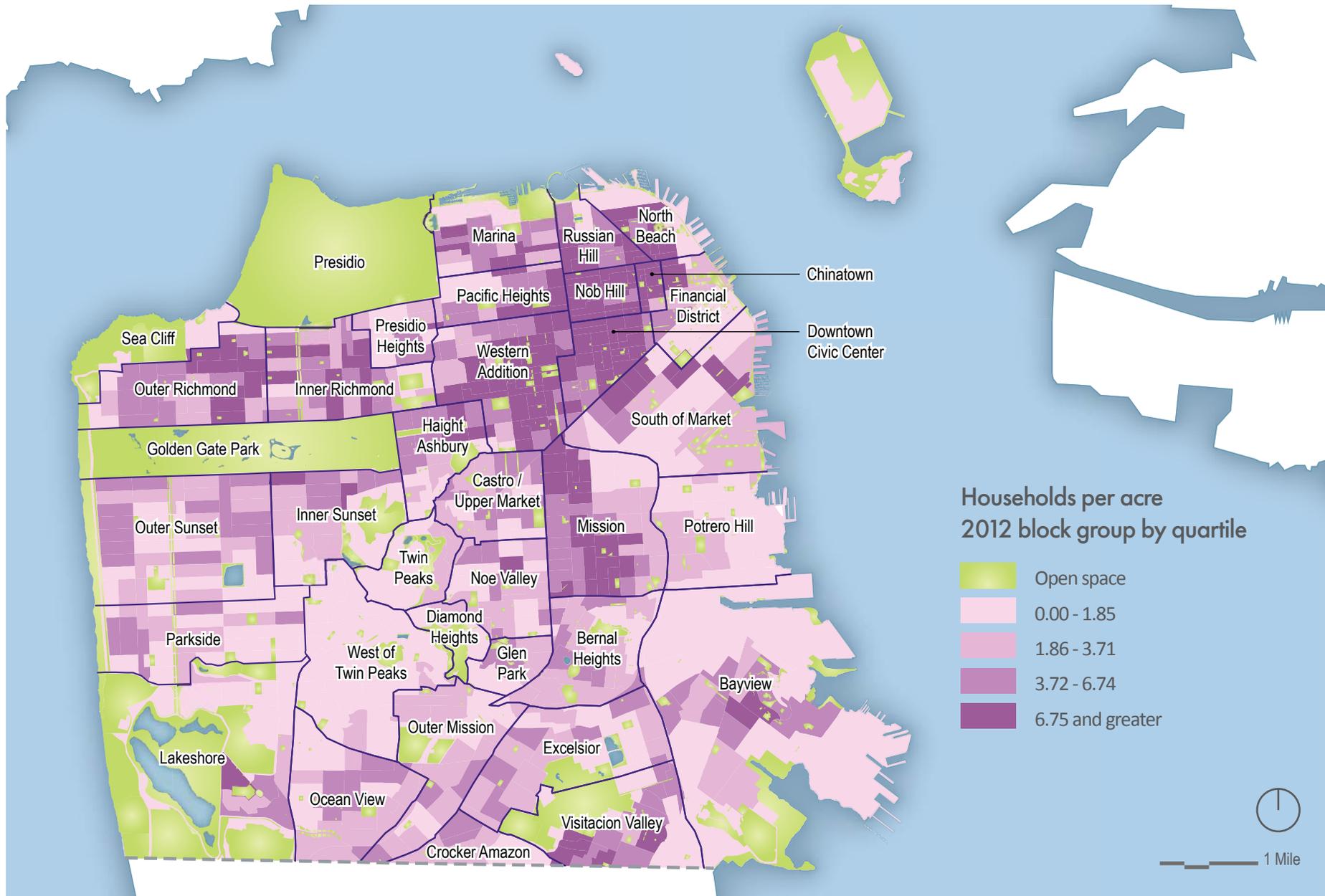
#### 4.3.1 LOCATIONS OF RECEPTIVE POPULATIONS AS MAPPED BY CORRELATE

##### Low Income

Almost all block groups in Chinatown, Nob Hill, and Downtown Civic Center were in the highest quartile of households earning less than \$40,000 per year (Figure 12). This core low-income area extends into the southwestern portion of North Beach, eastern Western Addition, and along Van Ness Avenue in Pacific Heights and Russian Hill. Low-income residents were also concentrated in the eastern half of the Outer Richmond, in the northwest quadrant of the Mission, and north of Cesar Chavez from Valencia to Bryant Street, as well as, in slightly lower numbers, in central Bayview and in Visitacion Valley.



*The former St. Anthony Dining Room in the Tenderloin*



**Figure 12. Density of low-income residents with an annual household income less than \$40,000**

Sources: Map created by author. See Appendix D for source information.

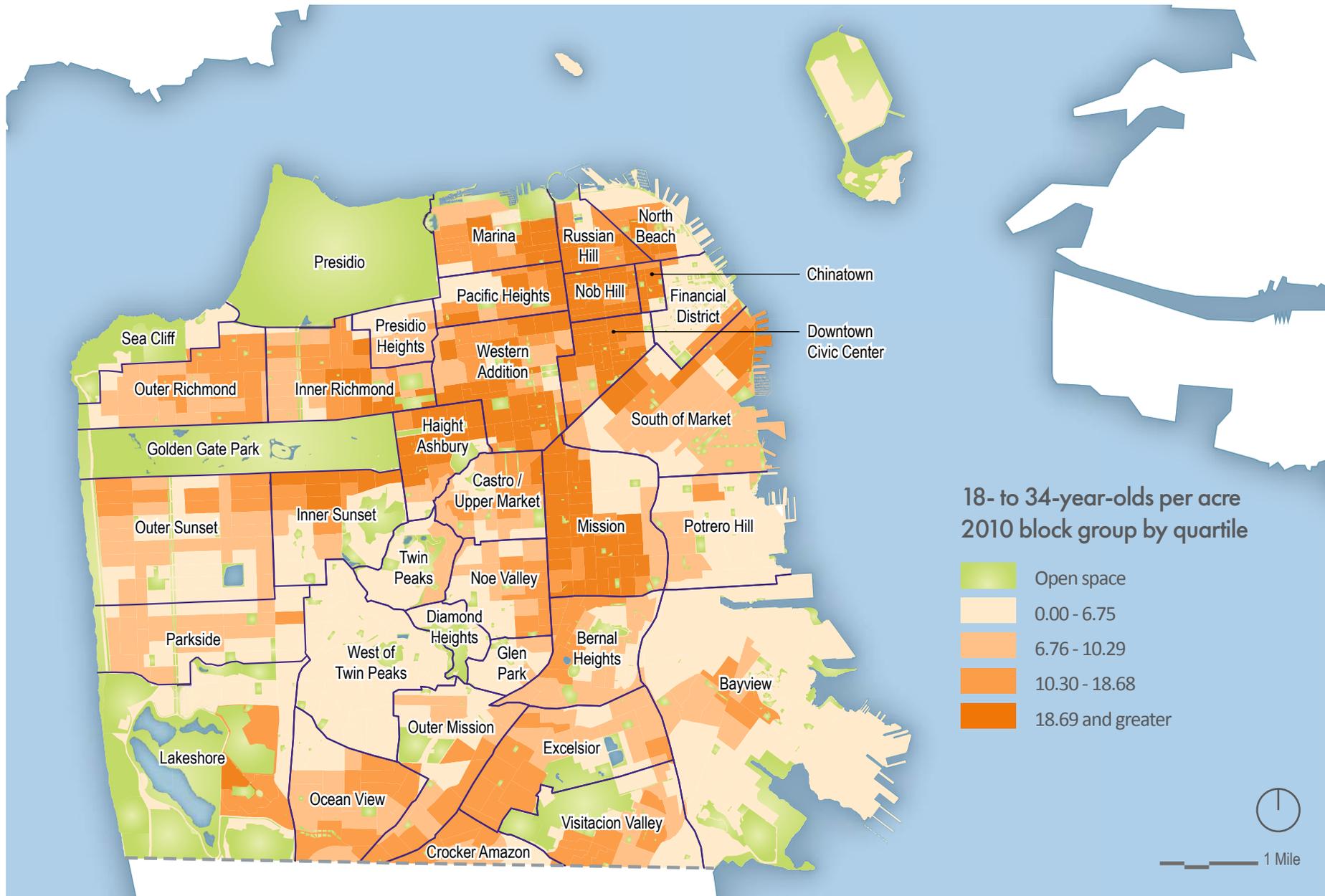
Notes: Density of low-income residents is shown in quartiles. All coastal block groups were trimmed at the shoreline to portray accurate physical boundaries.

## Young Adults

Young adults were found in high densities in nearly all of Haight Ashbury, Nob Hill, Chinatown, and Downtown Civic Center (Figure 13). Block groups in the densest quartile were also clustered in Western Addition south of Eddy Street, and north of Sutter Street between Webster and Van Ness. Roughly 60 percent of the Mission had high concentrations of young people, excluding the northeast quadrant. Other places with many young residents included an area along Van Ness Avenue in the Marina, Pacific Heights, and Russian Hill; the southwestern portion of North Beach; and the northern edge of the Inner Sunset along Golden Gate Park.



*A crowd of Millennials*



**Figure 13. Density of young adults**

Sources: Map created by author. See Appendix D for source information.

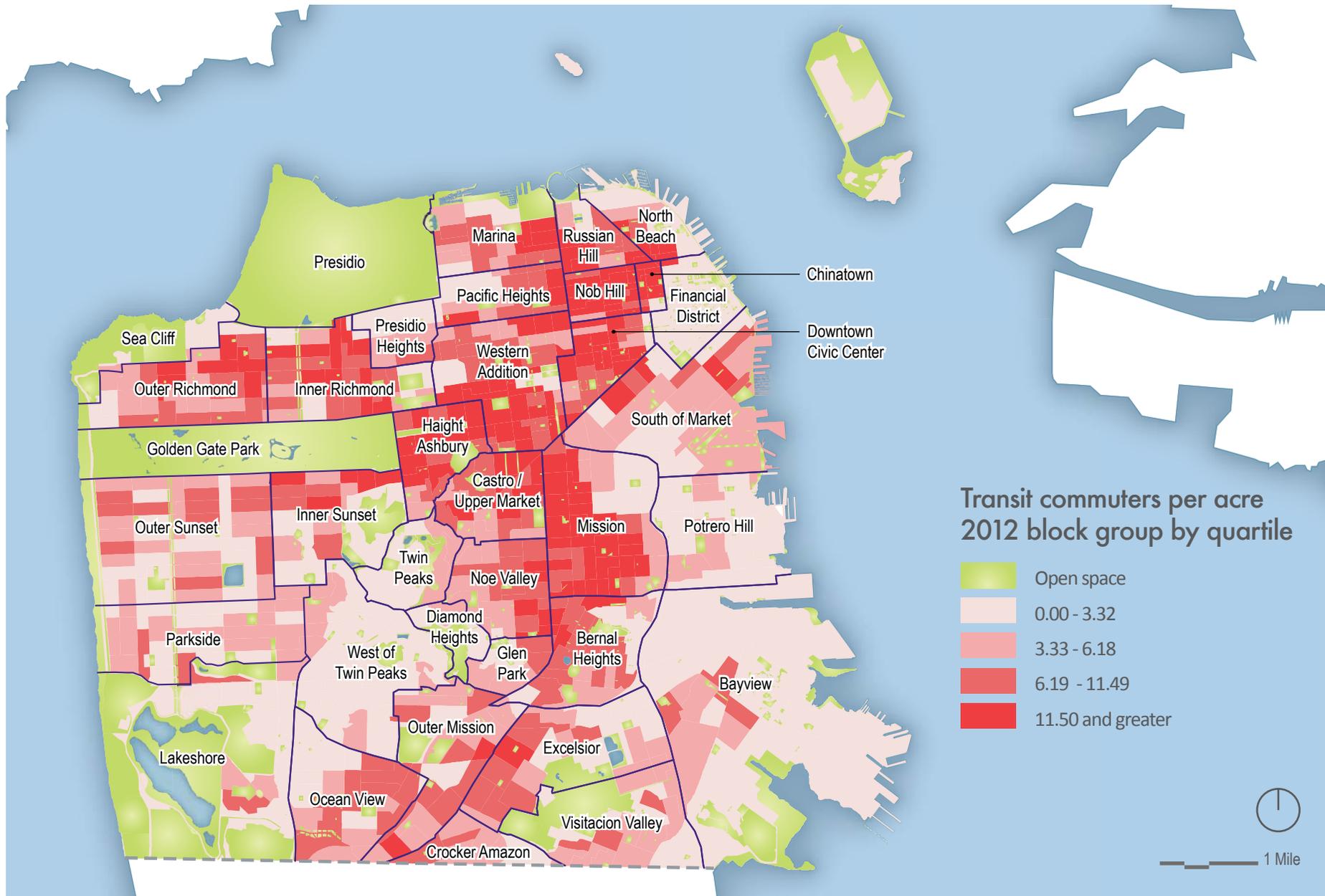
Notes: Density of young adults is shown in quartiles. All coastal block groups were trimmed at the shoreline to portray accurate physical boundaries.

## Public Transit Users

People who usually take public transit to work were concentrated in roughly the same locations as young adults (Figure 14). Small exceptions cropped up in the Castro near Market Street, in the eastern Marina from Filbert to Vallejo, and in the northern Inner Sunset from 7th to Funston avenues.



*Congested Muni train in Duboce Park*



**Figure 14. Density of San Francisco residents who commute to work via public transit**

Sources: Map created by author. See Appendix D for source information.

Notes: Density of residents who usually commute to work by transit is shown in quartiles. All coastal block groups were trimmed at the shoreline to portray accurate physical boundaries.

#### 4.3.2 LOCATIONS OF SUITABLE ENVIRONMENTS AS MAPPED BY CORRELATE Population Density

Nob Hill, Chinatown, Downtown Civic Center and Haight Ashbury are almost entirely in the top quartile of population density (Figure 15). Russian Hill and North Beach also have very high densities of people, except along the waterfront. Additional places with a high number of residents per acre include: most of the Mission, apart from the northeast quadrant; Western Addition south of Eddy Street; several block groups west of Van Ness Avenue from Bay to McAllister Streets; and the blocks east of Mission Street from Avalon Avenue to Guttenberg Street.



*A crowd of pedestrians on a busy San Francisco street*

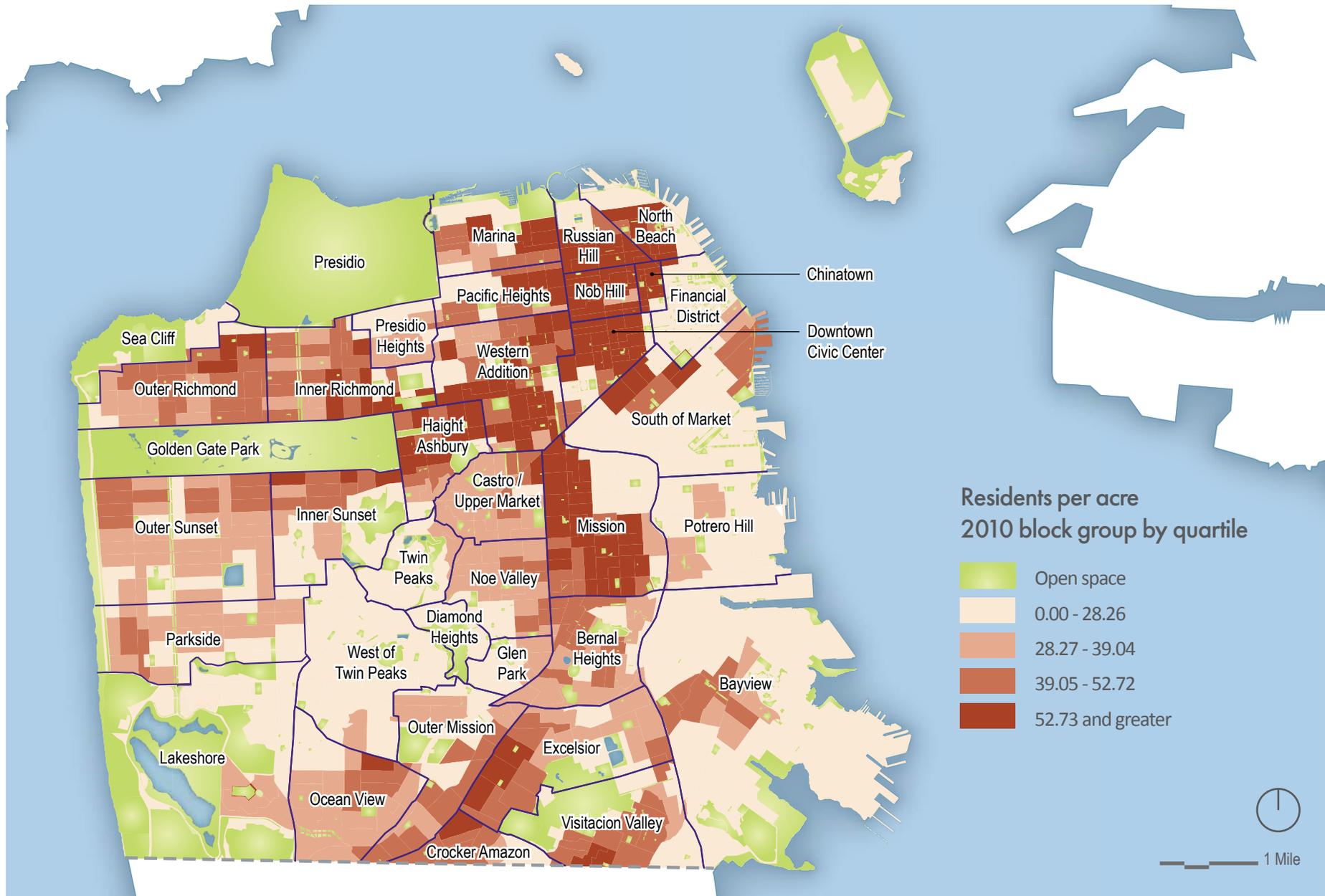


Figure 15. Population density

Sources: Map created by author. See Appendix D for source information.

Notes: Population density is shown in quartiles. All coastal block groups were trimmed at the shoreline to portray accurate physical boundaries.

## Residential Density

Findings for residential density (i.e., housing units per acre) are largely similar to those for population density, as shown in [Figure 16](#). Two notable differences are the western edge of Excelsior and the southeastern block groups in the Mission; both had high population density but were not in the top quartile of residential density. This may indicate that the amount of housing in these areas is insufficient to accommodate the population, and units may be crowded.



*Taylor & Eddy project designed by David Baker Architects*

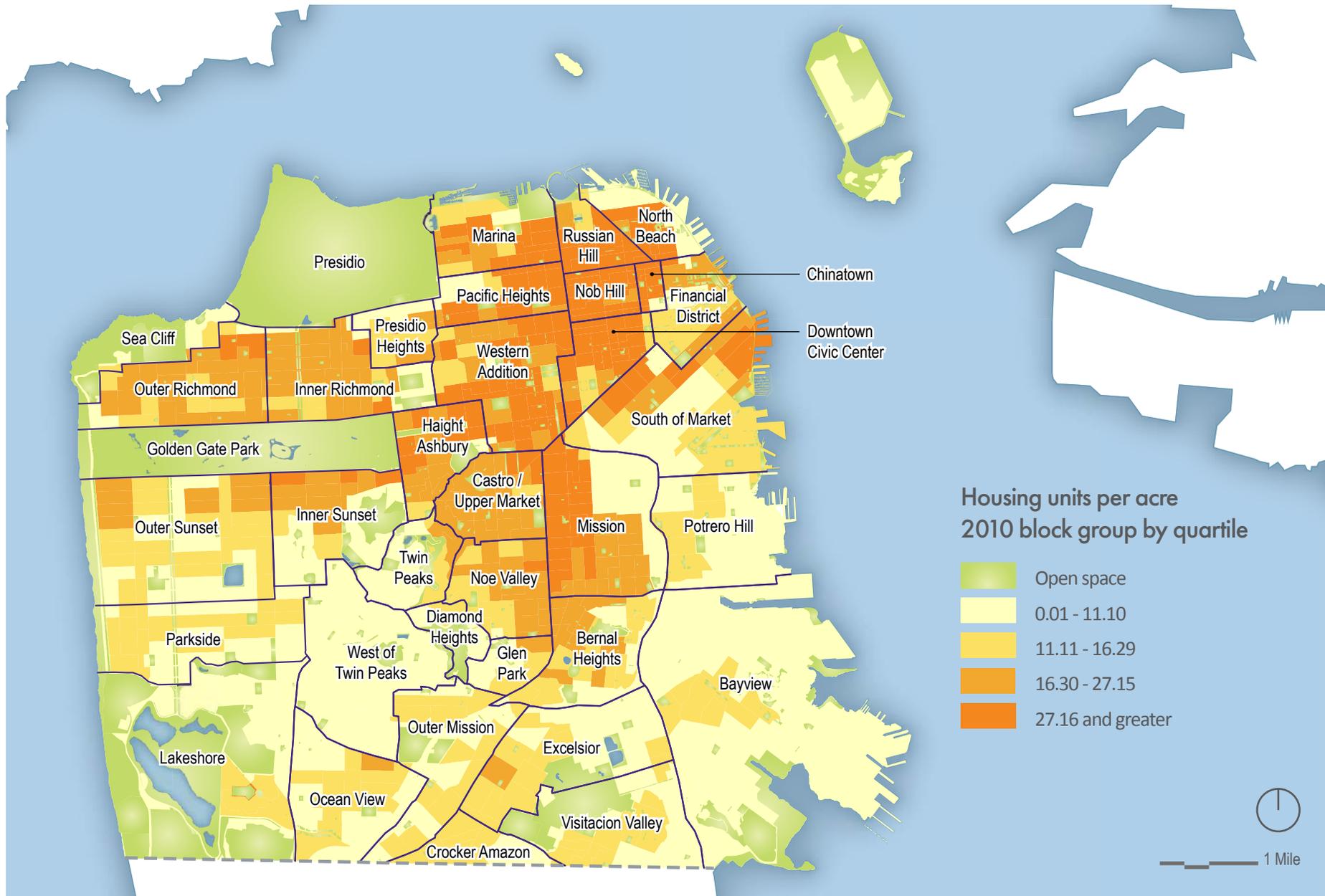


Figure 16. Residential density

Sources: Map created by author. See Appendix D for source information.

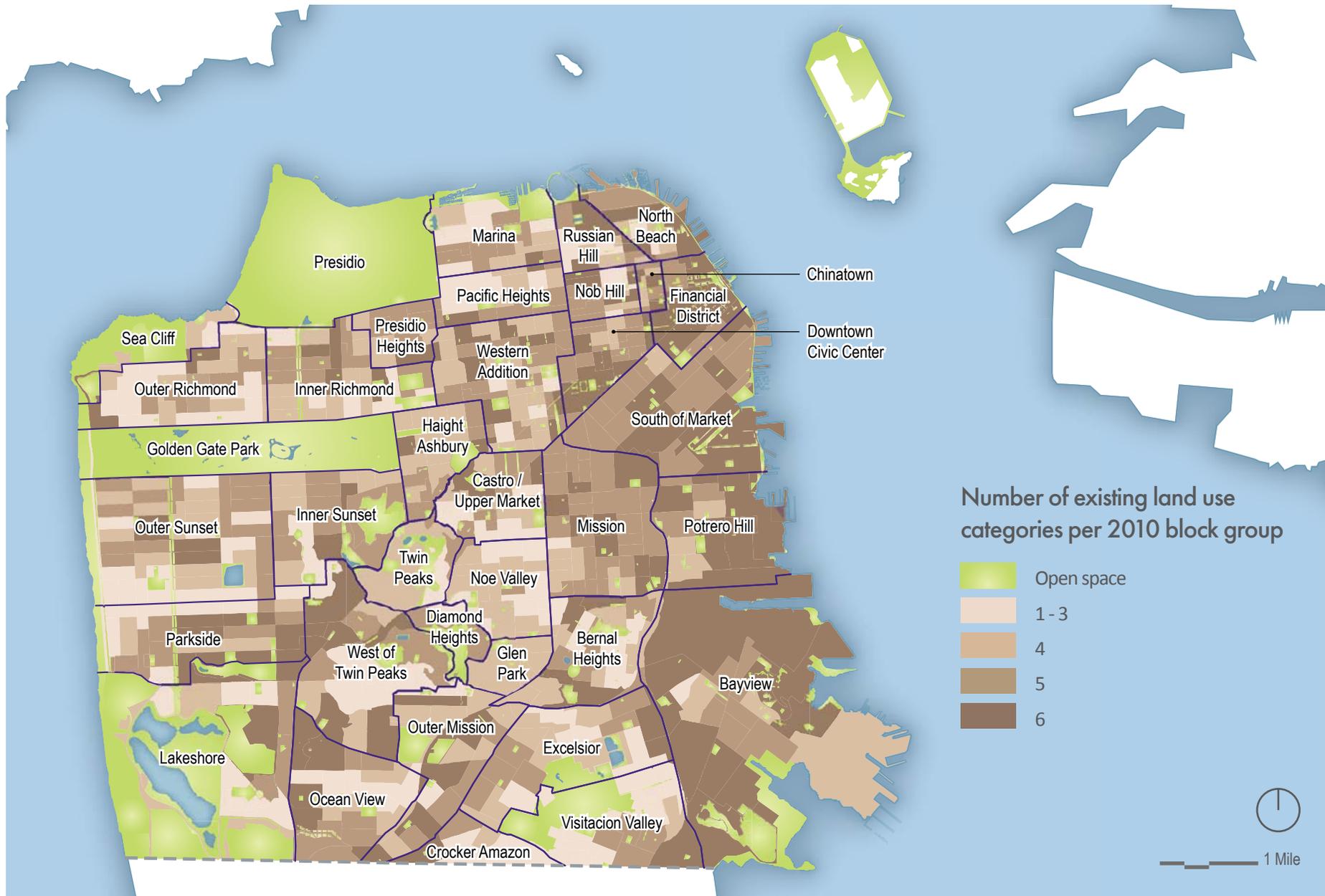
Notes: Residential density is shown in quartiles. All coastal block groups were trimmed at the shoreline to portray accurate physical boundaries.

### Land Use Mix

As shown in **Figure 17**, the largest areas with a diverse mix of land uses are predominantly located in eastern neighborhoods along the waterfront, such as North beach, the Financial District, South of Market, Potrero Hill, and Bayview. Downtown Civic Center and West of Twin Peaks also contain several block groups with a variety of land uses. Block groups with six distinct land uses are sparsely scattered throughout many other neighborhoods, demonstrating an abundance of active centers dispersed across the city.



*Mixed use along 8th & Howard which has 162 units of affordable housing above retail*



**Figure 17. Land use mix**

Sources: Map created by author. See Appendix D for source information.

Notes: Land uses categories are: commercial, residential, industrial, institutional, mixed use, and open space. All coastal block groups were trimmed at the shoreline to portray accurate physical boundaries.

## Percent Slope

The Percent Slope map (Figure 18) shows many neighborhoods in San Francisco having steep inclines that deter walking—no surprise to anyone familiar with the city. There are particular standouts: Twin Peaks and the surrounding neighborhoods all have large areas with steep slopes, and in northern San Francisco, much of Russian Hill, Nob Hill, Chinatown, North Beach, Pacific Heights, and the Presidio is shown to be formidable terrain. Other steep areas include Potrero Hill, Bernal Heights, Visitacion Valley, Excelsior, Ocean View, and portions of Bayview.



*Steep San Francisco street*



### 4.3.3 COMPOSITE SUITABILITY MAPS OF DEMOGRAPHIC AND ENVIRONMENTAL CORRELATES

#### Locations with Receptive Populations

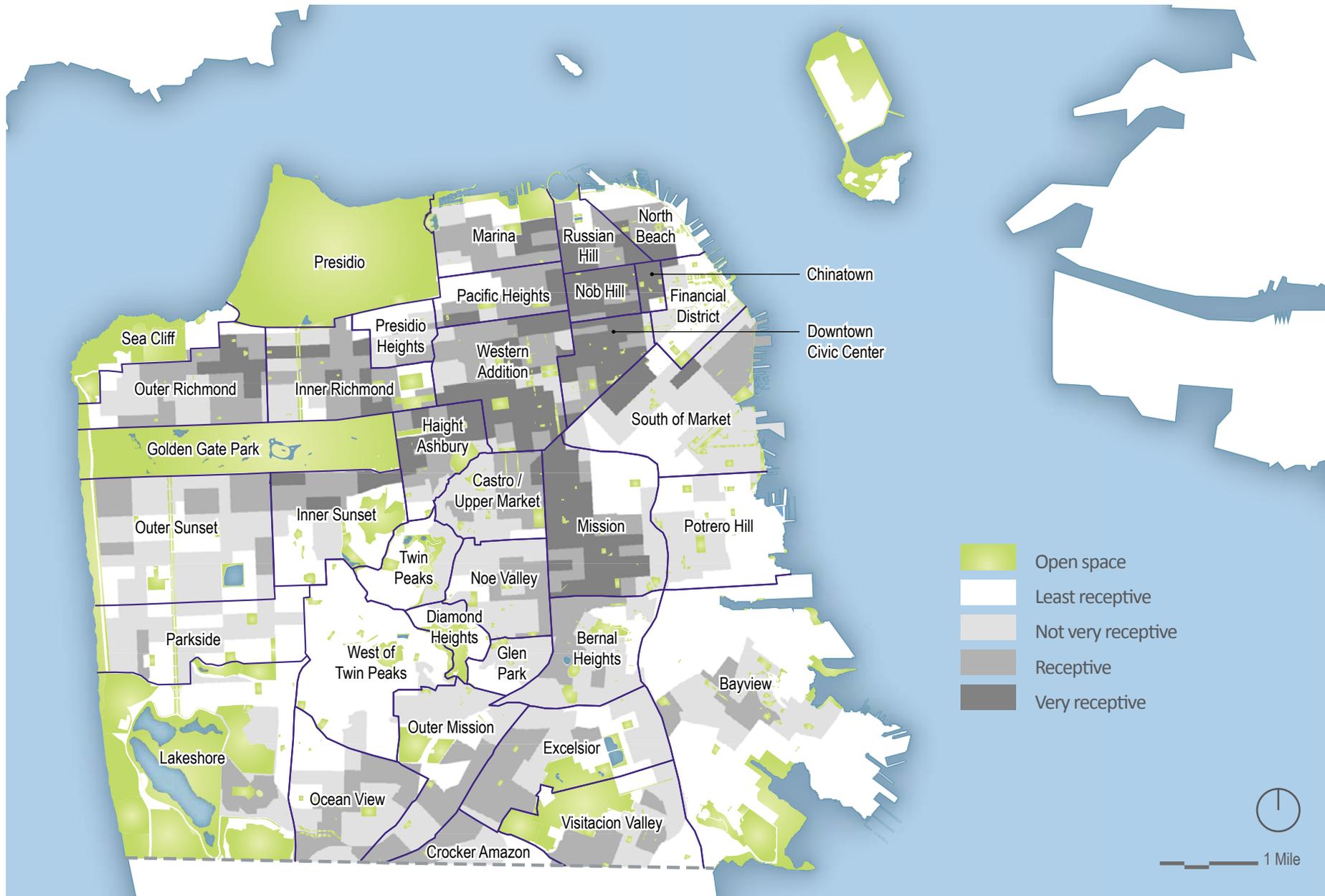
Figure 19 illustrates block groups in San Francisco that have a high density of people who are receptive to utility walking. This suitability map combines findings for young age, low income, and people who take public transit to work, giving each correlate equal weight. All block groups were scored from one to four, with a four indicating that the location contains the populations that are most apt to walk for transport.

Population density appears to be a strong predictor of the presence of the other demographic correlates studied. For example, low-population-density neighborhoods such as Twin Peaks, Diamond Heights, Glen Park, and West of Twin Peaks do not contain any sites with receptive populations. Sparsely populated neighborhoods along the waterfront – Potrero Hill, Bayview, South of Market, and the Financial District – also have few, if any, areas with populations who are likely to walk for utility.

Most other neighborhoods have at least a few block groups with receptive or very receptive populations. Residents who are most likely to walk

for utility are predominantly located in northern San Francisco east of Golden Gate Park, and in the Mission. Large areas in the highest quartile are found in: almost all of Nob Hill, Downtown Civic Center, and Chinatown; along Van Ness Avenue north of McAllister; Western Addition south of Eddy Street; and northern Haight Ashbury. In the Mission, roughly 60 percent of block groups have receptive populations.





**Figure 19. Populations receptive to utility walking**

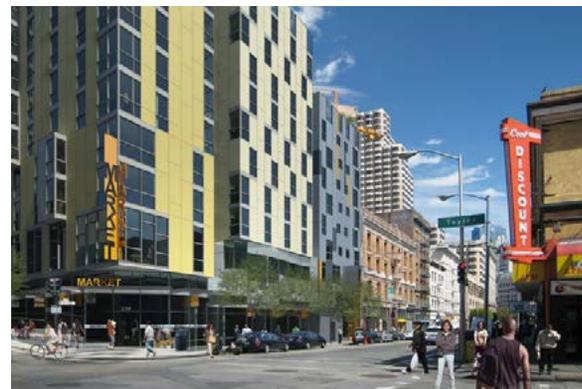
Sources: Map created by author. See Appendix D for source information.

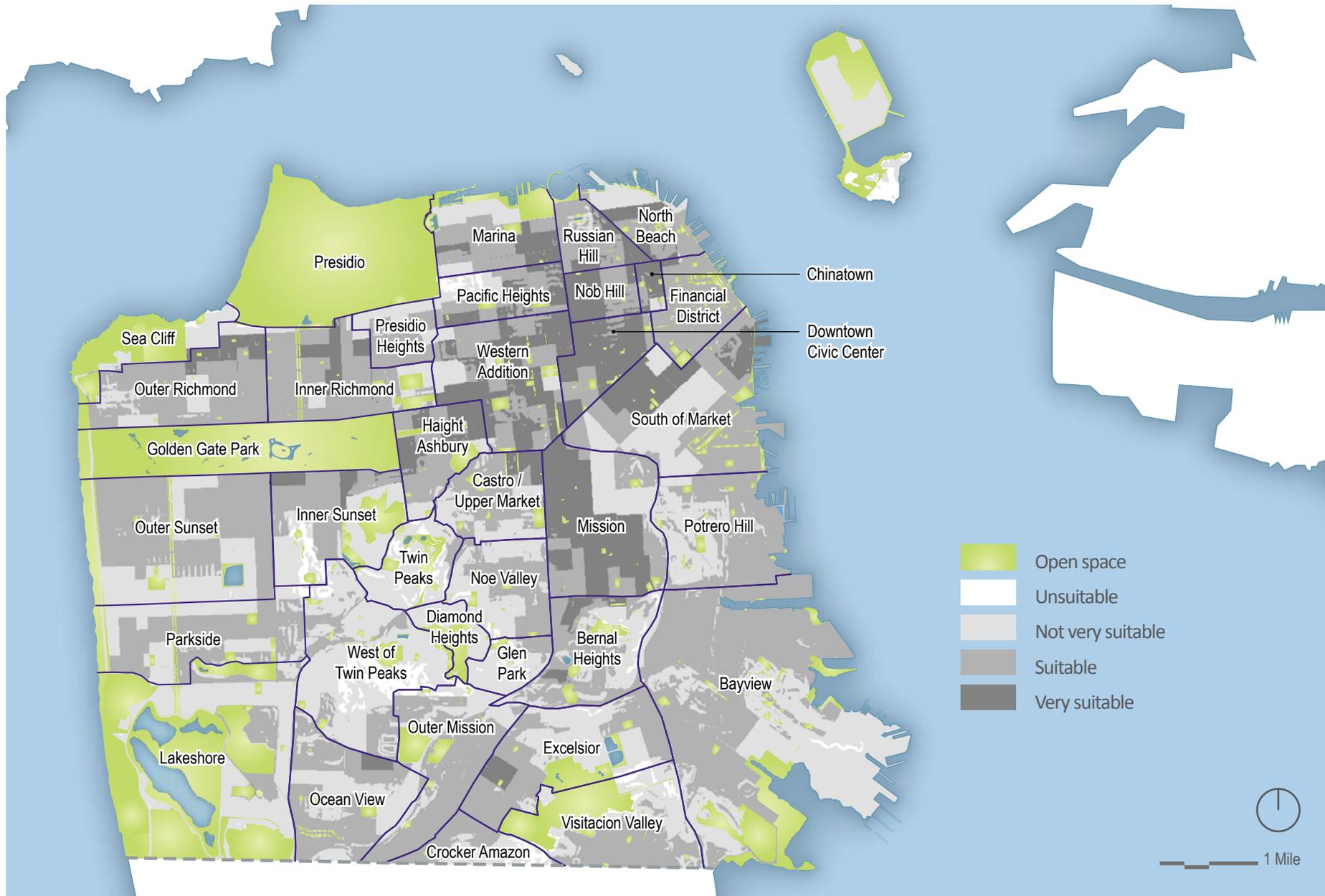
Note: Demographic correlates to utility walking are: being a young adult, low-income resident, and/or commuter who usually takes public transit to work.

### Locations of Ideal Environmental Conditions

The suitability of environmental conditions for utility walking is mapped by block group across the city in **Figure 20**. To determine which San Francisco environments are most conducive to utility walking, findings for population density, residential density, land-use mix and percentage slope are combined (weighted equally).

As the map reveals, most of the city is composed of suitable or very suitable environments for utility walking. Ideal physical characteristics are concentrated in northeastern San Francisco. Very suitable block groups are found throughout Downtown Civic Center, in adjacent South of Market areas, in the majority of the Mission, in lower Haight Ashbury, along Van Ness Avenue from Chestnut to McAllister Streets, in Chinatown, and scattered across Western Addition. Places with steep terrain such as Twin Peaks, Diamond Heights, West of Twin Peaks, Glen Park, most of Bernal Heights, a portion of Potrero Hill, and part of Bayview are not very conducive to walking for transport.





**Figure 20. Suitable environments for utility walking**

Sources: Map created by author. See Appendix D for source information.

Note: Environmental correlates to utility walking are: population density, residential density, land use mix, and percent slope.

### Places with Both Receptive People and Conducive Environments for Utility Walking

The final suitability map locates optimal conditions for pedestrian infrastructure, finding 18-plus loci throughout the city that are extremely conducive to walking for transport (Figure 21). To create this assessment, both demographic and environmental correlates to utility walking were combined with equal weight. The most receptive sites have both populations and physical characteristics associated with higher levels of utility walking.

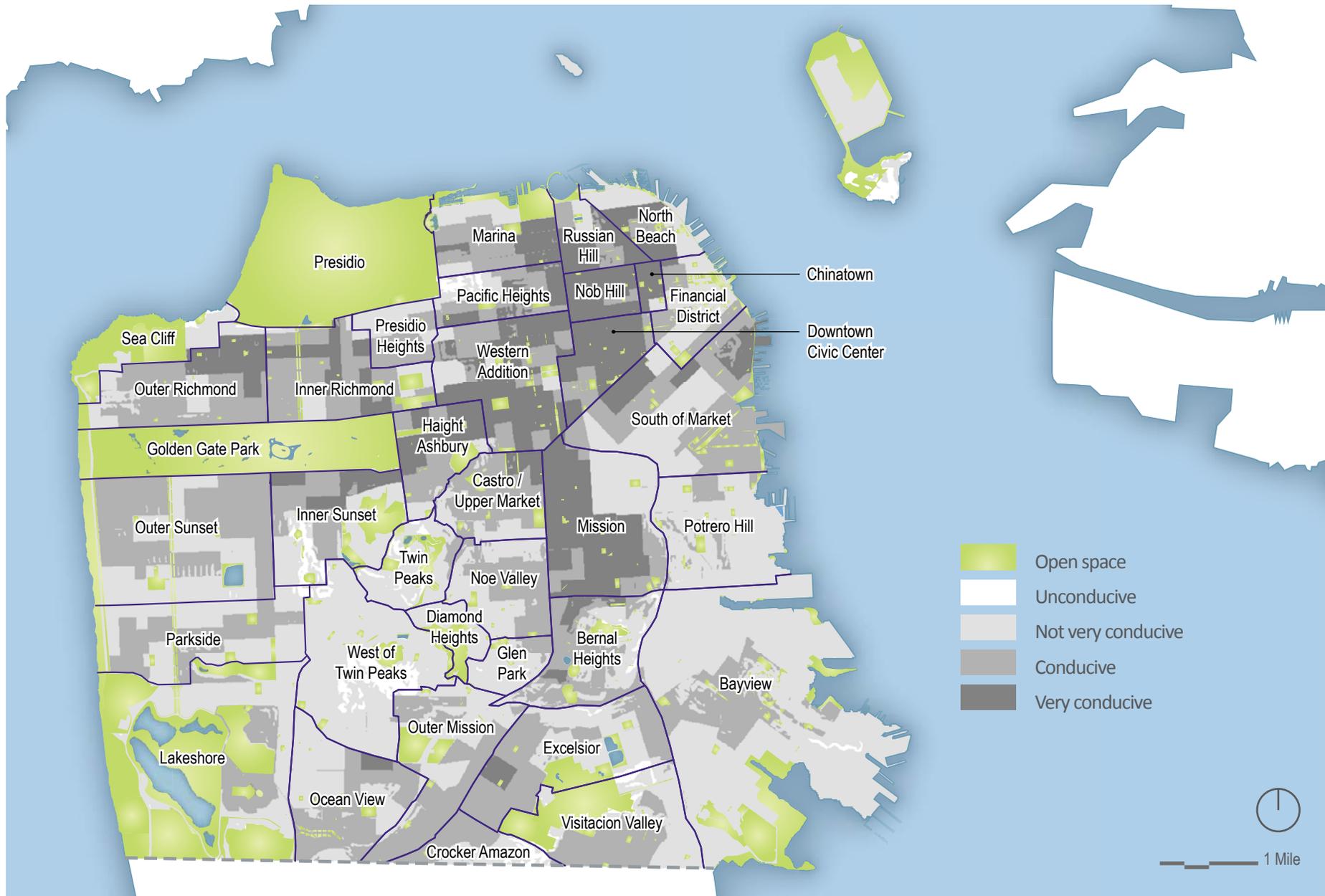
Three large areas are revealed that are very well suited for utility walking. The first spans from the Marina at Buchanan Street, east to Sansome Street, and south to Howard Street, excluding the Financial District. The second includes the majority of Western Addition and northern Haight Ashbury. The third is in the Mission, west of South Van Ness Avenue and south of 19th Street.

A total of 18 neighborhoods have ideal conditions for utility walking. Table 16 ranks each by the amount of land it contains that was scored “very conducive.” All but five of these neighborhoods have more than 100 acres that are particularly conducive to walking. Those with the greatest amount of very favorable land include: the Mission, with 656 acres; Western Addition, with 562 acres; and Downtown Civic Center, with 319 acres. In addition, the Nob Hill, South of Market, and Haight Ashbury areas each contain more than 200 acres well suited to utility walking.

A few neighborhoods comprise areas that are more than 75 percent composed of block groups that are likely to encourage walking. Almost all of Nob Hill – 92 percent – is very receptive to utility walking, despite its challenging topography. Chinatown is another place with steep terrain that predominantly contains areas ripe with potential pedestrians. In the Downtown Civic Center, 77 percent of sites are apt to promote walking.

**Table 16. Areas very receptive to utility walking by neighborhood**

Neighborhood	Very receptive area (in acres)	Percentage of neighborhood rated very receptive
Mission	656.3	59%
Western Addition	562.4	58%
Downtown / Civic Center	318.7	77%
Nob Hill	217.3	92%
South of Market	214.7	16%
Haight Ashbury	204.9	42%
Outer Richmond	195.5	23%
Inner Richmond	194.5	23%
Russian Hill	166.3	55%
Inner Sunset	134.7	16%
Marina	131.0	21%
Pacific Heights	123.3	29%
North Beach	117.2	29%
Chinatown	70.3	82%
Bernal Heights	64.1	9%
Castro / Upper Market	58.9	11%
Excelsior	47.8	5%
Ocean View	29.1	3%



**Figure 21. Areas with both populations and environments conducive to utility walking**

Sources: Map created by author. See Appendix D for source information.

Note: Correlates to utility walking are: young adults, low-income residents, public transit users, population density, residential density, land-use mix and percent slope.



# CHAPTER FIVE

## MAPPING CORRELATES TO UTILITY BIKING

Much as Chapter 4 did for utility walking, this chapter describes the mapping analysis of the PABS data as it pertains to utility cycling; findings from this analysis are intended to inform the decisions of city officials as they prioritize funding for specific cycling infrastructure improvements. The mapping study determined the locations of demographic and environmental indicators of utility biking throughout San Francisco.

The chapter provides details, first for demographic variables and then for environmental, of the process of deciding which of the correlates to utility biking were to be mapped, based on findings from the literature review and the Pedestrian and Bicycling Survey. There follows a methodology that explains the process of mapping each variable and producing synthesis maps that reflect the sum of all findings. The last section reviews the findings from the mapping analysis to identify those locations where cycling infrastructure improvements would be most effective at increasing rates of biking for transport, i.e., those having populations and environmental characteristics most conducive to utility cycling.

### 5.1 DECIDING WHICH CORRELATES TO MAP

Considerable research proves that certain population and physical characteristics are more conducive to biking for transport than others. According to the literature review, being of male gender, young age, and higher educational attainment, as well as having limited access to a motor vehicle, had a significant positive effect on the odds of utility biking (see [Table 17](#); sources listed in [Appendix C](#)). There are some additional review findings that support the assertion that white people, students, and adults without children are also more apt to bike for transport. The review found the impacts of income to be equivocal.

[Table 17](#) shows whether each demographic correlate is backed by literature review findings and PABS findings, and whether there is data available. It also provides explanations of why the excluded correlates were omitted. (Exclusions were made as follows: Income was not mapped because the literature review findings were contradictory. Student status and access to a motor vehicle were omitted because this data was unavailable at the block group level. White race was left out because intentionally locating non-motorized transport improvements in white areas violates Title VI of the Civil Rights Act of

1964.) The density of males, young people, those with a high school diploma or equivalent, and households without children were also included in the analysis and mapped across the city to identify sites where residents are most likely to bike for utility.

The literature review also found considerable evidence supporting the association of bike infrastructure; bike facilities such as lockers, showers, and parking; population density; and greater mix of land uses with a greater likelihood of cycling for transport ([Table 18](#)). One study of Danish cities and an extensive literature review of over 300 studies found that steep slopes pose an impediment. Findings for proximity to public transit were unclear, and therefore it was excluded from the mapping analysis. Information for shower and locker locations was unavailable and was also omitted. All other environmental correlates were mapped.

**Table 17. Determining which demographic correlates to utility biking to map**

Correlate	Literature review findings	Relationship found by PABS?	Data available?	If not mapped, why not?
<i>Mapped correlates</i>				
Gender	<ol style="list-style-type: none"> <li>1. Male gender positively related in ten studies and one literature review that assessed gender.</li> <li>2. No conflicting evidence was discovered.</li> </ol>	No	Yes	N/A
Educational attainment	<ol style="list-style-type: none"> <li>1. Six studies that spanned the globe found higher educational attainment was a predictor.</li> <li>2. An investigation of three Brazilian cities established a negative correlation. This contrary evidence is the only assessment from a low or middle income country.</li> </ol>	No	Yes	N/A
Young age	<ol style="list-style-type: none"> <li>1. Most research found young age to be associated, but there was some additional evidence.</li> <li>2. Younger people were more likely to cycle and the probability of cycling decreased with age in 4 studies.</li> <li>3. Another investigation of two cities found contrary results: younger residents cycled more in Adelaide, but not in Ghent.</li> <li>4. A pooled review of data from three cities found a curvilinear relationship.</li> </ol>	Yes	Yes	N/A
Children	<ol style="list-style-type: none"> <li>1. A Danish study found adults with children were negatively correlated to cycling distance.</li> </ol>	No	Yes	N/A
<i>Unmapped correlates</i>				
Students	<ol style="list-style-type: none"> <li>1. Students were positively related according to three studies.</li> <li>2. No conflicting evidence was discovered.</li> </ol>	N/A	No	Data for student status was not available at the block group level.
White race	<ol style="list-style-type: none"> <li>1. Two examinations of commuting in the U.S. found non-whites cycled less for utility.</li> <li>2. No conflicting evidence was discovered.</li> </ol>	No	Yes	Intentionally locating transportation improvements in predominately white areas violates Title VI of the Civil Rights Act of 1964.
Income	<ol style="list-style-type: none"> <li>1. Findings were ambiguous.</li> </ol>	No	Yes	Correlation direction was inconsistent.
Motor vehicle access	<ol style="list-style-type: none"> <li>1. Limited motor vehicle access was positively associated in six investigations.</li> <li>2. No conflicting evidence was discovered.</li> </ol>	No	No	Data for motor vehicle access was not available at the block group level.

Sources: See Appendix C for literature review sources by correlate.

**Table 18. Determining which environmental correlates to utility biking to map**

Correlate	Literature review findings	Data availability	If not mapped, why not?
<i>Mapped correlates</i>			
Population density	<ol style="list-style-type: none"> <li>Two studies and a 2003 literature review found high population density was a predictor.</li> <li>Urbanization level or compact development – both proxies for density – were positively related in two reports and a 2010 literature review.</li> <li>Another investigation had conflicting results: population density was insignificant, however the city-level density measures used may have been too coarse to be effective.</li> </ol>	Yes	N/A
Land-use mix	<ol style="list-style-type: none"> <li>A study of bike mode share in India and a 2003 literature review showed a greater mix of land uses was positively related.</li> <li>Four additional research projects verify the importance of short trip distance. A greater mix of land uses provides more proximate destinations, thereby minimizing trip distance.</li> </ol>	Yes	N/A
Topography	<ol style="list-style-type: none"> <li>A Danish study and an extensive literature review found steep slopes were a deterrent.</li> </ol>	Yes	N/A
Proximity to bike infrastructure	<ol style="list-style-type: none"> <li>Positive correlations were found in two studies of bicycle commuting and two active travel literature reviews.</li> <li>Analysis of commuting in large cities in the U.S. found a strong positive association with Type II (i.e., Class II) bike lanes per square mile, but bike paths were not independently correlated.</li> </ol>	Yes	N/A
Bike facilities	<ol style="list-style-type: none"> <li>Five research projects and one literature review of bicycle commuting found a relationship with bike facilities.</li> <li>While results for specific facilities or combination of facilities varied by study, parking, lockers and showers were all positively correlated.</li> </ol>	Partial	Locker and shower locations were not mapped because data was unavailable. Public bike parking was mapped.
<i>Unmapped correlates</i>			
Proximity to public transit	<ol style="list-style-type: none"> <li>Findings were ambiguous</li> </ol>	Yes	Correlation direction was inconsistent.

Sources: See Appendix C for literature review sources by correlate.

Note: Population density is defined as the number of people per unit of land.

## 5.2 MAPPING METHODOLOGY

This section provides insight into the methodology and datasets that inform the mapping analysis for utility bicycling, with details regarding each step.

The procedures for mapping correlates to utility biking were very similar to those for mapping variables related to walking for transport (see [Section 4.2: Mapping Methodology](#)). Demographic predictors of utility biking (male gender, educational attainment beyond high school, young adult status, and absence of children in household) were each mapped as people per acre by block group using data from the *2010 Census* or from the *2008-2012 American Community Survey* five-year estimates. The calculated density of each variable was divided into quartiles and assigned a score of one to four; a higher score indicates a greater concentration of a given cohort. Physical environmental variables (proximity to bike lanes, access to bike parking, population density, land use mix, and percentage slope) were also mapped throughout the city (using various data from the above sources and the SFMTA; citations below) and scored from one to four, with four indicating the most favorable condition.

As with the mapping of walking for transport in the previous chapter, three composite suitability maps are then presented: One weighted overlay

combines all demographic variables; another merges all physical characteristics; and the final map integrates all correlates to utility biking.

### 5.2.1 MAPPING DEMOGRAPHIC CORRELATES TO UTILITY BIKING: DATA AND DEFINITIONS

This section defines the specific demographic correlates and datasets, citing sources for each.

Information for age, gender, population, and the number of children per household was gathered from the 2010 Census. Educational attainment for adults 25 years and older was obtained from the 2008-2012 *American Community Survey* five-year estimates (sources as cited in [Chapter 4](#) unless otherwise noted below).

The following demographic correlates were mapped (as persons per acre by block group):

- Male gender, defined by biological sex;
- Educational attainment, measuring adults aged 25 years or older who received a high school diploma or equivalent;
- Young age, i.e., adults from 18 to 34 years old; and
- Households without any children, i.e., those with no people under 18 years of age.

### 5.2.2 MAPPING ENVIRONMENTAL CORRELATES TO UTILITY BIKING: DATA AND DEFINITIONS

This section defines the specific environmental correlates and datasets, citing sources for each (where they differ from those in [Chapter 4](#)).

#### Proximity to Class II Bike Lanes

The SFMTA bicycle route network information was derived from *DataSF*, the website for material issued by the City and County of San Francisco.<sup>80</sup> Quarter-mile and half-mile buffers from Class II bike lanes were produced using the Network Analyst extension of ArcGIS—Network Analyst service areas calculate distance along the street network, providing a more accurate picture than buffers measured “as the crow flies” (i.e., radii), because residents access bike routes by traversing the street system. Sites within a quarter-mile of Class II bike lanes were scored as fours, those between a quarter of a mile and half a mile away were given a two, and all others were not scored.

80. San Francisco Municipal Transit Agency, “SFMTA Bikeway Network” City and County of San Francisco, September 2014, accessed September 29, 2014, <http://ow.ly/G9x3n>.

### Access to Public Bike Parking

Public bike parking locations were also obtained from *DataSF*.<sup>81</sup> A Network Analyst service area was generated to identify all areas within 1/8 mile of these facilities. Places within this buffer were assigned a score of four, and places outside this distance were not scored.

### Population Density

Population density data was extracted from the 2010 Census and mapped per the techniques described in [Section 4.2.2: Mapping Environmental Correlates to Utility Walking: Data and Definitions](#). (A definition of population density is provided in the same section.)

### Land Use Mix and Percentage Slope

The steps for mapping land use mix and percentage slope mirror those explained in [Section 4.2.2: Mapping Environmental Correlates to Utility Walking: Data and Definitions](#).

### 5.2.3 PREPARATION OF COMPOSITE SUITABILITY MAPS FOR UTILITY BIKING

Three composite suitability maps for utility walking were created, each showing the locations of, respectively:

- high concentrations of receptive populations;
- conducive environments; and
- demographic and environmental suitability combined with equal weight.

The procedures for creating composite suitability assessments in ArcGIS are detailed in [Section 4.2.3: Preparation of Composite Suitability Maps for Utility Walking](#). The methods described in that section were followed here, with the following exception: environmental suitability variables input into the weighted overlay were weighted differently based on their relative importance (whereas in the utility walking section, as explained therein, environmental correlates were weighted equally).

The weighting that was used is as follows: According to an extensive literature review of over 300 studies of non-motorized transport, policies which promote bike infrastructure are the most effective means of increasing utility biking rates, more so than community design programs.<sup>82</sup> Therefore, proximity of bike lanes and bike parking were each assigned a 25 percent influence. Slope was also weighted 25 percent because it is a considerable deterrent to cycling.<sup>83</sup> Population density and land use mix were given less importance, at 15 and 10 percent respectively.

81. San Francisco Municipal Transit Agency, "Bicycle Parking (Public)" City and County of San Francisco, accessed September 29, 2014, <https://data.sfgov.org/Transportation/Bicycle-Parking-Public-/w969-5mn4>.

82. Kevin J. Krizek, Ann Forsyth and Laura Baum, *Walking and Cycling International Literature Review Final Report* (Melbourne: Department of Transportation Walking and Cycling Branch, 2009) 7.

83. *Ibid.*, 7.

## 5.3 MAPPING ANALYSIS FINDINGS FOR UTILITY BIKING

This section describes the mapping analysis process used to identify the locations of populations and environments that are conducive to utility biking, leading up to and including the final composite suitability map presented at the end of the section.

### 5.3.1 LOCATIONS OF POPULATIONS RECEPTIVE TO BIKING FOR TRANSPORT

#### Males

Places with high population density typically generated the most men per acre. These areas include almost all of Nob Hill, Chinatown and Downtown Civic Center; Russian Hill and North Beach south of Greenwich Street; Western Addition south of Eddy Street; roughly 60 percent of the Mission; most block groups in Haight Asbury adjacent to the Panhandle; and east of Mission Street from Avalon Avenue to Guttenberg Street (Figure 22). Large sections of the Castro, the Richmond, Excelsior, Visitacion Valley and Crocker Amazon neighborhoods contained block groups in the third quartile.



*A men's group outing*

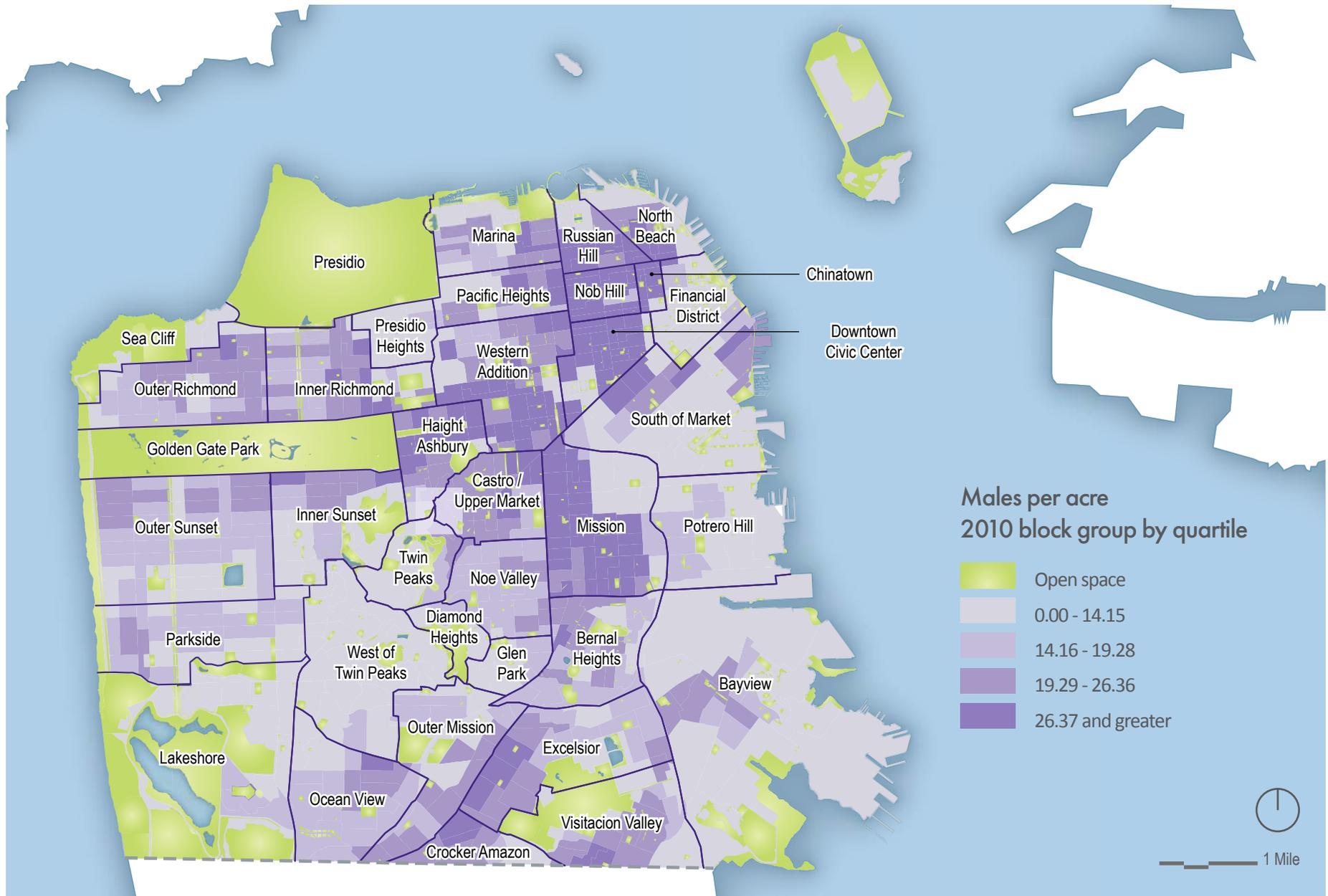


Figure 22. Density of males

Sources: Map created by author. See Appendix D for source information.

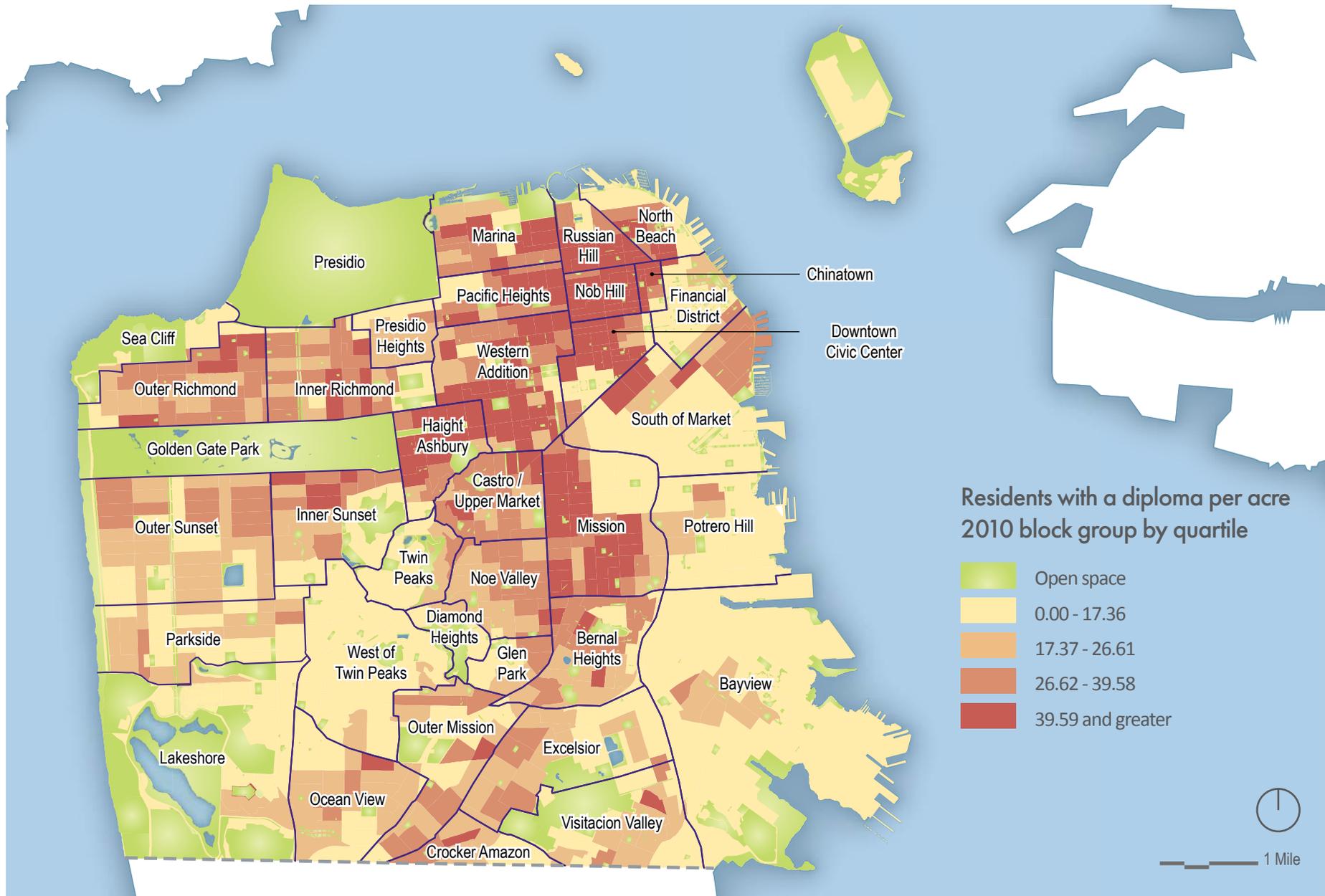
Notes: Density of males is shown in quartiles. All coastal block groups were trimmed at the shoreline to portray accurate physical boundaries.

## Higher Education Attainment

San Franciscans over 25 years old with a high school diploma or equivalent were more concentrated in the northeast quadrant of the city (Figure 23). Virtually all of Nob Hill, Russian Hill and Chinatown were in the highest quartile. Additional high-density sites were mainly in the surrounding neighborhoods: eastern portions of Pacific Heights and the Marina; most of Downtown Civic Center, north of McAllister Street; Western Addition, east of Webster from Geary Boulevard to California Street; and several block groups in North Beach from Broadway to Chestnut Street. Other nearby places with sizeable areas in the top quartile were: Western Addition south of Eddy Street; Haight Ashbury, adjacent to the Panhandle and Golden Gate Park; and throughout the Mission, excepting the northeast quadrant.



*High school students in San Francisco*



**Figure 23. Density of adults 25 years and older with a high school diploma or GED**

Sources: Map created by author. See Appendix D for source information.

Notes: Density of residents with a high school diploma/GED is shown in quartiles. All coastal block groups were trimmed at the shoreline to portray accurate physical boundaries.

### Households without Children

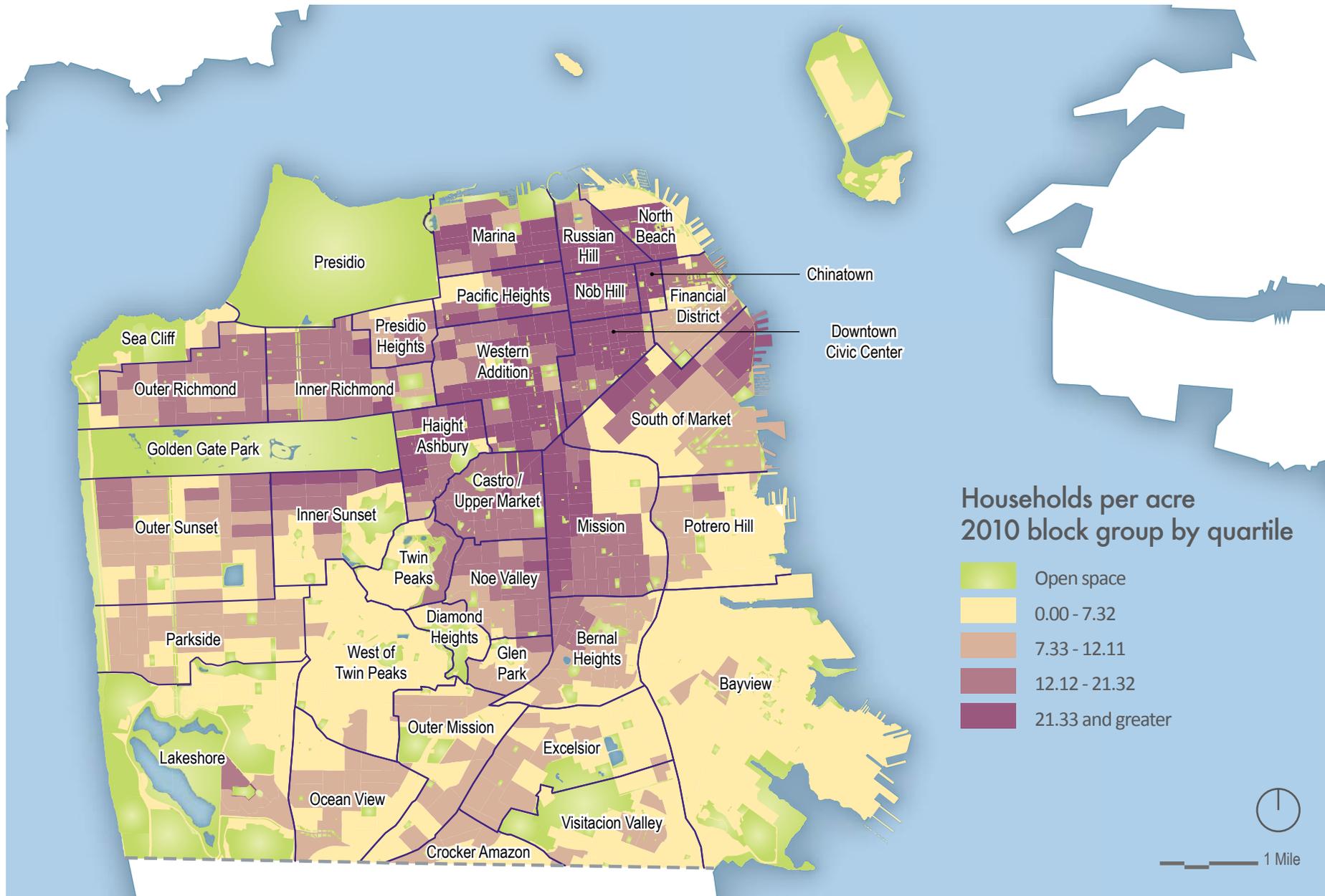
Households without children were found in essentially the same locations as people with a high school diploma (Figure 24). The principal difference was that more sites were in the third quartile, including the Mission south of 19th Street, most of the Castro, northern Inner Sunset and large portions of the Inner and Outer Richmond.

### Young Adults

Young adulthood correlated to both walking and biking for utility. Findings for young adults are as presented in Section 4.3.1: Locations of Receptive Populations as Mapped by Correlate.



*"Surrounded by adults, a child crosses Market Street in San Francisco, which is becoming older and whiter as families leave." See Appendix E for image and caption source.*



**Figure 24. Density of households without children**

Sources: Map created by author. See Appendix D for source information.

Notes: Density of households without children is shown in quartiles. All coastal block groups were trimmed at the shoreline to portray accurate physical boundaries.

### 5.3.2 LOCATIONS OF SUITABLE ENVIRONMENTS AS MAPPED BY CORRELATE Proximity to Class II Bike Lanes

Figure 25 indicates sites within a quarter mile and half mile of existing Class II facilities. Only ten percent of San Francisco’s bicycle network includes dedicated paths and cycle tracks.<sup>84</sup> Access to bike lanes is critical for increasing cycling rates.<sup>85</sup> Class II bike lanes are sparsely scattered across several neighborhoods but are predominately clustered in the Mission, South of Market and Western Addition (Figure 25). Typically, bike lanes avoid places with steep topography. (These include Nob Hill, Pacific Heights, Presidio Heights, Twin Peaks, Diamond Heights, Noe Valley, Bernal Heights, Excelsior, southern Haight Ashbury, and the majority of the Castro; refer to Figure 18 for percent slope).

The entire Mission, most of South of Market, and the bulk of Western Addition are within a quarter-mile of a bike lane. In a few neighborhoods, bike lanes are found at the perimeter but are lacking at the center. For example, only the edges of Potrero Hill, the Richmond neighborhoods, Bernal Heights, and Visitacion Valley fall within the quarter-mile buffer, while internal blocks within these neighborhoods are half a mile away from such facilities. All places with steep topography listed above are a half mile or more from a bike lane.

Notably, two sizeable areas with gentle slope do not have easy access to bike lanes: a large region comprising Parkside and southern Outer Sunset; and the southern portion of Bayview. These locations may therefore be ripe for improvements.



Above: 2014 Bike to Work Day in San Francisco

Right: Green bike lane on Market Street



84. San Francisco Municipal Transit Agency, *SFMTA Bicycle Strategy April 2013* (San Francisco: SFMTA, April 2013), 6, accessed August 31, 2013, <http://ow.ly/F7gu4>.

85. Jennifer Dill and Theresa Carr, "Bicycle Commuting And Facilities In Major U.S. Cities: If You Build Them, Commuters Will Use Them," *Transportation Research Record: Journal of the Transportation Research Board* 1828, no. 1 (2003): 119, 121.

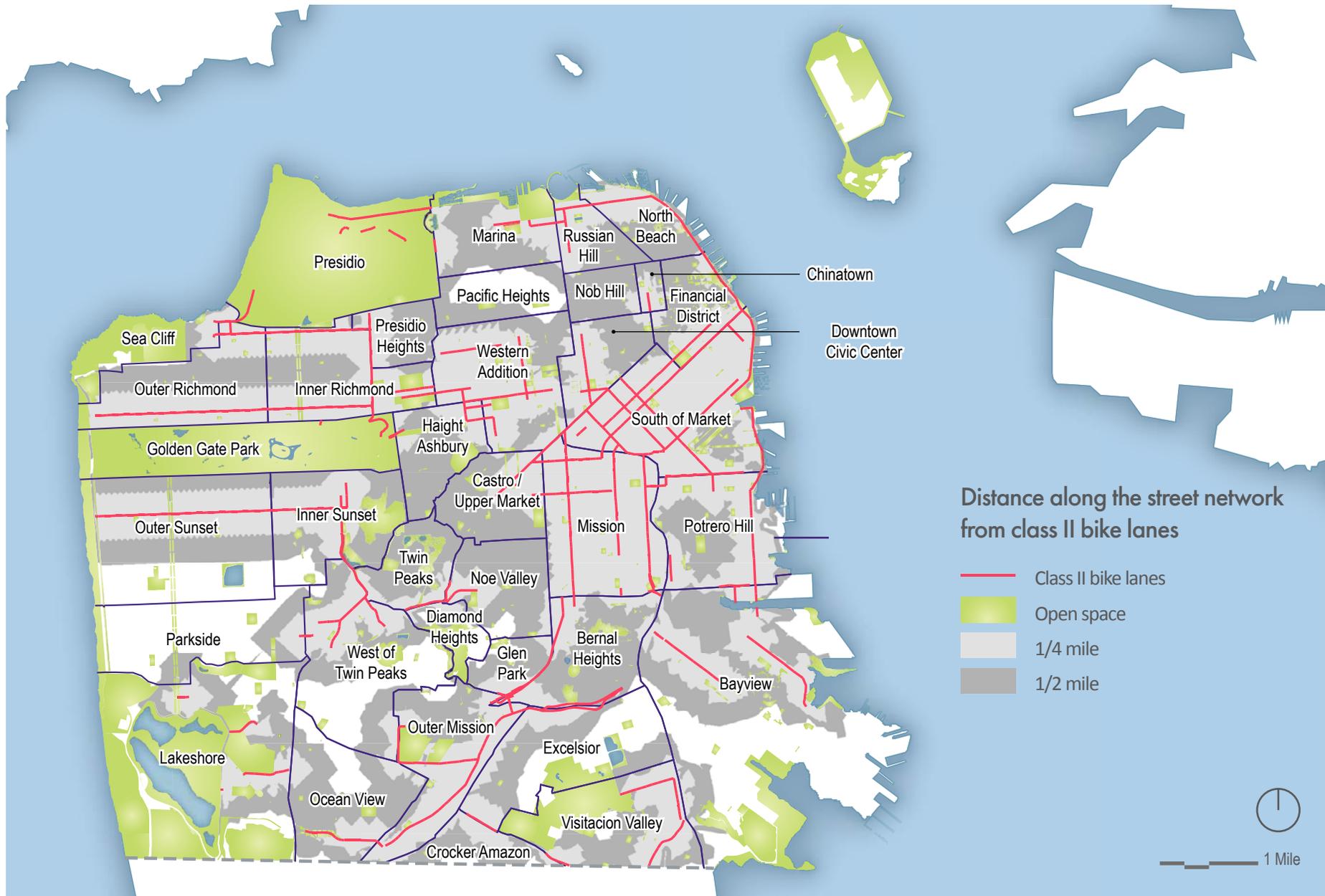


Figure 25. Proximity to Class II bike lanes

Sources: Map created by author. See Appendix D for source information.



### Proximity to Public Bike Parking

If convenient bike parking is unavailable, many residents will not bike.<sup>86</sup> To address this issue, the City has recently installed a great deal of public bike parking. Over 90 percent of the 2,521 facilities are small bike racks (with four or fewer spaces) installed on the sidewalk. Another 153 facilities include multiple small racks or lot parking with five to 10 spaces. More than 80 sites provide between 12 and 200 spaces in a combination of lots, garages or on the sidewalk.

Figure 26 is a point-density map; it illustrates places where bike parking facilities are densely clustered and where they are scarce. Bike parking is concentrated in the “Core Bicycle Area” defined in the 2013 *SFMTA Bicycle Strategy* as “central-downtown corridors.”<sup>87</sup> The largest parking areas are also found in the core bicycle area. In southern San Francisco, facilities are shown to be relatively few and more dispersed.

A distance (1/8 of a mile) equal to a two-to-three-minute walk from all bike parking is mapped in Figure 27. Excluding large parks, most of northern San Francisco has access to public bike parking within a couple of minutes’ walk. Many places in the southern half of the city fall outside of this threshold.

### Population Density, Land Use Mix, and Percent Slope

Population density, land use mix, and percent slope correlate to both walking and biking for transport. Findings for these variables are discussed in Section 4.3.2: *Locations of Suitable Environments as Mapped by Correlate*.



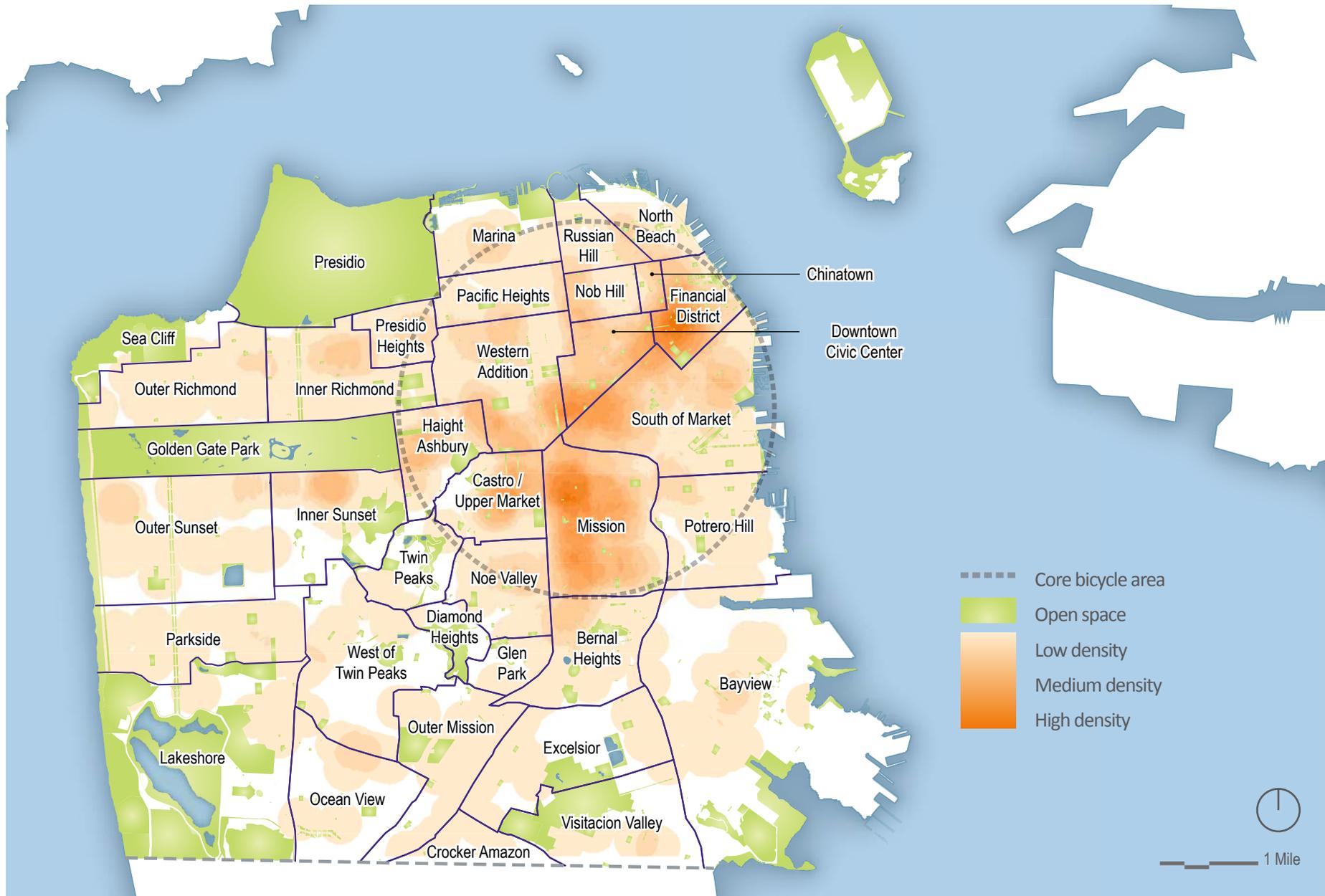
*Above: Bike corral on 18th Street in the Castro District which was installed in December 2011*

*Right: SFMTA stencil before installation of a bicycle rack on Folsom Street*



86. San Francisco Municipal Transportation Agency, *2012 San Francisco State of Cycling Report*, (San Francisco: SFMTA, 2012), 7, accessed September 5, 2014, <http://ow.ly/F7gjR>.

87. San Francisco Municipal Transit Agency, *SFMTA Bicycle Strategy April 2013* (San Francisco: SFMTA, April 2013), 19, accessed August 31, 2013, <http://ow.ly/F7gu4>.



**Figure 26. Density of public bike parking facilities**

Sources: Map created by author. See Appendix D for source information.

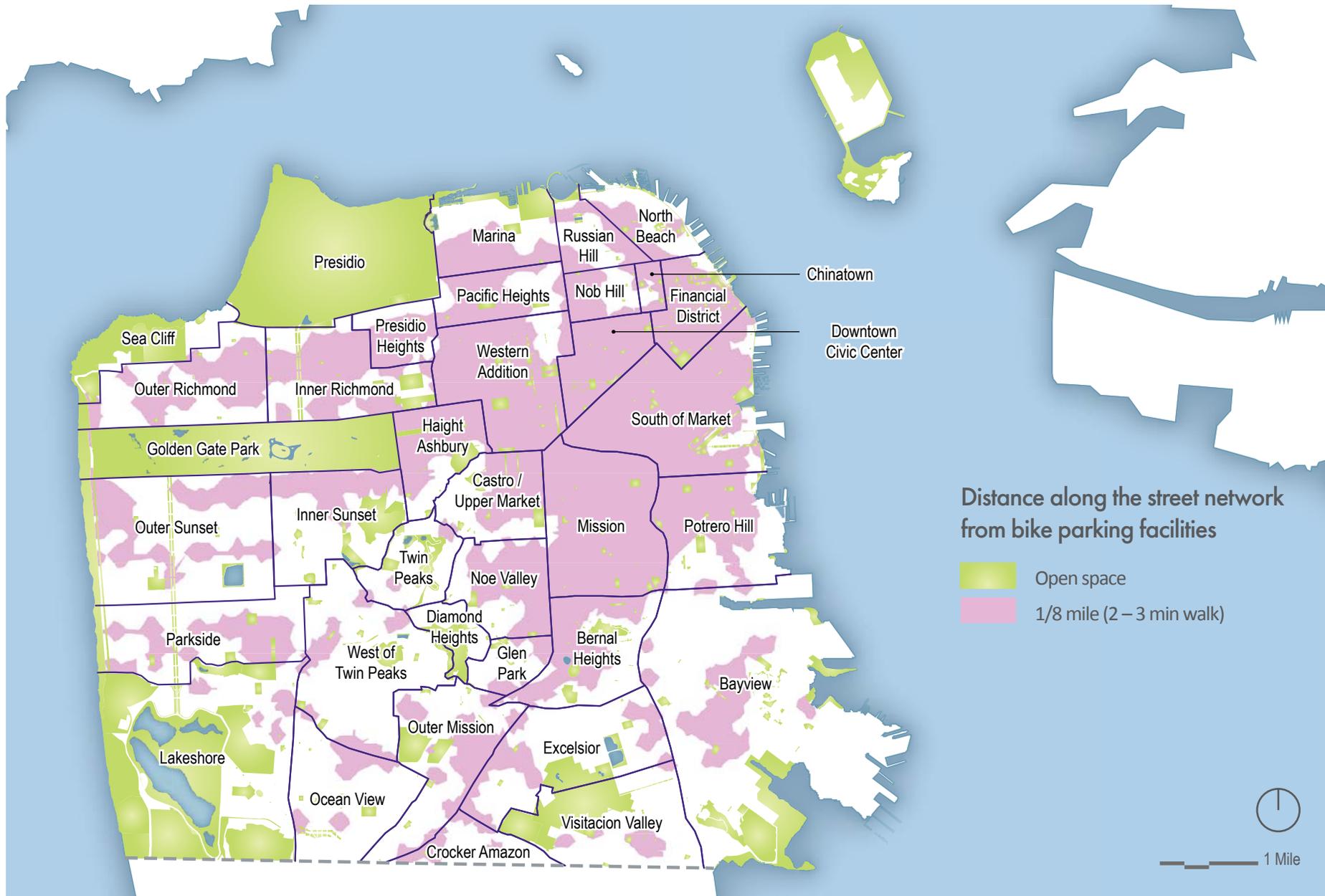


Figure 27. Proximity to public bike parking

Sources: Map created by author. See Appendix D for source information.

### 5.3.3 COMPOSITE SUITABILITY MAPS OF DEMOGRAPHIC AND ENVIRONMENTAL CORRELATES

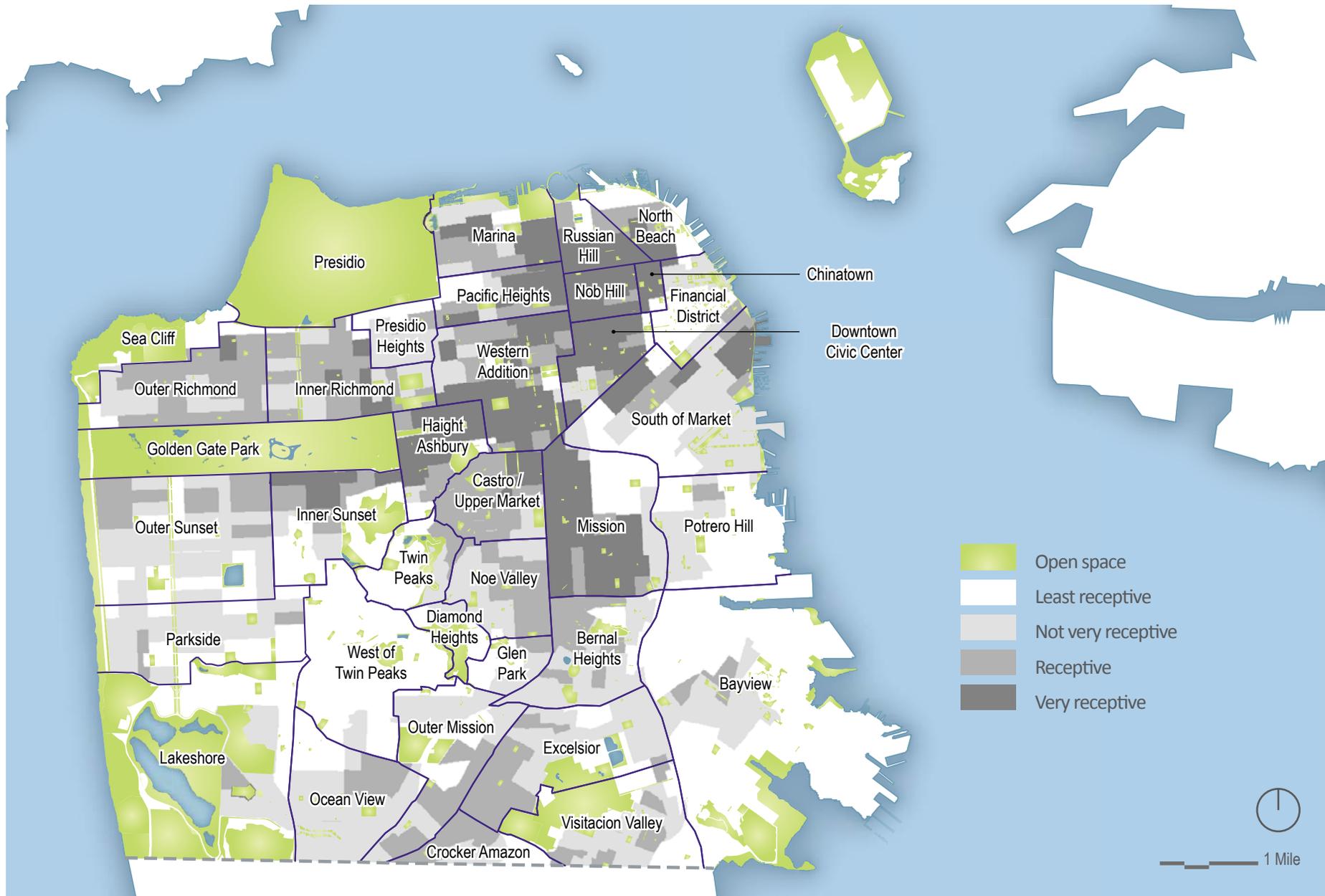
#### Locations with Receptive Populations

**Figure 28** displays block groups across the city with high concentrations of people who are apt to bike for transport based on demographic findings. To create this suitability assessment, a composite was created combining the mapping analysis for young age, male gender, households without children, and adults 25 years and older with a high school diploma.

The intensity of each demographic correlate is typically greater in dense areas, simply because there are more people in general. Therefore, population density has a considerable impact on demographic suitability. Compact neighborhoods in northeast San Francisco and the Mission contain the most receptive populations to utility biking. Low-density districts consist of few, if any, block groups with high concentrations of people who are likely to bike for transport.

In three locations, demographic suitability does not correspond to population density. Block groups along Mission Street in Excelsior and Crocker Amazon failed to achieve a score of “very receptive” because residents with a high school degree and households without children were scarce. Conversely, Eastern Noe Valley and the Castro — both relatively low-density neighborhoods — earned a score of “receptive” due to the presence of those demographics.





**Figure 28. Populations receptive to utility biking**

Sources: Map created by author. See Appendix D for source information.

Note: Demographic correlates to utility biking are: male gender, young adult status, attainment of a high school diploma or GED for adults over 25 years of age, and households without children.

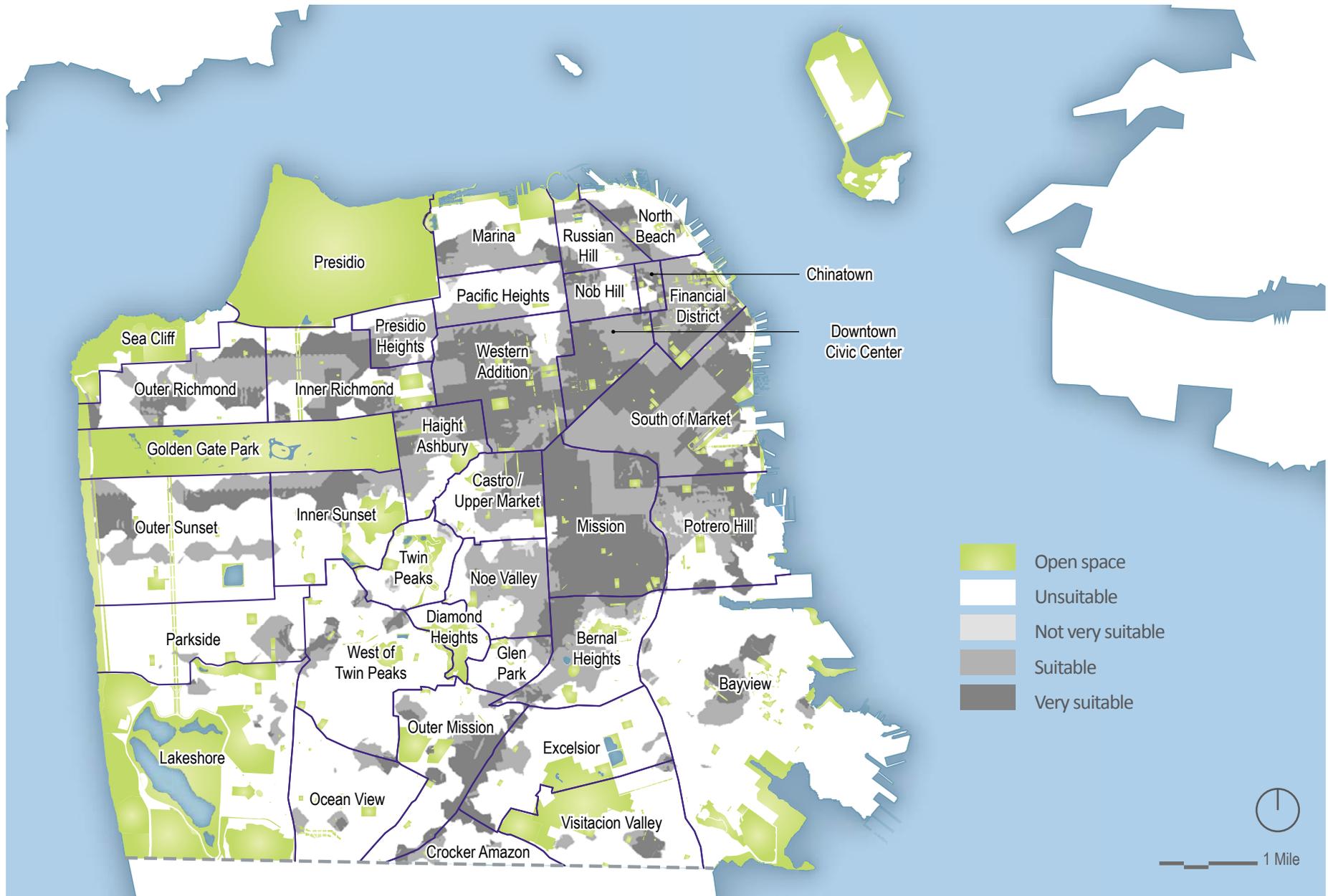
### Ideal Environmental Conditions

Figure 29 identifies the most favorable environments for utility biking in the city. Results for proximity to Class II bike lanes, availability of public bike parking, population density, land use mix, and percent slope are combined to produce this evaluation.

Physical characteristics in northern San Francisco are mainly favorable for utility biking. Quite a few neighborhoods are almost entirely composed of well suited areas, as the map shows. In southern districts, environmental conditions are generally poor. One exception is along Mission Street south of Cesar Chaves Street.

Access to bike lanes and public bike parking had a profound effect on this assessment. Sites in excess of a couple minutes' walk from bike parking have inadequate conditions for increasing utility biking rates. Places farther than a quarter of a mile from a Class II bike lane did not obtain a score of "very suitable." Percent slope magnified the importance of bike infrastructure, because bikers typically avoid steep areas, and infrastructure is lacking in those locations.





**Figure 29. Suitable environments for utility biking**

Sources: Map created by author. See Appendix D for source information.

Note: Environmental correlates to utility biking are: proximity to Class II bike lanes, proximity to public bike parking, population density, land use mix, and percent slope.

### Places with Both Receptive Populations and Conducive Environments for Utility Cycling

The final composite suitability map reveals ideal locations for bike infrastructure (Figure 30) given all factors examined thus far. To produce this suitability analysis, both demographic and environmental correlates to utility biking were combined with equal weight. Consequently, the most conducive sites contain both populations and physical characteristics associated with higher levels of utility biking.

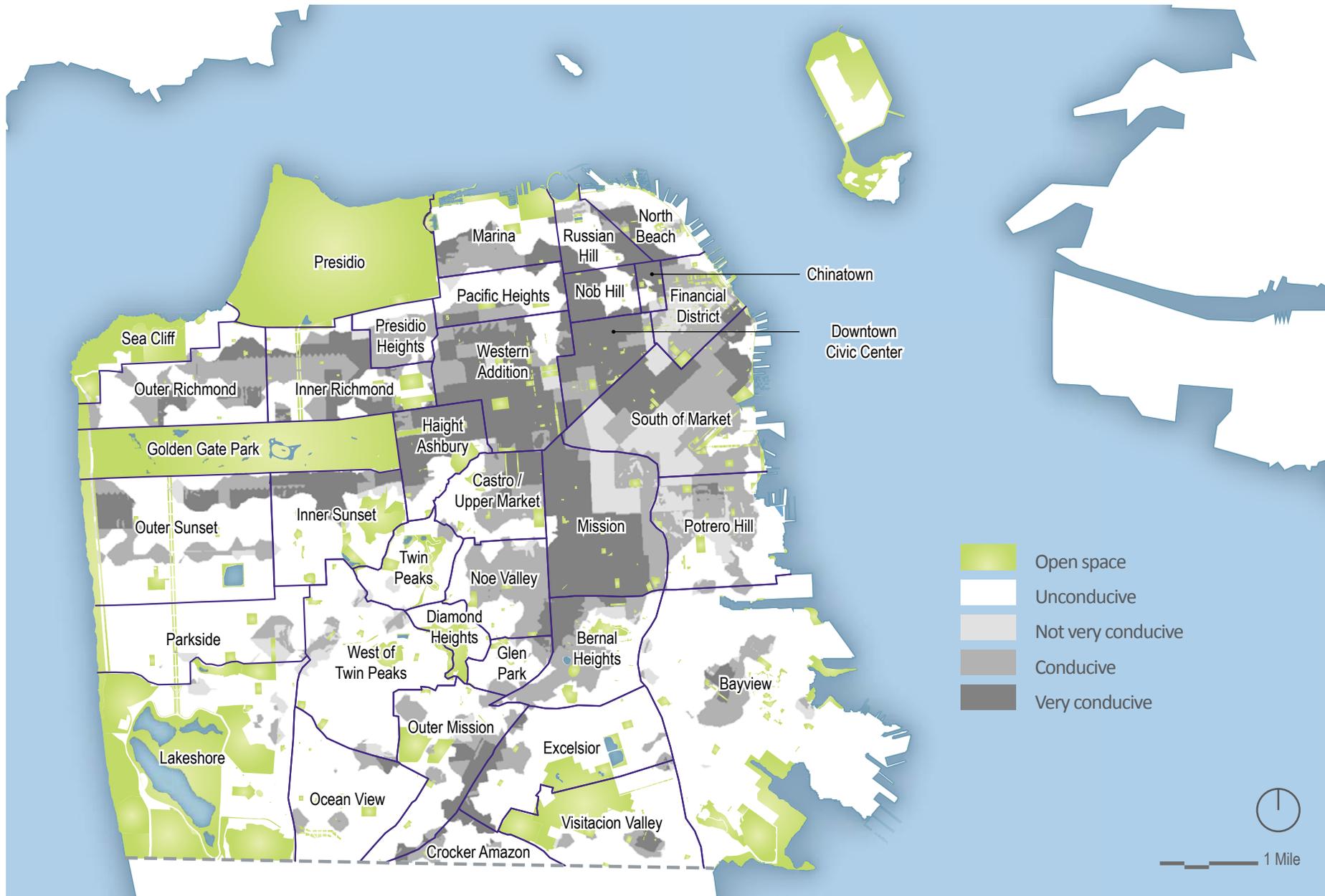
A few sizeable areas were discovered that are very conducive to utility biking. The first is in the Mission west of South Van Ness Avenue and south of 19th street. Another includes nearly all of Western Addition and northern Haight Ashbury. One more encompasses most of Downtown Civic Center, a few adjacent block groups across Market Street, western Nob Hill, and the southwest corner of Russian Hill.

In 27 out of 37 neighborhoods, at least some portion of the area has optimal conditions for utility biking. Table 19 lists all 27 in order from those with the largest “very conducive” area to the smallest. The Mission and Western Addition have the greatest amount of land that is well suited for biking, at 729 and 647 acres respectively. Four neighborhoods include over 200 acres of very favorable land: South of Market, Downtown Civic Center, Haight Ashbury, and the Inner Richmond. Still another nine districts have highly receptive areas ranging in size from roughly 100 to 190 acres.

Smaller highly receptive sites are concentrated in a few places: along parts of Mission Street in Excelsior and northern Bernal heights, along Columbus north of Broadway Street, in Inner Sunset adjacent to Golden Gate park, and South of Market east of 2nd Street. Some of these locations are split by neighborhood boundaries, causing areas in each to be quite small.

**Table 19. Areas very receptive to utility biking by neighborhood**

Neighborhood	Very receptive area (in acres)	Percentage of neighborhood rated very receptive
Mission	729.4	66%
Western Addition	647.3	67%
South of Market	313.7	23%
Downtown / Civic Center	300.2	73%
Haight Ashbury	282.7	58%
Inner Richmond	238.1	28%
Inner Sunset	190.5	22%
Outer Sunset	151.2	10%
Nob Hill	145.6	62%
Castro / Upper Market	121.4	22%
Outer Richmond	119.1	14%
Outer Mission	103.8	12%
Russian Hill	101.4	33%
Marina	96.3	16%
Bernal Heights	96.0	13%
North Beach	81.7	20%
Excelsior	70.6	7%
Pacific Heights	55.6	13%
Chinatown	51.8	60%
Bayview	38.3	1%
Financial District	38.0	9%
Crocker Amazon	30.7	10%
Noe Valley	24.4	4%
Visitacion Valley	23.5	2%
Potrero Hill	12.3	1%
Ocean View	11.8	1%
Glen Park	9.2	4%



**Figure 30. Areas with both populations and environments conducive to utility biking**

Sources: Map created by author. See Appendix D for source information.

Note: Correlates to utility biking are: male gender, young adult status, attainment of a high school diploma or GED for adults over 25 years of age, households without children, proximity to Class II bike lanes, proximity to public bike parking, population density, land use mix, and percent slope.



# CHAPTER SIX

## RECOMMENDATIONS FOR SPECIFIC IMPROVEMENTS

This chapter reviews active and planned City projects proposed in various policy documents, examining which ones should be prioritized for immediate infrastructure improvements, per the findings of this report, and recommending other specific improvements.

Over the next five years, the City has allocated \$17 million in funding available for capital improvements to increase walk mode share and reduce pedestrian injuries. Another \$55 million has been budgeted for bicycle improvements over the next two years.

To assess the value of a particular project, city officials must gauge how each intervention will impact levels of non-motorized transport. The findings of this study provide an additional metric for prioritizing improvements that this research predicts will increase walking and cycling rates most effectively. Policies that target infrastructure in underserved areas with receptive populations and environments for utility walking and biking are essential for maximizing the impact of available funding and meeting the City's active-travel mode-share goals.

Projects in the works per the SFMTA *Capital Improvement Program, Vision Zero: Capital Project Implementation in Support of Vision Zero*

and the *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC)* are reviewed in this section to help prioritize those improvements that fall within the most suitable areas (as indicated by this research).<sup>88</sup> Additionally, underserved areas that should be considered for improvements are also presented.

### 6.1 POLICIES AND RECOMMENDED IMPROVEMENTS: UTILITY WALKING

To determine which pedestrian improvements should be prioritized for immediate construction, capital projects listed in various policy documents are compared to the walking suitability assessment presented as [Figure 21](#). First, pedestrian high-injury streets identified by the San Francisco Department of Public Health are overlaid onto the suitability assessment ([Figure 31](#)).<sup>89</sup> Next, walk improvements listed in *Vision Zero: Capital Project Implementation in Support of Vision Zero* are evaluated to ascertain which are located in receptive areas for walking ([Table 20](#)).<sup>90</sup> Finally, pedestrian projects from the *Draft SFMTA Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* that occur on streets with very favorable conditions for increasing utility walking rates are discussed, and presented in [Table 21](#).<sup>91</sup>

88. San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 42-55, 92-108, accessed November 7, 2014, <http://ow.ly/Fw3FT>; San Francisco Municipal Transportation Agency, *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC)* (San Francisco: SFMTA, March 2014), 7, accessed September 5, 2014, <http://ow.ly/F7iMt>; San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

89. San Francisco Department of Public Health Open Data, "Pedestrian High-Injury Corridors, San Francisco, CA," City and County of San Francisco, August 17, 2014, accessed August 20, 2014, <http://ow.ly/FwaKi>.

90. San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

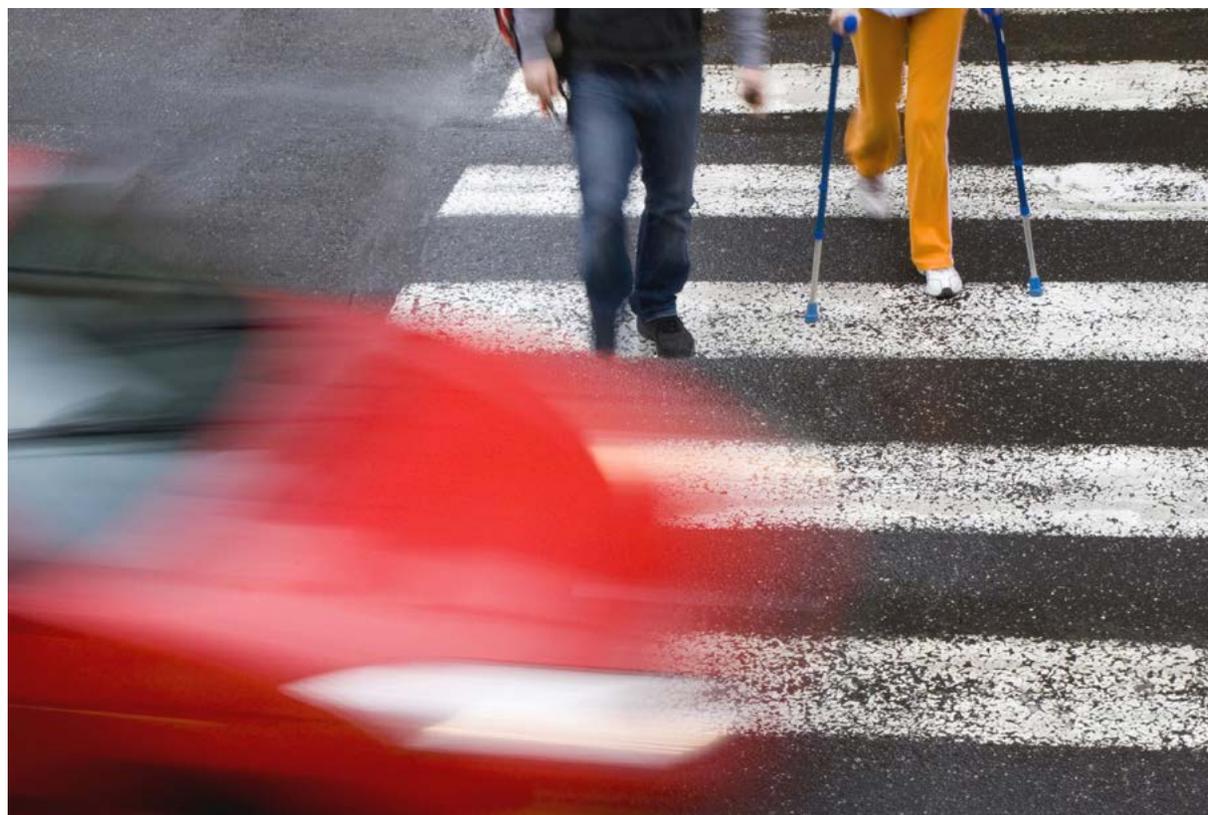
91. San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 92-108, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

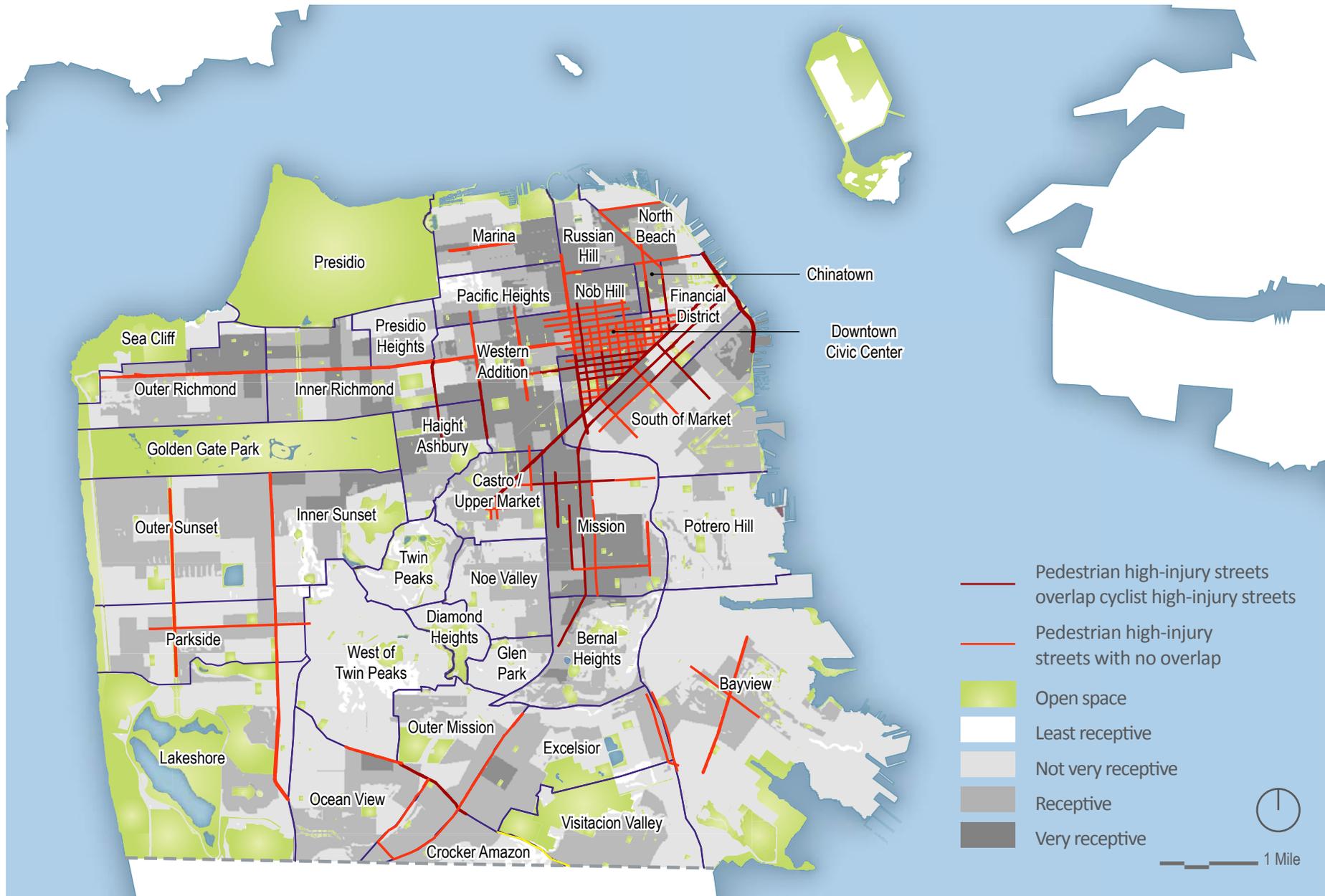
### 6.1.1 PRIORITY PEDESTRIAN HIGH-INJURY STREETS

Figure 31 illustrates which pedestrian high-injury corridors should be prioritized for immediate infrastructure improvements because this research indicates that they are surrounded by populations or built-environment characteristics associated with higher levels of utility walking. The majority of dangerous streets are concentrated near Downtown Civic Center and southern Nob Hill. Underserved corridors north of Market Street and east of Franklin Street are some of the most ideal and necessary places for new pedestrian improvements. Almost all high-injury streets in the Mission should be given precedence for funding, except for 16th Street east of South Van Ness Avenue. Other roads prone to pedestrian accidents and fatalities that should be improved in the near term are: Webster Street; Divisadero Street; Masonic Avenue south of Turk Street; Market Street west of 5th Street; and Mission and Howard streets from 5th to 11th streets.

### 6.1.2 OTHER AREAS RECEPTIVE TO UTILITY WALKING

This research also identifies places that are not pedestrian high-injury streets, but which have ideal conditions for increasing walk mode-share (Figure 31). These areas are: Haight Ashbury along the Panhandle, Western Addition south of Eddy Street, the Inner Sunset along Golden Gate Park, and along Van Ness Avenue in Russian Hill and the Marina.





**Figure 31. Pedestrian high-injury corridors in areas best suited to utility walking**

Sources: Map created by author. See Appendix D for source information.

Note: Correlates to utility walking are: being a young adult, low-income resident, and/or commuter who usually takes public transit to work; population density; residential density; land use mix; and percent slope.

**Table 20. Vision Zero pedestrian improvements in areas best suited to utility walking**

ID#	Project	Details
2	Ellis Street/Eddy Street, from Leavenworth to Mason streets	Conversion of Ellis and Eddy streets to two-way traffic operations, including installation of pedestrian signals at Ellis/Taylor intersection and Eddy/Taylor intersection
4	Golden Gate Avenue, from Polk to Jones streets	Road diet (i.e., reduction in number of automobile travel lanes)
5a	Howard Street Near-Term A	Temporary corner bulb-outs (“bulbs”) & continental crosswalks at target locations
7	Polk Street, from McAllister to Union streets	Early implementation of Polk Street safety and street treatments, such as daylighting, signal re-timing, and colored curbs
10b	Webster Street, from Fulton to Sutter	Pedestrian bulbs at Turk/Webster
10c	Webster Street, from Fulton to Sutter streets	Additional pedestrian improvements, such as temporary bulbs and daylighting, at McAllister and Post streets
16	Irving Street, from Arguello Boulevard to 9th Avenue	Pedestrian and bus bulbs, as well as a new traffic signal
19	Mission Street, from 18th to 23rd streets	Pedestrian intersection treatments, such as daylighting and continental crosswalks
21	Sutter Street, at Mason, Taylor, and Leavenworth streets	Four bulbs at each intersection
24	Columbus Avenue, Broadway to Union Street	Bulbs at intersections of Stockton Street with Green, Vallejo, and Grant streets
28	Geary Blvd./Leavenworth Street and Eddy Street/Mason Street	Pedestrian intersection treatments, such as temporary bulbs, continental crosswalks, and a leading pedestrian interval
33	6th Street at Minna Street	New traffic signal
37	Persia Triangle improvements	Pedestrian intersection treatments, including bulbs and lighting, on streets bounded by Mission and Persia Streets and Ocean Avenue
38	Valencia Street/Duboce Avenue	Variety of spot improvements, such as daylighting, vehicle turn restrictions, and signal upgrades

Source: San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, “Vision Zero: Capital Project Implementation in Support of Vision Zero,” October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

### 6.1.3 PRIORITY VISION ZERO PEDESTRIAN PROJECTS

*Vision Zero: Capital Project Implementation in Support of Vision Zero* identifies 40 projects totaling over \$20 million, many of which are intended to help reduce pedestrian injuries and deaths (Figure 9).<sup>92</sup> Eight of these projects are already completed, and SFMTA has committed to implementing another 24 Vision Zero projects by 2024.<sup>93</sup> Pedestrian improvements in support of Vision Zero that are expected per the findings of this research to most effectively increase walking rates are listed in Table 20.

### 6.1.4 PRIORITY PEDESTRIAN PROJECTS FROM SFMTA'S CAPITAL IMPROVEMENT PROGRAM

The *Draft SFMTA Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* includes 40 pedestrian projects totaling over \$67 million which are expected to improve: congestion, street design, and the safety of people walking.<sup>94</sup> For some projects listed in that document, specific locations are not provided. Pedestrian improvements proposed in areas that are best suited to utility walking are listed in Table 21.

**Table 21. CIP pedestrian improvement projects in areas best suited to utility walking**

CIP#	Project
PE0109	Columbus Avenue pedestrian improvements
PE0117	Turk Street at Webster Street pedestrian improvements
PE0122	Pedestrian Safety spot improvements within a block radius of Octavia Street
PE0157	Market and Octavia streets intersection improvement project
PE0158	Oak and Octavia streets intersection improvement project

Source: San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 92-108, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

<sup>92</sup> San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

<sup>93</sup> Ibid.

<sup>94</sup> San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 92-108, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

## 6.2 POLICIES AND RECOMMENDED IMPROVEMENTS: UTILITY BIKING

To establish which bike improvements should be given precedence for near-term funding, capital projects listed in several policy documents are evaluated using the biking suitability assessment map (Figure 30). First, cyclist high-injury streets presented in the *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee* in March 2014 are superimposed onto the biking suitability assessment (Figure 32).<sup>95</sup> Next, bike projects enumerated in the *Vision Zero: Capital Project Implementation in Support of Vision Zero* are examined to identify those in areas conducive to utility biking (Table 22).<sup>96</sup> In conclusion, bike improvements proposed in the *Draft SFMTA Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* that are found to be surrounded by favorable conditions for increasing biking rates are given in Table 23.<sup>97</sup>

### 6.2.1 PRIORITY CYCLIST HIGH-INJURY STREETS

Cyclist high-injury corridors that should be prioritized for immediate infrastructure improvements are shown in Figure 32. These underserved streets are clustered in northeastern San Francisco and the Mission. Downtown Civic Center between Eddy and McAllister streets is unsafe for cyclists, though it is surrounded by populations and environmental conditions which are associated with higher levels of cycling; this situation deserves remediation. Polk Street south of Union also has a high rate of severe injuries and fatalities to cyclists in an area that is notably receptive to biking. Additional streets that are dangerous for cyclists and that should be improved in the near-term are located in: Haight Ashbury; southern Western Addition; the Mission, except in the northeast quadrant; and a few places in South of Market.

### 6.2.2 PRIORITY VISION ZERO BICYCLE IMPROVEMENTS

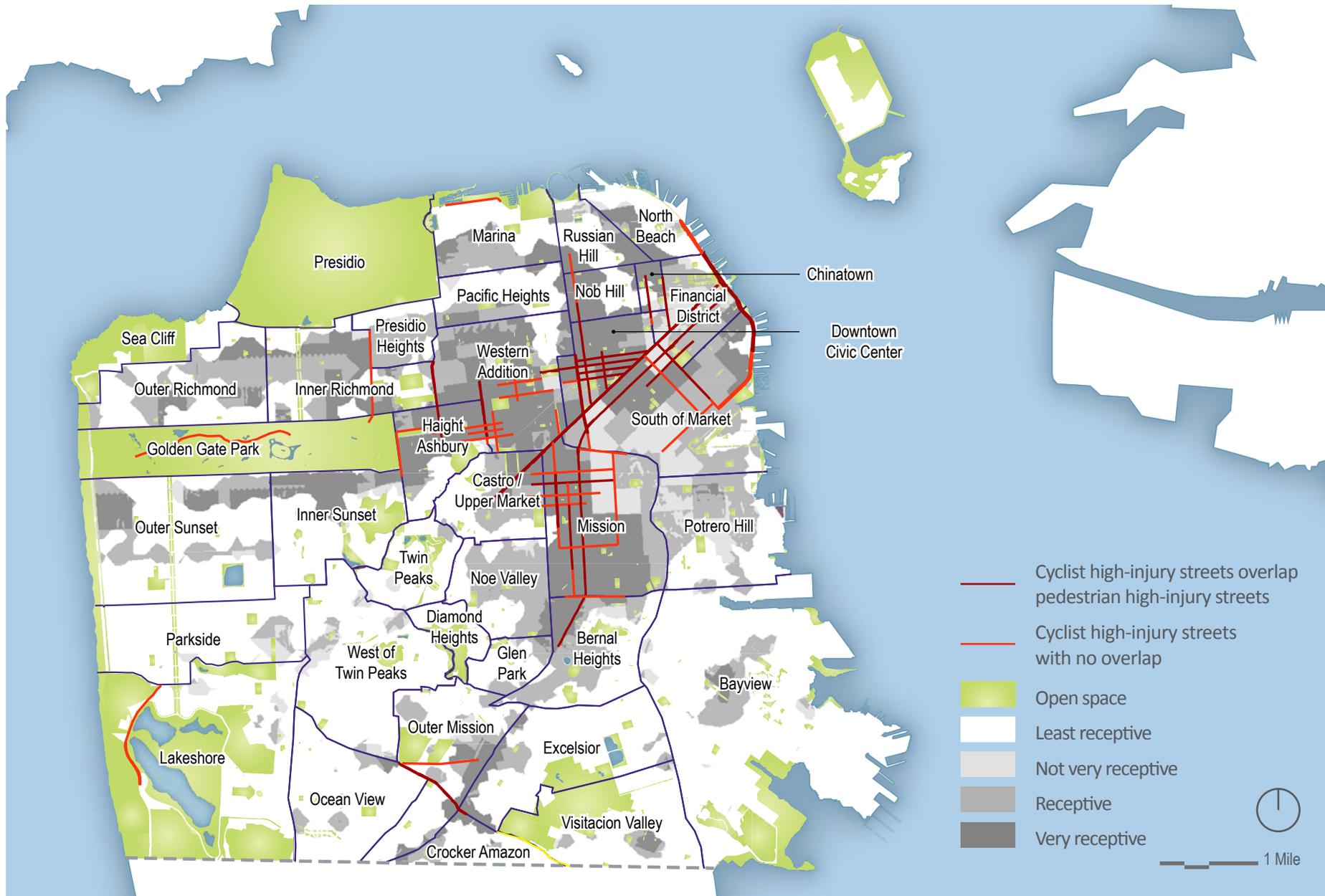
A few projects listed in *Vision Zero: Capital Project Implementation in Support of Vision Zero* are along bicycle high-injury corridors (Figures 9 and 32), making them prime targets for improvements.<sup>98</sup> Improvements in support of Vision Zero that are expected to most effectively increase utility biking rates are listed in Table 22.

95. San Francisco Municipal Transportation Agency, *SFMTA Livable Streets Report to the San Francisco Bicycle Advisory Committee (BAC)* (San Francisco: SFMTA, March 2014), 7, accessed September 5, 2014, <http://ow.ly/F7iMt>.

96. San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

97. San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 42-55, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

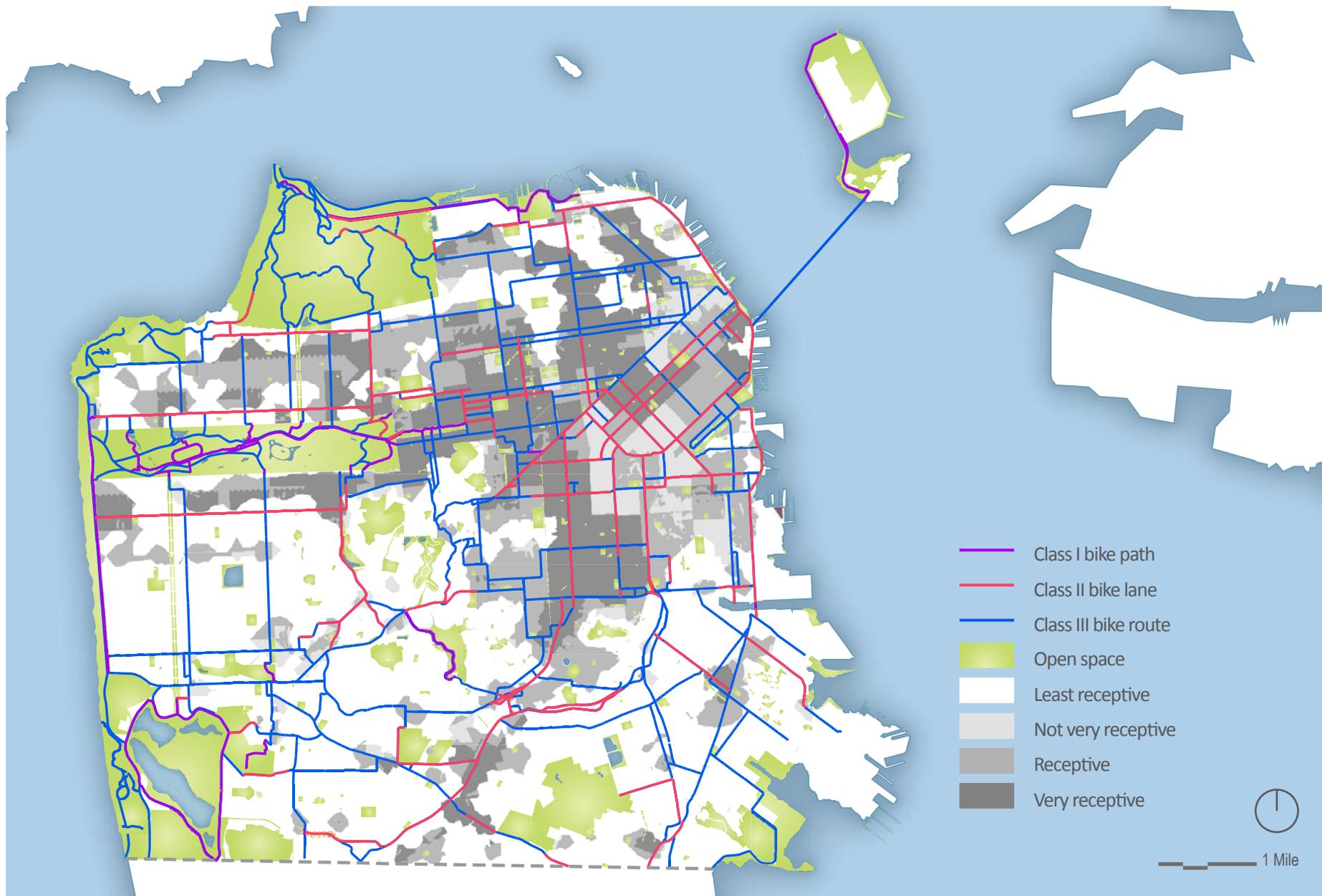
98. San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.



**Figure 32. Cyclist high-injury corridors in areas best suited to utility biking**

Sources: Map created by author. See Appendix D for source information.

Note: Correlates to utility biking are: men, young adults, people over 25 with a high school diploma or GED, households without children, proximity to bike lanes, proximity to public bike parking, population density, land-use mix and slope.



**Figure 33. Bicycle route network in areas best suited to utility biking**

Sources: Map created by author. See Appendix D for source information.

Note: Correlates to utility biking are: men, young adults, people over 25 with a high school diploma or GED, households without children, proximity to bike lanes, proximity to public bike parking, population density, land-use mix and slope.

### 6.2.3 PRIORITY BICYCLE PROJECTS FROM SFMTA'S CAPITAL IMPROVEMENT PROGRAM

The *Draft SFMTA Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* includes 49 bicycle-related projects, totaling over \$119 million, that aim to create new bicycle facilities and improve cyclist safety.<sup>99</sup> Many projects itemized in that document do not provide exact locations. Bicycle improvements proposed in areas that are receptive to utility biking are listed in [Table 23](#).

### 6.2.4 OTHER AREAS RECEPTIVE TO UTILITY BIKING

The June 2013 *SFMTA Bicycle Strategy Update Needs Assessment* identified strategic gap-closures needed to improve the fragmented bicycle network ([Figure 8](#)).<sup>100</sup> Post and Sutter streets are also strategic network gap-closures that are located in places with favorable conditions for increasing bike rates. Additional existing bike routes in areas where improvements are expected to have the largest possible effect are: Columbus Avenue, Taylor Street, California Street, Broadway east of Polk Street, and Webster south of Fulton Avenue ([Figure 33](#)).

99. San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 42-55, accessed November 7, 2014, <http://ow.ly/Fw3FT>.

100. San Francisco Municipal Transit Agency, *SFMTA Bicycle Strategy April 2013* (San Francisco: SFMTA, April 2013), 3, accessed August 31, 2013, <http://ow.ly/F7gu4>.

**Table 22. Vision Zero bicycle improvements in areas best suited to utility biking**

ID#	Project	Details
4	Golden Gate Avenue, from Polk to Jones streets	Road diet
5a	Howard Street Near-Term A	Restriping for bike lane buffer from 6th to 11th streets
7	Polk Street, from McAllister to Union streets	Bicycle measures at intersections
10a	Webster Street, from Fulton to Sutter streets	Addition of a buffer to the bike lane
18	Market Street, from Gough to 12th streets	Raised cycle-track pilot project
30	King Street bike improvements	Bike lane extension between 2nd and 3rd streets

Source: San Francisco Department of Public Works and San Francisco Municipal Transportation Agency, "Vision Zero: Capital Project Implementation in Support of Vision Zero," October 14, 2014, 3-7, accessed November 7, 2014, <http://ow.ly/Fw3dS>.

**Table 23. CIP bicycle projects in areas best suited to utility biking**

CIP#	Project
BI0101	2nd Street bike lanes
BI0102	5th Street bike lanes
BI0103	7th Street streetscape
BI0118	California Pacific Medical Center--26th Street and Cesar Chavez Street corridor evaluation
BI0121	Folsom and Essex streets pilot project
BI0127	Polk Street improvement project
BI0136	Western Addition - downtown bikeway connector
BI0137	Wiggle - neighborhood green corridor
BI0138	Market and Octavia streets - bicycle spot improvements and network upgrades
BI0154	Folsom Street streetscape
BI0155	Masonic Avenue streetscape

Source: San Francisco Municipal Transportation Agency, *Draft Capital Improvement Program for Fiscal year 2015 - Fiscal Year 2019* (San Francisco: SFMTA, May 20, 2014), 42-55, accessed November 7, 2014, <http://ow.ly/Fw3FT>.



# CHAPTER SEVEN

## CONCLUSIONS

The conclusion begins with summaries of the key findings from the research conducted—the literature review, the Pedestrian and Bicycling Survey, and the mapping analysis of correlates to utility walking and biking.

A survey of the limitations of this research is then presented, in order to ensure that these findings are interpreted appropriately; this is followed by proposals for potential future research projects building upon this study.

### 7.1 SUMMARY OF FINDINGS

#### 7.1.1 LITERATURE REVIEW FINDINGS

The literature review confirmed that specific types of people are more likely than others to walk or bike for utility. People earning a low income and public transit users have greater odds of walking for transport. Males, students, households without children, and those with a high level of education are positively associated with biking for utility. Young age, white race, and limited access to a motor vehicle correlate to increased levels of both modes of utility NMT.

Environmental conditions also play an important role in the decision to walk or bike. For example, steep hills are an impediment to both modes, especially cycling. For example, one study which examined the impact of steep slopes found that “1m of vertical travel on a bicycle can be considered to be equivalent to approximately 8m of horizontal travel.”<sup>101</sup>

Additional environmental correlates were also identified. The presence of bike infrastructure and bike facilities such as parking, showers and lockers have a strong effect on the propensity to bike for utility. Increased residential density is associated with greater odds of walking for transport. Population density and greater land use mix are related to increased rates of both walking and biking for transport.

#### 7.1.2 PEDESTRIAN AND BICYCLING SURVEY FINDINGS

The Pedestrian and Bicycling Survey (PABS) tested the relationships found in the literature review for applicability in San Francisco. By directly evaluating the population of interest, regression analysis of the PABS data examined potential departures from the literature review due to unique characteristics of the city.

#### PABS Findings: Utility Walking

Almost all residents in the sample walked for utility in the past week. Discovering that most residents walk for utility is an important finding which provides support for additional pedestrian infrastructure throughout the city.

Only 47 percent of San Franciscans who are employed or students walked for their entire commute to work or school in a typical week. Of those residents who regularly commuted solely on foot, 30 percent did so at least five days a week. These findings demonstrate an opportunity to increase the walk mode share of commute trips.

Females are approximately twice as likely as males to walk to work or school in a typical week. Policies which target females may be an effective means for increasing pedestrian mode share of commute trips.

---

<sup>101</sup>. Kevin J. Krizek, Ann Forsyth and Laura Baum, *Walking and Cycling International Literature Review Final Report* (Melbourne: Department of Transportation Walking and Cycling Branch, 2009) 10.

### PABS Findings: Utility Biking

A small percentage of San Franciscans biked for utility, consistent with research for other locations. Just 18 percent of residents reported cycling for transport in the past week. A total of 11 percent of residents rode to work or school, while 6 percent cycled to transit and 13 percent biked to other destinations.

In a typical week, only 13 percent of the sample commuted to work or school via bike. A slightly higher proportion –15 percent – of residents who are employed or who are students reported biking regularly to work or school.

One correlation identified in the literature review was confirmed: young age was associated with increased utility biking. Young adults were 3.8 times more likely than seniors to bike for transport. Middle aged adults were 3.3 times more apt to bike for utility than their senior counterparts.

### 7.1.3 MAPPING ANALYSIS FINDINGS

#### Mapping Analysis Findings: Utility Walking

The most suitable locations for pedestrian infrastructure are concentrated in northeast San Francisco and in the Mission (Figure 21). A few neighborhoods contain large areas with very favorable conditions; these are the Mission, Western Addition, and Downtown Civic Center. Over 75 percent of Nob Hill, Chinatown and Downtown Civic Center are well suited for pedestrians.

#### Mapping Analysis Findings: Utility Biking

Receptive areas for cycling infrastructure are predominately located in northern San Francisco and in the Mission (Figure 30). Southern San Francisco is largely unsuitable for biking, with a few small exceptions.

The Mission and Western Addition have the greatest amount of land that is well suited for biking. Four more neighborhoods have significant areas with very favorable conditions: South of Market, Downtown Civic Center, Haight Ashbury, and the Inner Richmond. Several others contain smaller but still notable areas that are conducive to utility biking.

## 7.2 LIMITATIONS AND POTENTIALS OF THIS RESEARCH

### 7.2.1 LIMITATIONS OF THIS STUDY

Several limitations of this research project must be acknowledged in order to better understand the impact and scope of these findings:

- There are numerous factors that contribute to where people walk beyond those considered in this investigation.
- Census data used in the mapping analysis is based on where residents live and therefore relates to trip origins but not destinations.
- Some correlates to non-motorized transport in the literature review are not mapped in chapters four and five. (Refer to tables 10, 11, 13, and 14 to see which correlates were omitted and the reasons for exclusion.)
- This research does not prove a causal relationship for correlates to active travel. Instead, it establishes correlation, fulfilling one condition required to prove a causal relationship. Findings from this project provide a starting point from which future studies can establish causation.

- Due to the relatively small number of people who responded to the PABS survey (271), findings from the logistic regression analysis should be given only their due weight; the survey achieved a confidence level of 90 percent, as discussed in [Section 3.6.6: Study Limitations](#).
- Though a number of variables tracked by the PABS fairly well matched the census data for the population of San Francisco, the sample did diverge from the full population by 5 percentage points or more along a number of variables: age, race, employment status, educational attainment, and those earning a high or low income (as opposed to those in the mid-range, whose proportion was representative). (Consult [Section 3.4.5: Is the Sample Representative of the Population of San Francisco?](#) for a comparison of specific cohorts.)
- Bicycle parking demand is not addressed. Only the presence of bike parking is considered in this study.
- Walking and biking trips are frequently overestimated by respondents because they are “considered to be a virtuous behavior.”<sup>102</sup>

### 7.2.2 RECOMMENDED FUTURE RESEARCH BUILDING UPON THIS STUDY

Future research can extend the mapping analysis presented herein to include additional active travel correlates. Having limited access to a motor vehicle was found to correlate to both walking and biking for utility. Data on household vehicle ownership can be used to identify places where there are high densities of people with limited access to a motor vehicle. Similarly, information on student status can be used to find places with high concentrations of students (who correlate to utility biking).

Subsequent research into active travel in San Francisco would benefit by administration of the Pedestrian and Bicycling Survey to a larger number of residents; a sample large enough to generate a closer statistical representation of the entire population is necessary to conclusively prove demographic correlations to walking and biking in San Francisco.

A recent 2011 SFMTA survey of bicycling relied on data from an intercept survey.<sup>103</sup> Findings from intercept surveys are difficult to apply to the general population.<sup>104</sup> Therefore, for some applications, intercept surveys should be replaced with a more robust instrument, such as the

PABS. Given the lack of reliable non-motorized transport trip data, an active travel survey similar to the PABS could provide great insight into how much walking or biking is occurring and who is completing the majority of trips.

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102. Kevin J. Krizek, Ann Forsyth and Asha Weinstein Agrawal, *Pedestrian and Bicycling Survey (PABS): User's Manual* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010) 29.

103. San Francisco Municipal Transit Authority, *2012 San Francisco State of Cycling* (San Francisco, CA: SFMTA, 2012), 16, accessed August 31, 2013, <http://ow.ly/FwB2l>.

104. Ann Forsyth, K. Krizek and A. W. Agrawal, *Measuring Walking and Cycling Using the PABS (Pedestrian and Bicycling Survey) Approach: A Low-Cost Survey Method for Local Communities* (San Jose, CA: Mineta Transportation Institute, San Jose State University, 2010) 7-8.



# APPENDIX A

## PEDESTRIAN AND BICYCLING SURVEY



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Department of Urban and  
Regional Planning  
One Washington Square  
San José, California 95192-0185  
Voice: 408-924-5882  
Fax: 408-924-5872  
urbplan@email.sjsu.edu  
www.sjsu.edu

May 9, 2014

Dear San Francisco resident:

How do you get around San Francisco on a daily basis? Your household has been randomly selected to participate in a survey studying how people travel around the city. The survey is being conducted by researchers at San José State University. We will share the results with city planners in San Francisco, to help them improve local transportation for everyone.

Please have the survey completed by **the adult in your household who had the most recent birthday**. (By "adult," I mean anyone 18 years or older.)

The survey must be completed and **mailed back within two weeks**. A postage-paid envelope is included.

The back of this letter has information explaining your rights as a subject of research conducted through San José State University. We appreciate your taking time to read this information.

Thank you very much for completing this important survey. Your response will help improve local transportation in San Francisco!

Sincerely,

Rebecca Walters, AICP  
San Jose State University Graduate Student  
Candidate for Master of Urban Planning

The California State University:  
Chancellor's Office  
Bakersfield, Channel Islands, Chico, Dominguez Hills,  
East Bay, Fresno, Fullerton, Humboldt, Long Beach,  
Los Angeles, Maritime Academy, Monterey Bay,  
Northridge, Pomona, Sacramento, San Bernardino,  
San Diego, San Francisco, San José, San Luis Obispo,  
San Marcos, Sonoma, Stanislaus



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### Agreement to Participate in Research

"Walking and Cycling in San Francisco: Identifying Underserved Locations that are Particularly Conducive to Active Travel via the Pedestrian and Bicycling Survey"

(Responsible Investigator: Rebecca Walters)

You are invited to participate in a survey study on how people get around in their daily transportation. The survey involves questions about your travel, how often you bicycle and walk, for what purposes you make these trips, and some demographic information about yourself.

There is no anticipated risk to you from participating in this project. There are no direct benefits for participating in this study either! You may, however, learn a little bit about how and where you travel. The results of this study may be published, but no information that could identify you will be included.

Participation in the study is voluntary. If you decide to participate in the study, you are free to not answer any question and to withdraw at any time without any negative effect on your relations with San José State University or with any other participating institutions or agencies.

No service of any kind, to which you are otherwise entitled, will be lost or jeopardized if you choose to not participate in the study. By filling in the survey and returning it we will know that you have agreed to be in this study. Thanks for doing this!

5/9/14

Rebecca Walters, AICP

May 9, 2014

Questions about this research may be addressed to Rebecca Walters at 415-272-0748. Complaints about the research may be presented to Asha W. Agrawal, Department of Urban and Regional Planning, SJSU, at 408-924-5853. Questions about a research subjects' rights or research-related injury may be presented to Pamela Stacks, Ph.D., Associate Vice President, Graduate Studies and Research, SJSU, at 408-924-2427.

The California State University:  
Chancellor's Office  
Bakersfield, Channel Islands, Chico, Dominguez Hills,  
East Bay, Fresno, Fullerton, Humboldt, Long Beach,  
Los Angeles, Maritime Academy, Monterey Bay,  
Northridge, Pomona, Sacramento, San Bernardino,  
San Diego, San Francisco, San José, San Luis Obispo,  
San Marcos, Sonoma, Stanislaus

# PEDESTRIAN AND BICYCLING SURVEY

## HOW DO YOU GET AROUND TOWN?

This survey asks you questions about how you get around for your daily travel, with a focus on how often you bicycle and walk. Even if you never walk or bicycle, we are still very interested in your responses. Thank you for taking the time to complete this survey!

### Questions about your recent travel

- What is today's date? \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_  
Month Day Year
- Were you out of town during the last 7 days?  
 No OR  Yes (If yes, how many days? \_\_\_\_\_)
- Check one box for each line below to tell us THE MOST RECENT TIME you used each type of travel. Note that some trips you make may fit into multiple categories below. For example, if you walked to the store yesterday to get exercise AND to buy bread, then you would check "Last 7 Days" for both row "g" and row "h."

Type of Travel	Last 7 Days	Last Month	Last 3 Months	Last Year	Not Used in the Last Year
a) Passenger or driver in a vehicle (for example, a car, truck, motorcycle, or taxi)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
b) Public transit (for example, bus, train, or ferry)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
c) Bicycle to or from public transit	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
d) Bicycle to a destination OTHER THAN public transit (for example, to a job, store, park, or friend's house)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
e) Bicycle for recreation or exercise (do not include riding a stationary bicycle)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
f) Walk to or from public transit	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
g) Walk to a destination OTHER THAN public transit (for example, to a job, store, park, or friend's house)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
h) Walk for recreation, exercise, or to walk the dog	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>

### Questions about HOW OFTEN you BICYCLED in the last 7 days

In the last 7 days (up to yesterday), on how many days did you:

- Bicycle to OR from public transit (for example, to a bus or train stop) . . . Number of days \_\_\_\_
- Bicycle to OR from work or school. . . . . Number of days \_\_\_\_
- Bicycle to get somewhere OTHER than work, school, or public transit. (For example, to go shopping, see a friend, or eat a meal. Do NOT include trips with no destination, such as a bike ride solely for exercise.) . . . Number of days \_\_\_\_
- Ride a bicycle for exercise or recreation, without having a destination for the trip. . . . . Number of days \_\_\_\_

### Questions about HOW OFTEN you WALKED in the last 7 days

In the last 7 days (up to yesterday), on how many days did you:

- Walk to OR from public transit (for example, to a bus or train stop) . . . Number of days \_\_\_\_
- Walk to OR from work or school. . . . . Number of days \_\_\_\_
- Walk to get somewhere OTHER than work, school, or public transit. (For example, to go shopping, see a friend, or eat a meal. Do NOT include trips with no destination, such as a walk solely for exercise.) . . . Number of days \_\_\_\_
- Walk for exercise or recreation, without having a destination for the trip. . . . . Number of days \_\_\_\_

### Questions about your general travel

- DURING A TYPICAL WEEK, how many days does your commute to work or school include any of the following forms of transportation? If you don't commute, mark each one as "0."
  - Number of days walking: \_\_\_\_  
(count walking to or from a parked car or transit stop IF the walk was at least 10 minutes)
  - Number of days bicycling: \_\_\_\_
  - Number of days taking public transit (for example, a bus, train, or ferry): \_\_\_\_
  - Number of days driving myself: \_\_\_\_
  - Number of days riding as a passenger with someone else: \_\_\_\_

**Some questions about you and your household**

13. In what year were you born?

Year: \_\_\_\_\_

14. What two streets intersect closest to your home?

\_\_\_\_\_ and \_\_\_\_\_  
 (First street name) (Second street name)

15. What zip code do you live in? \_\_\_\_\_

16. What is your legal gender?

- 1 Male       2 Female       3 Prefer not to say

17. What is your race or ethnicity? (Check all that apply.)

- 1 African American or Black       5 Native Hawaiian or other Pacific Islander  
 2 American Indian or Alaskan Native       6 White  
 3 Asian       7 Don't know  
 4 Hispanic or Latino       8 Other (please explain: \_\_\_\_\_)

18. Which categories best describe you? (Check all that apply.)

- 1 Working for pay OUTSIDE the home       5 A homemaker  
 2 Working for pay INSIDE the home       6 Going to school  
 3 Looking for work       7 Retired  
 4 Other, please explain: \_\_\_\_\_

19. What is the highest level of education you have completed?

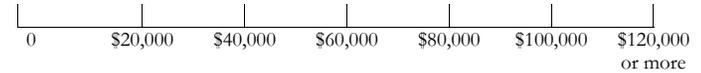
- 1 No high school diploma       7 Bachelor's degree  
 2 High school diploma       8 Master's degree  
 3 GED or alternative credential       9 Professional school degree  
 4 Some college, less than 1 year       10 Doctorate degree  
 5 Some college, 1 or more years, no degree       11 Other, please explain:  
 6 Associates degree      \_\_\_\_\_

Some final questions ask about your household. By "household" we mean all the people who currently live with you in your home. Please do not include renters or tenants. If you live in a dormitory, in a boarding house, or with roommates, just answer the following questions for yourself AND CHECK HERE .

20. How many people live in your household, including you?

Number of people under 18: \_\_\_\_      Number of people 18 years and older: \_\_\_\_

21. To understand travel choices, and for statistical purposes, we need an idea of your total household income. Please mark an "X" on the scale below to indicate the APPROXIMATE TOTAL ANNUAL COMBINED income of all the working adults in your household.



THANK YOU!



### Algunas preguntas sobre usted y su casa

13. ¿En que año nació?

Año: \_\_\_\_\_

14. ¿Cuales son las calles que cruzan cerca de su casa?

\_\_\_\_\_ y \_\_\_\_\_  
(Nombre de la primera calle) (Nombre de la segunda calle)

15. ¿A que código postal vive? \_\_\_\_\_

16. ¿Cuál es su género?

1 Masculino 2 Femenino 3 Prefiero no contestar

17. ¿Que es su raza o origen étnico? (Marque todas las que correspondan)

1 Afroamericano o Negro 5 Hawaiano nativo o isleño del Pacífico  
2 Indio americano o nativo de Alaska 6 Blanco  
3 Asiático 7 No lo se  
4 Hispano o Latino 8 Otro (por favor explique: \_\_\_\_\_)

18. ¿Cuales son las categorías que mejor lo/la describen? (Marque todas las que correspondan)

1 Trabajo por pago FUERA de casa 5 Ama de casa  
2 Trabajo por pago DENTRO de casa 6 Asisto a la escuela  
3 Busco trabajo 7 Retirado(a)  
4 Otro, por favor explique: \_\_\_\_\_

19. ¿Cuál es el más alto nivel de educación que usted ha completo?

1 No diploma secundaria 7 Título de Bachillerato  
2 Diploma de secundaria 8 Título de Maestria  
3 Credencial de secundaria alternativa 9 Título Profesional  
4 Algo de Universidad, menos de 1 año 10 Título Doctorado  
5 Algo de Universidad, 1 o más años, no título 11 Algún otro, explique por favor: \_\_\_\_\_  
6 Algún título asociado a Universidad \_\_\_\_\_

Algunas últimas preguntas sobre su hogar. En este caso, “hogar” se refiere a todas las personas que actualmente viven con usted en su casa. Por favor, no incluya a inquilinos o arrendatarios. Si vive en un dormitorio, en una casa de huéspedes, o con compañeros de cuarto, solo responda por si mismo a las siguientes preguntas Y MARQUE ESTA CASILLA .

20. ¿Cuántas personas viven en su hogar, incluyendo a usted?

Numero de personas que son menores de 16 años: \_\_\_\_

Número de personas que tienen 16 años o más: \_\_\_\_

21. Para entender sus elecciones de transporte, y con fines estadísticos, necesitamos tener una idea de los ingresos totales de su hogar. Por favor, marque una “X” en la escala abajo para indicar el TOTAL APROXIMADO INGRESO ANUAL COMBINADO de todos los adultos que trabajan y viven en su hogar.



# PEDESTRIAN AND BICYCLING SURVEY

## 您在城市中如何选择出行方式？

此问卷旨在了解您如何选择每日出行的方式，尤其是选择骑自行车或步行的方式。即便您从未步行或骑自行车，我们也非常希望了解您的反馈。感谢您百忙之中抽时间完成此问卷！

### 您的最近出行

1. 今日的日期 \_\_\_\_\_ / \_\_\_\_\_  
月 日
2. 你上礼拜是否离开本城市？  
 没有 或  有 (若有，离开几日 \_\_\_\_\_)
3. 请在每一行您最近使用过的交通工具下打“X”。某些出行目的可能属于多项选择。例如，若您昨日步行去健身并顺便购买面包，请在“g”选项和“h”选项中选择“上礼拜”。

出行方式	上礼	前三个		去年从未	
	拜	上个月	月	去年	使用
a) 开车或乘车 (例如汽车, 卡车, 摩托车或的士)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
b) 公共交通工具 (例如巴士, 火车或轮船)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
c) 骑自行车往返搭乘车站	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
d) 骑自行车去非去车站的目的地 (例如上班, 购物, 公园或者访友)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
e) 骑自行车玩耍或锻炼 (不包括健身用固定自行车)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
f) 步行来回车站	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
g) 步行去其他非搭乘公共交通的目的地 (例如上班, 购物, 公园或访友)	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>
h) 步行玩耍, 健身或遛狗	<input type="checkbox"/> <sub>1</sub>	<input type="checkbox"/> <sub>2</sub>	<input type="checkbox"/> <sub>3</sub>	<input type="checkbox"/> <sub>4</sub>	<input type="checkbox"/> <sub>5</sub>

## 过去一礼拜您骑车的频率

您在过去一礼拜 (一直到昨天), 共有几天:

4. 骑车往返车站 (例如巴士或火车站) ... 天数 \_\_\_\_\_
5. 骑车往返上班或上学..... 天数 \_\_\_\_\_
6. 骑车但不是去上学, 上课或公车站 (例如, 购物, 访友或吃饭。请勿包括无目的地仅为健身的骑车) .. 天数 \_\_\_\_\_
7. 无目的地仅为健身或娱乐的骑车..... 天数 \_\_\_\_\_

## 过去一礼拜您步行的频率

过去一礼拜 (一直到昨天), 您有多少天:

8. 步行往返车站 (例如, 去公车站或火车站) ... 天数 \_\_\_\_\_
9. 步行往返上班或上学..... 天数 \_\_\_\_\_
10. 步行但不是去上班, 上学或车站 (例如购物, 访友或吃饭。请勿包括毫无目的只为健身的步行) ... 天数 \_\_\_\_\_
11. 无目的地仅为健身或娱乐的步行..... 天数 \_\_\_\_\_

## 您的日常出行

12. 平常一礼拜中您有多少天使用以下交通工具上班或上学? 若您不上学或上班, 请标注“0”。
  - a) 步行的天数: \_\_\_\_\_ (请包括停车或出公车站后 10 分钟以上的步行)
  - b) 骑车的天数: \_\_\_\_\_
  - c) 搭公共交通的天数 (例如巴士, 火车或轮船): \_\_\_\_\_
  - d) 开车的天数: \_\_\_\_\_
  - e) 搭乘他人车的天数: \_\_\_\_\_

## 您和您的家庭

13. 您出生的年份?

年: \_\_\_\_\_

14. 离您住所最近的两条街的十字路口是?

\_\_\_\_\_ 和 \_\_\_\_\_  
(第一条街名) (第二条街名)

15. 您住所所在的邮编是 \_\_\_\_\_

16. 您的性别是?

1 男性       2 女性       3 不便透露

17. 您的种族? (可多选)

1 非裔美国人       5 夏威夷或其他太平洋岛民  
 2 印第安人或阿拉斯加居民       6 白人  
 3 亚洲人       7 不清楚  
 4 西班牙裔或拉丁美洲裔       8 其他(请标注: \_\_\_\_\_)

18. 下列哪项符合您的情况 (可多选)

1 有薪在外工作者       5 全职太太/先生  
 2 有薪在家工作者       6 在校学生  
 3 求职中       7 已退休  
 4 其他 (请标注: \_\_\_\_\_)

19. 您所接受的最高学历?

1 高中以下       7 学士  
 2 高中       8 硕士  
 3 普通高中同等学力 (GED)       9 职业学校学历  
 4 少于 1 年的大学教育       10 博士  
 5 1 年以上大学教育但无证书       11 其他, 请标注:

\_\_\_\_\_

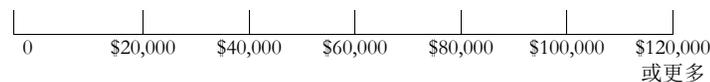
6 大专

最后是关于家庭成员的问题。家庭成员的意思是所有目前与您居住在一起的人。请不要包括租房者或房客。若您居住在宿舍, 公寓或与室友同住, 请就**您自己**的情况回答, 并在此处打“X”。 .

20. 包括您在内, 您的家庭一共有多少人?

18 岁以下的人数: \_\_\_\_\_ 18 岁及以上的人数: \_\_\_\_\_

21. 为了更好地了解出行选择及统计需要, 我们需要了解您家庭的总收入情况。请按您家庭中所有成年工作者的**大致年收入**的实际情况在以下范围中打“X”。



非常感谢!



# APPENDIX B

## PEDESTRIAN AND BICYCLING SURVEY RESPONSES

This appendix presents the results of the 271 complete surveys used for analysis in the report.

*Note:* Percentages may not sum to 100% due to rounding.

### Questions about your recent travel

2. Were you out of town during the last 7 days?

No	(192)	71%
Yes	(75)	28%
Missing	(4)	1%

Yes (If yes, how many days? \_\_\_\_\_)

Mean	0.9
Standard deviation	2.2
Number of responses	73

3. Check one box for each line below to tell us THE MOST RECENT TIME you used each type of travel. Note that some trips you make may fit into multiple categories below. For example, if you walked to the store yesterday to get exercise AND to buy bread, then you would check “Last 7 Days” for both row “g” and row “h.”

Type of Travel	Last 7 Days	Last Month	Last 3 Months	Last Year	Not Used in the Last Year	Missing
a. Passenger or driver in a vehicle (for example, a car, truck, motorcycle, or taxi)	91%	6%	1%	1%	0%	0%
b. Public transit (for example, bus, train, or ferry)	65%	13%	8%	3%	9%	3%
c. Bicycle to or from public transit	6%	3%	2%	5%	79%	5%
d. Bicycle to a destination OTHER THAN public transit (for example, to a job, store, park, or friend’s house)	14%	4%	4%	7%	66%	4%
e. Bicycle for recreation or exercise (do not include riding a stationary bicycle)	13%	4%	8%	10%	61%	4%
f. Walk to or from public transit	64%	13%	6%	4%	11%	1%
g. Walk to a destination OTHER THAN public transit (for example, to a job, store, park, or friend’s house)	85%	8%	1%	1%	5%	0%
h. Walk for recreation, exercise, or to walk the dog	72%	14%	3%	3%	6%	1%

## PEDESTRIAN AND BICYCLING SURVEY RESPONSES

### Questions about HOW OFTEN you BICYCLED in the last 7 days

In the last 7 days (up to yesterday), on how many days did you: Number of days \_\_\_\_

Number of days	0	1	2	3	4	5	6	7	Missing	Below out-of-town threshold
4. Bicycle to OR from public transit (for example, to a bus or train stop)	81%	3%	0%	1%	0%	0%	0%	0%	3%	11%
5. Bicycle to OR from work or school	77%	3%	1%	1%	2%	3%	0%	0%	2%	11%
6. Bicycle to get somewhere OTHER than work, school, or public transit. (For example, to go shopping, see a friend, or eat a meal. Do NOT include trips with no destination, such as a bike ride solely for exercise.)	75%	5%	3%	2%	0%	1%	0%	0%	2%	12%
7. Ride a bicycle for exercise or recreation, without having a destination for the trip	76%	6%	3%	0%	1%	0%	0%	0%	2%	12%

### Questions about HOW OFTEN you WALKED in the last 7 days

In the last 7 days (up to yesterday), on how many days did you: Number of days \_\_\_\_

Number of days	0	1	2	3	4	5	6	7	Missing	Below out-of-town threshold
8. Walk to OR from public transit (for example, to a bus or train stop)	25%	7%	9%	7%	5%	14%	3%	13%	1%	12%
9. Walk to OR from work or school	58%	4%	3%	3%	3%	7%	1%	6%	3%	12%
10. Walk to get somewhere OTHER than work, school, or public transit. (For example, to go shopping, see a friend, or eat a meal. Do NOT include trips with no destination, such as a walk solely for exercise.)	11%	10%	13%	7%	7%	12%	2%	20%	1%	15%
11. Walk for exercise or recreation, without having a destination for the trip	27%	14%	10%	8%	3%	7%	1%	13%	1%	15%

### Questions about your general travel

12. DURING A TYPICAL WEEK, how many days does your commute to work or school include any of the following forms of transportation? If you don't commute, mark each one as "0."

Number of days	0	1	2	3	4	5	6	7	Missing	Mean
a. Number of days walking: ____ (count walking to or from a parked car or transit stop IF the walk was at least 10 minutes)	57%	3%	4%	5%	3%	17%	1%	7%	2%	1.9
b. Number of days bicycling: ____	87%	2%	2%	3%	2%	3%	0%	1%	1%	0.4
c. Number of days taking public transit (for example, a bus, train, or ferry): ____	51%	7%	6%	6%	4%	15%	3%	5%	3%	1.9
d. Number of days driving myself: ____	52%	8%	8%	4%	6%	14%	1%	6%	0%	1.8
e. Number of days riding as a passenger with someone else: ____	81%	6%	4%	4%	0%	3%	0%	1%	1%	0.5

### Some questions about you and your household

13. In what year were you born?

Age Categories	
Under 18 years (0)	0%
18 to 24 years	0%
25 to 34 years	1%
35 to 44 years	15%
45 to 54 years	20%
55 to 64 years	23%
65 to 74 years	18%
75 to 84 years	14%
85 years and over	5%
Mean	52 years
Median	50 years
Youngest respondent	23 years
Oldest respondent	93 years

14. What two streets intersect closest to your home?  
Not reported to protect respondent privacy

15. What zip code do you live in?  
Not reported to protect respondent privacy

16. What is your legal gender?

Male	51%
Female	49%

17. What is your race or ethnicity?  
(Check all that apply)

African American or Black	3%
American Indian or Alaskan Native	0%
Asian	19%
Hispanic or Latino	6%
Native Hawaiian or other Pacific Islander	1%
White	68%
Don't know	0%
Other	1%

## PEDESTRIAN AND BICYCLING SURVEY RESPONSES

18. Which categories best describe you?  
(Check all that apply.)

Working for pay OUTSIDE the home	68%
Working for pay INSIDE the home	14%
Looking for work	5%
Other (please explain)	4%
Homemaker	3%
Going to school	6%
Retired	20%

19. What is the highest level of education you have completed?

No high school diploma	1%
High school diploma	4%
GED or alternative credential	0%
Some college, less than 1 year	3%
Some college, more than 1 year	9%
Associates Degree	5%
Bachelor's degree	35%
Master's degree	27%
Professional school degree	7%
Doctorate Degree	8%
Other, please explain	15%

20. How many people live in your household including you?

Number of people under 18: \_\_\_\_

0	80%
1	9%
2	9%
3	1%
4	0%

Number of people 18 and older: \_\_\_\_

1	37%
2	63%

21. Some final questions ask about your household. By "household" we mean all the people who currently live with you in your home. Please do not include renters or tenants. If you live in a dormitory, in a boarding house, or with roommates, just answer the following questions for yourself.

Less than \$20,000	5%
\$20,000 to \$39,999	6%
\$40,000 to \$59,999	9%
\$60,000 to \$79,999	13%
\$80,000 to \$99,999	10%
\$100,000 to \$119,999	17%
\$120,000 or more	40%

Mean	\$90,000
Median	\$80,000

# APPENDIX C

## LITERATURE REVIEW SOURCES

### MAPPED DEMOGRAPHIC CORRELATES TO UTILITY WALKING

- Young age 1. Asha Weinstein Agrawal and Paul Schimek, "Extent and Correlates of Walking in the USA," *Transportation Research: Part D* 12, no. 8 (December 2007): 558; Melissa Bopp, Andrew T. Kaczynski and Gina Besenyi, "Active Commuting Influences among Adults," *Preventive Medicine* 54, no. 3 (March 2012): 238; Chanam Lee and Anne Vernez Moudon, "Environmental Correlates of Walking for Transportation or Recreation Purposes," *Journal of Physical Activity and Health* 3, S1 (2006): S89; Pnina O. Plaut, "Non-Motorized Commuting in the US," *Transportation Research: Part D* 10, no. 5 (September 2005): 350; T. M. Rahula and Ashish Vermab, "Study of Impact of various Influencing Factors on NMT Mode Choice," *Procedia - Social and Behavioral Sciences* 104 (December 2013): 1112, 1115.
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- Low income 2. Mary O. Hearst, John R. Sirard, Ann Forsyth, Emily D. Parker, Elizabeth G. Klein, Christine G. Green and Leslie A. Lytle, "The Relationship of Area-Level Sociodemographic Characteristics, Household Composition and Individual-Level Socioeconomic Status on Walking Behavior among Adults," *Transportation Research Part A: Policy & Practice* 50 (March 2013): 149; Gavin Turrell, Michele Haynes, Lee-Ann Wilson and Billie Giles-Corti, "Can the Built Environment Reduce Health Inequalities? A Study of Neighbourhood Socioeconomic Disadvantage and Walking for Transport," *Health & Place* 19 (January 2013): 93.
- Public transit use Asha Weinstein Agrawal and Paul Schimek, "Extent and Correlates of Walking in the USA," *Transportation Research: Part D* 12, no. 8 (December 2007): 548-63; Chanam Lee and Anne Vernez Moudon, "Environmental Correlates of Walking for Transportation or Recreation Purposes," *Journal of Physical Activity and Health* 3, S1 (2006): S86.

# LITERATURE REVIEW SOURCES

## UNMAPPED DEMOGRAPHIC CORRELATES TO UTILITY WALKING

Gender	Asha Weinstein Agrawal and Paul Schimek, “Extent and Correlates of Walking in the USA,” <i>Transportation Research: Part D</i> 12, no. 8 (December 2007): 561; Chanam Lee and Anne Vernez Moudon, “Environmental Correlates of Walking for Transportation or Recreation Purposes,” <i>Journal of Physical Activity and Health</i> 3, S1 (2006): S89; Pnina O. Plaut, “Non-Motorized Commuting in the US,” <i>Transportation Research: Part D</i> 10, no. 5 (September 2005): 350; T. M. Rahula and Ashish Vermab, “Study of Impact of various Influencing Factors on NMT Mode Choice,” <i>Procedia - Social and Behavioral Sciences</i> 104 (December 2013): 1115.
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White race 2.	Chanam Lee and Anne Vernez Moudon, “Environmental Correlates of Walking for Transportation or Recreation Purposes,” <i>Journal of Physical Activity and Health</i> 3, S1 (2006): S86.
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# APPENDIX D

## FIGURE SOURCES

- Figure 1. City and County of San Francisco, “Data SF: Data Catalog,” August 14, 2014, accessed August 20, 2014, <https://data.sfgov.org/>; Jeff Johnson, “Elevation Contours (Zipped Shapefile Format)” City and County of San Francisco, August 14, 2014, accessed August 20, 2014, <http://ow.ly/FyAcn>.
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