Bicycle Access to the Oakland Waterfront

The High Street Connection to the San Francisco Bay Trail

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The High Street Connection to the San Francisco Bay Trail

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Thank you to the City of Oakland and the East Bay Regional Park District
for support in completing this research study.

Executive Summary

This study aims to promote an active lifestyle in Oakland by improving bicycle access to the Oakland shoreline for residents living in the Jefferson, Fremont, and Melrose neighborhoods. The Metropolitan Transportation Commission (MTC) and Association of Bay Area Governments (ABAG) define these communities as "Communities of Concern" in the Regional Transportation Plan: Plan Bay Area.

The Oakland waterfront and the Bay Trail are within one mile of the these neighborhoods, but they cannot be safely accessed by bicycle along High St. due to the absence of adequate bicycle facilities. Research conducted as part of this study shows that bicycling facilities can reduce transportation costs and improve health for residents, and potentially lead to more livable streets and increased property values in a community.

The City of Oakland's 2007 Bicycle Master Plan proposes installation of a Class II bike lane along this corridor. To confirm this is an appropriate recommendation, a customized audit tool was developed to assess the current conditions of High St. for a 13-block segment from Foothill Blvd. to the High St. Bridge. Research of existing audit examples along with information gathered through a detailed literature review guided the selection of street block segment factors and intersection design elements to be included in the audit. The street audit was conducted in the summer of 2017. The results of the audit findings and design recommendations are summarized in the tables and figures in chapters V and VI of this report.

Based on the audit findings and observations, design recommendations that promote cycling along the High St. corridor are included in the adjacent table.

Providing these bicycle-oriented design solutions aim to increase the comfort level of bicyclists, while also maintaining the appropriate traffic flow for motorists on High St. Potential adjustments to signal operation and cyclist detection at intersections will ensure ample time for bicyclists to navigate the cross streets that intersect this busy corridor as well.

Improvements to the street conditions may provide improved community character, health and economic benefits, and quality of life for lower income residents in the Fremont, Jefferson, and Melrose communities. Coordinating these improvements with other street improvement projects are a cost effective way for Oakland to ensure that the bicycle network remains connected and functional for all East Oakland communities.

High Street Recommendations

- Apply a road diet to High St. by reducing the number of vehicle lanes to three with a two-way center left turn lane as part of any future repaving project to create space for a future bicycle facility.
- As a short term solution, construct a 5' wide striped Class II bike lane with colored pavement in both directions of travel and relocate drain grates, utilities, and other obstructions.
- As a long term solution, construct a 5-7' wide two-way Class IV bikeway with a 3' wide buffer on the north side of High St. and potentially remove a portion of the existing sidewalk, relocate drain grates, utilities, and other obstructions.
- Investigate potential installation of Bike Boxes at the intersections of International Ave., San Leandro St., Coliseum Way and Oakport St.
- Implement pedestrian and cyclist activated traffic signal improvements at the Bancroft Ave., Coliseum Way, and Oakport St. intersections
- At a minimum, improve signage, road striping, and bike oriented pavement markings as part of any future repaving project on High St.

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I. Introduction

1.1 Research Question

This report will examine how the High Street Corridor in East Oakland, CA can be redesigned to provide safer and more comfortable bicycle access between the Oakland Waterfront/San Francisco Bay Trail (Bay Trail) and the Jefferson, Fremont, and Melrose neighborhoods in east Oakland. The communities of Jefferson, Fremont, and Melrose are designated as disadvantaged communities or "Communities of Concern" in the Regional Transportation Plan, called Plan Bay Area.[1] Relevant policies to improve Communities of Concern in Plan Bay Area include reducing adverse health impacts associated with air quality, road safety, and physical inactivity by 10% and decreasing the share of lower-income residents' household income consumed by transportation and housing by 10%.[2] Providing bicycle friendly streets within Oakland can positively impact these communities while meeting the goals of Plan Bay Area.

The High Street Corridor between the Jefferson, Fremont, and Melrose neighborhoods is not currently designed for safe bicycle access. Residents in these East Oakland neighborhoods are within 1-mile of the Bay Trail and the Oakland waterfront, but cyclists who choose to ride along High St. to access these facilities must currently share the roadway with a high volume of vehicles and large trucks travelling between Oakland and the City of Alameda. The recommendations in this report aim to achieve the transportation goals of Plan Bay Area and the City of Oakland's Bicycle Master Plan by providing equitable non-motorized transportation alternatives.

1.2. Report Structure

Chapter II of this report will describe the study area and the surrounding neighborhoods affected by any proposed improvements along High St. A summary of current bicycle facilities that provide connections to and from the High St. corridor and East Oakland are included in this section.

Chapter III outlines the local and regional benefits that improved bicycle facilities will provide. This section describes how this research will benefit East Oakland communities by complimenting the policies and vision of Oakland's Bicycle Master Plan as well as regional policies adopted in Plan Bay Area.

Chapter IV describes how analysis of the High St. study corridor was conducted with a customized street audit. The steps taken to develop and conduct a street audit are described in detail, as are the elements included in the audit and their importance. This section also provides the methodology for how street block segments and intersections were evaluated.

Chapter V reports the block segment and intersection findings of the High St. audit. The findings for block segments are divided into: general road factors, pavement factors, and location or environmental factors that affect bicycle travel along this street. The findings for intersections are reported by: physical intersection elements, non-motorized intersection elements, and cross street intersection elements.

Chapter VI provides design recommendations for the High St. block segments and intersections based on the results of the audit.

All photos displayed in this report were taken by the author unless otherwise stated. All maps were created by the author using GIS data provided by the City of Oakland and the East Bay Regional Park District.

Figure 1 - High St. Directional Sign Near Howard St.

1 ABAG and MTC, Plan Bay Area, accessed September 23, 2016, http://www.mtc.ca.gov/planning/plan_bay_area/

2 MTC Resolution No. 4217 – Equity Framework for Plan Bay Area 2040: 11, accessed November 18, 2016, https://mtc.legistar.com/View.ashx?M=F&ID=4193765&GUID=72E-4A9EF-81DD-42A7-A212-63C70B8AA7AF

II. The Study Area

2.1 The High Street Study Corridor

High Street is a 3.9-mile arterial street in East Oakland, CA that stretches from the Oakland Hills through the City of Alameda. This project will focus on the 1-mile section of High St. between Foothill Blvd. and the High St. Bridge. The study corridor travels through urban-residential, commercial and industrial land uses. Along the corridor there is one large grocery store, one large food supply distribution center, two shopping centers with various shops and restaurants, five gas stations, several auto repair shops and a handful of industrial warehouses. There are approximately seven schools, ten parks, one library, one recreation center, and the Fruitvale BART Station within 1-mile of the study area. The Oakland Coliseum and the Coliseum BART Station are just over 1-mile away from the study area.

AC Transit routes 14 and 648 travel along High St. between Foothill Blvd. and International Blvd. Line 14 is mainly a connector route from the West Oakland BART Station to the Fruitvale BART Station. This route provides a connection from the Jefferson neighborhood to these stations. Line 648 is a "Service to Schools Line" that connects from Fruitvale BART to Skyline High School via High St. and other city streets.

The lane configuration of High Street currently allows two lanes of travel in either direction separated by a double yellow centerline for a total of four lanes of vehicle travel. There are currently no separated bicycle facilities and minimal bicycle related signage. The land uses along the corridor and the vehicle mix on the roadway pose challenges to bicycle travel. These challenges include a railroad crossing in a heavy industrial area and the Interstate 880 freeway interchange.

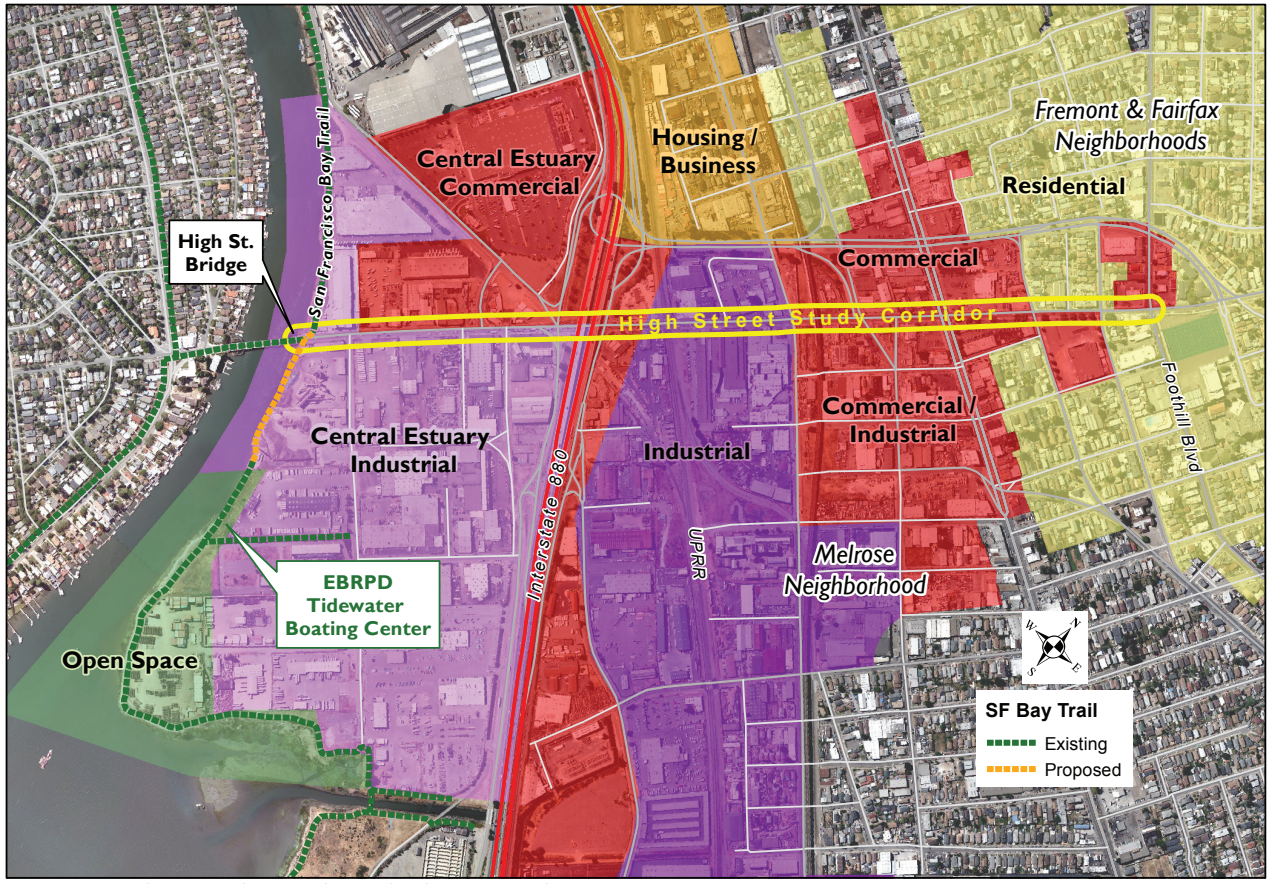


Figure 2 - High St. Study Corridor and Adjacent Land Uses

Figure 3 - Interstate 880 Underpass

High St. bicycle and pedestrian count data collected by the City of Oakland in 2000 and 2009 at five intersections within the study area is included in Appendix A. This count data was collected for two-hour periods at 7:00 am and

Figure 4 - UPRR Crossing

4:00 pm for cyclists, pedestrians, and vehicles at the intersections of Bond St., Bancroft Ave., International Blvd., San Leandro St., and Coliseum Way. While some of this data is over ten years old, national trends suggest that these numbers have only increased since 2001.[3]

At all locations the number of cyclists observed was greater in the evening than the morning. Bicycle counts ranged between 11 and 77; with the highest bicycle counts collected at Bond St. (60) and Bancroft Ave. (77). Vehicle counts were also higher in the evening compared to the morning counts, with the highest counts observed at International Ave. (5,807) and at Coliseum Way (5,475). This data shows that the highest level of vehicle traffic and the highest level of bicycle traffic are happening concurrently, thus increasing the likelihood of bicycle/vehicle conflicts. Oakland's 2007 Bicycle Master Plan Figure H.2 in Appendix B shows a history of bicycle collisions reported at all of these intersections between 2000-2004.

High St. is an important connector to the Bay Trail along the Oakland waterfront. The Bay Trail is a planned 500-mile network of bicycle and hiking trails that will form a continuous ring around the bay once completed.[4] This trail is typically designed as 10-15 feet of paved surface with non-paved shoulders.[5] The Bay Trail travels through open space and urban communities throughout the Bay Area. Approximately eight miles of existing and proposed segments of this trail are designated along the Oakland shoreline; also referred to as the Oakland Waterfront Trail. This trail can be accessed at the south end of the study area near the High St. Bridge, where there is an existing 9-car parking area with a picnic table and two benches.


Figure 5 - SF Bay Trail Staging Area Near High St. Bridge


Figure 6 - EBRPD Tidewater Boating Center

The East Bay Regional Park District (EBRPD) currently operates 3 miles of Bay Trail along the Oakland waterfront and operates the popular Tidewater Boating Center in Martin Luther King Jr. Shoreline Park near the High Street Bridge.

The Bay Trail and Tidewater Boating Center offer access to views of the shoreline, bird watching, boat rental and launching, fishing, and picnicking. These facilities are within a bikable distance of the Jefferson, Fremont, and Melrose neighborhoods in East Oakland.

2.2 The Jefferson, Fremont, and Melrose Neighborhoods

The three Oakland neighborhoods of focus in this study are Jefferson, Fremont, and Melrose. These communities are wedged in between Interstate 880 and Highway 185 to the north and an industrial warehouse and distribution district to the south all accessible from High St. The Metropolitan Transportation Commission (MTC) and Association of Bay Area Governments (ABAG)

3 The National Household Travel Survey, USDOT (2009), accessed March 28, 2018, http://nhts.ornl.gov/2009/pub/stt.pdf

4 ABAG, SF Bay Trail, accessed October 15, 2016, http://baytrail.org/about-the-trail/welcome-to-the-san-francisco-bay-trail/

5 Ibid

define these neighborhoods as "Communities of Concern" in Plan Bay Area.[6] Communities of Concern are defined as all census tracts in the Bay Area that have a concentration of both minority and low-income households (<200% Federal Poverty level), and a combination of six additional factors including: Limited English proficiency, zero-vehicle households, seniors 75 years and over, people with disability, single-parent family, and severely rent-burdened households.[7] The Oakland waterfront and the Bay Trail are within one mile of the Jefferson, Fremont and Melrose neighborhoods, but they cannot be safely accessed by bicycle except by the bold and adventurous who feel comfortable sharing the road with vehicles.

2.3 Bikeway Connections to the Oakland Waterfront / San Francisco Bay Trail

Future bicycle facilities installed along High St. will provide much needed connectivity to several intersecting bikeways and bike routes. Bike facility descriptions in this report will follow the descriptions found in Chapter 1000 of the California Department of Transportation's Highway Design Manual. This manual separates bike facilities into Shared Roadway, Class I, Class II, Class III, and Class IV Bikeways.[8] Chapter 1002 describes these Bikeway Facilities as follows:

- A Shared Roadway is one with no bikeway designation, signage or pavement markings on the roadway. On Shared Roadways bicyclists and vehicles share the travel lanes. This is the most unprotected condition for bicyclists and the existing condition along most of High St.

- A Class I Bikeway or Bike Path is a facility completely separated from vehicle traffic and away from the influence of parallel streets. The Bay Trail along the Oakland Waterfront is a Class I facility. This facility requires significant ROW to construct and is challenging and expensive to install.

- A Class II Bikeway or Bike Lane is designed to separate vehicles and bicyclists by highly visible pavement markings or buffer space by eliminating a vehicle travel lane or designating the paved shoulder for bicycle travel. This does not completely prevent interactions between bikes and vehicles, but is safer than a Shared Roadway or Class III Bikeway.

- A Class III Bikeway or Bike Route is typically shared with motor vehicles with a white stripe or shoulder at best. If pavement markings are installed on Class III facilities, they may appear safer than shared roadways, but do not provide a high comfort level for most bicyclists.

- A Class IV Bikeway or Separated Bikeway or Cycle Track is installed along the existing roadway, but is physically separated from vehicular traffic by a flexible or inflexible barrier, raised curb, vegetation, or on street parking. These facilities require a significant amount of ROW, intersection treatments, and pavement markings to implement.

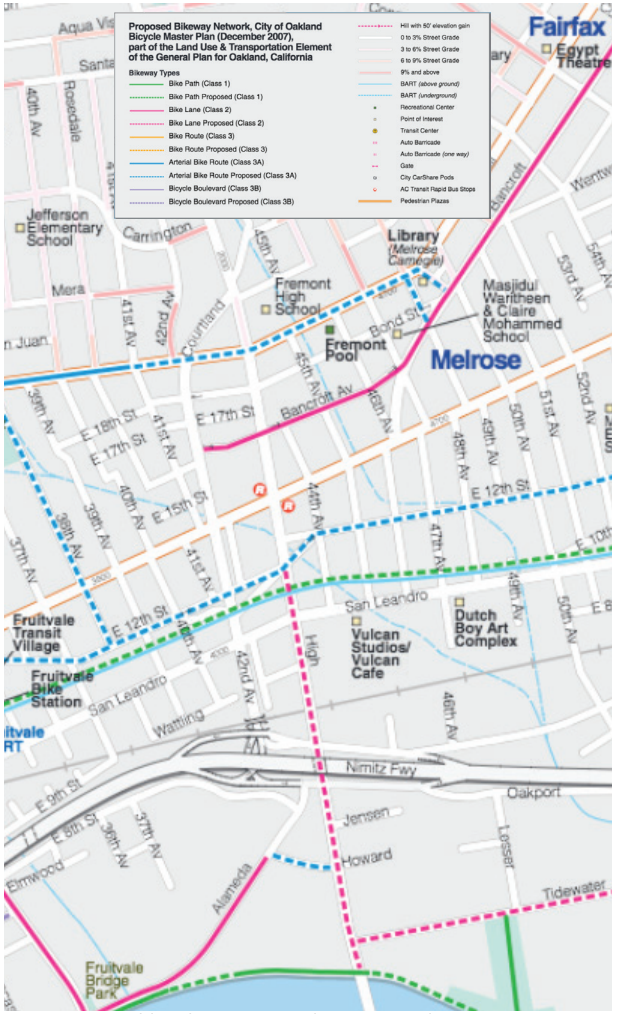


Figure 7 - Oakland 2007 Bicycle Master Plan Map

The City of Oakland's Bicycle Master Plan designates the study area from East 12th St. to the High St. Bridge as a proposed Class II Bikeway.[9]

6 Association of Bay Area Governments and Metropolitan Transportation Commission, Plan Bay Area, accessed September 23, 2016, http://www.mtc.ca.gov/planning/plan_bay_area/

7 Ibid

8 California Department of Transportation, Highway Design Manual, accessed March 2, 2018, http://www.dot.ca.gov/design/manuals/hdm/mct/HDM_6th_Ed.pdf

9 City of Oakland, 2007 Bicycle Master Plan, accessed October, 21 2016, http://www2.oaklandnet.com/Government/o/PWA/o/EC/s/BicycleandPedestrianProgram/OAK024597

The majority of High St. currently exists as a Shared Roadway. There is no separated bikeway, almost no bicycle oriented pavement markings and no paved shoulder. There is a designated Bike Route (or Class III bikeway) along High St. from Howard St. to Martin Luther King Jr. Shoreline Park via Tidewater Ave. and across the High St. Bridge.

This route is a connection to more developed bike facilities on other streets, but does not include pavement markings. Bike Route signs are posted between Tidewater Ave. and Howard St. directing cyclists travelling from Alameda to Class II and Class III bike lanes along Alameda Ave. via Howard St. Signs directing cyclists travelling towards Alameda across the High St. Bridge also direct cyclists to the Martin Luther King Jr. Shoreline and Tidewater Boating Facility.

Figure 8 - Bike Route to Alameda and Martin Luther King Jr. Shoreline


Figure 9 - Sharrow along 41st St. in Oakland, CA

Three other existing bikeway facilities intersect High St. at the Foothill Blvd., Bancroft Ave. and E 12th St. intersections. Bancroft Ave. has a Class II bikeway along the shoulder of the south travel lane designated by poorly visible pavement markings. This Class II bike lane along Bancroft begins one block to the northwest and extends over 1-mile southeast to Havenscourt Blvd. where further extensions are proposed. Along Foothill Blvd. there are pavement markings painted on the road showing a bicycle and arrows referred to as a "sharrow" that provide an indication to bicyclists and motorists to share the travel lane.[10]

There is also a designated Bike Route along E 12th St. that begins at the Fruitvale BART Station and ends at Melrose Elementary School on 54th Ave. This route is identified in Oakland's Bicycle Master Plan crosses High St.; but no signage or markings were observed.

The Alameda County Transportation Commission is currently sponsoring the East Bay Greenway: Lake Merritt BART to South Hayward BART project. The East Bay Greenway is a proposed bicycle and pedestrian facility that will travel along the BART alignment for approximately 16 miles between the cities of Oakland, San Leandro, and Hayward.[11] Once this trail and linear park is constructed it will connect directly to any future bicycle facility on High St.


Figure 10 - Future East Bay Greenway Corridor

10 Cambridge Dictionary, Cambridge Advanced Learner's Dictionary & Thesaurus, *Cambridge University Press*, accessed March 3, 2018, https://dictionary.cambridge.org/us/dictionary/english/sharrow

11 Alameda County Transportation Commission, East Bay Greenway Project Description, accessed March 28, 2018, https://www.alamedactc.org/eastbaygreenway

Lastly, there is an existing Ford GoBike bike-share station roughly 1/10 mi. away at the intersection of Foothill Blvd. and 42nd St. Ford GoBike is a bike share system that provides public bike rentals for use as transportation.[12] A network of Ford GoBike rental stations is set-up throughout Oakland. Users pay by credit card to remove a bike from one station and may return it to any other bike share station in the network.[13] As Oakland becomes more bike friendly, bike-share may become a more popular mode of transportation.

Figure 11 - Ford GoBike Station on Broadway near 40th St. - Oakland, CA

12 Ford GoBike, https://www.fordgobike.com/about
13 Ibid

III. Local and Regional Benefits

3.1 Oakland Communities

This study aims to promote an active lifestyle in Oakland by improving bicycle access to the Oakland shoreline for residents living in the Jefferson, Fremont, and Melrose neighborhoods. Rising health and environmental concerns along with an aging population in the Bay Area are increasing the demand for walking and cycling and reducing the demand for automobile travel.[14] Research cited in the following paragraphs shows that bicycle facilities can also improve community character, raise property values, reduce transportation costs, and improve health.

There are many factors that promote an active lifestyle, but installation of bicycle facilities along neighborhood streets within close proximity to residents can improve community health by promoting physical activity.[15] Increased physical activity has been shown to lower the risk of diseases associated with being overweight and sedentary.[16]

Improving bicycle access along High St. could play an important role in improving the health of residents living in these communities by promoting physical activity and improving air quality by reducing Greenhouse Gas emissions (GHGs).[17] Improvements recommended for High St. have the potential to improve community character and reduce insecurity for those who currently do not feel comfortable sharing the road with vehicles along High St.[18]

Economic benefits from installation of additional bicycle facilities may also be realized. These include increased economic value of residential property, transportation cost savings, and less short-term absences from work due to increased health.[19] While there are many factors that affect the price of homes, proximity to bicycle facilities has been shown to increase residential property values.[20] While rising home prices are a source of concern in the Bay Area, increasing property values could benefit longtime homeowners in this low-income part of the region.

Providing additional opportunities to ride a bike could potentially reduce transportation costs for those who cannot afford a car or transit fairs. In the 2016 American Community Survey, low-income cyclists make up half of all Census-reported commuter cyclists, who rely extensively on bicycles for basic transportation needs like

14 Todd Litman, "Changing Travel Demand: Implications for Transport Planning," *ITE Journal* 76, no. 9 (2006): 27.
15 Peter James et al., "Urban Sprawl, Physical Activity, and Body Mass Index: Nurses' Health Study and Nurses' Health Study II" *American Journal of Public Health* 103, no. 2 (2013): 369
16 Ibid

17 Neil Maizlish et. al, "Health Co-benefits and Transportation-Related Reductions in Greenhouse Gas Emissions in the San Francisco Bay Area," *American Journal of Public Health* 103, no. 4 (2013): 705.
18 Ibid: 600
19 Kjartan Saelensminde, "Cost-benefit Analyses of Walking and Cycling Track Networks Taking Into Account Insecurity, Health Effects and External Costs of Motorized Traffic, *Transportation Research Part A: Policy and Practice* 38, no. 8 (2004): 600
20 Timothy Welch et al., "Long-Term Impact of Network Access to Bike Facilities and Public Transit Stations on Housing Sales Prices in Portland, Oregon." *Journal of Transport Geography* 54 (2016): 270

Figure 12 - Class II Bike Lane on Broadway - Oakland, CA

3.2 Current Policies and Vision for Bicycling in Oakland

This research project compliments efforts by the City of Oakland to provide alternative modes of transportation that encourage a more active lifestyle.[22] The Oakland Bicycle Master Plan vision statement pledges that "Oakland will be a city where bicycling is fully integrated into daily life, providing transportation and recreation that are both safe and convenient".[23] Oakland aims to create a bicycle friendly community by developing a network of bikeways and support facilities that provide convenient access to cyclists.[24] The plan highlights the benefits of reducing trips required by vehicle that will reduce GHG emissions and improve public health.[25] The City views bicycling as an affordable mode of transportation that is broadly accessible to those who earn lower incomes and will improve the livability and quality of life in Oakland.[26]

Figure 13 - Class IV Bike Lane on Broadway - Oakland, CA

The Oakland Bicycle and Pedestrian Facilities Program plans and implements bicycle projects identified in the Oakland Bicycle Master Plan by implementing bicycle safety improvements on local streets.[27] This program improves connectivity between residential areas and transit centers, employment areas, and open spaces by implementing street and road improvements such as bike lane installation and complete streets projects. Great strides are being made to provide more bicycle facilities in Oakland. With over 885 miles of roadway to audit and maintain, this study will hopefully help Oakland further this goal.[28]

The weather and topography in East Oakland provide an opportunity to promote bicycle travel where no bicycle facilities currently exist. Residents in the lower-income neighborhoods of Jefferson, Fremont, and Melrose are within one mile of outdoor facilities and programs along the Oakland Waterfront. These facilities include the San Francisco Bay Trail, Union Point Park and the EBRPD Tidewater Boating Facility. EBRPD, the Bay Trail Project, and the City of Oakland are working collaboratively to close gaps in the Bay Trail along the Oakland Waterfront. This study compliments those efforts by suggesting the benefits of safe bicycle access from local communities to these facilities along local streets.

21 American Community Survey: S0802: "Means of Transportation to Work by Selected Characteristics", 2011-2015 5-year estimate, US Census Bureau (2016)

22 City of Oakland, 2007 Bicycle Master Plan: 15, accessed March 3, 2018, http://www2.oaklandnet.com/oakca1/groups/pwa/documents/report/oak024989.pdf

23 City of Oakland, 2007 Bicycle Master Plan: 15, accessed March 3, 2018, http://www2.oaklandnet.com/oakca1/groups/pwa/documents/report/oak024989.pdf

24 Ibid: 15

25 Ibid: 19

26 Ibid: 20

27 City of Oakland, Bicycle & Pedestrian Facilities Program, accessed October 13, 2016, http://www2.oaklandnet.com/government/o/PWA/o/EC/s/BicycleandPedestrianProgram/OAK024559

28 California Department of Transportation, California Public Road Data 2013 (November 2014): 16, accessed November 18, 2016, http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/prd/2013prd/2013PublicRoadData

3.3 Regional and State Policies

Roadway improvement projects that provide access to alternative modes of transportation are needed to meet State and regional transportation goals for reduction of GHGs mandated by Senate Bill 375. In order to comply with this State mandate, the Metropolitan Transportation Commission (MTC) and the Association of Bay Area Governments (ABAG) have established goals to improve bicycle and pedestrian facilities in Plan Bay Area.[29]

A strong equity analysis, or "the evaluation of the distribution of transportation benefits and costs in a fair and appropriate manner" is a major focus of Plan Bay Area.[30] This plan proposes goals for improving these types of communities such as: reducing adverse health impacts associated with air quality, road safety, and physical inactivity by 10%; reducing vehicle operating and maintenance costs due to pavement conditions by 100%; and decrease the share of lower-income residents' household income consumed by transportation and housing by 10%.[31]

These reduction targets should incentivize local jurisdictions, such as Oakland, to identify transportation solutions that reduce congestion and lower the demand for the single occupancy vehicle.

The improvements proposed in this research report aim to achieve both the goals outlined in the Oakland Bicycle Master Plan and the equity and transportation goals of Plan Bay Area. Future grant-funding programs will favor projects that meet local and regional plan goals, so funding assistance may be available for Oakland. This study is a positive step toward providing bicycle improvements along High St. Results from this analysis will identify needed elements for Oakland to implement its Bicycle Master Plan, which will promote improved health and economic wellness of residents living in East Oakland.

Figure 14 - Green Class II Broadway - Oakland, CA

IV. Developing and Conducting the High Street Audit

The process of developing and conducting a street audit for the High St. study corridor began with researching existing audit guidelines from three different sources to determine audit elements to include in a customized audit tool. These audit examples, along with information gathered through a detailed literature review, guided the selection of street and intersection design elements to be included in the audit tool. The first section of this chapter provides a general overview of the audit tools researched and describes the process for creating the High St. audit tool. Appendix C includes a table of the High St. audit elements included and the information collected for each audit element.

4.1 Street Audit Tool Development

For this study a customized audit tool was created based on three audit tool examples: the Federal Highway Administration Office of Safety (FHWA); Washington University, St. Louis; and the University of North Carolina. For more detailed factors regarding intersection design, the California Department of Transportation Complete Intersections guide was also consulted.[32] Comparisons of these audit tools and a comprehensive review of relevant literature

29 Metropolitan Transportation Commission Resolution No. 4217 – Equity Framework for Plan Bay Area 2040: 11, accessed November 18, 2016, https://mtc.legistar.com/View.ashx?M=F&ID=4193765&GUID=72E4A9EF-81DD-42A7-A212-63C70B8AA7AF

30 Todd Litman, "Evaluating Transportation Equity," *World Transport Policy & Practice* 8, no. 2 (2016): 50, accessed September 23, 2016, www.vtpi.org/equity.pdf.

31 Metropolitan Transportation Commission Resolution No. 4217 – Equity Framework for Plan Bay Area 2040: 11, accessed November 18, 2016, https://mtc.legistar.com/View.ashx?M=F&ID=4193765&GUID=72E4A9EF-81DD-42A7-A212-63C70B8AA7AF

32 California Department of Transportation, Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians (2010), accessed March 14, 2017, http://nacto.org/docs/usdg/complete_intersections_caltrans.pdf.

provided the common elements that are typically included in a street audit.

The current safety conditions of High St. were assessed to determine effective design recommendations. The goal was to identify the current safety conditions of High St. and what opportunities exist on High St. to improve these conditions. The result is a customized audit tool separated into four sub-categories: general street conditions, pavement conditions, location factors, and intersection characteristics.

4.2 Audit Examples

The following paragraphs briefly describe three audit instruments researched: The FHWA Bicycle Road Safety Audit Guidelines and Prompt Lists; The Active-Neighborhood Checklist; and the Walking and Bicycling Suitability Assessment.

The *FHWA Bicycle Road Safety Audit Guidelines and Prompt Lists* was the primary source used to create the High St. audit tool. This document contains a thorough list of street elements that should be assessed to identify potential safety issues and conditions affecting cyclist's safety and where these issues are likely to occur. The prompt lists are organized to assess: street design, operation and user conflict, quality and conditions, obstructions, continuity and connectivity, lighting, visibility, signs and pavement markings, signals, and human behavior.[33]

The *Active-Neighborhood Checklist* was developed by Christine Hoehner at Washington University, St. Louis to assess street-level features of a neighborhood that are related to physical activity of both pedestrians and cyclists. Only elements of this checklist thought to influence cycling were considered for inclusion in the High St. audit tool. This checklist assesses five general areas: land use, public transit stops, street characteristics, quality of the environment, and presence of places to bicycle.[34] This checklist was somewhat redundant to the FHWA prompt lists, but provided additional guidance on the formatting and implementation of the audit. For example, this instrument focused on how land use effects cycling behavior and included the use of GIS to analyze land uses and street elements supplemented with photo documentation. Both of these methods were used in this audit.

The *Walking and Bicycling Suitability Assessment* (WABSA) developed by James Emery, Carolyn Crump, and Philip Bors at the University of North Carolina reinforced the elements to be included in a basic audit tool. This tool determines bicycle stress levels and divided audit elements into three categories: general road factors, pavement factors, and location factors.[35]
General road factors included number of lanes, speed limit, and average daily traffic. Pavement factors were categorized using the FHWA Highway Performance Monitoring System (HPMS) Pavement Condition Factors to assess the surface quality of the street. Finally, the location factors collected data on characteristics of the street environment such as grades, on street parking, turning lanes, driveways, land uses, and intersections and were entered into a formula to determine the bicycle suitability assessment scores.

In summary, the following categories were included in the examples referenced:

- Presence of bicycle lanes, shared lanes, and lane treatments
- Road markings (paint striping, symbols, signage, crosswalks)
- Lane widths and available space
- Speed limit and traffic volume
- Presence or absence of on street parking
- Pavement quality
- Intersection signal types and design
- Obstructions to visibility or areas of conflict

33 Federal Highway Administration Office of Safety: Bicycle Road Safety Audit Guidelines and Prompt Lists, Report No. FHWA-SA-12-018 (2012): 44-45

34 Christine Hoehner, "Active Neighborhood Checklist," Active Living Research, Washington University, St. Louis, (2011), accessed March 4, 2017. http://activelivingresearch.org/active-neighborhood-checklist

35 James Emery, Carolyn Crump, & Philip Bors, "Reliability and Validity of Two Instruments Designed to Assess the Walking and Bicycling Suitability of Sidewalks and Roads, *American Journal of Health Promotion*, (2003) 18(1); pp. 38-46.

4.3 Audit Elements Included in the High Street Audit Tool

Using a combination of the audit elements referenced in audit examples in section 4.2, the High St. audit tool elements chosen are included in Appendix C. Site-specific conditions also governed which elements to include and not to include.

The High St. audit block segment information closely follows the WABSA model by separating street elements into General Road Factors, Pavement Factors, and Location Factors. The intersection audit section borrows from several examples, but mainly uses the FHWA model by dividing intersection elements into Physical Intersection Elements, Non-motorized Intersection Elements, and Cross Street Elements.

These audit elements were supplemented with direct observations and GIS data including aerial photos, utility locations, street ROW, land uses, and fire hydrant locations. This data was provided by the City of Oakland and the East bay Regional Park District and helps to graphically represent the existing conditions of High St.

4.4 Audit Methodology

The High St. audit was conducted between 12:00 pm and 3:00 pm on July 8th, July 14th, and August 8th, 2017. Photographs of the corridor were taken after the field forms were completed at locations of interest or locations that were representative of the corridor as a whole. Each of the 12 block segments audited were collected on either side of the street using the audit sheets included in Appendix D.

Due to the skewed northeast to southwest angle of High St. (and the entire surrounding street grid) the cardinal direction descriptions need clarification. High St. technically travels northeast to southwest, but for the purposes of this audit, the direction of travel along High St. is considered east to west and the cross streets entering High St. are considered to cross High St. from the north and south.

The block segment numbering system identifies the block number, which side of the street (north or south) and the direction being travelled (east or west). The block segment conditions were recorded traveling west from Foothill Blvd. to the High St. Bridge on the north side of High St. and then recorded returning east on the south side of High St. This approach was taken to determine differences between both sides of the street and to observe conditions from a cyclist's perspective.

The block segments and intersections were divided into the numeric labeling system provided in Appendix E.

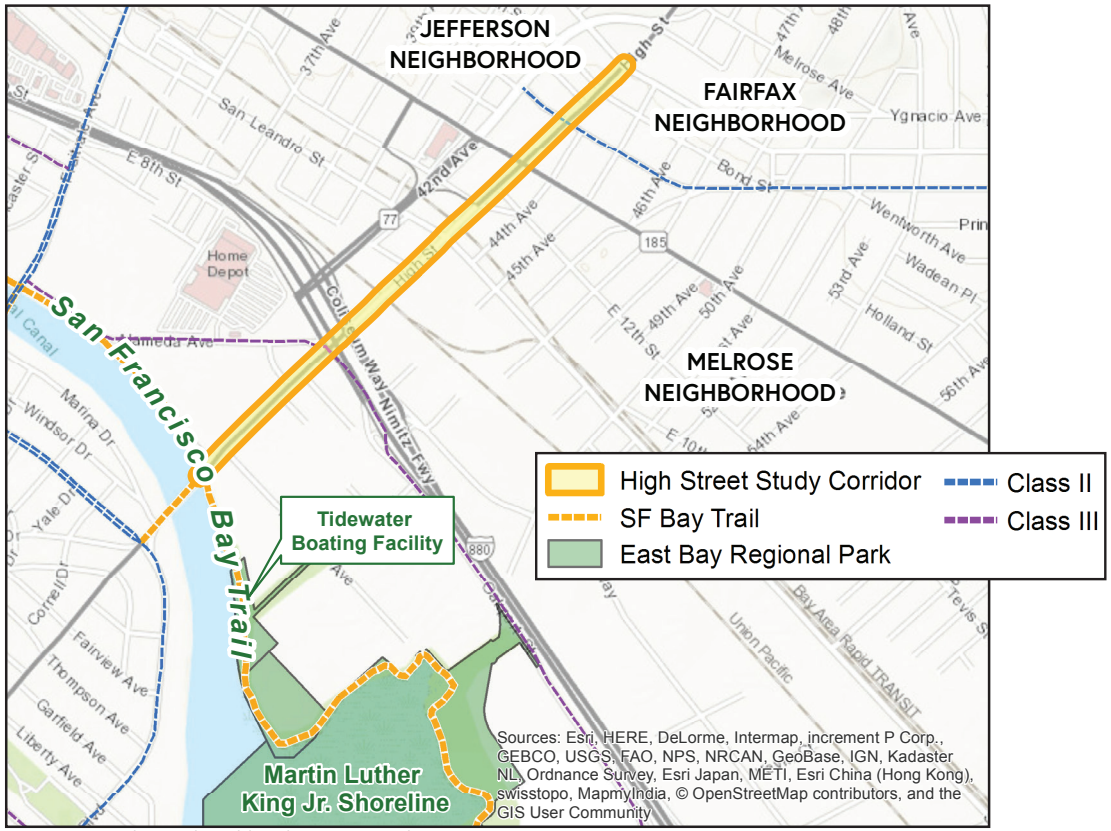


Figure 15 - Skewed Oakland Street Grid

V. Audit Findings

The High St. audit tool findings are separated into two sections: Block Findings by Audit Element and Intersection Findings by Audit Element. These sections discuss the findings and observations for each sub-category and summarize the results in the accompanying tables. Tables showing results for all block segment factors and intersection elements can be found in Appendix F. Figures 30 – 41 at the end of this chapter show the results of the audit graphically.

5.1 Block Findings by Audit Element

General Road Factors

General road factors that contribute to cyclist safety include speed limit, lane width, right of way (ROW) width, and the presence or absence of a bicycling facility. Table 1 shows the Block Segment General Road Factors audit findings.

The speed limit along the entire study area is 25 mph. The narrowness and common back-ups caused by turning vehicles appear to help slow traffic. The approximate outside travel lane width along the study corridor ranged from 10 to 12 ft. According to the GIS property data provided by Oakland, the ROW in the study area is approximately 65 ft. wide for 11 block segments, with the exception of the block segment underneath the I-880 overpass, which is approximately 110 ft. wide. The ROW is currently taken up by four lanes of vehicular travel, a curb and gutter, and sidewalks on both sides of the corridor that range in width between 6 - 12 ft. In some cases there is no sidewalk, but the space for one exists. There does appear to be some encroachment into the sidewalk ROW from local properties along the study corridor. If necessary to reduce the size of the ROW for installation of a bicycle facility, property boundaries may need to be verified.

The High St. audit categorized bicycle facility type by sharrow, Class 3, or Class 2 based on prior observations. There are no separated bike facilities or paved shoulders to safely ride a bicycle along High St. There is a section of High St. designated as a Bike Route, and there is a striped shoulder from Coliseum Way to Oakport St. that was recorded as a Class 3 Bikeway.

General Road Factors					
		Speed Limit (mph)	Ouside Lane Width	ROW Width	Bike Facility
N-W-01	Foothill Blvd to Bond St	25	10 ft	65 ft	None
N-W-02	Bond St to E 17th St	25	11.5 ft	65 ft	None
N-W-03	E 17th St to Bancroft Ave	25	11.5 ft	65 ft	None
N-W-04	Bancroft Ave to International Blvd	25	10 ft	65 ft	None
N-W-05	International Blvd to E 12th St	25	10 ft	65 ft	None
N-W-06	E 12th St to San Leandro St	25	10 ft	65 ft	None
N-W-07	San Leandro St to Wattling St	25	10 ft	65 ft	None
N-W-08	Wattling St to UPRR xing	25	<10 ft	65 ft	None
N-W-09	UPRR xing to Coliseum Way	25	10 ft	65 ft	None
N-W-10	Coliseum Way to Oakport St	25	~12 ft	~110 ft	Class 3
N-W-11	Oakport St to Howard St	25	10 ft	65 ft	None
N-W-12	Howard St to Tidewater Ave	25	11 ft	65 ft	Bike Route
N-W-13	Tidewater to High St Bridge	25	10 ft	60 ft	Bike Route
S-E-13	High St Bridge to Tidewater	25	20 ft	60 ft	Bike Route
S-E-12	Tidewater to Howard	25	10+ ft	65 ft	Bike Route
S-E-11	Howard St to Jensen St	25	10 ft	66 ft	None
S-E-10	Jensen St to Oakport St	25	12 ft	67 ft	None
S-E-09	Oakport St to Coliseum Way	25	12 ft	~110 ft	Class 3
S-E-08	Coliseum Way to UPRR xing	25	10 ft	65 ft	None
S-E-07	UPRR xing to San Leandro St	25	10 ft	65 ft	None
S-E-06	San Leandro St to E 12th St	25	10 ft	65 ft	None
S-E-05	E 12th St to E 12th St	25	10 ft	65 ft	None
S-E-04	E 12th St to International Blvd	25	10 ft	65 ft	None
S-E-03	International Blvd to Bancroft Ave	25	10 ft	65 ft	None
S-E-02	Bancroft Ave to Bond St	25	12 ft	65 ft	None
S-E-01	Bond St to Foothill Blvd	25	10 ft	65 ft	None

Table 1 - Block Segment General Road Factors

Pavement Factors

Pavement factors are helpful for determining current safety risks for cyclists on the roadway. Most likely any future bicycle facilities installed on High St. will involve repaving. Collecting this data provides a snapshot of maintenance hot spots that appear to receive more impact than others.

The pavement conditions were measured on a scale from very good, good, fair, poor, and very poor. The pavement condition for most block segments ranged from good to fair with the exception of a few notable locations. The pavement on both sides of High St. near the Union Pacific RR crossing is in the poorest shape.

Figure 16 - Poor Pavement Conditions near UPRR

Poor drainage and neglect are possible causes. The potholes and cracked pavement present an uninviting and hazardous surface to ride on for cyclists. The other notable segment with poor pavement quality is between San Leandro St. and E. 12th St. This segment passes under the BART tracks and is flanked by industrial land uses on either side. No notable activities causing damage were observed during the audit, but this section shows notable wear and tear.

Figure 17 - Poor Pavement Conditions near San Leandro St.

A 90-degree curb and gutter border both sides of High St. within the entire study area. For eleven out of twelve block segments the curb and gutter transitions directly into the outside travel lane in both directions. There is no paved shoulder or white stripe delineating the edge of the outside travel lane with the exception of the block between Coliseum Way and Oakport St. underneath the I-880 overpass. This block has a wider ROW that accommodates a striped shoulder that is roughly 7.5' wide on both sides of High St.

Striping and road marking conditions were categorized as clearly marked or in poor condition. Road striping, crosswalks, and painted warnings existed along the entire corridor. About 50% was poor or faded and 50% was clearly marked. Blocks considered having poor pavement markings directly correlated with blocks with poor pavement condition. For example, the block between Wattling St. and the UPRR crossing has considerate pavement damage and the striping and RR crossing warning markings on the pavement are almost not visible at all. In general, the pavement marking and striping is in better condition closer to residential areas towards Foothill Blvd. away from the heavy traffic and busy industrial land uses towards the shoreline.

Within the Pavement Factors category the High St. audit catalogued road obstructions. In general, road obstructions were considered on the surface of the roadway such as potholes, drain grates, uneven pavement, and manhole covers. This was collected to identify potential hazards for bikers, but also to determine the level of effort required to relocate utilities that conflict with potential bike facility improvements. Manhole covers and drain grates present a current hazard for cyclists, but they will likely not prevent installation of a future bike facility.

Figure 18 - Poor Pavement Conditions near Wattling St.

Due to the difficulty of recording every pothole within the study area, potholes of significant size were loosely counted. Potholes were encountered throughout the corridor, but were greater in number on the block segments with poor pavement condition, such as the Wattling St. to UPRR crossing.

Figure 19 - Pothole near Wattling St.

Figure 20 - Pothole near UPRR.

Roughly ten drain grates were observed on each side of High St. Figure 21 shows the typical style observed along High St. This material type may actually be safe for cyclists, but the pavement surrounding these drains seems worn in most cases.

Figure 21 - Drain Grate

A gap was noted in the transition between the 90-degree curb and gutter and the asphalt pavement for every block segment along the corridor. This was minor and noted as uneven for most segments, but the gap on some block segments is large enough that it could foul a bicyclist's tire.

Manhole and utility covers were also observed along the study corridor. Certain blocks had more than others and certain blocks had none. The Oakland GIS layer showing hydrants and manholes was used to identify the locations where most occur. Manholes and utility covers located in the outside lane may not present a problem for a future bike facility, but if possible, relocation or leveling of these utilities may be warranted because they do create a more uneven surface and present potentially major obstacles any time they need to be opened or simply become loose.

Figure 22 - Curb & Gutter Joint near UPRR

Figure 23 - Manhole in the Outside Lane

Pavement Factors										
						Road Obstructions				
		Pavement Condition	Curb	Paved Shoulder	Striping/Road Markings	Potholes	Drain Grates	Uneven Pavement	Manhole/ Utilities	Notes
N-W-01	Foothill Blvd to Bond St	Good	Yes	No	Clearly Marked	0	0	Yes	0	
N-W-02	Bond St to E 17th St	Good	Yes	No	Clearly Marked	0	1	Yes	0	
N-W-03	E 17th St to Bancroft Ave	Good	Yes	No	Clearly Marked	0	0	Yes	0	
N-W-04	Bancroft Ave to International Blvd	Good	Yes	No	Clearly Marked	0	1*	Yes	2	*Curb destroyed by drain
N-W-05	International Blvd to E 12th St	Good	Yes	No	Clearly Marked	0	1	Yes	2	
N-W-06	E 12th St to San Leandro St	Fair	Yes	No	Clearly Marked	0	1	Yes	0	
N-W-07	San Leandro St to Wattling St	Fair	Yes	No	Clearly Marked	0	0*	Yes	0	*Drain hole in curb, no grate
N-W-08	Wattling St to UPRR xing	Fair	Yes	No	Poor	3	0	Yes	1	
N-W-09	UPRR xing to Coliseum Way	Poor	Yes	No	Poor	0	1	No	2	
N-W-10	Coliseum Way to Oakport St	Good	Yes	7.5 ft	Poor	0	2	Yes	0	
N-W-11	Oakport St to Howard St	Fair	Yes	No	Poor	0	2	Yes	2	
N-W-12	Howard St to Tidewater Ave	Fair	Yes	No	Poor	0	3	Yes	5	
N-W-13	Tidewater to High St Bridge	Good	Yes	No	Clearly Marked	0	0	Yes	3	
Total							12		17	
S-E-13	High St Bridge to Tidewater	Good	Yes	No	Clearly Marked	0	1	Yes	1	
S-E-12	Tidewater to Howard	Good	Yes	No	Poor	0	1	No	0	
S-E-11	Howard St to Jensen St	Fair	Yes	No	Poor	1	1	Yes	0	
S-E-10	Jensen St to Oakport St	Good	Yes	No	Poor	2	1	Yes	0	
S-E-09	Oakport St to Coliseum Way	Good	Yes	7.5 ft	Clearly Marked	0	1	No	0	
S-E-08	Coliseum Way to UPRR xing	Poor	Yes	No	Poor	0	0	Yes	2	
S-E-07	UPRR xing to San Leandro St	Poor	Yes	No	Poor	8	0	Yes	2	
S-E-06	San Leandro St to E 12th St	Poor	Yes	No	Clearly Marked	5	1	Yes	5	
S-E-05	E 12th St to E 12th St	Fair	Yes	No	Poor	2	2	Yes	0	
S-E-04	E 12th St to International Blvd	Good	Yes	No	Clearly Marked	2	1	Yes	0	
S-E-03	International Blvd to Bancroft Ave	Good	Yes	No	Clearly Marked	0	0	Yes	0	
S-E-02	Bancroft Ave to Bond St	Good	Yes	No	Clearly Marked	0	0	minor	0	
S-E-01	Bond St to Foothill Blvd	Good	Yes	No	Clearly Marked	2	0	Yes	3	
Total							9		13	

Table 2 - Block Segment Pavement Factors

Location Factors

Location factors provide a more specific look at the use of the street corridor by observing elements such as: driveways entering and exiting the street, on and off-street parking, transit stop locations, sidewalks, and grade. This section also identifies existing bike amenities like bike racks, bike specific signage, bike lockers, etc. Horizontal and vertical obstructions to cyclist travel such as street trees, utility poles, or other utilities, and adequacy of street lighting was also collected.

High St. is not wide enough to allow for on-street parking within the study corridor. There are a few locations noted where the ROW is encroached upon with off-street parking on the sidewalk. This was observed outside of a few auto repair shops that appeared to be using the extra space to store vehicles.

Parking encroachments into the ROW were observed on the north side of High St. from Bancroft Ave. to International Blvd., San Leandro St. to Wattling St., Wattling St. to the UPRR crossing, and from Howard St. to Tidewater Ave. These vehicular encroachments, and the driveways associated with them, could interrupt continuous safe bicycle travel at these locations. Building frontages are used for parking outside of the ROW at several locations.

Very few transit stops exist along High St. within the study area. The four locations where AC transit bus routes stop are on both sides of High St. between Foothill Blvd. and Bond St., and both sides of High St. between Bancroft and International Ave. These stops are for AC Transit routes 14 and 648. Line 14 is mainly a connector route from the West Oakland BART Station to the Fruitvale BART Station. This line operates 7 days a week and on most holidays from approximately 5:30 am until 10:30 pm. This route provides a connection from the Jefferson neighborhood to these stations. Line 648 is a "Service to Schools Line" that connects from Fruitvale BART to Skyline High School via High St. This line operates Monday – Friday from approximately 7:00 am until 3:40 pm. except on major holidays. For residents who do not own cars and depend on transit to travel, providing a bicycle connection to these bus stops may increase ridership. However, stopping buses block continuous bicycle travel and may cause cyclist to swerve into traffic lanes when stopped.

The grade of High St. was measured in categories from severe (>10%), Moderate (>5%), and Flat. The entire study corridor was characterized as flat. The lower speed limit of 25 mph and the flat slope are conducive to safe bicycle travel as the severity of bicyclist crashes goes up with higher vehicle speeds.[36]

Figure 24 - Parking Encroachments, Hydrants, and Utility Poles near Howard St.

Figure 25 - Bike Rack near Foothill Blvd.

36 Federal Highway Administration, "Bicycle Road Safety Audit Guidelines and Prompt Lists," Federal Highway Administration Office of Safety, Report No. FHWA-SA-12-018 (2012): 17

There are very few bicycle amenities or signage related to bike facilities installed on the adjacent sidewalks. There is one bike rack installed in front of the Metro PCS store near the Foothill Blvd. intersection.

Street trees and utility poles within the sidewalks limit the available width of the street ROW. This audit catalogued the location and amount of both to determine which side of High St. is more challenging to install a bike facility due to these obstructions. There are very few street trees planted within the ROW along the study corridor.There are 17 trees planted on the south side of the street between International Blvd. and Foothill Blvd. There are three (3) trees planted within the ROW on the north side of the street between International Blvd. and E 12th St. Figures 30 - 41 show the locations of these trees.

In general, there are more utility poles and streetlights within the sidewalk ROW on the south side of High St. (42) than on the north side (16). Other potential obstructions within the ROW include fire hydrants, trashcans, and railroad crossing signal arms. Trashcans can be easily moved so should not present an obstruction to future bicycle facilities proposed. Most hydrants do not present a conflict as they are typically offset from the street, but there were eight (8) hydrants observed on both sides of High St. The existing at-grade railroad crossing may require improvements to the platforms or signals to provide additional bicycle access, but the signal arms do not appear constrain the ROW.

The amount of driveways was recorded in order to determine areas where vehicles entering and exiting the roadway may conflict with safe bicycle travel. The north side has 41 driveways while the south side has 35. The frequency of use and landuse type will determine the level of conflict possible at these locations and may affect design recommendations proposed.


Figure 26 - No Sidewalk Underneath the I-880 Overpass

The sidewalk width and condition varies along the corridor. Sidewalk width ranged from 6-12 ft., but was on average 7 ft. wide for most of the corridor. It is not clear whether the width varied due to encroachments or by design from block to block. There is no sidewalk on the north side of High St. between the UPRR crossing and Oakport St., and on both sides of the street underneath the I-880 overpass. In some cases noted earlier, the sidewalk is occasionally taken up by business uses for parking. In general, the sidewalks were adequately wide and in decent condition.

The street lighting was not adequate along most of the study corridor. The north side of the street was noted as having worse lighting than the south side, but there are block segments on both sides that are inadequate. Ten block segments out of twelve on the north side of High St. had poor street lighting and seven block segments out of twelve on the south side had poor street lighting. At a few locations a business, such as the Chevron gas station at the corner of Oakport St., provides significant lighting that spills out onto High St., but for the most part this corridor is poorly lit at night.


Figure 27 - Street Light near Jensen St.

Location Factors													
						Horizontal/ Vertical Obstructions?							
		Street Parking	Transit Stop	Grade	Bike Signage	Street Trees	Utility Poles	Other	Driveways	Bike Amenities	Sidewalk	Adequate Street Lighting	Notes
N-W-01	Foothill Blvd to Bond St	No	Yes	Flat	No	0	0		3	No	~12 ft	N; 1	Gas station provides significant lighting
N-W-02	Bond St to E 17th St	No	No	Flat	No	0	0	1 Hydrant	0	No	7 ft	N; 1	
N-W-03	E 17th St to Bancroft Ave	No	No	Flat	No	0	0	1 Hydrant	4	No	6 ft	N; 0	
N-W-04	Bancroft Ave to International Blvd	No*	Yes	Flat	No	0	0	signs	5	No	8-9 ft	N; 0	*Off St auto parking; ped curb ramp
N-W-05	International Blvd to E 12th St	No	No	Flat	No	3	0	signs	5	No	9-11 ft	N; 1	Lighting at intersections
N-W-06	E 12th St to San Leandro St	No	No	Flat	No	0	0	signs	2	No	6-9 ft	N; 1	No lighting under BART
N-W-07	San Leandro St to Wattling St	No*	No	Flat	No	0	3		2	No	8-12 ft	Y; 3	*Off St parking sidewalk
N-W-08	Wattling St to UPRR xing	No*	No	Flat	No	0	2	RR Signal arm	3	No	8 ft	N; 1	*Off St Parking Auto Biz
N-W-09	UPRR xing to Coliseum Way	No	No	Flat	No	0	1		3	No	No	N; 0	Concrete Drvwys, but gravel sidewalks
N-W-10	Coliseum Way to Oakport St	No	No	Flat	No	0	0		0	Yes*	No	N; 2	*Paved Shoulder w/ stripe; Underpass dark without sidewalk
N-W-11	Oakport St to Howard St	No	No	Flat	No	0	4	1 Hydrant	4	No	8 ft	N; 2	
N-W-12	Howard St to Tidewater Ave	No*	No	Flat	Yes	0	8	1 Hydrant	8	Yes**	11 ft***	Y; 7	*Off street parking at business; **Bike Route Sign MLK Shoreline; ***Sidewalk ends; 2 ped ramps
N-W-13	Tidewater to High St Bridge	No	No	Flat	Yes	2	3		1	No	5 ft*	N;1	*Plus a 5 ft landscape buffer
Total						5	21		40				
S-E-13	High St Bridge to Tidewater	No	No	Flat	Yes	0	4		0	No	8 ft	Y;2	
S-E-12	Tidewater to Howard	No	No	Flat	Yes	0	7		5	Yes*	11-12 ft	N; 1	*Bike Route Sign to Howard
S-E-11	Howard St to Jensen St	No	No	Flat	No	0	4	Signal Arm	1*	No	8 ft	Y; 2	*Ped curb ramp
S-E-10	Jensen St to Oakport St	No	No	Flat	No	0	3		3	No	~8 ft	N; 1	Business lights help brighten corridor
S-E-09	Oakport St to Coliseum Way	No	No	Flat	No	0	0		None	No	6 ft	N	Underpass needs lighting
S-E-08	Coliseum Way to UPRR xing	ccc	No	Flat	No	0	5	RR xing arm	4	No	10-12 ft	Y; 3	
S-E-07	UPRR xing to San Leandro St	No	No	Flat	No	shrubs	8	2 Hydrants	8	No	~12 ft	N; 2 w/ gaps	Poor Drainage Near UPRR
S-E-06	San Leandro St to E 12th St	No	No	Flat	No	0	3	2 Hydrants	3	No	6-10 ft	N; 1	
S-E-05	E 12th St to E 12th St	No*	No	Flat	No	0	2		2	No	10 ft	Y; 2	*Off St Parking/Auto Repair
S-E-04	E 12th St to International Blvd	No	No	Flat	No	0	2		2	No	12 ft; Poor	N; 1	
S-E-03	International Blvd to Bancroft Ave	No	Yes	Flat	No	6	4	1 Garbage Can	2	No	8 ft	Y; 3	
S-E-02	Bancroft Ave to Bond St	No	No	Flat	No	5	3		2	No	8 ft	Y; 3	Ped curb ramp
S-E-01	Bond St to Foothill Blvd	No	Yes	Flat	No	6	3	1 Garbage Can	2	Bike Rack	10 ft	N; 2 Overhead	
Total						17	48		33				

Table 3 - Block Segment Location Factors

With increased vehicular and bicyclist interactions, bicyclist and motorist shared intersections are one of the most crucial design features for bicycle safety.[37] There are a total of 16 intersections that were evaluated within the High St. study corridor. Physical intersection characteristics such as width, type, presence of turning lanes, road-marking conditions, presence or absence of signals, and intersection geometry were considered. Cross street characteristics such as number of lanes, speed, direction of travel, turning movements allowed, and presence or absence of a bike facility connection were also recorded. The condition of these elements determine the level of unprotected cyclist/ vehicular interactions that will take place within these intersections and identify physical characteristics that may pose challenges to future bicycle facility installation.

Physical Intersection Elements

Intersection type was described as the number of "legs", or directions of travel, entering the intersection and whether those legs have a traffic signal or stop sign for each direction of travel. Again, because of the skewed northeast to southwest angle of High St., the direction of travel along High St. is considered east to west and the cross streets entering these intersections are considered to cross High St. from the north and south.

There are 9 four-way intersections, and 7 three-way intersections within the study area. The

37 Ann Forsyth and Kevin J. Krizek, "Promoting Walking and Bicycling: Assessing the Evidence to Assist Planners," *Built Environment* 36, No. 4 (2010): 441

four-way intersections are larger and allow traffic through all four legs. Three-way intersections are mostly smaller side streets controlled by a stop sign. One exception is Howard St. that has a traffic signal controlling vehicles turning left and right onto High St. All four-way intersections have traffic signals controlling vehicular movement on all legs. The UPRR crossing is considered a four-way intersection for purposes of this audit. There are technically four legs of travel, but lighted signal gates were observed stopping both directions of vehicular traffic when a train is roughly 30 seconds from crossing the intersection.

Since this study aims to design a bike facility that travels along High St., the width of the eastbound and westbound sides of the four-way intersections were measured from curb to curb to determine how far a bicyclist would need to travel through the exposed area of the intersection. The width of each side of the intersection was then averaged and recorded. Intersections with more cross-street lanes entering the intersection were wider. The three-way intersections were measured longitudinally from curb to curb. Intersection widths ranged from 50 - 106 ft. with the average width of all intersections equaling approximately 70 ft. The widest and most problematic intersection is the west E. 12th St. intersection where both E 12th St. and Highway 77 (a short feeder to I-880) meet High St.

There are only two intersections that have turn lanes from High St. in both directions within the study area. Both left turn lanes allow turning during a green arrow phase from the inside travel lane to the Interstate 880 interchange at Oakport St. and Coliseum Way. All other intersections allow turning from High St. onto cross streets during a green light phase. There are no free right turns with islands or right turn lanes in either direction along High St. The absence of right turn lanes removes a significant challenge to installing bike lanes along the shoulder of this route.

Half of the intersections in the study area are skewed; meaning the angle of the intersection is not ninety degrees on all sides, which lengthens the crossing width. This will have an effect on the length of a bicycle facility installed through the intersection, but may not pose a barrier to implementation.

Physical Intersection Elements								
		Intersection Type						
		Type	Traffic Signals All Directions	Stop Sign One Direction	Width	Turn Lanes on High St	Skewed Angle	Notes
I-01	High St @ Foothill Blvd	4 Way	Yes		85 ft	None	Yes	
I-02	High St @ Bond St	4 Way	Yes		60 ft	None	No	Bond St One way northbound
I-03	High St @ E 17th St	3 Way	No	Yes	55 ft	None	No	Minor Dead end Residential
I-04	High St @ Bancroft Ave	4 Way	Yes		65 ft	None	Yes	
I-05	High St @ International Blvd	4 Way	Yes		95 ft	None	Yes	
I-06	High St @ E 12th St East	3 Way	No	Yes	55 ft	None	No	
I-07	High St @ E 12th St West	4 Way	Yes		106 ft	None	Yes	Hwy 77 southbound two lanes, separate signal phase
I-08	High St @ San Leandro St	4 Way	Yes		80 ft	None	Yes	
I-09	High St @ Wattling St	3 Way	No	Yes	60 ft	None	No	
I-10	High St @ UPRR Crossing	4 Way*	No		60 ft	None	Yes	*RR Crossing
I-11	High St @ Coliseum Way	4 Way	Yes		72 ft	Yes*	Yes	*East bound left on arrow only to freeway
I-12	High St @ Oakport St	4 Way	Yes		95 ft	Yes*	Yes	*Westbound left turn on arrow only
I-13	High St @ Jensen St	3 Way	No	Yes	50 ft	None	No	
I-14	High St @ Howard St East	3 Way	Yes		90 ft	None	No	
I-15	High St @ Howard St West	3 Way	No	Yes	50 ft	None	No	
I-16	High St @ Tidewater Ave	3 Way	No	Yes	55 ft	None	No	

Table 4 - Physical Intersection Elements

Non-Motorized Intersection Elements

The presence or absence of crosswalks, pedestrian signals and the condition of road markings indicate the level of non-motorized signalization that both cyclists and motorists are conditioned to at these intersections. Crosswalks are observed on at least two legs of all four-way intersections along High St. Five of the major intersections have pedestrian signals and crosswalks across all four legs of the intersection. There were no crosswalks noted at three-way intersections except for the Wattling St., Howard St. East, and Tidewater Ave. intersections. These intersections have a crossing of High St. that will require some level of coordination with proposed bike facilities. The quality of these crosswalks varies, but generally crosswalk markings are poorly visible at 9 out of 16 intersections.

Signal and crosswalk information was recorded for all legs. Pedestrian signals were observed at just over half of the intersections along High St. The absence of signals for those travelling along High St. was noted at three locations. At Bancroft Ave. there are no eastbound or westbound pedestrian signals. Pedestrian signals exist for those travelling along Bancroft Ave., but not for those travelling along High St. There are only pedestrian signals on two out of four legs of the intersection at Coliseum Way and Oakport St. Only the east and south legs of Coliseum Way allow crossing by signal and crosswalk. Only the south and west legs of Oakport St. allow crossing by signal and crosswalk, but a pedestrian signal is absent for those travelling west on the north side of High St. These may not exist to discourage crossing at these busy freeway entrance and exit points.

The UPRR crossing appears to have sufficient platform width to allow a pedestrian or bicycle facility, but there are no pedestrian level signal gates or signals at this intersection. Recommendations for improvements to the UPRR crossing are outside of the scope of this study.

No intersections have a dedicated signal phase for bicyclists. None of the intersections had a bike box or other markings for bicyclists except at Foothill Blvd. At this location there is a 30 x 40 inch bicycle detector pavement marking indicating bicyclists travelling toward the hills on High St. should queue at this location to be detected by the signal. The stencil is so small that it is easily missed and often obscured by vehicles stopped at the light.

Non-Motorized Intersection Elements							
				Ped/Bike Signal			
		Crosswalk	Clear Markings	Bike/Ped Signal	Dedicated Bike Phase	Bike Box	Notes
I-01	High St @ Foothill Blvd	4	Yes	Yes	No	No*	* Sharrow stencil visible at stop line, but no box
I-02	High St @ Bond St	4	Yes	Yes	No	No	Bond St One way northbound
I-03	High St @ E 17th St	No	No	No	No	No	Minor Dead end Residential
I-04	High St @ Bancroft Ave	4	No	No*	No	No	*No ped signals
I-05	High St @ International Blvd	4	Yes	Yes*	No	No	*No Ped signal on east leg of International
I-06	High St @ E 12th St East	No	No	No	No	No	
I-07	High St @ E 12th St West	3*	No	Yes	No	No	*West leg High St crossing no crosswalk/signal
I-08	High St @ San Leandro St	4	No	Yes	No	No	Crosswalks poorly marked/faded
I-09	High St @ Wattling St	1*	No	No	No	No	*Crosswalk crossing High St w/ no signal
I-10	High St @ UPRR Crossing	No	No	No	No	No	*RR Crossing; Roadway warning paint 150' away either direction, but in poor condition
I-11	High St @ Coliseum Way	2*	No	Yes**	No	No	*No crosswalk High St. westbound leg; **No Ped Signal on High westbound leg
I-12	High St @ Oakport St	2*	No	No	No	No	*No crosswalk High St westbound leg
I-13	High St @ Jensen St	No	Yes*	No	No	No	*Stop Bar and "Keep Clear" paint faded
I-14	High St @ Howard St East	2*	Yes	Yes	No	No	*Crosswalk on north and west legs only
I-15	High St @ Howard St West	No	Yes*	No	No	No	*Markings visible but fading; Dead end street
I-16	High St @ Tidewater Ave	1*	Yes	No	No	No	*One crosswalk across High, w curb ramps

Table 5 - Non-Motorized Intersection Elements

Figure 28 - Bike Detection Symbol on Piedmont Ave. - Oakland, CA

Cross Street Elements

Cross street information for 15 intersections recorded includes: number of lanes, speed limit, directions of travel, turning movements allowed, and bicycle facility connections. The majority of the cross streets have only two to three lanes of traffic in either direction.

The three largest intersections observed with four lanes of travel in all directions are Foothill Blvd., International Blvd., and San Leandro St. Each of these intersections requires a pedestrian or cyclist to cross 80 – 95 ft. All three of these locations have a high level of activity and multiple directions of travel merging to and from I-880 and Highway 77.

The speed limits posted on cross streets ranges from 25 to 30-mph. Some cross streets are shorter segments or private dead end streets with no posted speed limit. Bond St., Bancroft St., and E 12th St. are one-way streets. Coliseum Way and Oakport St. are both one-way streets on the north side of High St. but then shift to allow two lanes of travel on the south side of High St. As noted earlier, these two streets act as frontage roads for access to I-880. The north side of Coliseum Way is a freeway on-ramp and the north side of Oakport is a freeway off-ramp.

Most cross street intersections allow unrestricted turning movements onto High St. during a green light phase. At the one-way intersections, there are fewer options for motorists to choose from; which should provide more predictable motorist

Cross Street Elements							
		# Lanes	Speed	One Way	Free Turns	Bike Facility Connection	Notes
I-01	High St @ Foothill Blvd	4	25	No	Yes	Class 2	
I-02	High St @ Bond St	2	25	Yes	Yes	No	Bond St One way northbound
I-03	High St @ E 17th St	2	25	No	Yes	No	Minor Dead end Residential
I-04	High St @ Bancroft Ave	2	30	Yes	Yes	Yes*	*Bike lane north on Bancroft
I-05	High St @ International Blvd	4	25	No	Yes	No	
I-06	High St @ E 12th St East	2	25	No	Yes	No	
I-07	High St @ E 12th St West	5 to 3	25	Yes	No*	No	*No right on red from E 12th; One Way southbound
I-08	High St @ San Leandro St	4	30	No	Yes	No	
I-09	High St @ Wattling St	2	25	No	Yes	No	
I-10	High St @ UPRR Crossing	n/a	n/a	n/a	No	No	RR Crossing
I-11	High St @ Coliseum Way	3	30	North side	Yes	No	
I-12	High St @ Oakport St	3 to 2*	30	North side	Yes	No	*3 one-way lanes from north; 2 lanes from south bi-directional
I-13	High St @ Jensen St	2	No Posted	No	Yes	No	
I-14	High St @ Howard St East	3	No Posted	No	Yes	Yes*	*Bike Route
I-15	High St @ Howard St West	2	No Posted	No	Yes	No	*Markings visible but fading; Dead end street
I-16	High St @ Tidewater Ave	2	No Posted	No	Yes	Yes*	*Bike route

Table 6 - Cross Street Intersection Elements

behavior. Restrictions for right turning on a red are in place at the E 12th St. West intersection.

There are a few bicycle facilities that meet High St. that will provide connections to any future bicycle facility proposed. (See Section 2.3 for more detailed descriptions.) The Class 2 bike lane along Foothill Blvd. is well established and visible. Bancroft Ave has a Class 2 bike lane travelling in either direction, but unfortunately the striping for this bike lane is badly faded and needs to be re-established. As mentioned in Section 2.3, there is a Bike Route at the west end of the study area entering High St. from Howard, Tidewater Ave. and the High St. Bridge. There are no pavement markings helping to designate this Bike Route that travels along high street for a short time. Heavy traffic was observed mid-day at this location by large trucks and vehicles using Howard St. to access High St. from the industrial areas along Alameda Ave. This is apparently the only access route for delivery trucks from Industrial sites along Alameda Ave. to I-880. The signal timing at Oakport St. and the volume of traffic observed mid-day created a back up to the High St. Bridge.

The results of the High St. audit are shown in Figures 30 - 41 on the following pages.

Figure 29 - Howard St. Mid-day Traffic Jam

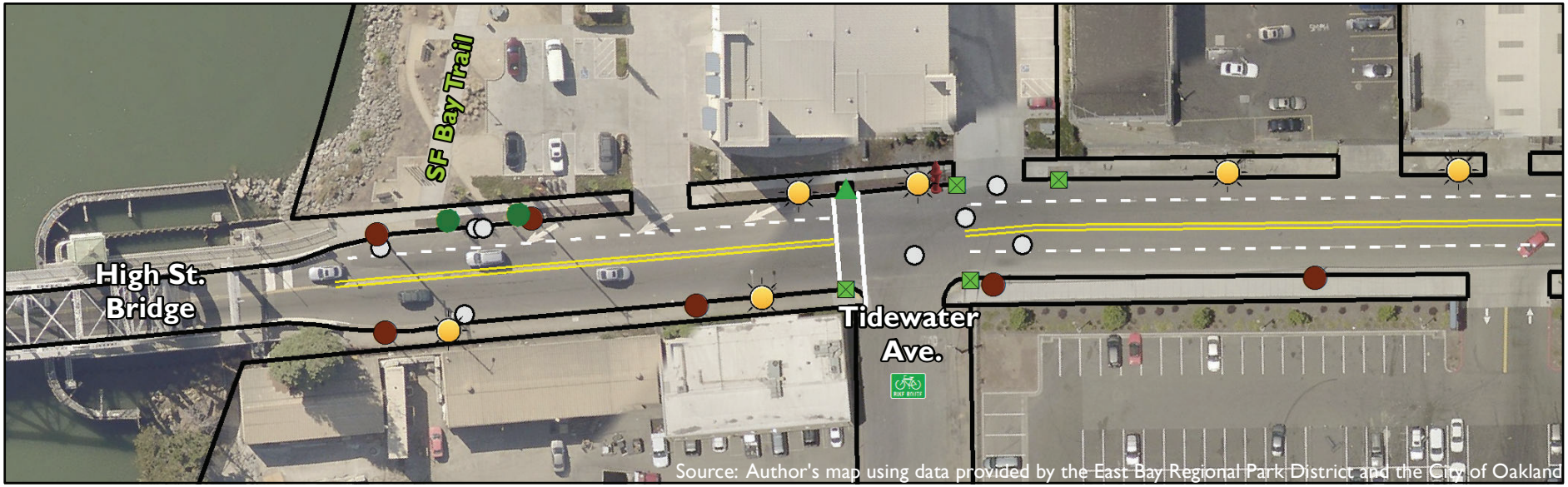


Figure 30: High St Bridge to Tidewater Ave. Audit Findings

Bike Route
RR X-Ing
Bus Stop
Utility Pole
Street Tree
Street Light
Drain Grate
Curb Ramp
Sewer/Utility Cover
Hydrants

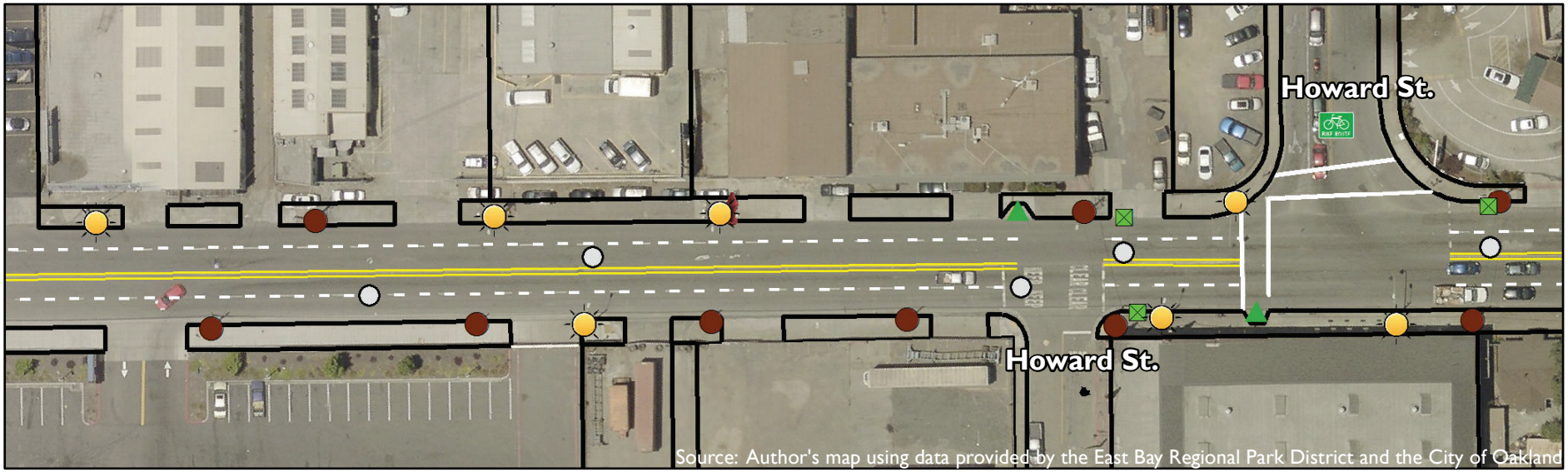


Figure 31 - Tidewater Ave. to Howard St. Audit Findings

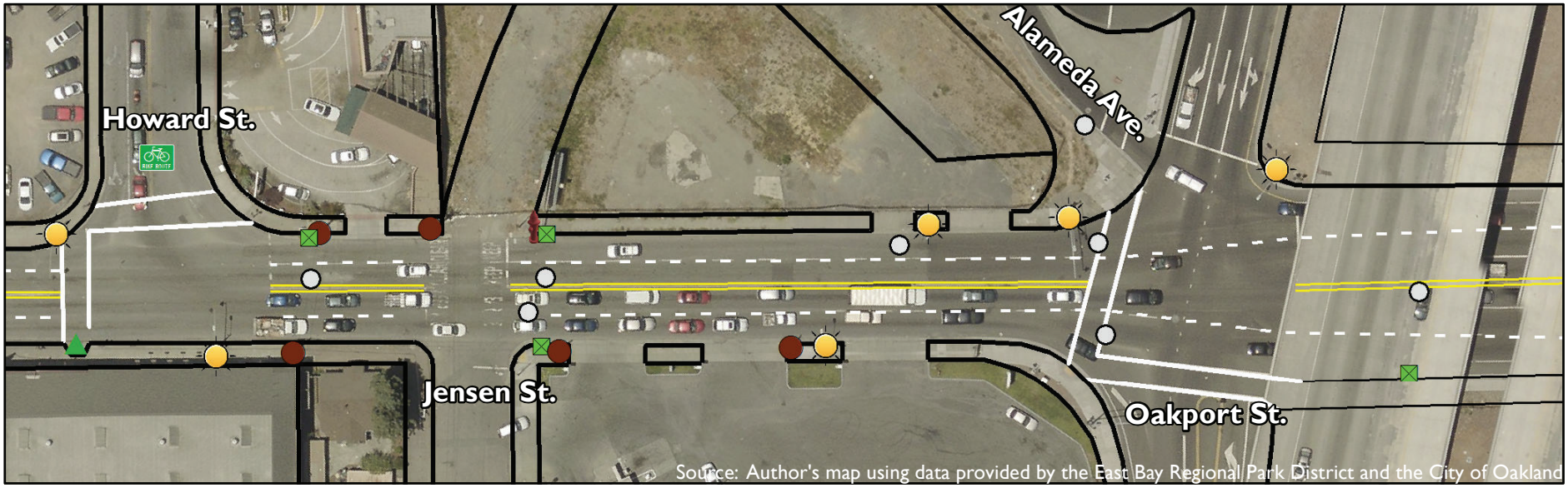


Figure 32 - Howard St. to Jensen St. & Jensen St. to Oakport St. Audit Findings

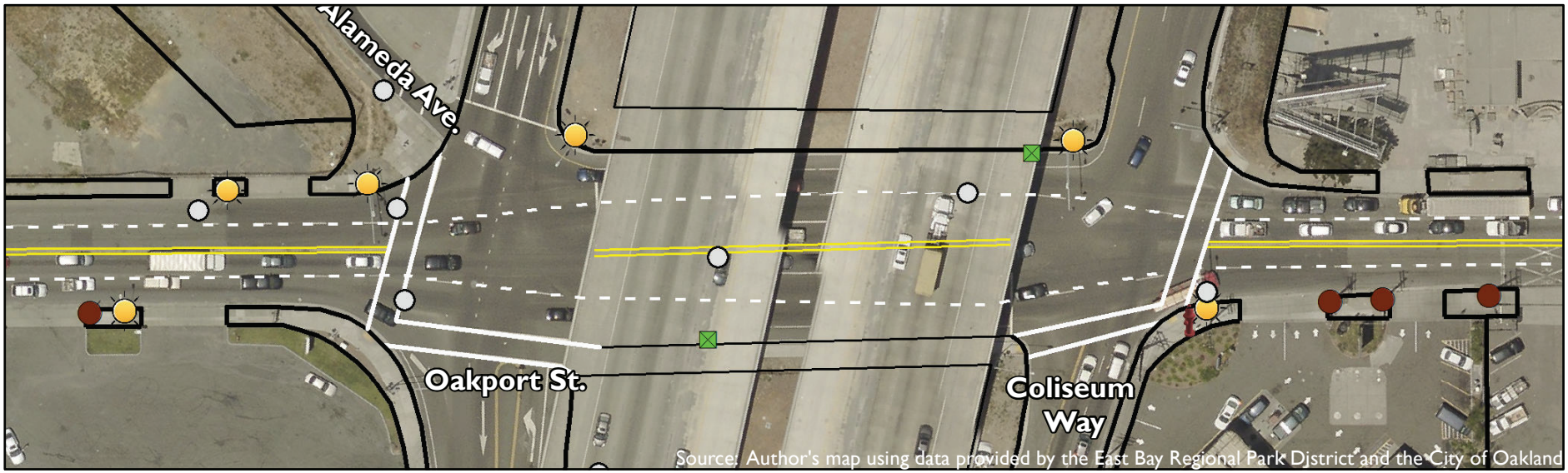


Figure 33 - Oakport St. to Coliseum Way Audit Findings

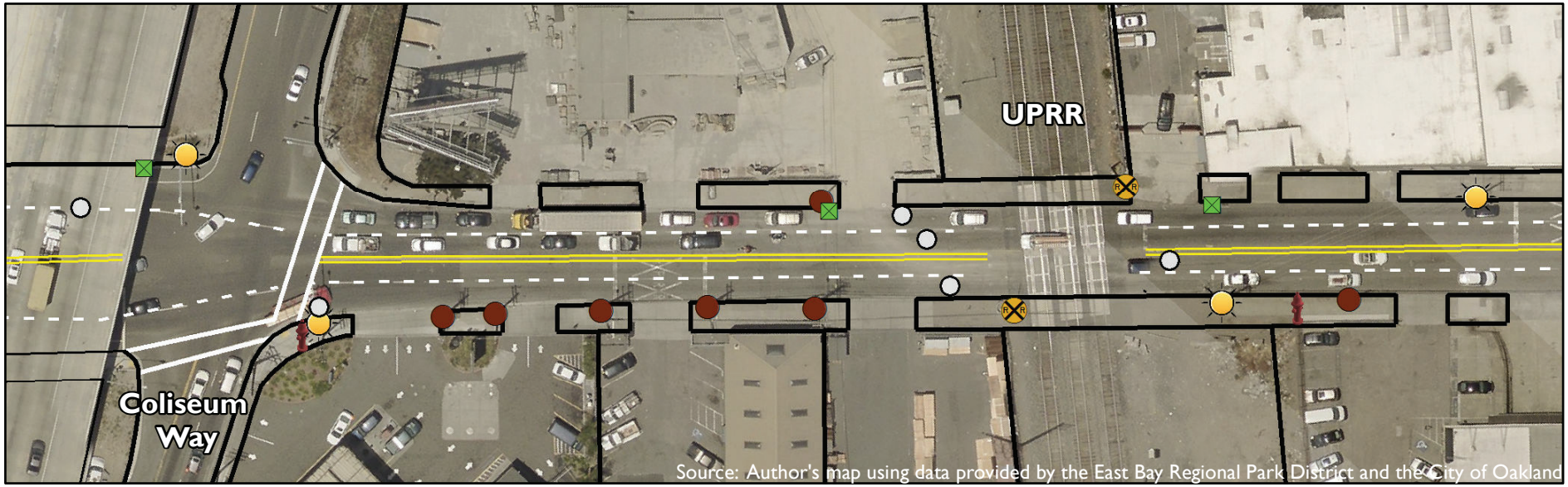
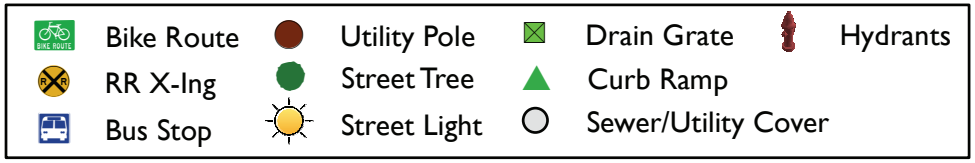


Figure 34 - Coliseum Way to UPRR Audit Findings



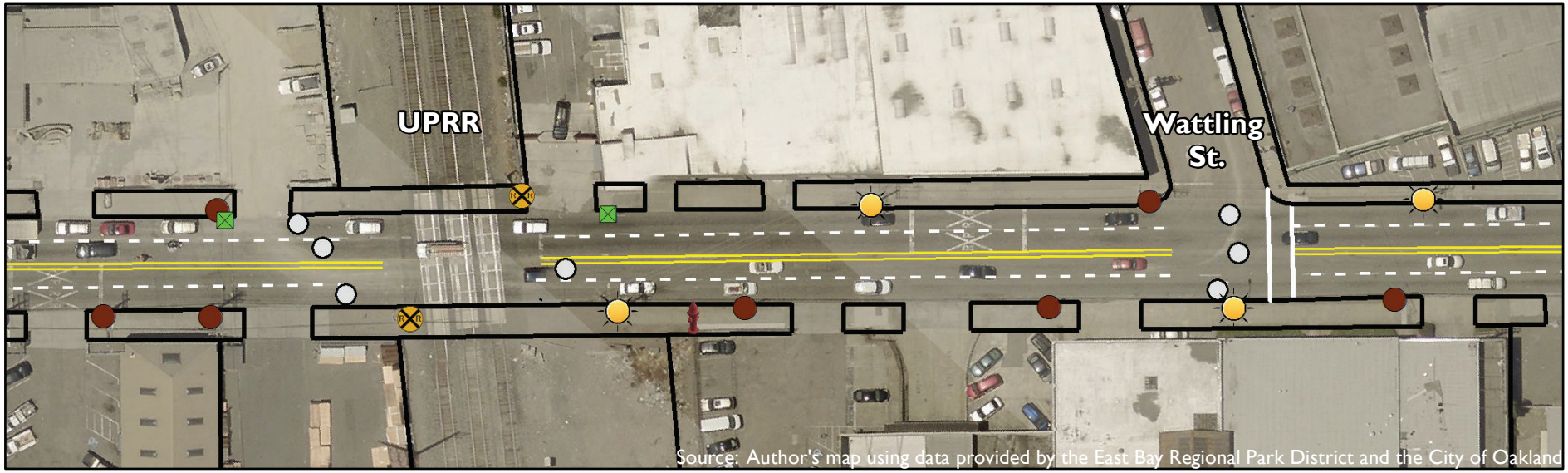


Figure 35 - UPRR to Wattling St. Audit Findings

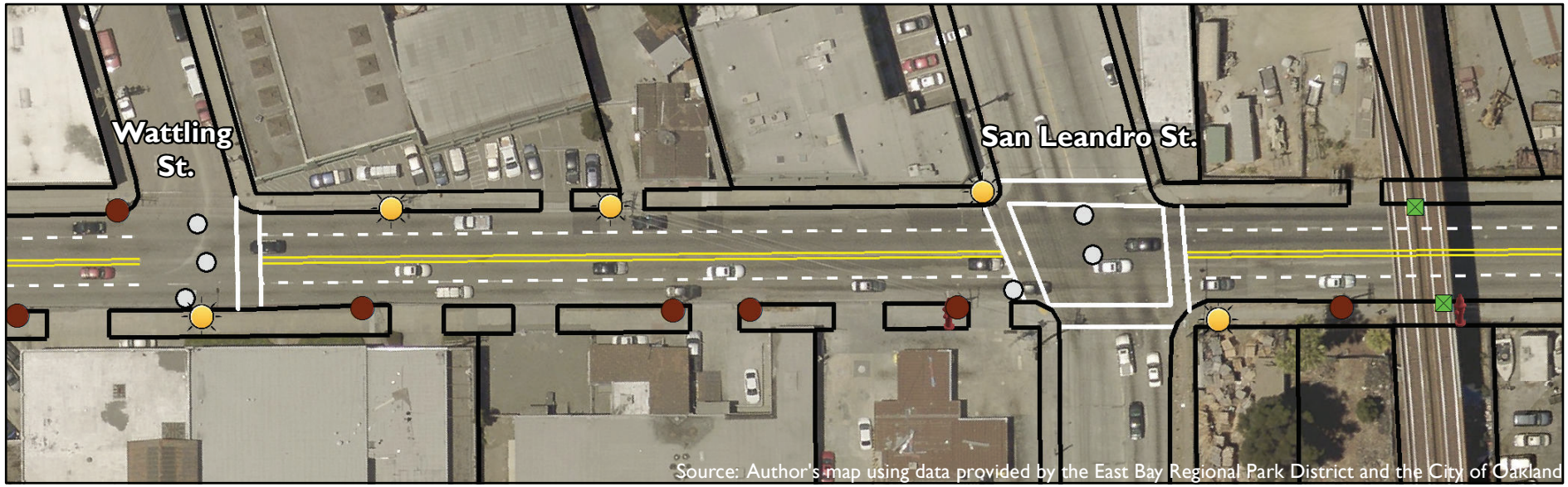
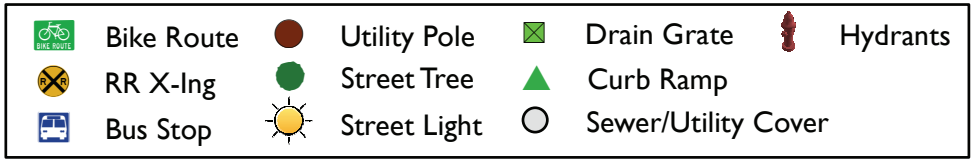


Figure 36 - Wattling St. to San Leandro St. Audit Findings



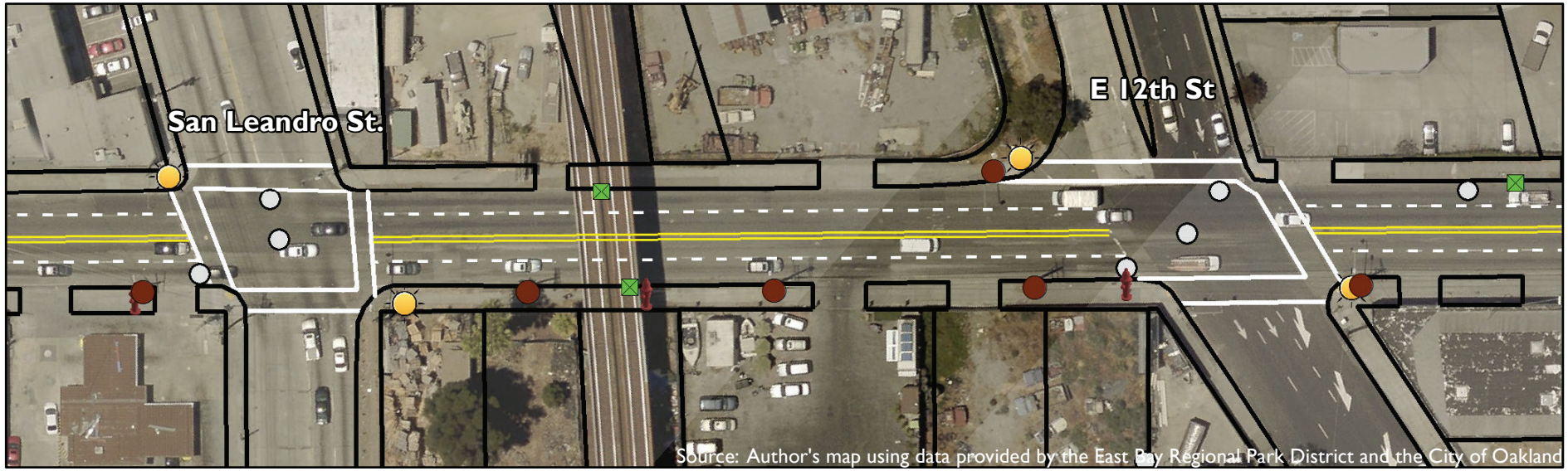


Figure 37 - San Leandro St. to E 12th St. Audit Findings

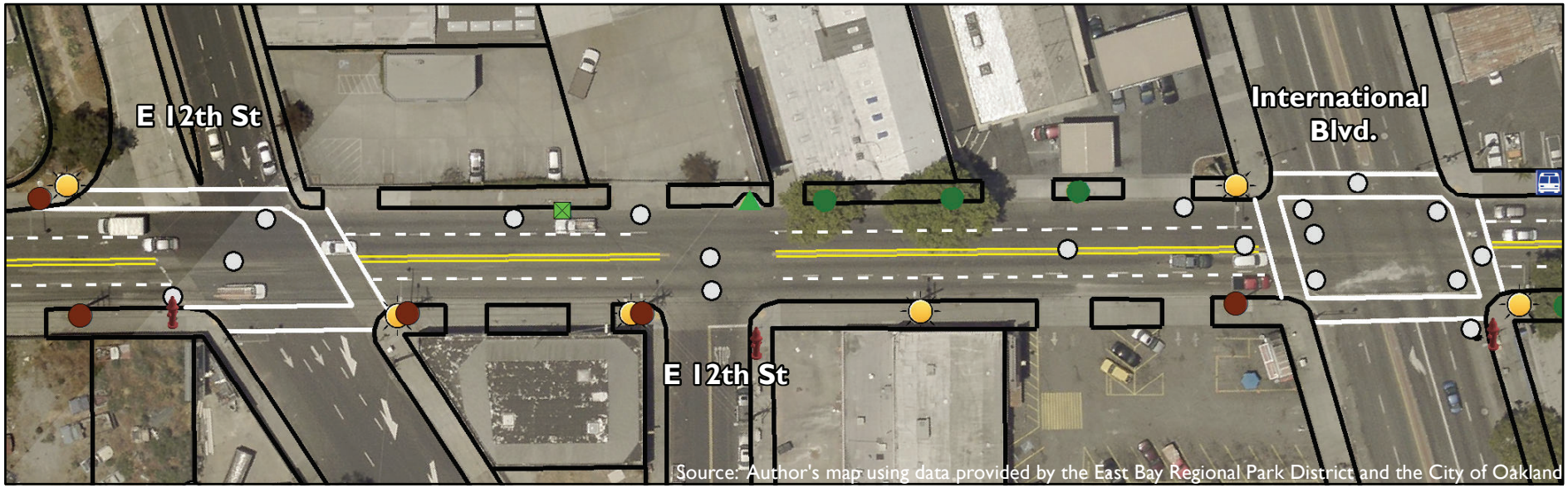


Figure 38 - E 12th St. to Internaional Blvd. Audit Findings

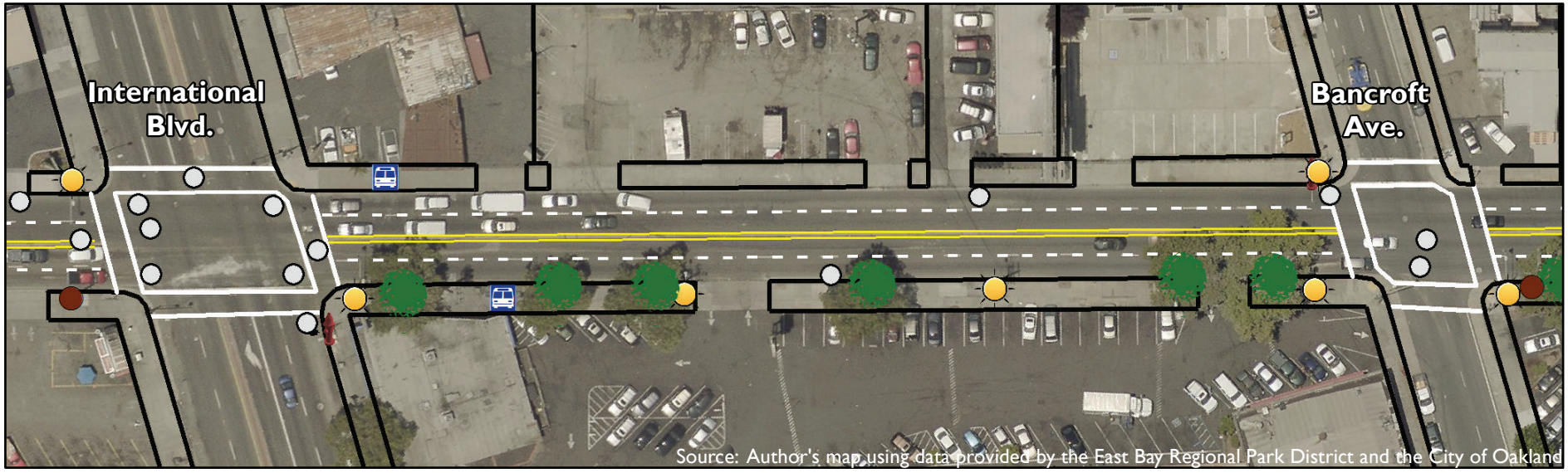


Figure 39 - International Blvd. to Bancroft Ave. Audit Findings

Bike Route
RR X-Ing
Bus Stop
Utility Pole
Street Tree
Street Light
Drain Grate
Curb Ramp
Sewer/Utility Cover
Hydrants

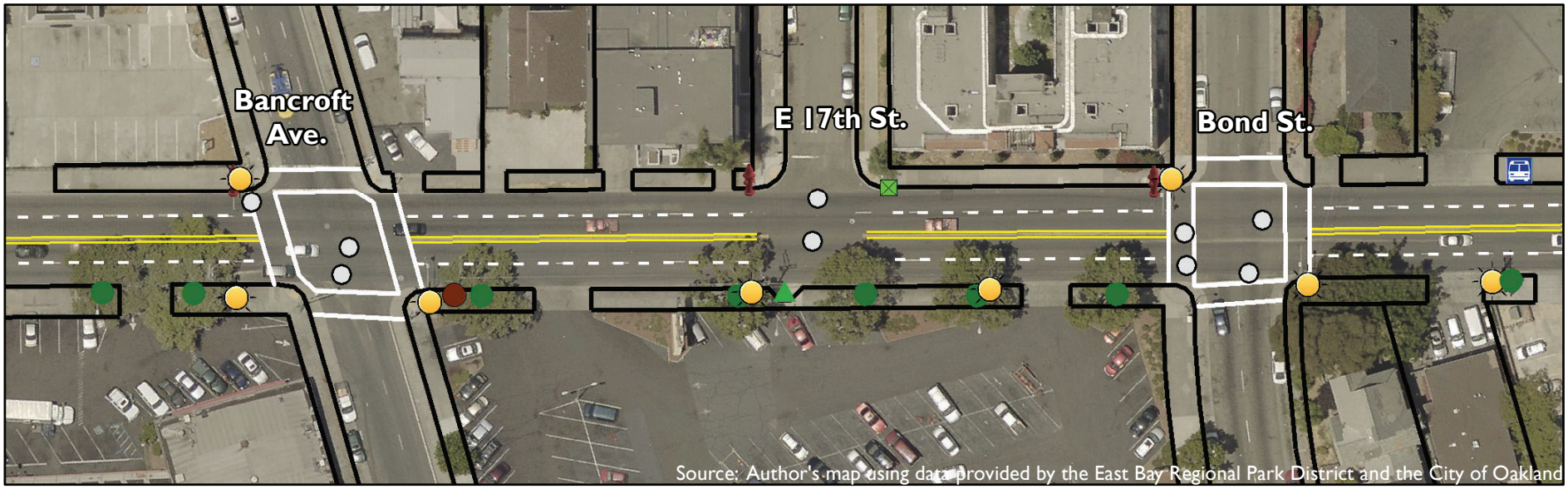
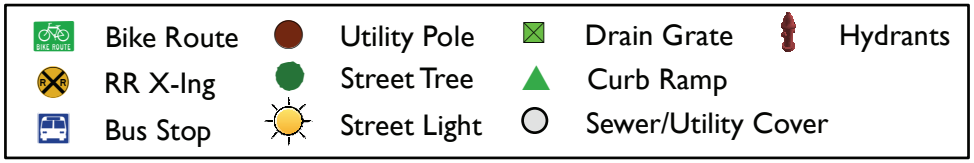


Figure 40 - Bancroft Ave. to E 17th St. & E 17th St. to Bond St. Audit Findings



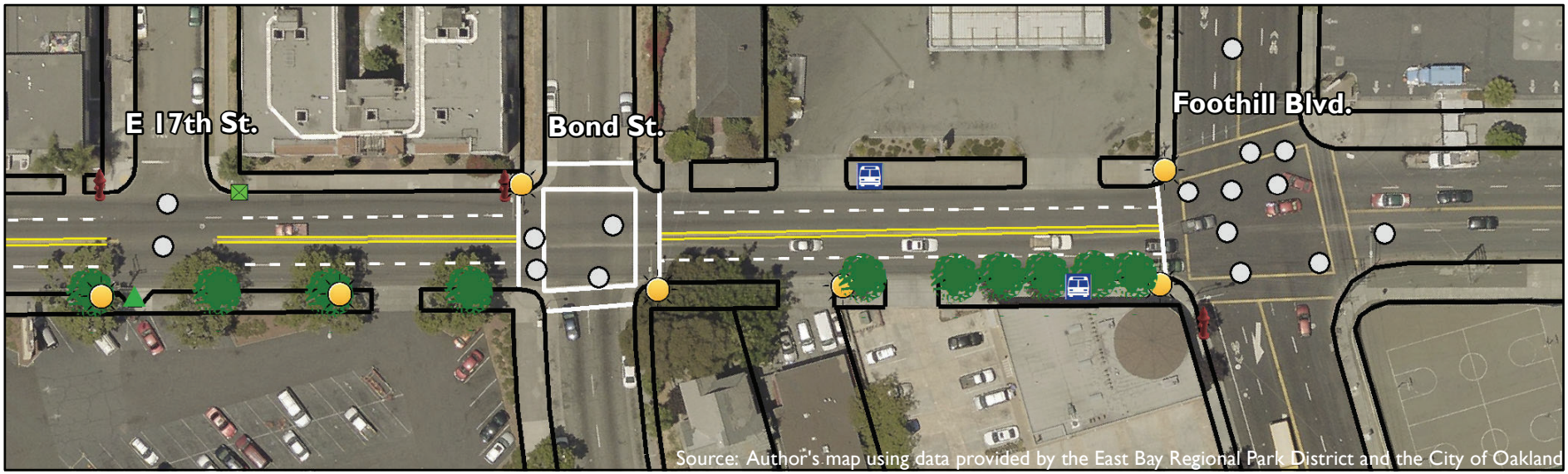


Figure 41 - E 17th St. to Bond St. & Bond St. to Foothill Blvd. Audit Findings

VI. Design Recommendations

There are many challenges to implementing bicycle facility improvements along the High St. study corridor, but based on the street audit findings and observations, a phased approach can be taken to provide multiple solutions. The first phase should consist of a practical, affordable, and effective solution implemented simultaneously with a future High St. repaving project. Future phases should strive to install a more transformative bicycle facility that maximizes safety and comfort for cyclists..

The overall current condition of High St. can be described as a Shared Roadway. The Oakland Bicycle Master Plan proposes an upgrade to a Class II facility for 8 of the 13 blocks within the study area. The following design recommendations include the additional five blocks between E 12th St. and Foothill Blvd.

Several documents were referenced to determine appropriate design recommendations for High St. Chapter 1000 of the Caltrans Highway Design Manual was used to categorize bikeway facility types. The 2017 National Association of City Transportation Officials (NACTO) "Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities" and the 2012 "Urban Bikeway Design Guide" were used to determine an appropriate facility and treatment guidelines. The 2012 American Association of State Highway and Transportation Officials (AASHTO) "Guide to Bicycle Facilities" was used to determine appropriate dimensions and safety measures to include in design recommendations.

6.1 Block Level Design Opportunities and Constraints

There are no paved shoulders and no white stripe for almost the entire corridor. The absence of street parking is a benefit, but reallocating lane space for any new bike facility will be necessary. The curb-to-curb roadway is roughly 40 to 44 ft. wide and completely occupied by four travel lanes that range between 10-12 ft. in width. At a minimum, the City of Oakland should place shared-lane markings along High St. to designate the outside lanes in each direction of travel as a shared-road facility. A Sharrow along with signage may improve the comfort level and safety of more experienced bicyclists.[38] This recommendation should be considered a temporary solution until greater improvements can be made.

A Class I bikeway is not recommended for High St. given current constraints, vertical obstructions, number of driveways and traffic volumes. The 60+-foot ROW width of the High St. corridor restricts installation of a separated bikeway. The cost of installing a Class I bikeway along this corridor would outweigh the benefits.

Implementation of a Class II or Class IV Bikeway facility is possible but will require a reallocation of road width equal to one vehicle travel lane. This is commonly referred to as a "road diet." The FHWA Road Diet Informational Guide defines a road diet as a "conversion of a four-lane undivided road to a three-lane undivided road made up of two through lanes and a center two-way left-turn lane".[39] FHWA suggests that roadways with an average of less than 20,000 vehicles per day are candidates for a road diet.[40] The recorded traffic volumes on High St. are between 20,000 and 25,000 ADT.[41] This daily average is just above the FHWA recommendation, so the City of Oakland should perform new traffic studies and a new operational analysis of each intersection if proceeding with a road diet.[42]

A Class IV facility would provide a higher level of separation and safety and should be sought as a long term solution. There is sufficient width to install a Class IV bikeway, or cycle track, on one side of the street by taking up one travel lane and some of the sidewalk. A Class IV facility requires a minimum width of 5-7 ft. plus a minimum 3 ft. buffer.[43] There is not sufficient ROW to install this facility type on both sides of the street without removing two traffic lanes and portions of sidewalk.

Reduction of sidewalk width along most block segments is possible. There are 21 utility poles and 5 trees on the north side of the corridor and 44 utility poles and 17 trees on the south

38 AASHTO, "Guide to Bicycle Facilities, 4th Edition" (2012): 4-4

39 FHWA, Road Diet Informational Guide: Section 3.3.5 (2014), accessed March 19, 2018, https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/ch3.cfm#s341

40 FHWA, Road Diet Informational Guide: Section 3.3.5 (2014), accessed March 19, 2018, https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/ch3.cfm#s341

41 City of Oakland, 2007 Bicycle Master Plan, accessed March 3, 2018, http://www2.oaklandnet.com/oakca1/groups/pwa/documents/report/oak024989.pdf

42 FHWA Road Diet Information Guide: Chapter 4.1.5 accessed March 19, 2018, https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/ch4.cfm#s41

43 NACTO, "Urban Bikeway Design Guide," Second Edition (2014), accessed March 28, 2018, https://nacto.org/publication/urban-bikeway-design-guide/

side. These vertical obstructions make it costly to widen the road. Reducing the sidewalk width, relocating utilites and drain grates on the north side of High St. is preferred over the south side as it would require less utility relocation. There are also many driveways that are either unnecessary or semi-premanently blocked off.

A Class IV Bikeway is the safest and most attractive facility, but this type of facility is typically more appropriate for streets with a higher speed limit and less curbside disruptions.[44] The speed limit on High St. is only 25 mph and each side of High St. has between 30-40 driveways that interrupt continuous bicycle travel. A Class IV Bikeway will also be costly and require greater design and traffic engineering efforts. This is a worthy long term goal, and should be pursued by the City of Oakland. However, a recommendation for a proposed bikeway facility that is less expensive can be implemented sooner as a short term solution.

Oakland's Bicycle Master Plan proposes a conventional Class II bike lane along most of the study corridor. This is an appropriate solution for High St. if adequate funding is not available for a Class IV at this time. The minimum width recommended by AASHTO for a Class II bikeway adjacent to a curb and gutter is 5 ft.[45] This dimension allows for a usable width of at least 4 ft. between the gutter and the pavement along the corridor.

Installation of a Class II bike lane is recommended on both sides of the street between Foothill Blvd. and the High St. Bridge. This allows connections to businesses and cross-streets on either side of the street and avoids potential for wrong-way riding.[46] Drain grates can be problematic for bike tires and present a safety hazard.[47] Drain grates should be replaced with a bicycle friendly cover and made flush with the pavement to provide the smoothest and safest surface for cyclists. Relocating drain grates underneath the sidewalk is also an option, but will be expensive and may require regrading to improve drainage.

For the majority of the study area, the Class II bike lane should be separated with a solid white line that is 4-6-in. thick and include standard bike lane symbol markings.[48] Green colored pavement is recommended to further designate the bike lane. This is a more expensive endeavor, but provides greater visibility for both motorists and cyclists. The solid white lines and green pavement should be substituted with dashed sections at the intersections and at major driveways where vehicles will need to enter the bike lane to make turns. The bike lane should remain solid for the majority of the 73 driveways observed along the route.[49]

A larger buffer than a 4-6-in. stripe is recommended on the block segment between Oakport St. and Coliseum Way. This segment travels under I-880 and experiences high traffic volumes. This block segment already has a 7.5 ft. paved shoulder, so the space is available for a 2.5 ft. wide buffered bike lane similar to the one shown in Figure 43.

Figure 42 - Interstate 880 Underpass Shoulder

Figure 43 - Buffered Class II Bike Lane on Broadway - Oakland, CA.

44 NACTO, "Urban Bikeway Design Guide," Second Edition (2014), accessed March 28, 2018, https://nacto.org/publication/urban-bikeway-design-guide/

45 AASHTO, "Guide to Bicycle Facilities, 4th Edition" (2012): 4-14

46 AASHTO, "Guide to Bicycle Facilities, 4th Edition" (2012): 4-12

47 AASHTO, "Guide to Bicycle Facilities, 4th Edition" (2012): 4-11

48 AASHTO "Guide to bicycle Facilities, 4th Edition" (2012): 4-17

49 Ibid

Standard bike lane markings and signage should be placed at every major intersection, at major driveways, and other visible locations. High St. is a fairly urban area with a high density of driveways and multiple interruptions, so the symbols should be spaced as often as every 100 ft.[50]

Any manholes or utility covers and drain grates should be made flush with the surface of the pavement and drain grates should be made of a material that is compatible for cycling.[51]

6.2 Intersection Design Opportunities and Constraints

Improvements to High St. should include removal of potential conflict points and installation of better pavement markings and queuing space for bicyclists at intersections. The Class II bike lanes proposed along block segments do not typically extend through intersections except at larger or skewed intersections.[52] Half of the intersections investigated are considered skewed, however, most of the angles are minor and won't prohibit straight travel through the intersection. The Coliseum Way, Oakport St., and E 12th St. intersections are skewed, experience higher traffic counts, and allow multiple turning movements for vehicles accessing I-880 and exiting Hwy 77. A dotted or dashed extension of the bike lane through these two intersections is warranted to further define the bicycle space.[53] Enhancements to bicyclist detection and signal operation should be investigated at all intersections. The traffic signals should be designed to detect bicycles, allow ample time to traverse intersections, and timed to reduce waiting periods during which stationary cyclists are exposed.[54]

High St. is currently a Shared Roadway facility, so bicyclists obey the same traffic laws and traffic signals as motorists. Since most intersections have pedestrian signals in the east/west direction of travel, these intersections should allow ample crossing time for cyclists as well. Further analysis of the Bancroft Ave., Coliseum Way, and Oakport St. intersections is warranted to add pedestrian signals to the crossing legs where they are lacking.

Pavement markings do exist at every intersection, but in general, improvements are needed to make stop bars, crosswalks, and warning paint more visible along the entire corridor. Installation of bike boxes is a great solution for calming traffic and providing cyclists a more visible safe haven while waiting for a green light. Installation of Bike boxes should be considered for all intersections within the study area, but should especially be considered at the International Ave., San Leandro St., Coliseum Way, and Oakport St. intersections. These 4-way intersections receive high traffic volumes and are large enough to allow extra space for bike boxes.

Figure 44 - NACTO Bike Box
Source: https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/bike-boxes/

most practical, affordable, and immediate solution for High St. until a better solution can be implemented. A proposed Class II design is shown in Figures 45 -56. This recommendation conforms to the City of Oakland's 2007 Bicycle Master Plan and would require less disruption to the street. The road diet and Class II installation should be implemented at the same time High St. is scheduled for repaving to maximize city funds and minimize disruption to this busy corridor. Repaving the entire street will also address observed pavement issues, faded pavement markings, and uneven drain grates or manhole covers.

All intersections within the study area should be re-evaluated to determine appropriate pavement markings and to identify changes required to the traffic signals to increase cyclist's safety. The street lighting within the study area is considered insufficient on most blocks. Detailed street lighting recommendations are outside the scope of this report, but should be considered when improving High St.

50 AASHTO, "Guide to Bicycle Facilities, 4th Edition" (2012): 4-20
51 AASHTO, "Guide to Bicycle Facilities, 4th Edition" (2012): 4-11
52 AASHTO, "Guide to Bicycle Facilities, 4th Edition" (2012): 4-22
53 Ibid
54 AASHTO, "Guide to Bicycle Facilities, 4th Edition" (2012): 4-22

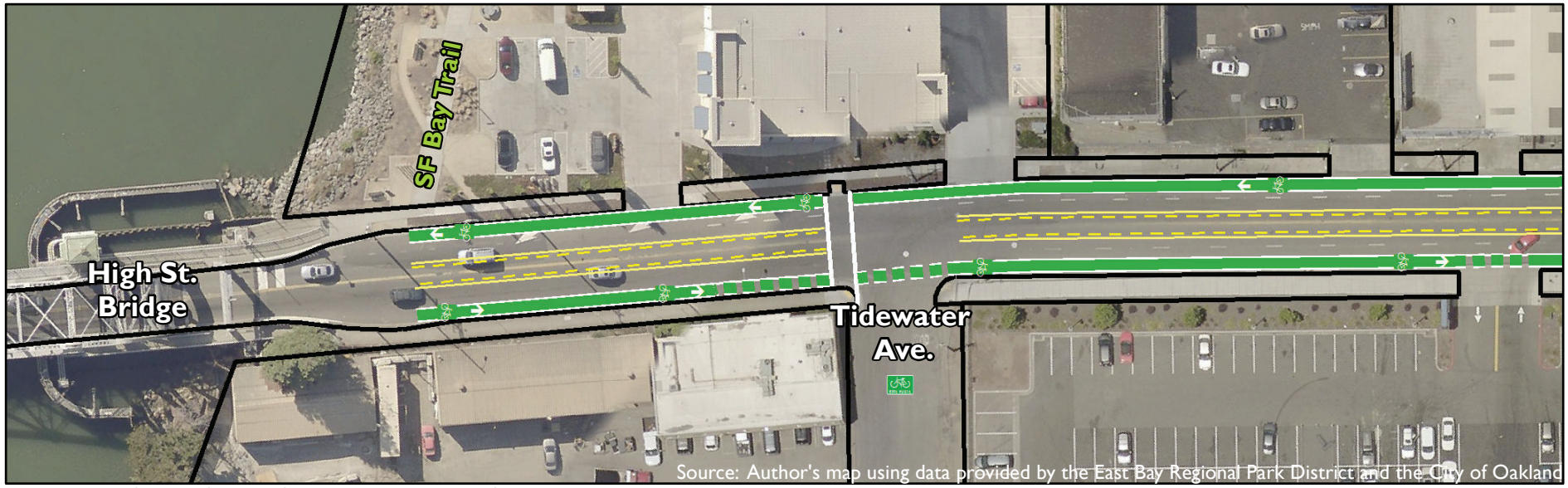
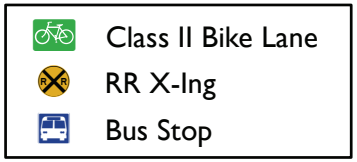


Figure 45 - High St. Bridge to Tidewater Ave. Recommendations



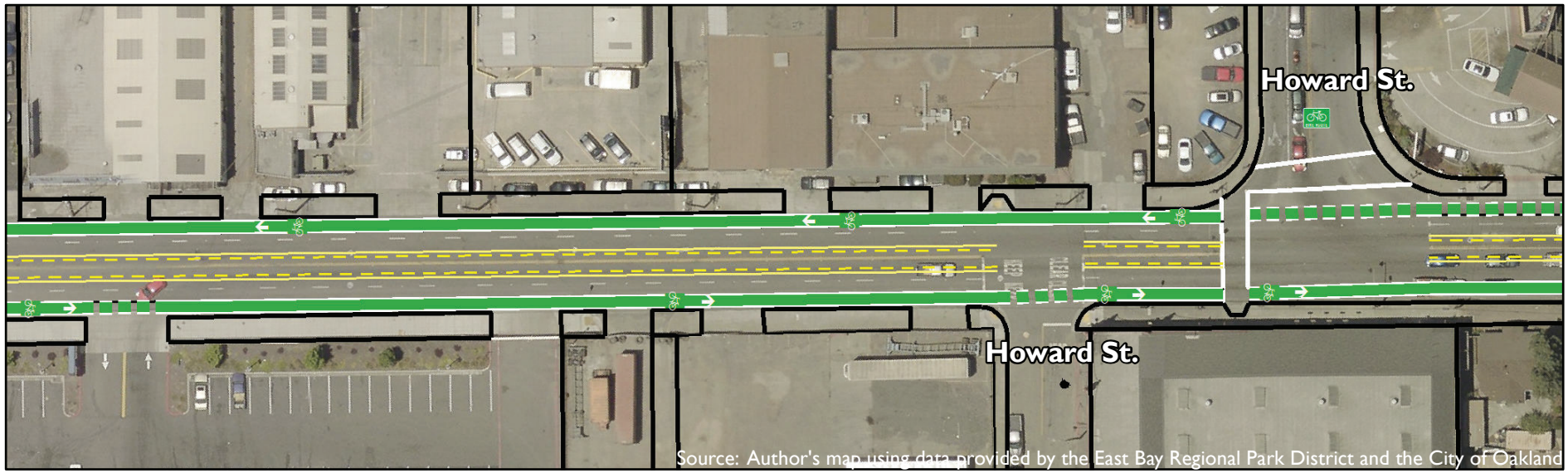


Figure 46 - Tidewater Ave. to Howard St. Recommendations

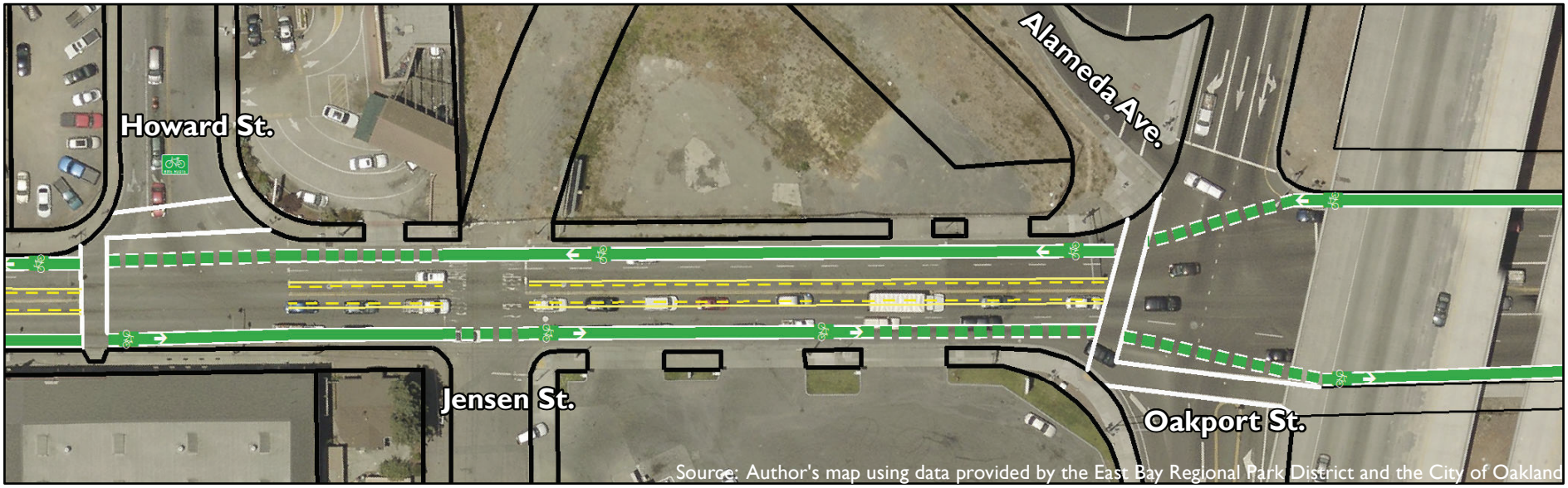
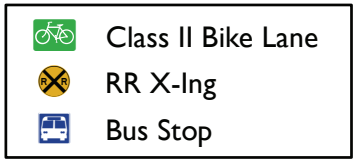


Figure 47 - Howard St. to Jensen St. & Jensen St. to Oakport St. Recommendations



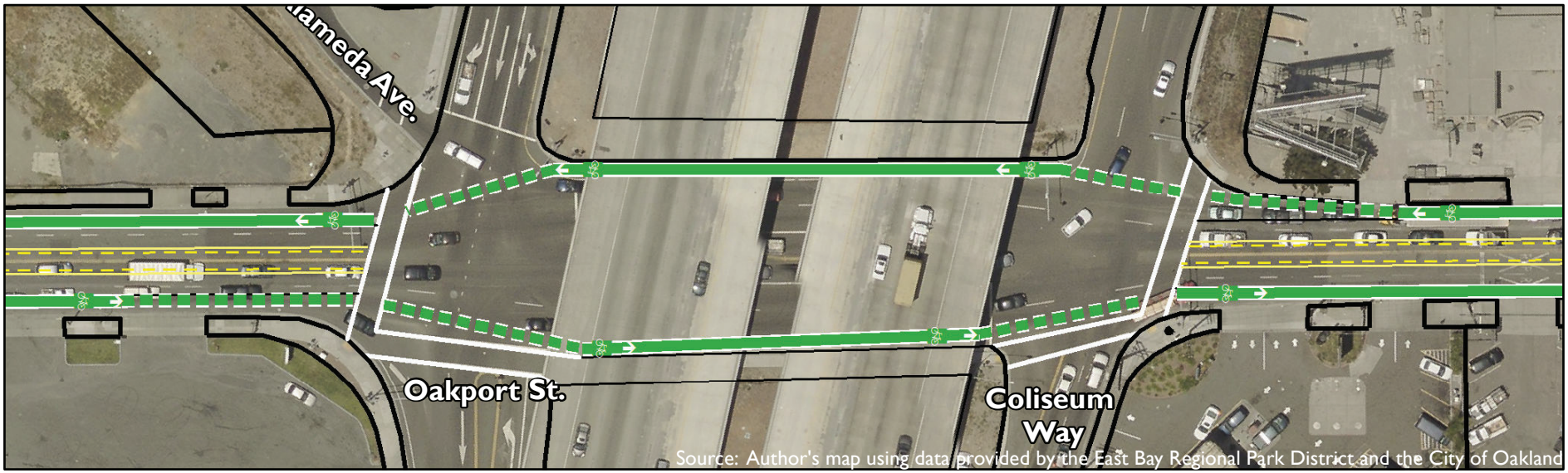


Figure 48 - Oakport St. to Coliseum Way Recommendations

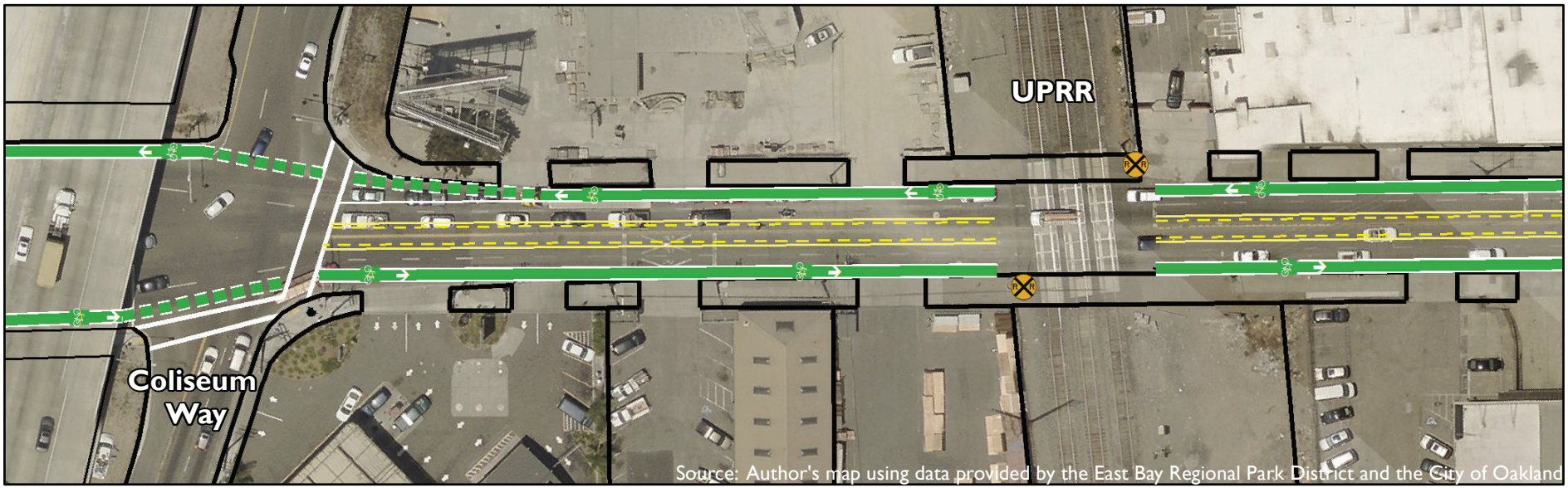
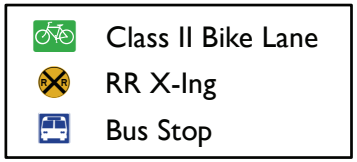


Figure 49 - Coliseum Way to UPRR Recommendations



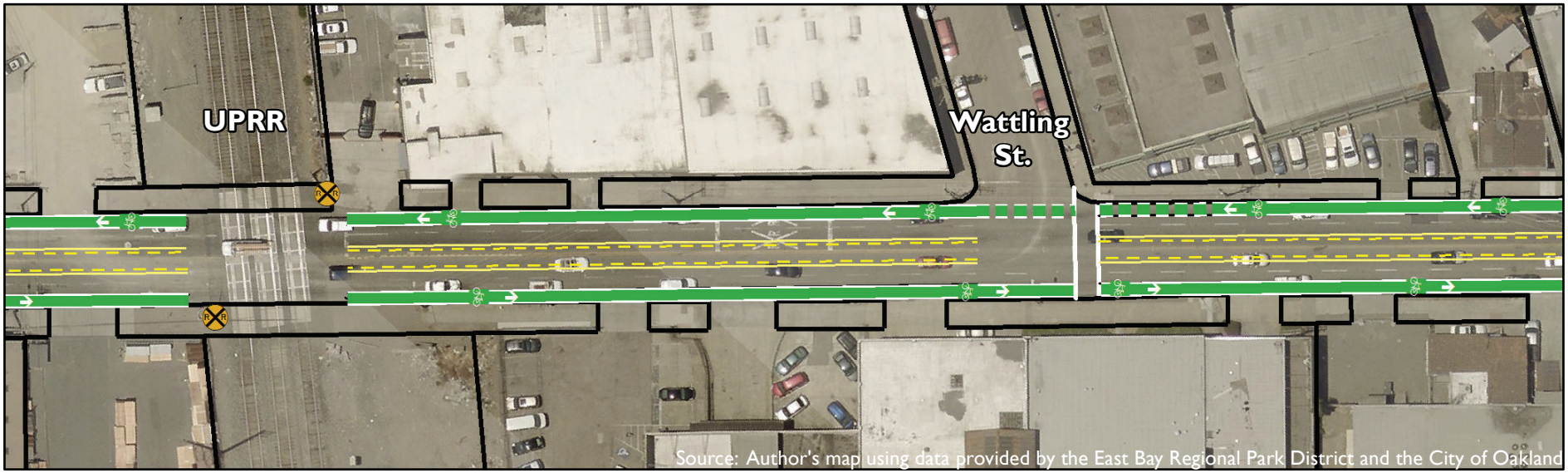


Figure 50 - UPRR to Wattling St. Recommendations

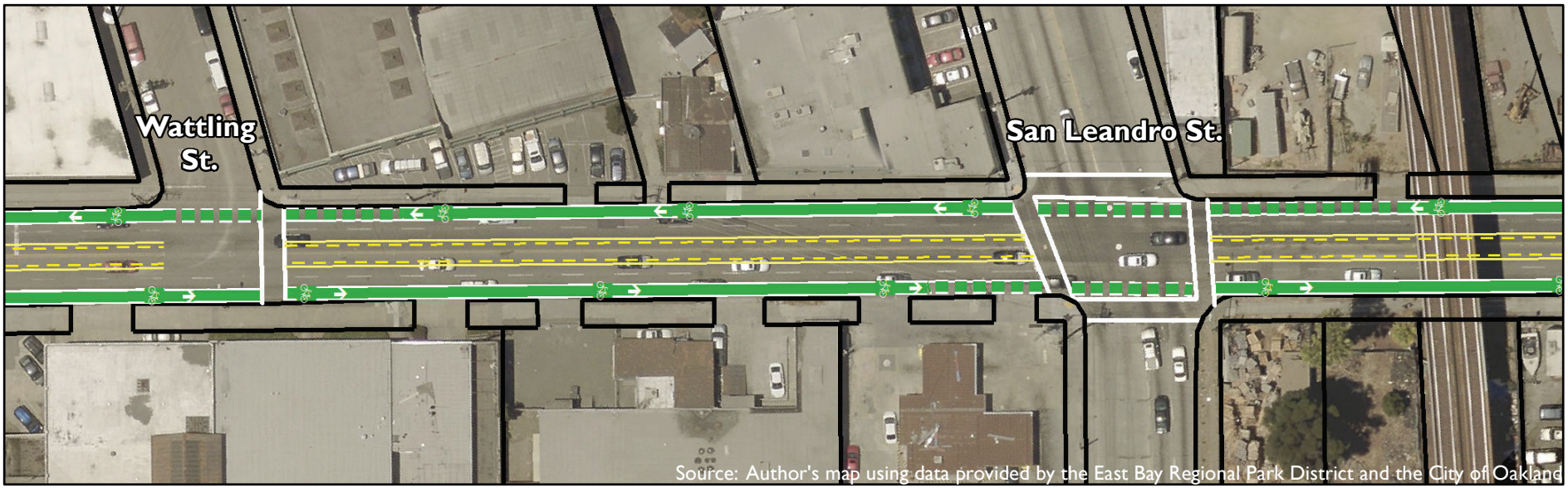


Figure 51 - Wattling St. to San Leandro St. Recommendations

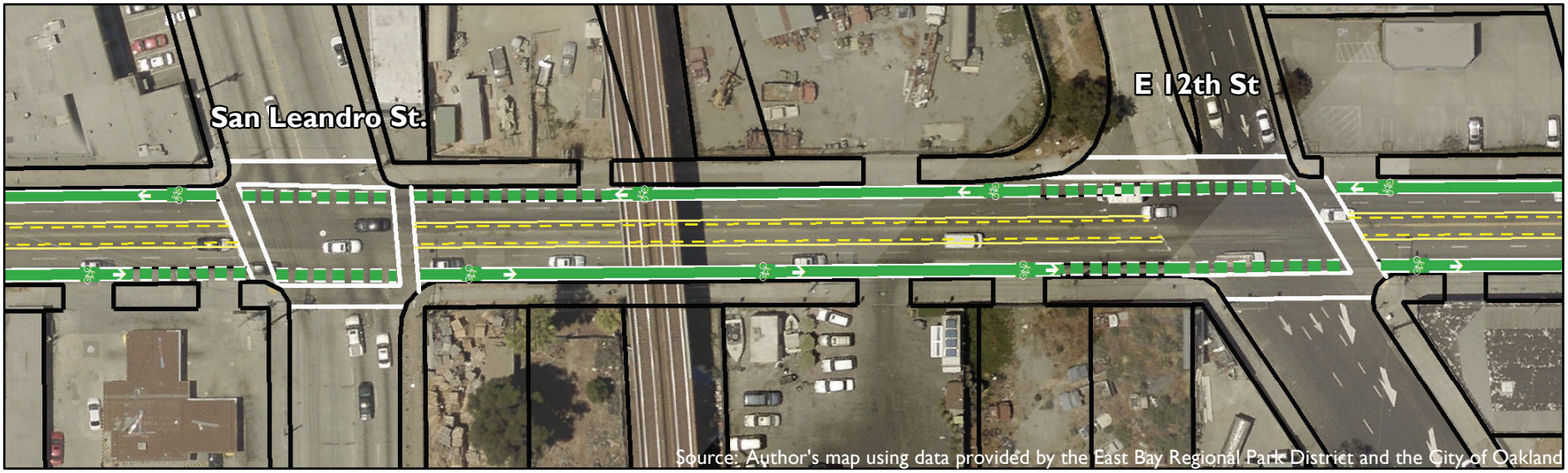
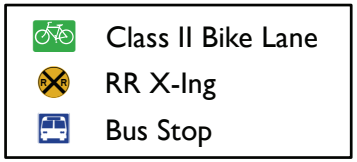


Figure 52 - San Leandro St. to E 12th St. Recommendations



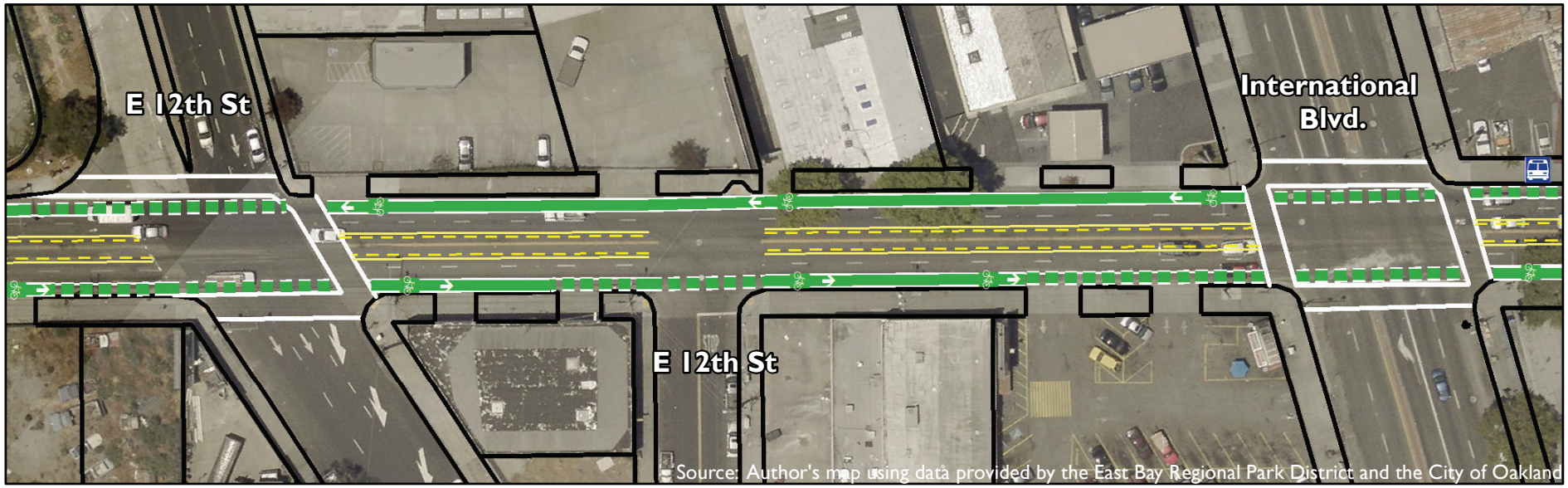
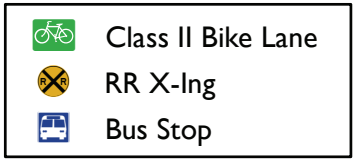


Figure 53 - E 12th St. to International Blvd. Recommendations



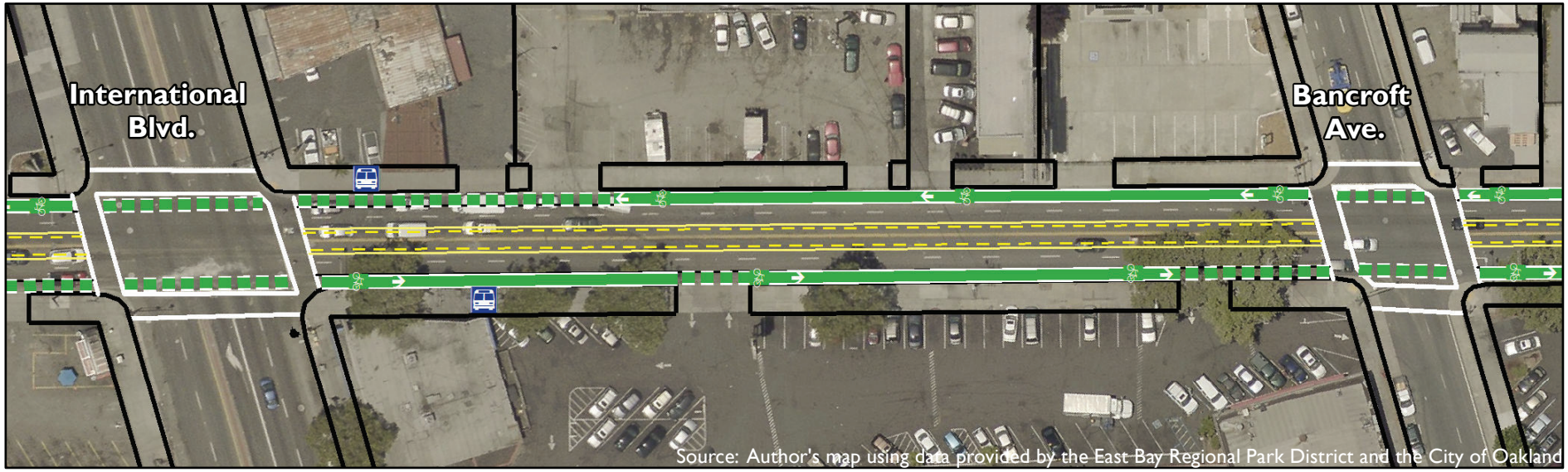


Figure 54 - International Blvd. to Bancroft Ave. Recommendations

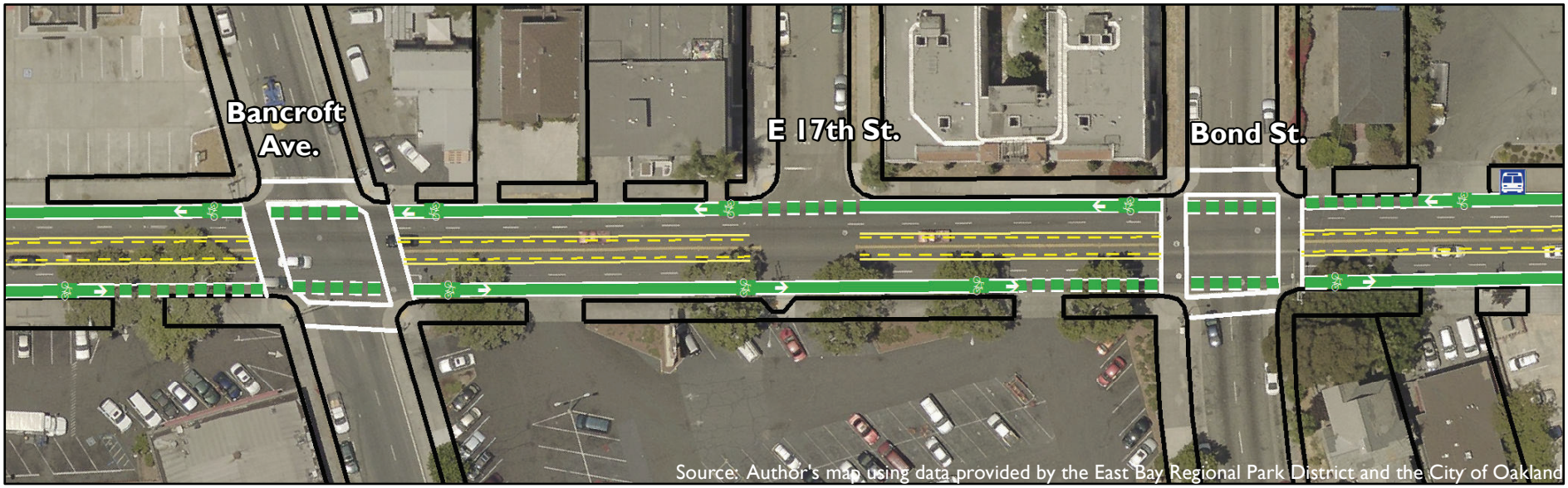
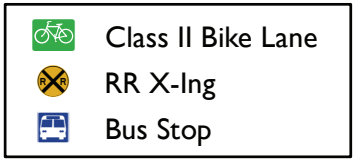


Figure 55 - Bancroft Ave. to E 17th St. & E 17th St. to Bond St. Recommendations



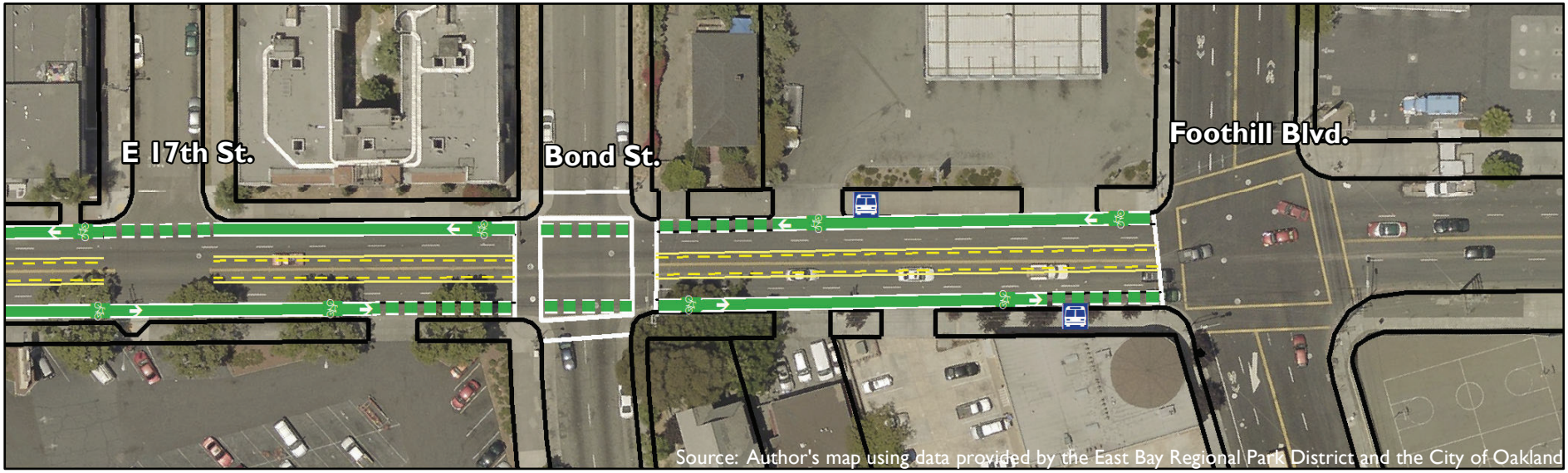


Figure 56 - E 17th St. to Bond St. & Bond St. to Foothill Blvd. Recommendations

VII. Conclusion

Insufficient or unsafe bicycling infrastructure, poorly designed intersections, and undesirable land use conditions along the High St. corridor increase cyclist's level of stress and lower their comfort level.[55] Oakland should strive for the safest bicycle facility possible while taking into account project costs and timeline.

A Class IV facility would provide a higher level of separation and safety and should be sought as a long term solution. There is sufficient width to install a Class IV bikeway on the north side of the street by taking up one travel lane and potentially some of the sidewalk. This is a more expensive endeavor and will require a higher level of design and disruption to the corridor.

Installation of a Class II bike lane is a less expensive, but appropriate, solution for High St. until a better solution can be implemented. A Class II bike lane is recommended on both sides of the street for 13 blocks between Foothill Blvd. and the High St. Bridge. This allows connections to businesses and cross-streets on either side of the street.

Disruption to the street and relocation of vertical obstructions or utilities will be required for installation of either bike facility. Improvements to High St. will require a high level of coordination with businesses along the High St. corridor.

In conclusion, design recommendations that promote cycling along the High St. corridor include:

- Apply a road diet to High St. by reducing the number of vehicle lanes to three with a two-way center left turn lane as part of any future repaving project to create space for a future bicycle facility.
- As a short term solution, construct a 5' wide striped Class II bike lane with colored pavement in both directions of travel and relocate drain grates, utilities, and other obstructions.
- As a long term solution, construct a 5-7' wide two-way Class IV bikeway with a 3' wide buffer on the north side of High St. and potentially remove a portion of the existing sidewalk, relocate drain grates, utilities, and other obstructions.
- Investigate potential installation of Bike Boxes at the intersections of International Ave., San Leandro St., Coliseum Way and Oakport St.
- Implement pedestrian and cyclist activated traffic signal improvements at the Bancroft Ave., Coliseum Way, and Oakport St. intersections
- At a minimum, improve signage, road striping, and bike oriented pavement markings as part of any future repaving project on High St.

Providing these bicycle-oriented design solutions would increase the comfort level of bicyclists, while also maintaining the appropriate traffic flow for motorists on High St. Potential adjustments to signal operation and cyclist detection at intersections will ensure ample time for bicyclists to navigate the cross streets that intersect this busy corridor. Improvements to the street conditions may provide improved community character, health and economic benefits, and quality of life for lower income residents.

Coordinating these improvements with other street improvement projects will be a cost effective way to ensure that the bicycle network remains connected and functional for the Fremont, Jefferson, and Melrose communities in East Oakland.

55 Anne V. Moudon et al., "Cycling and the Built Environment, a US Perspective," *Transportation Research Part D: Transport and Environment* 10, no. 3 (2005): 247

Bibliography

American Association of State Highway and Transportation Officials. "Guide to Bicycle Facilities, 4th Edition." (2012): 4-1 – 4-66

American Community Survey: S0802. "Means of Transportation to Work by Selected Characteristics, 2011- 2015 5-year estimate." US Census Bureau (2016)

Alameda County Transportation Commission. "East Bay Greenway: Lake Merritt BART to South Hayward BART Project Overview." Accessed March 25, 2018. https://www.alamedactc.org/eastbaygreenway

Association of Bay Area Governments. "SF Bay Trail." Accessed October 15, 2016. http://baytrail.org/about-the-trail/welcome-to-the-san-francisco-bay-trail/

Association of Bay Area Governments and Metropolitan Transportation Commission. "Plan Bay Area." (2013) Accessed September 23, 2016. http://www.mtc.ca.gov/planning/plan_bay_area/

California Department of Transportation. "Highway Design Manual." Accessed March 2, 2018. http://www.dot.ca.gov/design/manuals/hdm/mct/HDM_6th_Ed.pdf

California Department of Transportation. "California Public Road Data 2013." (2014): 16. Accessed November 18, 2016. http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/prd/2013prd/2013PublicRoadData

California Department of Transportation. "Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians." (2010) Accessed March 28, 2018. http://nacto.org/docs/usdg/complete_intersections_caltrans.pdf.

Cambridge Dictionary. "Cambridge Advanced Learner's Dictionary & Thesaurus." Cambridge University Press. Accessed March 3, 2018. https://dictionary.cambridge.org/us/dictionary/english/sharrow

Emery, James, Crump, Carolyn. "The WABSA Project: Assessing and Improving Your Community's Walkability & Bikeability." University of North Carolina at Chapel Hill, Department of Health Behavior and Health Education School of Public Health (2003): 18-34

Emery, James, Crump, Carolyn, Bors, Philip. "Reliability and Validity of Two Instruments Designed to Assess the Walking and Bicycling Suitability of Sidewalks and Roads." *American Journal of Health Promotion* 18, no. 1 (2003): 38-46.

Federal Highway Administration Office of Safety. "Bicycle Road Safety Audit Guidelines and Prompt Lists." Report No. FHWA-SA-12-018 (2012): 1-81

Bibliography

Ford GoBike. Accessed March 28,2018. https://www.fordgobike.com

Forsyth, Ann, Krizek, Kevin J. "Promoting Walking and Bicycling: Assessing the Evidence to Assist Planners." *Built Environment* 36, no. 4 (2010): 429-446.

Hoehner, Christine. "Active Neighborhood Checklist." Active Living Research. Washington University, St. Louis (2011): Accessed March 4, 2017. http://activelivingresearch.org/active-neighborhood-checklist

James, Peter, Troped, Philip J., Hart, Jaime E., Joshu, Corinne E., Colditz, Graham A., Brownson, Ross C., Ewing, Reid, Laden, Francine. "Urban Sprawl, Physical Activity, and Body Mass Index: Nurses' Health Study and Nurses' Health Study II." *American Journal of Public Health* 103, no. 2 (2013): 369-375

Litman, Todd. "Evaluating Transportation Equity." *World Transport Policy & Practice* 8, no. 2 (2016): 50-65. Accessed September 24, 2016. www.vtpi.org/equity.pdf.

Litman, Todd. "Changing Travel Demand: Implications for Transport Planning." *ITE Journal* 76, no. 9 (www.ite.org) (2006): 27-33. Updated version at www.vtpi.org/future.pdf.

Maizlish, Neil, Woodcock, James, Co, Sean, Ostro, Bart, Fanai, Amir, and Fairley, David. "Health Co-benefits and Transportation-Related Reductions in Greenhouse Gas Emissions in the San Francisco Bay Area." *American Journal of Public Health* 103, no. 4 (2013): 703-709.

Metropolitan Transportation Commission. "Resolution No. 4217 – Equity Framework for Plan Bay Area 2040." (2013): 11. Accessed November 18, 2016. https://mtc.legistar.com/View.ashx?M=F&ID=4193765&GUID=72E4A9EF-81DD-42A7-A212-63C70B8AA7AF

Moudon, A.V., Lee, C., Cheadle, A.D., Collier, C.W., Johnson, D., & Schmid, T.L., Weather, R.D. "Cycling and the Built Environment, a US Perspective." *Transportation Research Part D: Transport and Environment* 10, no. 3 (2005): 245-261.

National Association of City Transportation Officials. "Urban Bikeway Design Guide." Second Edition (2014) Accessed March 28, 2018. https://nacto.org/publication/urban-bikeway-design-guide/

National Association of City Transportation Officials. "Urban Street Design Guide: Visibility/Sight Distance." (2013) Accessed November 19, 2016. http://nacto.org/usdg/visibility-sight-distance/

National Association of City Transportation Officials. "Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities." (2017) Accessed March 28, 2018. https://nacto.org/wp-content/uploads/2017/12/NACTO_Designing-for-All-Ages-Abilities.pdf

Oakland, City of. "Bicycle Master Plan." (2007): 15-20. Accessed March 3, 2018.
http://www2.oaklandnet.com/oakca1/groups/pwa/documents/report/oak024989.pdf

Oakland, City of. "Bicycle & Pedestrian Facilities Program." Accessed October 13, 2016.
http://www2.oaklandnet.com/government/o/PWA/o/EC/s/BicycleandPedestrianProgram/OAK024559

Saelensminde, Kjartan. "Cost-benefit Analyses of Walking and Cycling Track Networks Taking Into Account Insecurity, Health Effects and External Costs of Motorized Traffic." *Transportation Research Part A: Policy and Practice* 38, no. 8 (2004): 593-606.

US Department of Transportation, Federal Highway Administration. "Manual on Uniform Traffic Control Devices." (2009) Accessed March 28, 2018.
http://nhts.ornl.gov/2009/pub/stt.pdf

US Department of Transportation, Federal Highway Administration. "2009 National Household Travel Survey." (2009) Accessed March 28, 2018.
http://nhts.ornl.gov/2009/pub/stt.pdf

Welch, Timothy, Gehrke, Steven R., Wang, Fangru. "Long-Term Impact of Network Access to Bike Facilities and Public Transit Stations on Housing Sales Prices in Portland, Oregon." *Journal of Transport Geography* 54 (2016): 264-272.

Appendix A: High Street Traffic Counts

City of Oakland Bicycle and Pedestrian Counts

LOC ID	INTERSECTION	COUNT DATE	COUNT TIME	DURATION (HRS)	BIKE TOTAL	PED TOTAL	VEHICLE TOTAL
226	Bancroft Ave & High St	3/2/2000	4:00 PM	2		114	
226	Bancroft Ave & High St	3/2/2000	4:00 PM	2			2986
226	Bancroft Ave & High St	3/2/2000	4:00 PM	2	77		
226	Bancroft Ave & High St	3/2/2000	7:00 AM	2		75	
226	Bancroft Ave & High St	3/2/2000	7:00 AM	2			2232
226	Bancroft Ave & High St	3/2/2000	7:00 AM	2	21		

Total Counts 6 Report Date 2/11/2016

City of Oakland Bicycle and Pedestrian Counts

LOC ID	INTERSECTION	COUNT DATE	COUNT TIME	DURATION (HRS)	BIKE TOTAL	PED TOTAL	VEHICLE TOTAL
232	Bond St & High St	3/2/2000	4:00 PM	2		99	
232	Bond St & High St	3/2/2000	4:00 PM	2			3061
232	Bond St & High St	3/2/2000	4:00 PM	2	60		
232	Bond St & High St	3/2/2000	7:00 AM	2		46	
232	Bond St & High St	3/2/2000	7:00 AM	2			2693
232	Bond St & High St	3/2/2000	7:00 AM	2	18		

Total Counts 6 Report Date 2/11/2016

City of Oakland Bicycle and Pedestrian Counts

LOC ID	INTERSECTION	COUNT DATE	COUNT TIME	DURATION (HRS)	BIKE TOTAL	PED TOTAL	VEHICLE TOTAL
257	Coliseum Wy & High St	4/23/2009	4:00 PM	2	17	65	5475
257	Coliseum Wy & High St	4/23/2009	7:00 AM	2	11	37	4759

Total Counts 2 Report Date 2/11/2016

City of Oakland Bicycle and Pedestrian Counts

LOC ID	INTERSECTION	COUNT DATE	COUNT TIME	DURATION (HRS)	BIKE TOTAL	PED TOTAL	VEHICLE TOTAL
303	High St & International Blvd	4/23/2009	4:00 PM	2	42	368	5807
303	High St & International Blvd	4/23/2009	7:00 AM	2	18	222	4441

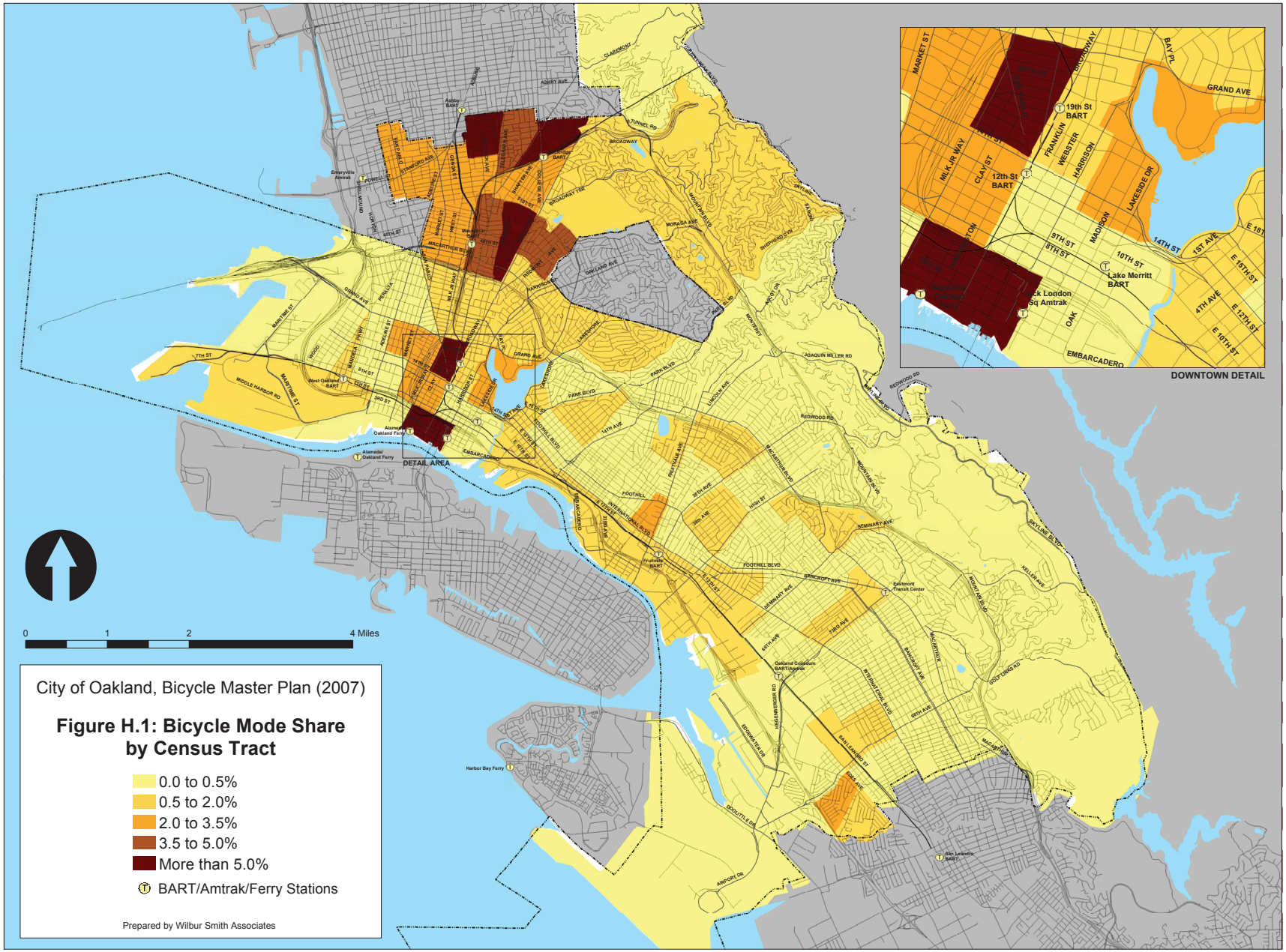
Total Counts 2 Report Date 2/11/2016

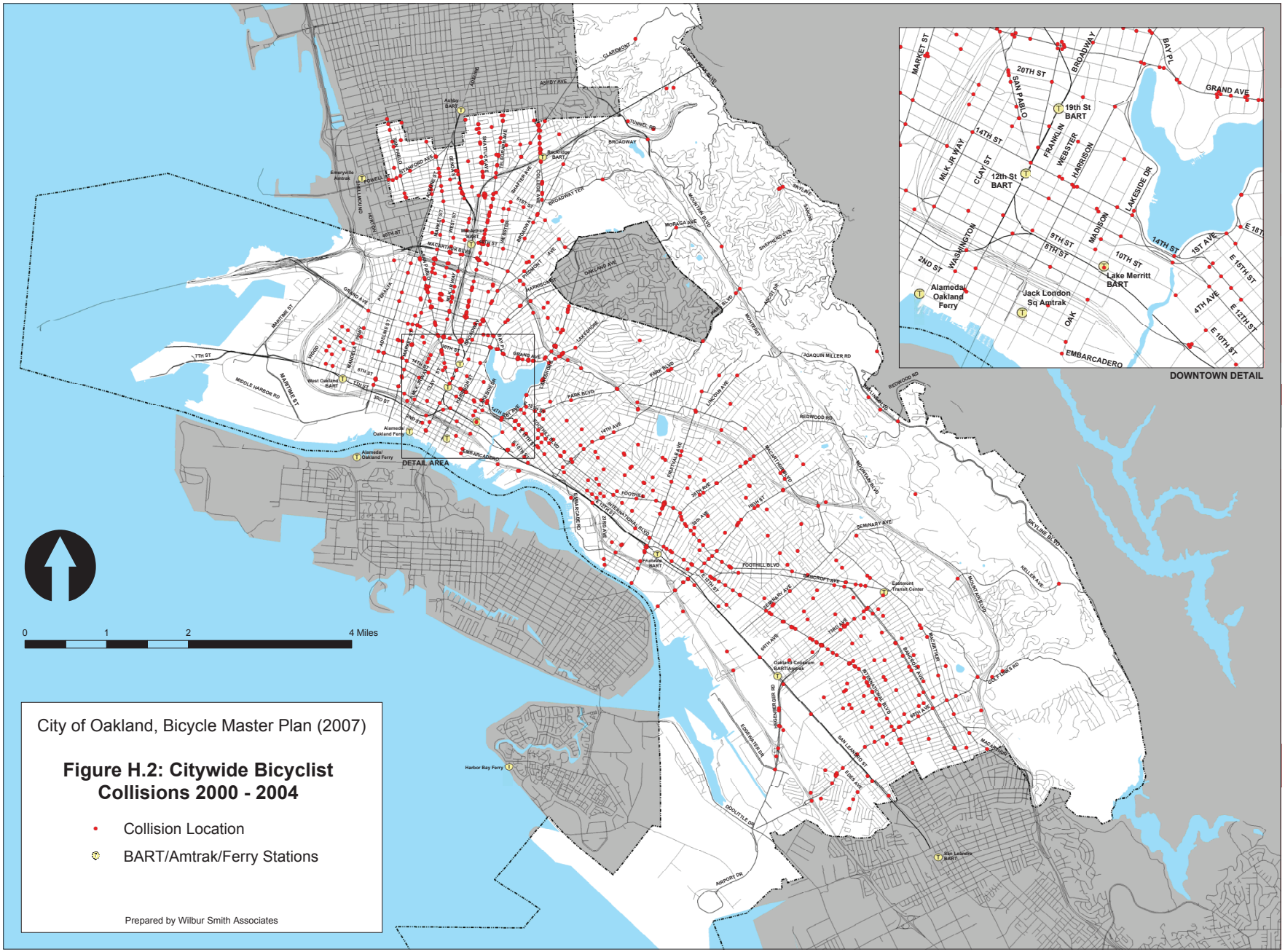
City of Oakland Bicycle and Pedestrian Counts

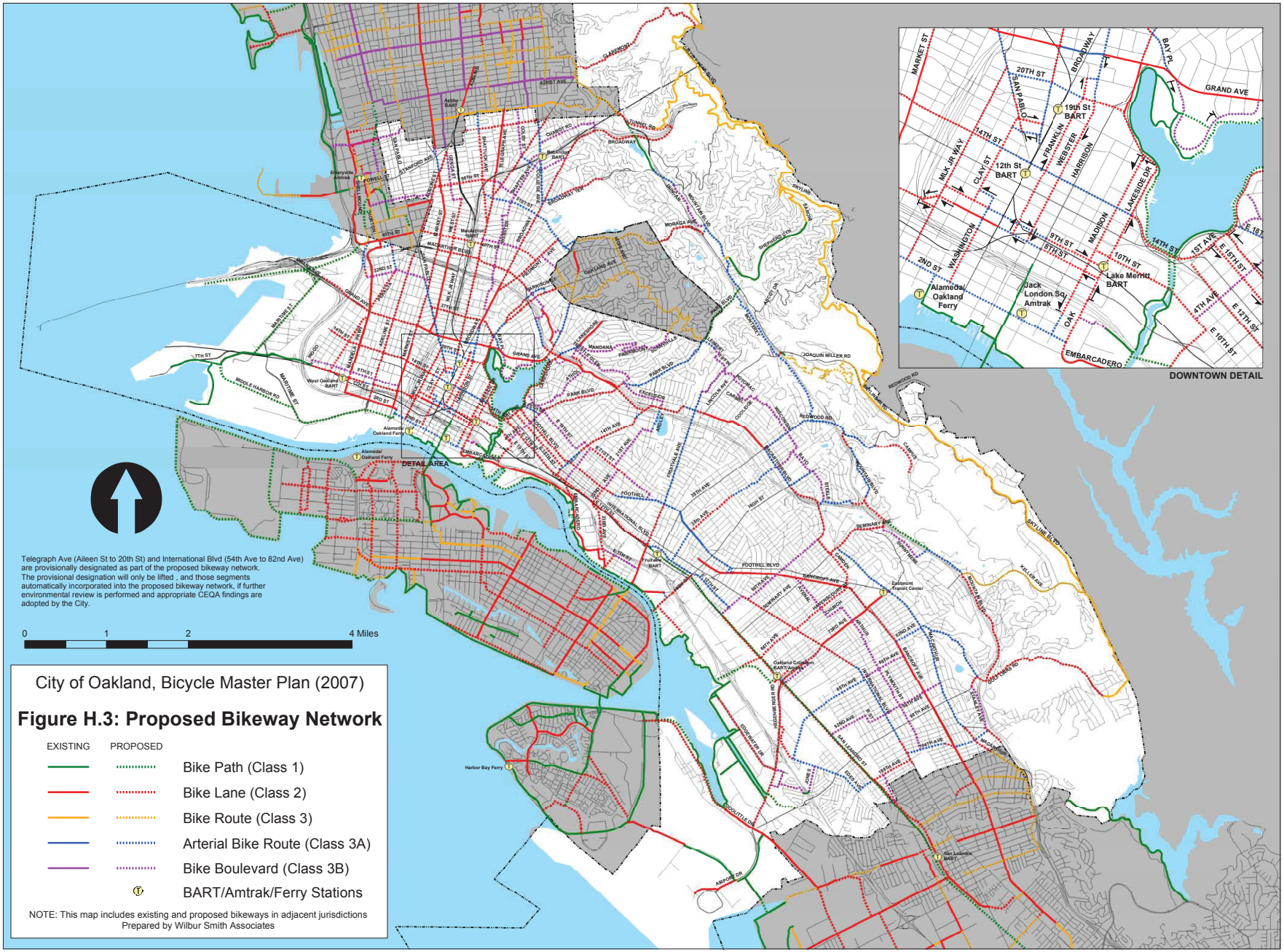
LOC ID	INTERSECTION	COUNT DATE	COUNT TIME	DURATION (HRS)	BIKE TOTAL	PED TOTAL	VEHICLE TOTAL
388	High St & San Leandro St	4/28/2009	4:00 PM	2	33	80	4855
388	High St & San Leandro St	4/28/2009	7:00 AM	2	27	102	4204

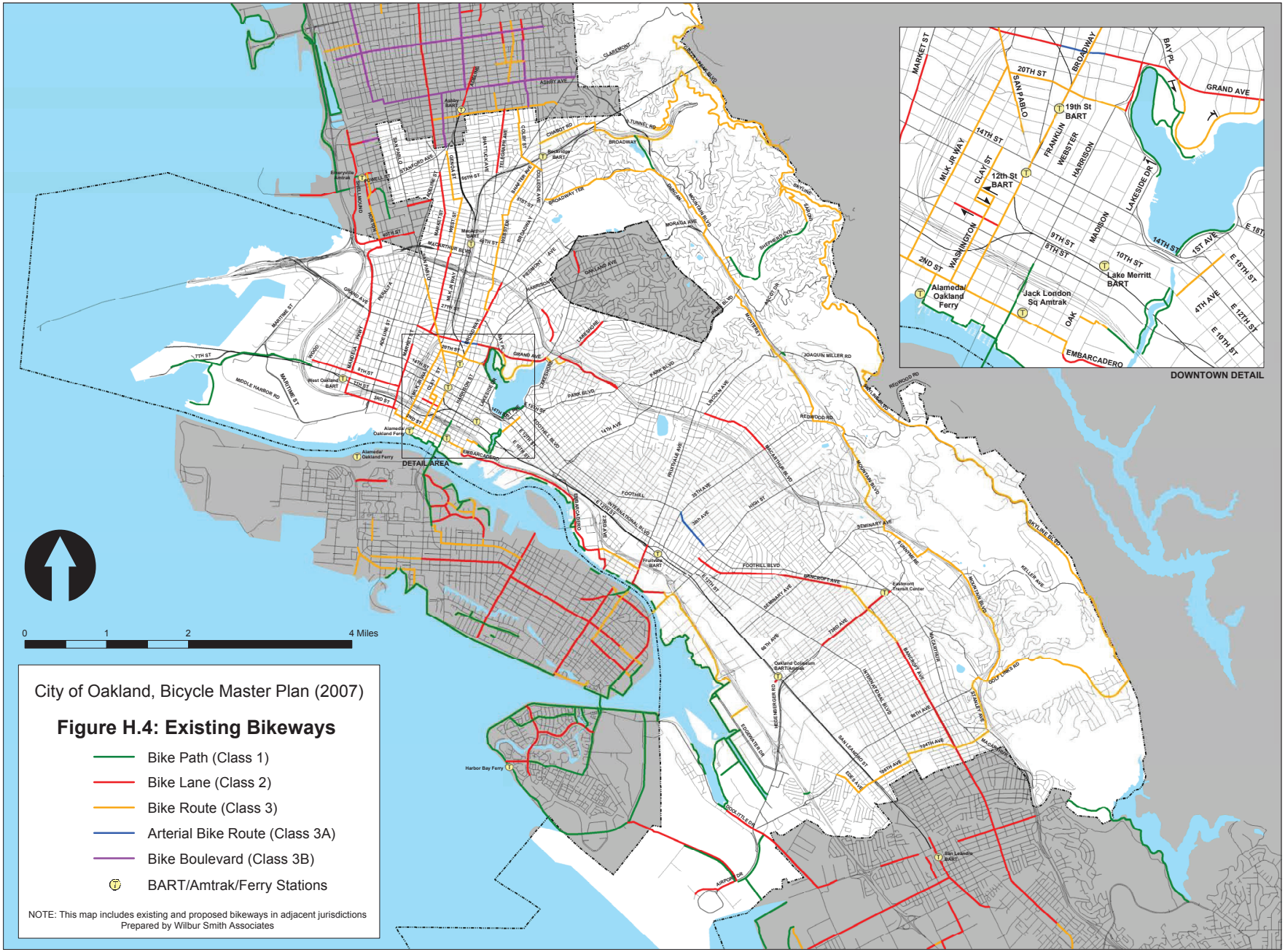
Total Counts 2 Report Date 2/11/2016

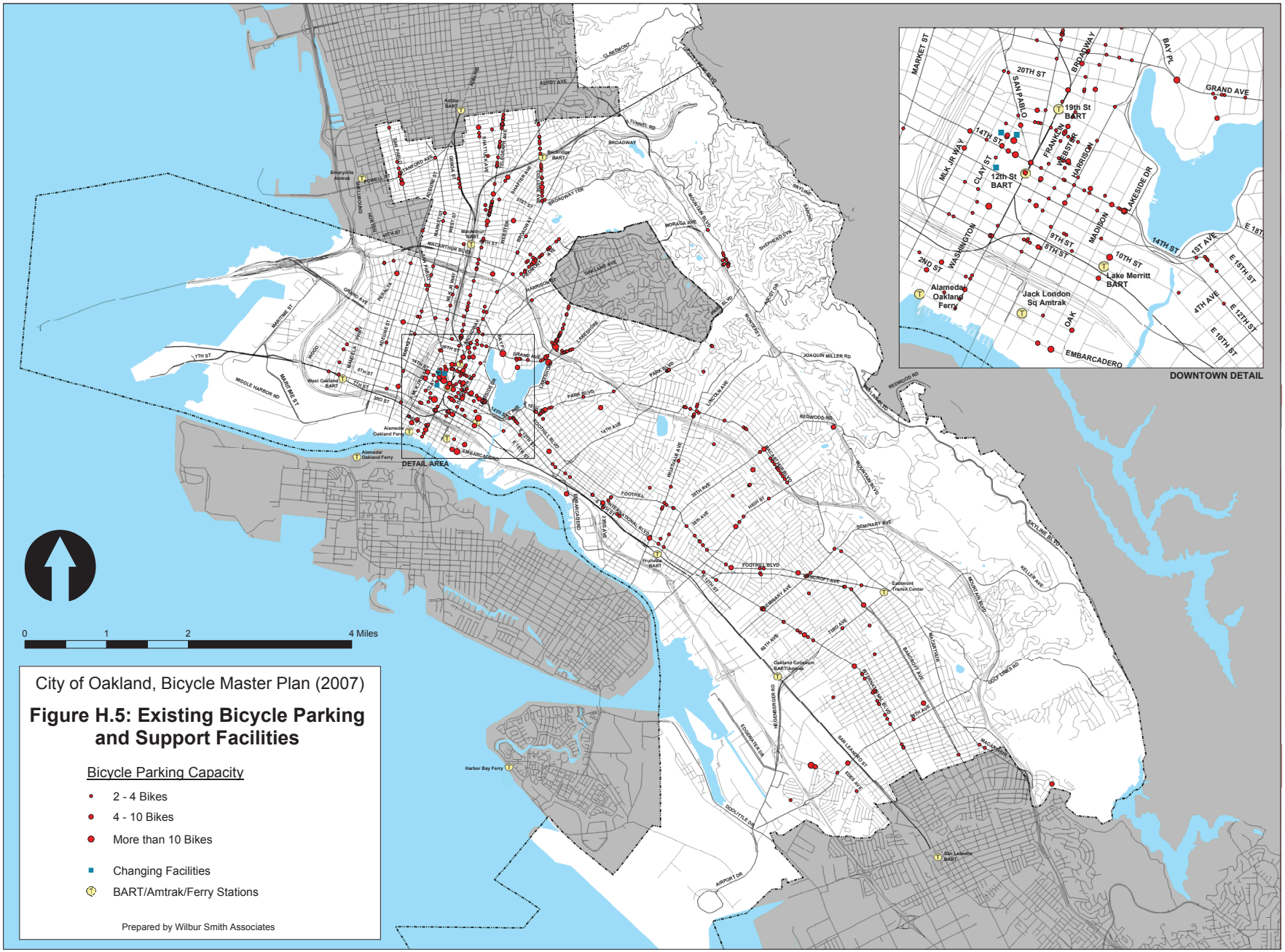
Appendix B: 2007 Oakland Bicycle Master Plan Maps

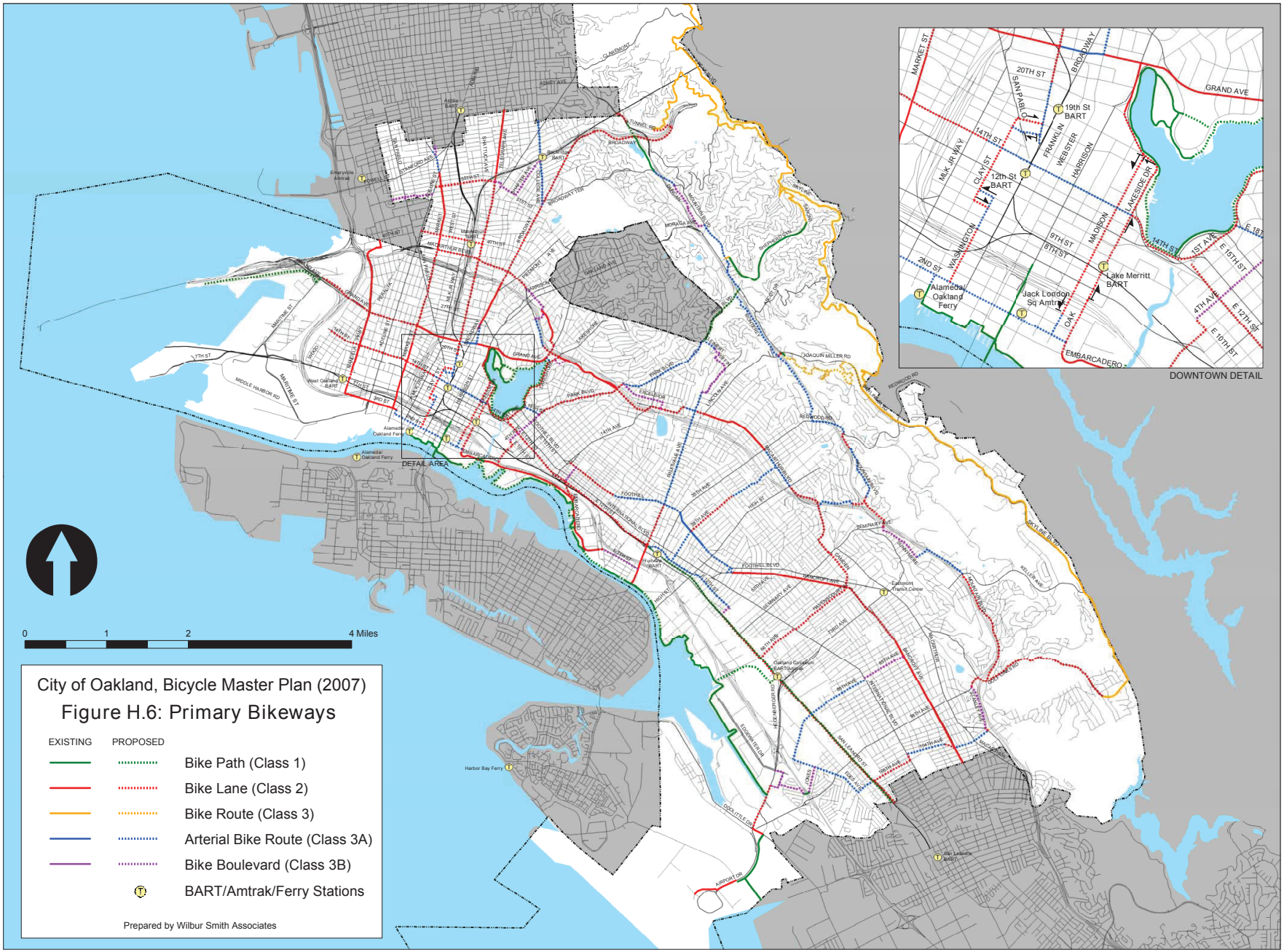


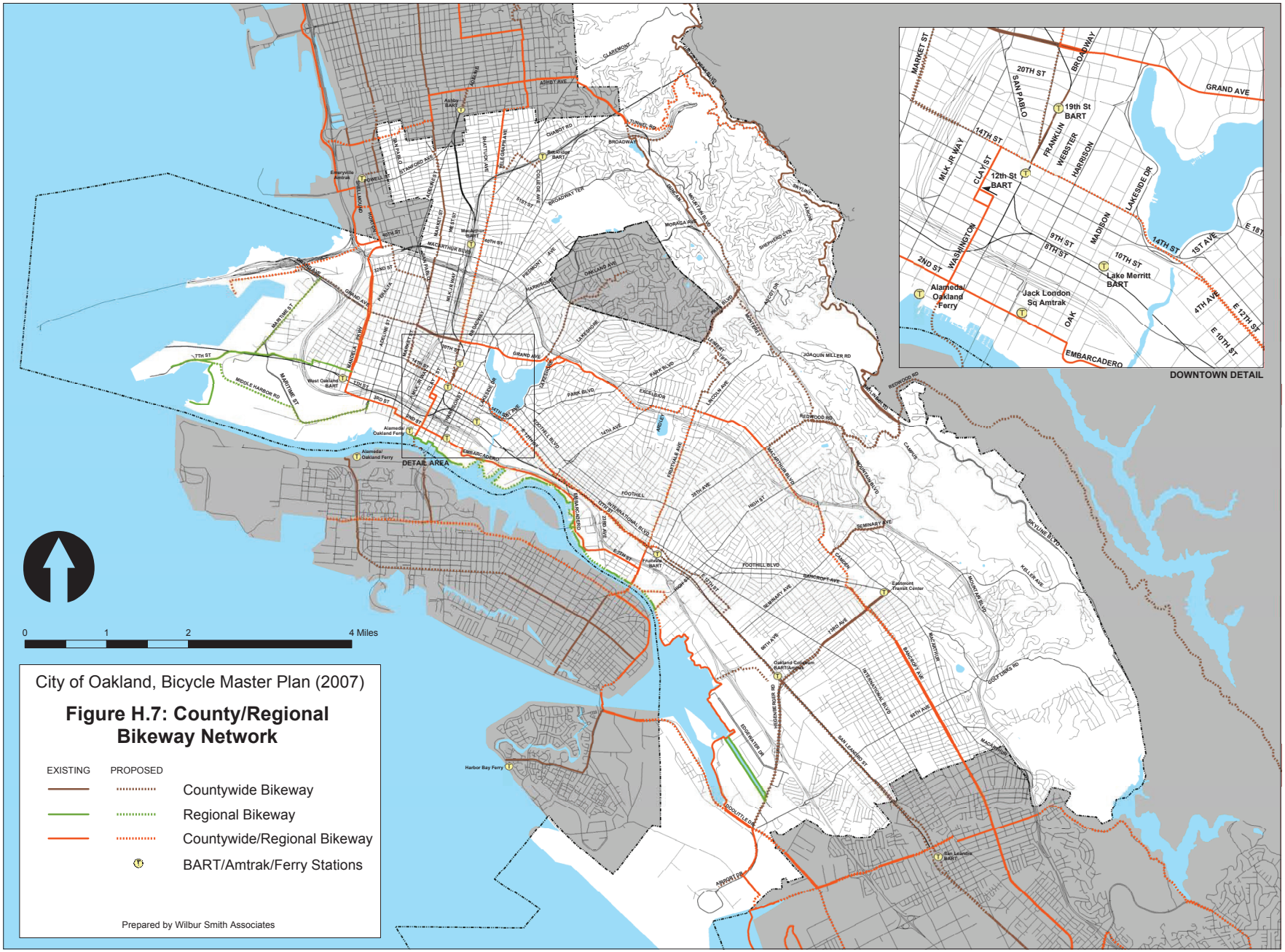

DOWNTOWN DETAIL
DETAIL AREA
0
1
2
4 Miles
City of Oakland, Bicycle Master Plan (2007)
Figure H.2: Citywide Bicyclist Collisions 2000 - 2004
Collision Location
BART/Amtrak/Ferry Stations
Prepared by Wilbur Smith Associates


DOWNTOWN DETAIL
DETAIL AREA
Telegraph Ave (Aileen St to 20th St) and International Blvd (54th Ave to 82nd Ave) are provisionally designated as part of the proposed bikeway network. The provisional designation will only be lifted , and those segments automatically incorporated into the proposed bikeway network, if further environmental review is performed and appropriate CEQA findings are adopted by the City.
0
1
2
4 Miles
City of Oakland, Bicycle Master Plan (2007)
Figure H.3: Proposed Bikeway Network
EXISTING
PROPOSED
Bike Path (Class 1)
Bike Lane (Class 2)
Bike Route (Class 3)
Arterial Bike Route (Class 3A)
Bike Boulevard (Class 3B)
BART/Amtrak/Ferry Stations
NOTE: This map includes existing and proposed bikeways in adjacent jurisdictions
Prepared by Wilbur Smith Associates


DOWNTOWN DETAIL
DETAIL AREA
0
1
2
4 Miles
City of Oakland, Bicycle Master Plan (2007)
Figure H.4: Existing Bikeways
Bike Path (Class 1)
Bike Lane (Class 2)
Bike Route (Class 3)
Arterial Bike Route (Class 3A)
Bike Boulevard (Class 3B)
BART/Amtrak/Ferry Stations
NOTE: This map includes existing and proposed bikeways in adjacent jurisdictions
Prepared by Wilbur Smith Associates


DOWNTOWN DETAIL
DETAIL AREA
0
1
2
4 Miles
City of Oakland, Bicycle Master Plan (2007)
Figure H.5: Existing Bicycle Parking and Support Facilities
Bicycle Parking Capacity
2 - 4 Bikes
4 - 10 Bikes
More than 10 Bikes
Changing Facilities
BART/Amtrak/Ferry Stations
Prepared by Wilbur Smith Associates


DOWNTOWN DETAIL
DETAIL AREA
0
1
2
4 Miles
City of Oakland, Bicycle Master Plan (2007)
Figure H.6: Primary Bikeways
EXISTING
PROPOSED
Bike Path (Class 1)
Bike Lane (Class 2)
Bike Route (Class 3)
Arterial Bike Route (Class 3A)
Bike Boulevard (Class 3B)
BART/Amtrak/Ferry Stations
Prepared by Wilbur Smith Associates


DOWNTOWN DETAIL
DETAIL AREA
0
1
2
4 Miles
City of Oakland, Bicycle Master Plan (2007)
Figure H.7: County/Regional Bikeway Network
EXISTING
PROPOSED
Countywide Bikeway
Regional Bikeway
Countywide/Regional Bikeway
BART/Amtrak/Ferry Stations
Prepared by Wilbur Smith Associates

Appendix C: High Street Audit Elements

Audit Element	Importance	Source
General Road Factors		
Speed Limit	Higher speeds on roadways are unsafe both physically and mentally for cyclists. Higher vehicle speeds on a roadway can increase the severity of collisions should they occur and may raise the need for a physical separation between cyclists and motorists.	WABSA (2003), FHWA (2012)
Outside Lane Width	The width of the outside land will determine how much space exists to fit a bike lane or bikeway capitalizing on the maximum level of separation between cyclists and motorists.	WABSA (2003), FHWA (2012)
ROW Width	The amount of available ROW along a street corridor will determine the amount of space available to accommodate a potential bike facility while maintaining pedestrian and vehicle access	
Bike lane Facility	Presence of a bike lane would identify space for a cyclist to travel and indicate an established use. The type of facility is important.	WABSA (2003)
Pavement Factors		
Pavement Condition	Smooth and uniform surfaces are more comfortable and safer for cyclists. Pavement conditions on roadways used by cyclists should be maintained to a higher standard.	WABSA (2003), FHWA (2012)
Road Obstructions	Potholes, manholes, utility covers, drain grates and other obstacles on the pavement surface could create safety hazards and increase the potential for tire and wheel damage. Attempts to avoid these obstacles may increase cyclist's exposure to crashes by causing them to swerve into vehicle lanes.	FHWA (2012)

Audit Element	Importance	Source
Curb Present	A curb can limit the available space for a cyclist on a roadway and introduce a potential hazard. A curb can also serve as a separation between cyclists and pedestrians.	WABSA (2003)
Pavement Markings	Clear striping provides visual cues to both motorists and cyclists by designating space for both.	FHWA (2012)
Location Factors		
On Street or Off Street Parking	Parking can block continuous travel by cyclists and create challenges to constructing bike lanes. Parking can also be used to separate moving vehicles from a bike facility. Parking is valuable to local businesses and residents.	FHWA (2012)
Transit Stops	Transit stops may attract cyclists who intend to use this mode. Transit stops may also prevent expansion of the roadway to accommodate cyclists. Stopped and merging buses create interruptions in travel and may force cyclists to unsafely pass using the vehicle lane.	FHWA (2012)
Grade	Steep grades discourage travel by bicycle and lower grade or flat roadways encourage it. Steeper or more challenging grades may prevent less experienced cyclists or those with disabilities from cycling. Steep grades may also cause motorists to speed depending on the downhill direction of travel.	FHWA (2012)
Paved Shoulder	Paved space on the shoulder is crucial for creating space for cyclists and the bigger the better. A width of 4-5+ feet is recommended for a bicycle friendly roadway.	WABSA (2003), FHWA (2012)
Signage	Appropriate location, height, condition and visibility of signage is an indication to motorists and cyclists that bike facilities exist along the roadway.	WABSA (2003), FHWA (2012)

Audit Element	Importance	Source
Horizontal/Vertical Obstructions	Obstructions that interrupt sight lines or cause cyclists to have to take evasive maneuvers discourage safe travel by bicycle. Objects protruding into the travel way such as low hanging signs, light fixtures, structural supports, etc. may not be noticed by cyclists. Horizontal operating space for cyclists should be free of obstacles that limit the space.	FHWA (2012)
Driveways	An increase in number of driveways per block segment increases the number of conflict points. Frequently used driveways increase interruptions from vehicles entering and exiting.	WABSA (2003), FHWA (2012)
Street Lighting	The presence of lighting increases the safety and security of cyclists and motorists.	Caltrans Intersection Guidebook (2010), FHWA (2012)
Sidewalks Present	Sidewalks create a separation between pedestrians and cyclists, which decreases conflict between the two. Sidewalks may provide additional ROW for roadway expansion.	WABSA (2003), FHWA (2012)
Bike Amenities	Bicycle amenities at origins or destinations such as bike racks, bike lockers, bike rentals and increased signage may encourage travel by bicycle.	WABSA (2003), FHWA (2012)
Intersection Factors		
Intersection Type	The type of intersection controls vehicular movements that may encourage or discourage travel by bicycle. Number of legs at the intersection and presence of a signal or stop sign will affect travel behavior.	Caltrans Intersection Guidebook (2010), WABSA (2003)
Width of Intersection	The number of lanes determines the amount of traffic on the roadway. The distance a cyclist must travel to cross an intersection increases the length of exposure time and may decrease cyclist's comfort level.	Caltrans Intersection Guidebook (2010)

Audit Element	Importance	Source
Turn Lanes	Vehicular turning lanes present conflict points on the roadway. Free right turns may increase the risk to crossing cyclists by allowing vehicles to turn at higher speeds. The presence of turn lanes effects the location and type of bicycle facility recommended.	Caltrans Intersection Guidebook (2010)
Pedestrian/Cyclist Signal	Signals oriented for cyclists and pedestrians increase intersection safety. Signal phasing, timing, and coordination may need to be adjusted if there is not adequate time for cyclists to clear an intersection before opposing traffic is released.	Caltrans Intersection Guidebook (2010), FHWA (2012)
Pavement Markings	Visible and well-maintained markings on the street such as painted crosswalks, bike boxes, continuous bike lanes, and clearly designated vehicle lanes prevent unsafe or irregular cyclist/motorist behavior at intersections.	FHWA (2012)
Cross Street Information	The number of lanes, one-way travel, turning movements and the speed limit of cross streets determines the level of safety and required crossing time.	FHWA (2012)
Railroad Xing	Railroad tracks can create a slippery surface or obstruction that can trap bicycle tires in the roadway. A 90-degree (or perpendicular) track orientation to the path of travel is safer than an angled orientation.	FHWA (2012)
Cross street Bike Lane Connection	Improved connectivity to existing bike facilities provides justification for additional bike facilities along a roadway by providing continuous access to important destinations.	FHWA (2012)
Skewed Angle	The angle of cross streets can affect vehicular speed and turning movements. Intersections with skewed angles may prevent construction of certain types of bike facilities.	Caltrans Intersection Guidebook (2010)

Appendix D: Audit Sheets

Block Segment

	Date:

General Road Factors

Speed Limit	
25 mph	
35 mph	
Greater than 35 mph	

Outside (curb) Lane Width

ROW Width

Bike Lane or Bike Facility Present	
None	
Sharrow	
Class 3	
Class 2	

Pavement Factors

Pavement Condition	
Very Good	
Good	
Fair	
Poor	
Very Poor	

Curb Present	
No	
Description: Yes	

Paved Shoulder	
No	
Yes	
Width	

Striping and Road Markings	
None	
Exist but in poor condition	
Notes: Clearly marked	

Road Obstructions	
# Potholes	
# Drain Grates	
Other: Uneven Pavement	

Block Segment

Location Factors

On Street or Off Street Parking?	
	No
Notes:	Yes

Transit Stops Present	
	No
Description:	Yes

Grade	
Severe (>10%)	
Moderate (> 5%)	
Flat	

Bicycle Oriented Signage	
	Yes
Notes:	No

Horizontal / Vertical Obstructions	
	No
Notes:	Yes

Driveways	
	None
Notes:	# Driveways

Bike Amenities	
	No
Notes:	Yes

Sidewalks	
	Yes
Notes:	No

Adequate Street Lighting	
	Yes
Notes:	No

Intersection:

	Date:

Intersection Type	
4-way	
3-way	
Signals for traffic in all directions	
Stop sign for traffic one direction	

Width of Intersection
Notes:

Turn Lanes	
Right turn only	
Free right turn	
No right turn	
Other	
Notes:	

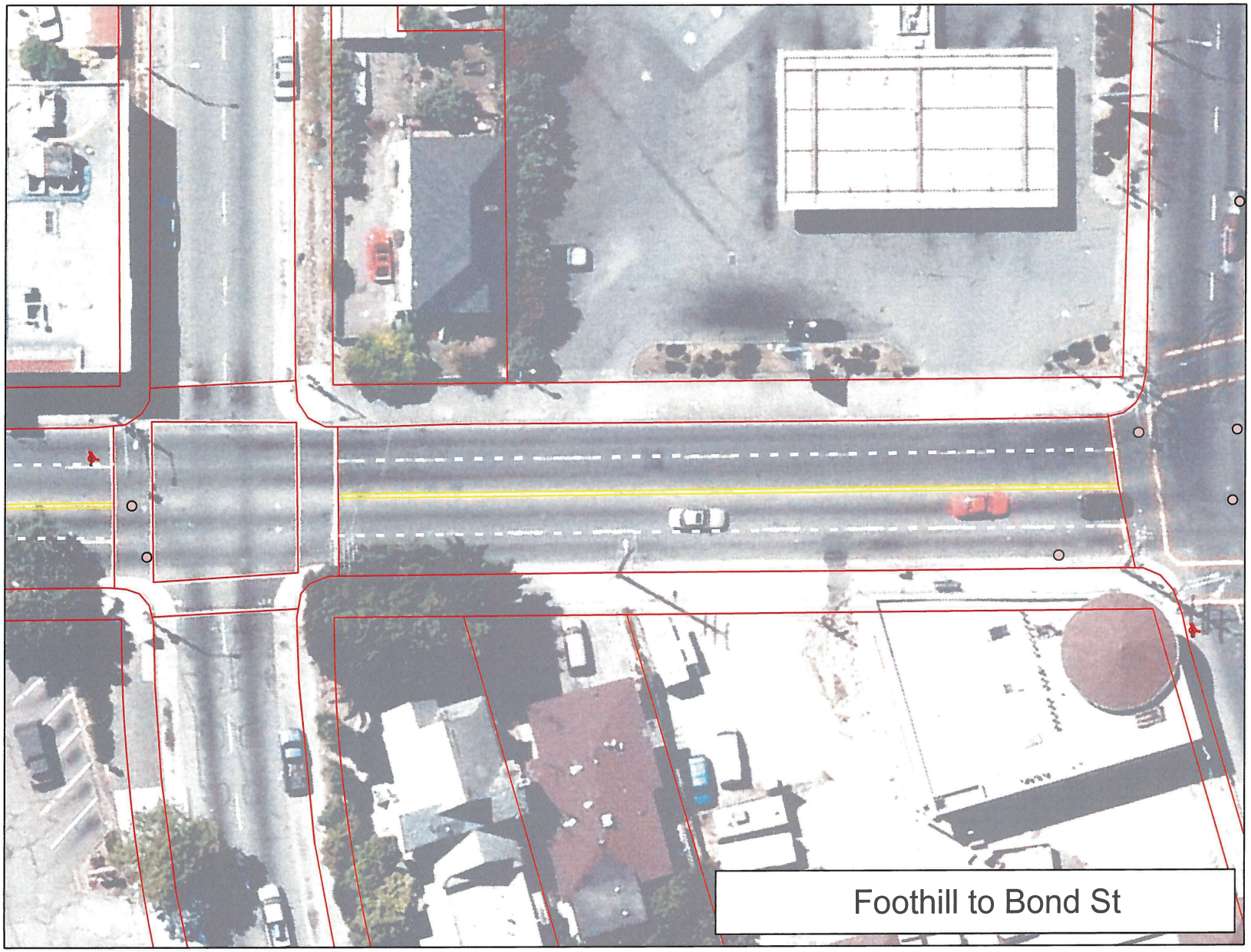
Pedestrian/Bicyclist Signal	
No	
Yes	
Notes: Dedicated Bike Phase	

Bike lane meeting High St?	
Yes	
No	

Skewed Angle?	
Yes	
No	

Cross street information	
Number of Lanes	
Speed Limit	
One Way?	
Notes: Free turning movements?	

Road Markings	
Crosswalk	
Bike box	
Clear lane designations	
Notes:	


Foothill to Bond St

Appendix E: Block Segment and Intersection Numbering

Block Segments

N-W 01 – Foothill to Bond St
N-W 02 – Bond St to E 17th St
N-W 03 – E 17th St to Bancroft Ave
N-W 04 – Bancroft Ave to International Blvd
N-W 05 – International Blvd to E 12th St
N-W 06 – E 12th St to San Leandro St
N-W 07 – San Leandro St to Wattling St
N-W 08 – Wattling St to UPRR Crossing
N-W 09 – UPRR Crossing to Coliseum Way
N-W 10 – Coliseum Way to Oakport St
N-W 11 – Oakport St to Howard St
N-W 12 – Howard St to Tidewater Ave
N-W 13 – Tidewater Ave to High St. Bridge

S-E 13 – High St. Bridge to Tidewater
S-E 12 – Tidewater to Howard St
S-E 11 – Howard St to Jensen St
S-E 10 – Jensen St to Oakport St
S-E 09 – Oakport St to Coliseum Way
S-E 08 – Coliseum to UPRR Crossing
S-E 07 – UPRR Crossing to San Leandro St
S-E 06 – San Leandro St to E 12th St
S-E 05 – E 12th St to E 12th St
S-E 04 – E 12th St to International Blvd
S-E 03 – International Blvd to Bancroft Ave
S-E 02 – Bancroft Ave to Bond St
S-E 01 – Bond St to Foothill Blvd

Intersections

I–01 – High St @ Foothill Blvd
I–02 – High St @ Bond St
I–03 – High St @ E 17th St
I–04 – High St @ Bancroft Ave
I-05 – High St @ International Blvd
I-06 – High St @ E 12th St East
I-07 – High St @ E 12th St West
I-08 – High St @ San Leandro St

I-09 – High St @ Wattling St
I–10 – High St @ UPRR Crossing
I-11 – High St @ Coliseum Way
I-12 – High St @ Oakport St
I-13 – High St @ Jensen St
I-14 – High St @ Howard St East
I-15 – High St @ Howard St West
I-16 – High St @ Tidewater Ave

Appendix F: High Street Block Segment Audit Results

		General Road Factors				Pavement Factors							
										Road Obstructions			
		Speed Limit (mph)	Ouside Lane Width	ROW Width	Bike Facility	Pavement Condition	Curb	Paved Shoulder	Striping/Road Markings	Potholes	Drain Grates	Uneven Pavement	Manhole/ Utilities
N-W-01	Foothill Blvd to Bond St	25	10 ft	65 ft	None	Good	Yes	No	Clearly Marked	0	0	Yes	0
N-W-02	Bond St to E 17th St	25	11.5 ft	65 ft	None	Good	Yes	No	Clearly Marked	0	1	Yes	0
N-W-03	E 17th St to Bancroft Ave	25	11.5 ft	65 ft	None	Good	Yes	No	Clearly Marked	0	0	Yes	0
N-W-04	Bancroft Ave to International Blvd	25	10 ft	65 ft	None	Good	Yes	No	Clearly Marked	0	1*	Yes	2
N-W-05	International Blvd to E 12th St	25	10 ft	65 ft	None	Good	Yes	No	Clearly Marked	0	1	Yes	2
N-W-06	E 12th St to San Leandro St	25	10 ft	65 ft	None	Fair	Yes	No	Clearly Marked	0	1	Yes	0
N-W-07	San Leandro St to Wattling St	25	10 ft	65 ft	None	Fair	Yes	No	Clearly Marked	0	0*	Yes	0
N-W-08	Wattling St to UPRR xing	25	<10 ft	65 ft	None	Fair	Yes	No	Poor	3	0	Yes	1
N-W-09	UPRR xing to Coliseum Way	25	10 ft	65 ft	None	Poor	Yes	No	Poor	0	1	No	2
N-W-10	Coliseum Way to Oakport St	25	~12 ft	~110 ft	Class 3	Good	Yes	7.5 ft	Poor	0	2	Yes	0
N-W-11	Oakport St to Howard St	25	10 ft	65 ft	None	Fair	Yes	No	Poor	0	2	Yes	2
N-W-12	Howard St to Tidewater Ave	25	11 ft	65 ft	Bike Route	Fair	Yes	No	Poor	0	3	Yes	5
N-W-13	Tidewater to High St Bridge	25	10 ft	60 ft	Bike Route	Good	Yes	No	Clearly Marked	0	0	Yes	3
											12		17
S-E-13	High St Bridge to Tidewater	25	20 ft	60 ft	Bike Route	Good	Yes	No	Clearly Marked	0	1	Yes	1
S-E-12	Tidewater to Howard	25	10+ ft	65 ft	Bike Route	Good	Yes	No	Poor	0	1	No	0
S-E-11	Howard St to Jensen St	25	10 ft	66 ft	None	Fair	Yes	No	Poor	1	1	Yes	0
S-E-10	Jensen St to Oakport St	25	12 ft	67 ft	None	Good	Yes	No	Poor	2	1	Yes	0
S-E-09	Oakport St to Coliseum Way	25	12 ft	~110 ft	Class 3	Good	Yes	7.5 ft	Clearly Marked	0	1	No	0
S-E-08	Coliseum Way to UPRR xing	25	10 ft	65 ft	None	Poor	Yes	No	Poor	0	0	Yes	2
S-E-07	UPRR xing to San Leandro St	25	10 ft	65 ft	None	Poor	Yes	No	Poor	8	0	Yes	2
S-E-06	San Leandro St to E 12th St	25	10 ft	65 ft	None	Poor	Yes	No	Clearly Marked	5	1	Yes	5
S-E-05	E 12th St to E 12th St	25	10 ft	65 ft	None	Fair	Yes	No	Poor	2	2	Yes	0
S-E-04	E 12th St to International Blvd	25	10 ft	65 ft	None	Good	Yes	No	Clearly Marked	2	1	Yes	0
S-E-03	International Blvd to Bancroft Ave	25	10 ft	65 ft	None	Good	Yes	No	Clearly Marked	0	0	Yes	0
S-E-02	Bancroft Ave to Bond St	25	12 ft	65 ft	None	Good	Yes	No	Clearly Marked	0	0	minor	0
S-E-01	Bond St to Foothill Blvd	25	10 ft	65 ft	None	Good	Yes	No	Clearly Marked	2	0	Yes	3
											9		13

Location Factors											Notes
				Horizontal/ Vertical Obstructions							
Street Parking	Transit Stop	Grade	Bike Signage	Street Trees	Utility Poles	Other	Driveways	Bike Amenities	Sidewalk	Adequate Street Lighting	
No	Yes	Flat	No	0	0		3	No	~12 ft	N; 1	Gas station provides significant lighting
No	No	Flat	No	0	0	1 Hydrant	0	No	7 ft	N; 1	
No	No	Flat	No	0	0	1 Hydrant	4	No	6 ft	N; 0	
No**	Yes	Flat	No	0	0	signs	5	No	8-9 ft	N; 0	*Curb destroyed near drain; **Off St parking; ped curb ramp
No	No	Flat	No	3	0	signs	5	No	9-11 ft	N; 1	Lighting at intersections
No	No	Flat	No	0	0	signs	2	No	6-9 ft	N; 1	No lighting under BART
No**	No	Flat	No	0	3		2	No	8-12 ft	Y; 3	*Drain hole in curb, no grate; **Off St parking sidewalk
No*	No	Flat	No	0	2	RR Signal arm	3	No	8 ft	N; 1	*Off St Parking Auto Biz
No	No	Flat	No	0	1		3	No	No	N; 0	Concrete Drvwys, but gravel sidewalks
No	No	Flat	No	0	0		0	Yes*	No	N; 2	*Paved Shoulder w/ stripe; Underpass dark without sidewalk
No	No	Flat	No	0	4	1 Hydrant	4	No	8 ft	N; 2	
No*	No	Flat	Yes	0	8	1 Hydrant	8	Yes**	11 ft***	Y; 7	*Off street parking; **Bike Route Sign; ***Sidewalk ends; 2 ped ramps
No	No	Flat	Yes	2	3		1	No	5 ft*	N;1	*Plus a 5 ft landscape buffer
				5	21		40				
No	No	Flat	Yes	0	4		0	No	8 ft	Y;2	
No	No	Flat	Yes	0	7		5	Yes*	11-12 ft	N; 1	*Bike Route Sign to Howard
No	No	Flat	No	0	4	Signal Arm	1*	No	8 ft	Y; 2	*Ped curb ramp
No	No	Flat	No	0	3		3	No	~8 ft	N; 1	Business lights help brighten corridor
No	No	Flat	No	0	0		None	No	6 ft	N	Underpass needs lighting
ccc	No	Flat	No	0	5	RR xing arm	4	No	10-12 ft	Y; 3	
No	No	Flat	No	shrubs	8	2 Hydrants	8	No	~12 ft	N; 2 w/ gaps	Poor Drainage Near UPRR
No	No	Flat	No	0	3	2 Hydrants	3	No	6-10 ft	N; 1	
No*	No	Flat	No	0	2		2	No	10 ft	Y; 2	*Off St Parking/Auto Repair
No	No	Flat	No	0	2		2	No	12 ft; Poor	N; 1	
No	Yes	Flat	No	6	4	1 Garbage Can	2	No	8 ft	Y; 3	
No	No	Flat	No	5	3		2	No	8 ft	Y; 3	Ped curb ramp
No	Yes	Flat	No	6	3	1 Garbage Can	2	Bike Rack	10 ft	N; 2 Overhead	
				17	48		33				

Appendix G: High Street Intersection Audit Results

		Physical Intersection Elements						Non-Motorized Intersection Elements				
		Intersection Type								*Ped/Bike Signal*		
		Type	Traffic Signals All Directions	Stop Sign One Direction	Width	Turn Lanes on High St	Skewed Angle	Crosswalk	Clear Markings	Bike/Ped Signal	Dedicated Bike Phase	Bike Box
I-01	High St @ Foothill Blvd	4 Way	Yes		85 ft	None	Yes	4	Yes	Yes	No	No*
I-02	High St @ Bond St	4 Way	Yes		60 ft	None	No	4	Yes	Yes	No	No
I-03	High St @ E 17th St	3 Way	No	Yes	55 ft	None	No	No	No	No	No	No
I-04	High St @ Bancroft Ave	4 Way	Yes		65 ft	None	Yes	4	No	No*	No	No
I-05	High St @ International Blvd	4 Way	Yes		95 ft	None	Yes	4	Yes	Yes	No	No
I-06	High St @ E 12th St East	3 Way	No	Yes	55 ft	None	No	No	No	No	No	No
I-07	High St @ E 12th St West	4 Way	Yes		106 ft	None	Yes	3*	No	Yes	No	No
I-08	High St @ San Leandro St	4 Way	Yes		80 ft	None	Yes	4	No	Yes	No	No
I-09	High St @ Wattling St	3 Way	No	Yes	60 ft	None	No	1*	No	No	No	No
I-10	High St @ UPRR Crossing	4 Way*	No		60 ft	None	Yes	No	No	No	No	No
I-11	High St @ Coliseum Way	4 Way	Yes		72 ft	Yes*	Yes	2**	No	Yes***	No	No
I-12	High St @ Oakport St	4 Way	Yes		95 ft	Yes*	Yes	2**	No	No	No	No
I-13	High St @ Jensen St	3 Way	No	Yes	50 ft	None	No	No	Yes*	No	No	No
I-14	High St @ Howard St East	3 Way	Yes		90 ft	None	No	2*	Yes	Yes	No	No
I-15	High St @ Howard St West	3 Way	No	Yes	50 ft	None	No	No	Yes*	No	No	No
I-16	High St @ Tidewater Ave	3 Way	No	Yes	55 ft	None	No	1*	Yes	No	No	No

Cross Street Elements					
# Lanes	Speed	One Way	Free Turns	Bike Facility Connection	Notes
4	25	No	Yes	Class 2	* Sharrow stencil visible at stop line, but no box
2	25	Yes	Yes	No	Bond St One way northbound
2	25	No	Yes	No	Minor Dead end Residential
2	30	Yes	Yes	Yes**	*No ped signals; **Bike lane north on Bancroft
4	25	No	Yes	No	No Ped signal on east leg of International
2	25	No	Yes	No	
5 to 3	25	Yes	No***	No	*West leg High St. no crosswalk/signal;**Hwy 77 southbound two lanes, separate signal phase; ***No right on red from E 12th; One Way southbound
4	30	No	Yes	No	Crosswalks poorly marked/faded
2	25	No	Yes	No	*Crosswalk crossing High St w/ no signal
n/a	n/a	n/a	No	No	*RR Crossing; Roadway warning paint 150' away either direction, but in poor condition
3	30	North side	Yes	No	*East bound left on arrow only to freeway; **No crosswalk High St. westbound leg; ***No Ped Signal on High westbound leg
3 to 2***	30	North side	Yes	No	*Westbound left turn on arrow only; **No crosswalk High St westbound leg; ***3 one-way lanes from north; 2 lanes from south bi-directional
2	No Posted	No	Yes	No	*Stop Bar and "Keep Clear" paint faded
3	No Posted	No	Yes	Yes**	* Crosswalk on north and west legs only; **Bike Route
2	No Posted	No	Yes	No	*Markings visible but fading; Dead end street
2	No Posted	No	Yes	Yes**	*One crosswalk across High, w curb ramps; **Bike route