TELEGRAPH AVENUE COMPLETE STREETS IMPLEMENTATION PLAN

ROADWAY DESIGN OPTIONS REPORT

CITY OF OAKLAND

ALAMEDA County Transportation Commission

FEHR & PEERS

cd+a COMMUNITY DESIGN + ARCHITECTURE

APRIL 2014

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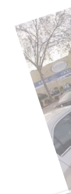

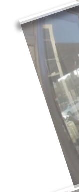

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PURPOSE STATEMENT

A project purpose statement was presented for public review and comment as part of the web-based survey. Based on comments from survey respondents and input from project stakeholders, the purpose statement has been revised to read as follows:

The Telegraph Avenue Complete Streets Implementation Plan will design Telegraph Avenue to be a better street for walking, bicycling, riding transit, and driving between 20th and the Berkeley border, with a focus on the area south of 57th Street. In its current state, Telegraph Avenue has safety challenges for all users, including speeding, a lack of space for bicyclists, inadequately-sized bus stops, difficult pedestrian crossings, and public safety concerns. Addressing these issues is critical to enhancing the economic vitality of Telegraph Avenue neighborhoods, including Uptown, KONO and Temescal.

A redesign of Telegraph Avenue must improve the safety and accessibility of all modes, make the street more comfortable and enjoyable for walking and bicycling, and balance the needs and convenience of all users. The project will consider not only through-travel but also access to the businesses, residences, restaurants, and gathering spaces that make Telegraph Avenue a great destination.

The Complete Streets Implementation Plan will use an extensive outreach process including surveys, stakeholder interviews, and public meetings to create a design that meets the community's needs. When completed in late 2014, the Plan will provide a long-term design concept for the corridor, as well as a funding and phasing plan with near-term action items that the City can pursue immediately.

Note: Existing City of Oakland policy statements and resolutions, including the Oakland General Plan, provided a basis for the above statement.


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INTRODUCTION

This report presents a range of Complete Streets options for improving the Telegraph Corridor (primarily from 57th Street to 20th Street, with limited analysis from 57th Street to the Berkeley border). The design options are intended to enhance the vibrancy and livability of the existing business districts and neighborhoods along the corridor. Based on the public feedback received to date[1] as well as the data analysis performed in Task 1: Existing Conditions Analysis[2], the project team developed the following materials:

- **Purpose Statement:** A purpose statement was developed to guide the redesign of Telegraph Avenue to be a more complete and economically vibrant street by improving safety and accessibility of all modes, making the street more comfortable and enjoyable for walking and bicycling, and balancing the needs and convenience of all users.
- **Alternative Roadway Design Options:** The project team divided the corridor into three (3) segments and developed three (3) alternative cross sections for each segment, as well as six (6) variations on those alternatives to study bus stop and intersection approach conditions. The project team also produced an extended plan view drawing to show how these cross section options could operate and transition along a segment of the corridor.
- **Bus Stop and Transit Options:** The project team developed bus stop consolidation recommendations, assessed baseline transit performance, and estimated the change in transit performance associated with proposed multi-modal roadway improvements, including a road diet (i.e., reducing the number of vehicle travel lanes), and transit enhancement features.
- **Pedestrian Crossing Options:** The project team developed recommendations for the locations of crosswalks throughout the extended corridor (Alcatraz Avenue to 20th Street), and evaluated unsignalized crosswalk improvement options.
- **Streetscape and Urban Design Options:** The project team reviewed the 2005 Telegraph Avenue Pedestrian Streetscape Improvement Project and indicated which recommendations to advance and modify to create a more complete street. The project team also developed concepts showing elements of the cross section options in greater detail and with interim implementation strategies.

Note: This report provides a summary of design alternatives developed in response to public outreach conducted to date. The report does NOT identify a preferred design. A preliminary recommendation for each corridor segment will be developed based on objective analysis of the various options, public feedback, impacts to maintenance and other criteria. Recommendations will be distributed via a separate document for further feedback. Where required, environmental studies will also be conducted.

Design options presented are intended to provide a long-term vision for the corridor. Actual implementation will occur in phases, with the extent of each phase dependent on environmental clearance, funding availability for both capital and maintenance expenses (e.g., landscaping elements would not be included without an on-going maintenance plan) and coordination with other capital improvement projects in the corridor.

1. The Stakeholder Outreach and Public Survey Report that analyzes and summarizes stakeholder input and responses to the public online survey can be found at http://www2.oaklandnet.com/n/OAK046218

2. A summary of the Existing Conditions Report is provided below in this report. The full Existing Conditions Report and figures can be found on the City's Telegraph Avenue project website at http://www.oaklandnet.com/TelegraphAvenue

SUMMARY OF FINDINGS

The following section provides a summary of key findings from this Roadway Design Options Report:

ALTERNATIVE ROADWAY DESIGN OPTIONS

CORRIDOR SEGMENTS

For the purposes of developing design options, the project team divided Telegraph Avenue (from 20th to 57th Street) into three primary segments (see Figure 1 on page 11). Segmentation is based primarily on traffic volumes, land use context and connections with the surrounding multimodal transportation network. Segment A extends from 57th Street to 52nd Street, Segment B from 52nd Street to 48th Street, and Segment C from 48th Street to 20th Street. These segments have the following general characteristics, relative to one another:

- **Segment A:** Highest traffic volumes, medium commercial and pedestrian activity
- **Segment B:** High to medium traffic volumes, including left turning movements, highest commercial and pedestrian activity
- **Segment C:** Lowest traffic volumes, high to medium commercial and pedestrian activity

CROSS SECTIONS – VEHICLE TRAVEL LANE PARAMETERS

Based on each segment's characteristics, the project team explored the potential to implement a "road diet" to transform some of the existing vehicle travel lanes into space for bicyclists, pedestrians and transit. To this end, the team developed alternative cross sections that generally include the following standard vehicle travel lane parameters:

- **Segment A parameters:** Maintain four travel lanes, two in each direction, and remove the center turn lane;
- **Segment B parameters:** Maintain four travel lanes, two in each direction, and maintain a center turn lane;
- **Segment C parameters:** Remove two travel lanes, maintain one travel lane in each direction, and maintain a center turn lane.

CROSS SECTIONS – COMPLETE STREETS DESIGN OPTIONS

Within the parameters defined above, the three segments can accommodate various bicycle, pedestrian and transit facility improvements. The project team developed and evaluated fifteen different cross section configurations over the length of the corridor. While all design options may be considered through ongoing stakeholder and public outreach, the project team, including city staff, has identified most likely options for each segment. Likely options were identified based on context and existing conditions analysis, engineering judgment, and input from stakeholders and over 1,100 responses from community members to the project's public online survey. Table 1 provides an overview of these options.

BUS STOP AND TRANSIT OPTIONS

Existing transit service on Telegraph Avenue consists of the AC Transit Line 1 and 1R. With the opening of BRT service between Uptown Oakland and San Leandro, AC Transit is exploring the potential to consolidate the Line 1 and 1R into a single line between downtown Oakland and Berkeley. The project team developed a range of physical and operations options for implementation of such a consolidated line for the Oakland portion of that corridor (20th Street to Alcatraz Avenue).

STOP CONSOLIDATION

A consolidated Line 1 would provide more consistent headways between buses, reduce bus bunching, and maintain more consistent transit stop spacing. The project team recommended that certain stops be maintained and others be relocated or consolidated. The resulting stop locations were determined with respect to current ridership data, and destinations such as BART stations, hospital/medical centers, commercial clusters, and schools, as well as proximity to other AC Transit lines. The spacing of consolidated stops averages approximately 1,100 feet, with a maximum distance of 1,650 feet.

Table 1: Summary of Most Likely Roadway Design Options by Corridor Segment

SEGMENT	EXISTING CONDITION	TRAFFIC OPERATIONAL REQUIREMENTS[1]	DESIGN OPTION 1	DESIGN OPTION 2
Segment A (52nd - 57th Street)	▪ Two travel lanes in each direction ▪ Continuous center turn-lane ▪ Parking on both sides	▪ Two through lanes in each direction	Remove: ▪ Center turn-lane ▪ Parking under SR24 overpass Add: ▪ Striped bike lanes	Remove: ▪ Center turn-lane ▪ Parking on one side of street and under SR24 overpass Add: ▪ Protected cycle track
Segment B (48th - 52nd Street)	▪ Two travel lanes in each direction ▪ Continuous center turn-lane ▪ Parking on both sides	▪ Two through lanes in each direction ▪ Center turn lane	Remove: ▪ N/A Add: ▪ Shared lane markings for bicycles	Remove: ▪ Parking on one side of street Add: ▪ Striped bike lanes
Segment C (20th - 48th Street)	▪ Two travel lanes in each direction ▪ Continuous center turn-lane ▪ Parking on both sides	▪ One through lane in each direction ▪ Center turn lane	Remove: ▪ One travel lane in either direction Add: ▪ Protected cycle tracks	Remove: ▪ One travel lane in either direction Add: ▪ Buffered bicycle lanes

[1] Operational requirements necessary to meet City of Oakland policy for efficient traffic flow based on "Level of Service"

TRANSIT DESIGN TREATMENT OPTIONS

To further improve transit reliability and improve the transit rider and operator experience (better stop amenities, easier boarding/alighting, fewer conflicts between buses and vehicles/bicycles), the project team developed a suite of transit design options:

- **Transit Signal Priority (TSP):** This feature improves bus speed and reliability by giving buses longer green phases to proceed through traffic signals with less delay.
- **Relocation of bus stops to intersection far-side:** This strategy improves bus speed and reliability by preventing buses from missing a green phase on the near-side of a signalized intersection. It also reduces delay and improves safety by positioning the bus beyond crosswalks, reducing the likelihood of transit riders and other pedestrians crossing in front of the bus.
- **Bus bulb-outs and transit islands:** Bus bulb-outs improve bus speed and reliability by reducing the time required to serve a bus stop, providing more room for amenities at bus stops, improving the ease of boarding and alighting buses, and reducing pedestrian crossing distances. Where bus bulb-outs are separated from the curb as "transit islands" they provide space for a bicycle facility between the curb and bus stop to eliminate conflicts between bicyclists and buses pulling into and away from stops.
- **Queue-bypass lane:** Queue bypass lanes improve speed and reliability by providing a separate lane for buses approaching a traffic signal to reduce transit delay due to congestion. Queue-bypass lanes can be implemented in conjunction with parking lanes to serve transit during peak-hour commute times without reducing parking capacity during other times.

CONSOLIDATED LINE 1 PERFORMANCE

The project team analyzed the expected performance of transit under three alternatives:

1. Consolidated Line 1 with no other changes;
2. Consolidated Line 1 with proposed road diet; and
3. Consolidated Line 1 with proposed road diet and transit design treatments.

The complete package of transit and roadway improvements analyzed in Alternative 3 would provide substantial multi-modal benefits to all users of the corridor, including transit riders and operators, pedestrians, and bicyclists, while maintaining or improving transit operating speeds.

PEDESTRIAN CROSSING OPTIONS

Standard crosswalk striping at signal-controlled pedestrian crossing locations is typically a sufficient indication of where pedestrians should cross a street and provides good visibility of crossings to drivers. The street design concepts for Telegraph Avenue developed for this project recommend improvements for these signalized pedestrian crossings, including installing several missing crosswalks. At unsignalized crosswalks, which occur frequently throughout the project corridor, motorists must legally yield to pedestrians crossing the street but often fail to do so. To make these locations more visible and convenient, additional design enhancements can be implemented, as indicated in Table 2.

In addition to applying the above enhancements to crossings as specified in the Pedestrian Crossing Options section of this report, the project team recommends increasing the number of marked crossings from 30 to 37 within the project corridor, to provide evenly spaced opportunities to cross Telegraph Avenue safely. The new crossings would improve the average spacing between crosswalks to less than 340 feet. Additionally, five previously uncontrolled crosswalks located within 200 feet of a signalized intersection would be relocated to nearby signalized intersections.

STREETSCAPE AND URBAN DESIGN OPTIONS

The project team supports the recommendations of the 2005 Telegraph Avenue Pedestrian Streetscape Improvement Project, including more pedestrian-scaled lighting, corner bulb-outs, median refuges, and high-visibility crosswalks, additional street tree plantings, parking meter repair/replacement with kiosks, bus bulb-outs, and sidewalk repair/repaving.

Protected bike lanes present additional place-making and urban design opportunities for Telegraph Avenue beyond those envisioned by the 2005 Streetscape Project. These include transit islands and planters. The project team also revisited the 2005 Streetscape Project concept of vacating Shattuck Avenue between 45th and 46th Streets, incorporating a "pavement to parks" strategy with green infrastructure and an improved connection between Telegraph Avenue and Shattuck Avenue.

Table 2: Unsignalized Crossing Design Enhancement Elements

TREATMENT	DESCRIPTION	BENEFIT
High-Visibility (HV) Striping and Signs	▪ "Ladder" or "zebra" crosswalk striping, or other custom format ▪ Signs indicating the location of crossings	▪ Improves visibility of crossings to oncoming roadway users
Curb Extensions	▪ Extension of the sidewalk towards the edge of the adjacent parking lane ▪ Also referred to as "bulb-outs"	▪ Provides better visibility between pedestrians and motorists ▪ Shortens the pedestrian crossing distance
Median Refuges	▪ Physical or painted island adjacent to the pedestrian crossing in the middle of the roadway	▪ Protects pedestrians from vehicle travel lanes and allows pedestrians to cross one half of the street at a time
Rectangular Rapid Flashing Beacons (RRFB)	▪ Push-button activated flashing lights mounted to pedestrian crossing signs on the side of the roadway	▪ On-demand, high-visibility indication to drivers and bicyclists that a pedestrian is crossing the street
Pedestrian Hybrid Beacon (PHB)	▪ Push-button activated overhead flashing lights mounted on mast arms above the roadway	▪ On-demand, high-visibility indication to drivers and bicyclists that a pedestrian is crossing the street

SUMMARY OF EXISTING CONDITIONS

The following highlights key findings from the project's Existing Conditions Analysis; a stand-alone report is available in its entirety on the project website[3].

- **Crash Data:** The project analyzed crash data from 2007 to 2011 between 20th Street and Alcatraz Avenue. During this period, the most common collision on Telegraph Avenue involved motorists colliding with other motorists, with 138 reported collisions. 66 motorist-bicyclist collisions and 68 motorist-pedestrian collisions were also reported during this period. Collisions resulted primarily from drivers speeding, failing to yield and/or signal when making turns, failing to yield to bicyclists when opening car doors ("dooring") and when turning, and failing to yield to pedestrians in crosswalks. Collisions were dispersed throughout the corridor, suggesting that corridor-wide solutions should be provided.
- **Bicycle Volumes:** Bicycle tube counts were collected on Telegraph Avenue between 40th Street and 41st Street over a nine-day period in October 2013. On average over 1,200 bicycle trips were counted on weekdays and nearly 700 on weekends, the highest recorded to date in the City of Oakland. The Telegraph Avenue bicycle counts are nearly twice as high as parallel continuous routes (e.g., Webster Street), despite higher auto volumes on Telegraph Avenue, indicating the appeal of the corridor's many destinations and direct connections for people riding bicycles.
- **Pedestrian Crossings:** The project corridor currently has 30 marked crossings over approximately 2.3 miles, for an average spacing of over 400 feet between crossings. The I-580 and HWY-24 underpasses create crossing spacing of over 700 feet. Other large gaps between crossings exist in the commercial/retail districts of Temescal and KONO where retail businesses line both sides of the street. At unsignalized crossings, only 20 to 38 percent of drivers were observed to yield to pedestrians. This analysis suggests that crossing conditions should be improved by increasing the number of crossings per mile, shortening crossing distances with bulb-outs and median refuges, and considering additional treatments such as high-visibility markings, flashers, overhead and hybrid beacons.
- **Transit Travel Time and Delay:** AC Transit operates the Line 1 and 1R bus routes within the project corridor, with average stop spacing of 850 feet and 2,500 feet, respectively. Stops shared by both the Line 1 and 1R have the highest passenger activity: 20th Street, 24th Street, 30th Street/31st Street, 40th Street, and 49th Street. Line 1 speeds average between 7.8 and 11.4 mph, while Line 1R speeds average between 10.3 and 14.7 mph. Bus stops feature a range of amenity levels with some stops featuring shelters, seating, and next-bus displays, while others feature only flag signs.
- **Traffic Operations:** Motor vehicle, pedestrian and bicycle volumes were collected at key intersections in the corridor in October 2013, and supplemented with previously reported data. It is City of Oakland policy that Telegraph Avenue perform at Level of Service (LOS) E or better. Motorists currently experience low to moderate delay throughout the corridor. All signalized intersections perform at LOS C or better during the AM and PM peak hour, with the exception of Telegraph Avenue/51st Street and Telegraph Avenue/52nd Street/Claremont Avenue, which operate at LOS D in the PM peak hour.
- **Past Studies:** The project team reviewed relevant documents, including past BRT and AC Transit studies, streetscape plans, parking analyses, and City of Oakland policies. Highlights from these studies, plans and policies were used to inform the range of design options developed by the project team to improve the Telegraph Avenue corridor.

3. See the project website at http://www.oaklandnet.com/TelegraphAvenue

ALTERNATIVE ROADWAY DESIGN OPTIONS

CORRIDOR SEGMENTS

The project team divided the Telegraph Avenue study corridor into three (3) segments labeled A, B and C. The divisions are based primarily on traffic volumes and intersection Level of Service (LOS – see definition in inset box), as well as land use context and connections with the surrounding multimodal transportation network. Figure 1 illustrates the extent of each segment and Table 3 provides a summary of relative conditions.

SEGMENT A

Segment A is bound by 57th Street to the north and 52nd Street/Claremont Avenue to the south. The existing curb-to-curb width is 68-feet, with locations around the Highway 24 overpass presenting a greater width of up to 80-feet. There are three pairs of existing Line 1 transit stops in this segment, all of which have relatively low boarding and alighting volumes.

Segment A has the study corridor's highest motor vehicle volumes. This is due largely to the presence of the Highway 24 eastbound on-ramp and westbound off-ramp on Telegraph, and the connection via 52nd Street to the Highway 24 westbound on-ramp west of Shattuck Avenue. With the exception of the 52nd Street/Claremont Ave intersection[4], Segment B's signalized intersections operate at LOS C or better. While there are a moderate number of left turn movements at 55th Street and 52nd Street/Claremont Avenue, there are relatively few land uses that require mid-block left turn movements to access driveways within this segment. This condition is similar to the section north of Aileen Street, where there is currently no center turn lane. North of Aileen Street, the removal of the center turn lane allows for provision of Class II bike lanes, with two vehicle travel lanes and parallel parking in each direction. With regard to on-street parking, the existing parallel parking below the Highway 24 overpass does not serve immediately adjacent businesses or residents, and many of the businesses and residents south of Highway 24 have off-street parking.

The traffic volumes in this segment most likely require that two through lanes remain in each direction for any redesign concept. However, Segment A presents opportunities for design features that better and more safely accommodate people on bicycles and on foot through the removal of the center turn lane and/or removal of parking under the highway. There is also potential to incorporate improvements to transit facilities, particularly bus bulbs. These improvements are described below in the Bus Stop and Transit Options section, and additional details about their design and integration with the roadway are provided in the Streetscape and Urban Design Concepts section.

Level of Service – Definition

Level of service (LOS) is a term used to describe the operating conditions of a roadway or intersection. The level of service of a facility is designated with a letter, A to F, based on motorist delay with A representing the most free flowing operating conditions; LOS A is not necessarily the ideal condition as it can indicate that an intersection is overbuilt. City of Oakland policy requires that Telegraph Avenue maintain an intersection LOS of E or higher.

Table 3: Corridor Segment Conditions

SEGMENT	INTERSECTION LOS[1]	AVERAGE HOURLY VEHICLE TRAFFIC VOLUME[2]	POTENTIAL FOR ROAD DIET
Segment A	Good	1,800 (AM); 2,200 (PM)	Medium
Segment B	Fair	1,300 (AM); 1,500 (PM)	Low - Medium
Segment C	Good - Excellent	1,000 (AM); 1,300 (PM)	High

[1] Relative to the other segments in the corridor.
[2] Calculated as the sum of vehicle volumes at signalized intersections divided by the number of signalized intersections per segment; Segment A: 57th Street to 52nd Street; Segment B: 52nd Street to 48th Street; Segment C: 45th Street to 20th Street. Traffic counts for the corridor were recorded on weekdays in October 2013, September and October 2009, and November 2008. See the Existing Conditions Report section on Traffic Operations for a more detailed explanation.

4 See the Existing Conditions Report, Table 10 for additional information about the LOS of the 52nd Street/Claremont Avenue and Telegraph intersection, which is affected by the performance of the closely spaced 51st Street and Telegraph intersection.

SEGMENT B

Segment B is bound by 52nd Street/Claremont Avenue to the north and the 48th Street to the south. The existing curb-to-curb width is 70-feet, with locations around the 51st Street and 52nd Street/Claremont intersections presenting slightly greater widths of 74 – 76-feet. Segment B includes one pair of existing Line 1/1R transit stops with high volumes of passenger boardings and alightings.

Segment B has lower motor vehicle volumes than Segment A. However, delay and queuing in the project study area is highest in Segment B due to a combination of relatively high through vehicle volumes, high volumes of turning traffic, and closely spaced signalized intersections. Telegraph Avenue/51st Street and Telegraph Avenue/52nd Street/Claremont Avenue operate at LOS C in the AM peak hour and LOS D in the PM peak hour, and experience the highest delay of any intersections on the corridor (see the Existing Conditions Report for additional details).

Because of these conditions, this segment is unlikely to support a road diet that eliminates travel or turn lanes. Eliminating parking lanes on one or both sides of the street would provide some options to provide dedicated bicycle lanes, and transit stops could be improved through adjustment of stop location and stop design. However, the land use context of Segment B includes many popular commercial and retail establishments that strongly support maintaining on-street parking to accommodate customer parking. The 2012 Temescal Parking Policies and Management Plan reviewed in the Telegraph Avenue Complete Streets Existing Conditions Report provides analysis and some recommendations for better managing the existing parking supply in this segment. These recommendations include metering additional parking spaces on side streets[5], which could potentially provide an opportunity for limited removal of some on-street parking on Telegraph within this segment. If feasible, removing some on-street parking in this segment of Telegraph would provide flexibility to allow dedicated bike lanes, as well as improvements to transit facilities as described in the Bus Stop and Transit Options section below.

SEGMENT C

Segment C is bound by 48th Street to the north and 20th Street to the south. The existing curb-to-curb width is 70-feet for the entire segment, with a handful of locations with slightly greater widths. There are five paired stops and three unpaired existing Line 1 transit stops, and three pairs of existing Line 1R transit stops in this segment, with varying boarding and alighting volumes.

Segment C has the study corridor's lowest motor vehicle volumes. This is due in part to the absence of highway on- and off-ramps on or adjacent to the Telegraph corridor for the majority of this segment. All signalized intersections within Segment C operate at LOS A or B, with the exception of Telegraph Avenue/27th Street, which operates at LOS C in the AM Peak. The majority of intersections in Segment C operate at LOS A.

Segment C includes lower Temescal, which features a variety of relatively intensive and pedestrian-serving land uses, including the future MacArthur Transit Village development. Further south, the Pill Hill district includes medical uses, and throughout this and the KONO district there are many restaurants, cafes, bars, and shops. The section of Telegraph Avenue between 20th Street and Grand Avenue generally has lower-intensity land uses, although there are several new and proposed businesses.

The extremely low delay for automobiles as measured by LOS and the lower traffic volumes in Segment C provide the greatest opportunity to support a road diet that can allow for traffic calming and improved vehicle safety, better accommodation and safety of people on bicycles and on foot, and improvements to transit facilities as described in the Bus Stop and Transit Options section below.

5. See Temescal Parking Polices and Management Plan, March 2012, Section 6.2: Recommended Strategies.

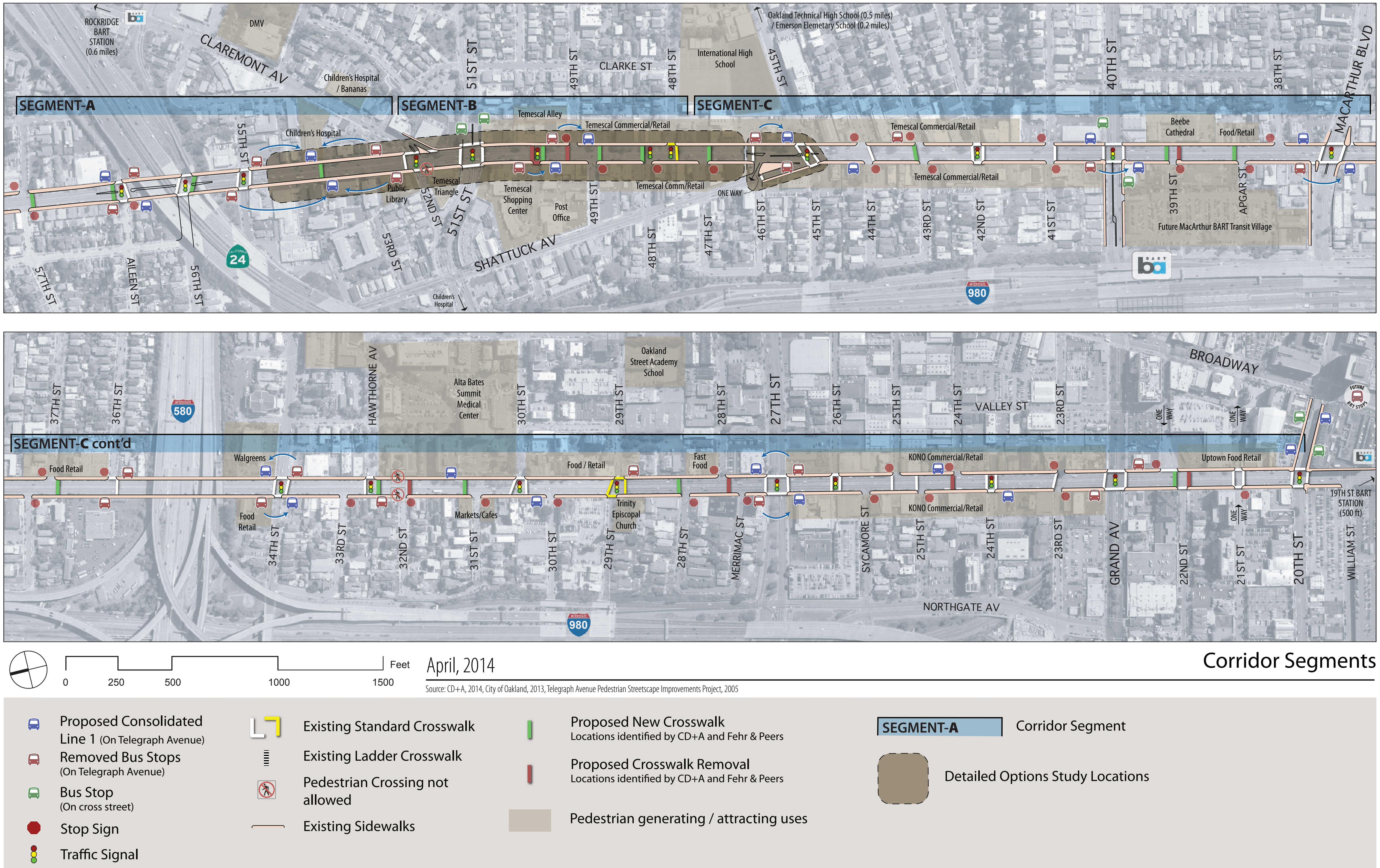


Figure 1: Corridor Segments

Bicycle Infrastructure – Definitions

The Telegraph Avenue Complete Streets Implementation Project considers four categories of bicycle accommodation along the street: cycle tracks, buffered bike lanes, bike lanes, and shared lane markings or "sharrows" (see Figures 2 – 5 for examples of these elements). The National Association of City Transportation Officials[1] (NACTO) has published the NACTO Urban Bikeway Design Guide for design and implementation of bicycle infrastructure, which provides the following definitions of these elements:

Cycle tracks (Figure 2)

"A cycle track is an exclusive bike facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. A cycle track is physically separated from motor traffic and distinct from the sidewalk. Cycle tracks have different forms but all share common elements—they provide space that is intended to be exclusively or primarily used for bicycles, and are separated from motor vehicle travel lanes, parking lanes, and sidewalks. In situations where on-street parking is allowed cycle tracks are located to the curb-side of the parking (in contrast to bike lanes)."

"Cycle tracks may be one-way or two-way, and may be at street level, at sidewalk level, or at an intermediate level. If at sidewalk level, a curb or median separates them from motor traffic, while different pavement color/texture separates the cycle track from the sidewalk. If at street level, they can be separated from motor traffic by raised medians, on-street parking, or bollards. By separating cyclists from motor traffic, cycle tracks can offer a higher level of security than bike lanes and are attractive to a wider spectrum of the public."

Buffered Bike Lanes (Figure 3)

"Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane."

Bike Lanes (Figure 4)

"A Bike Lane is defined as a portion of the roadway that has been designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing traffic conditions and facilitate predictable behavior and movements between bicyclists and motorists. Conventional bike lanes run curbside when no parking is present, adjacent to parked cars on the right-hand side of the street or on the left-hand side of the street in specific situations. Bike lanes typically run in the same direction of traffic, though they may be configured in the contra-flow direction on low-traffic corridors necessary for the connectivity of a particular bicycle route. A bike lane is distinguished from a cycle track in that it has no physical barrier (bollards, medians, raised curbs, etc.) that restricts the encroachment of motorized traffic." Currently, there are bike lanes on both sides of Telegraph Avenue between 57th Street and Alcatraz Avenue.

Shared Lane Markings or "Sharrows" (Figure 5)

"Shared Lane Markings (SLMs), or 'sharrows,' are road markings used to indicate a shared lane environment for bicycles and automobiles. Among other benefits shared lane markings reinforce the legitimacy of bicycle traffic on the street and recommend proper bicyclist positioning. The shared lane marking is not a facility type, it is a pavement marking with a variety of uses to support a complete bikeway network."

"Desirable shared lane marking applications … strengthen connections in a bikeway network … [and] fill a gap in an otherwise continuous bike path or bike lane, generally for a short distance."

1. See the NACTO website at http://www.nacto.org

Bicycle Infrastructure – Interaction with Other Modes

Building upon the NACTO definitions of these elements, the following descriptions by the project team provide additional detail about the ways in which cycle tracks, bike lanes and sharrows affect the interaction between bicyclists and other roadway users:

Cycle tracks

Cycle tracks provide people on bikes the greatest protection from moving vehicles. This is a benefit not only to bicyclists, but to motorists, bus drivers and transit riders as well. Bicyclists using protected cycle tracks are not in the path of through-moving motorists or buses, and they are not in the path of motorists entering and exiting on-street parking spaces or buses arriving at or leaving transit stops. This provides greater reliability and convenience for bicyclists as well as drivers, bus operators and transit patrons. Additionally, when designed with an adequate buffer between on-street parking and the bicycle throughway, cycle tracks keep bicyclists out of the "door zone" of parked cars.

However, because cycle tracks are located between the parking lane (when on-street parking is present) and the sidewalk, bicyclists are restricted to width of the cycle track alone, which makes avoiding obstructions in the lane more difficult, including slower bicyclists. Furthermore, pedestrians entering and exiting parked vehicles and transit islands must cross the path of cyclists. Properly designed facilities provide adequate sight lines and space to accommodate such interactions safely. There are a variety of special design solutions for cycle tracks at intersections, depending on the need for right and left vehicle turn lanes, the presence of bus stops, and other conditions.

Buffered Bike Lanes

Buffered bike lanes provide people on bikes less protection from moving vehicles than cycle tracks, but greater protection than standard bike lanes or sharrows. Bicyclists using buffered bike lanes are not in the path of through-moving motorists or buses, but they are in the respective paths of motorists and buses accessing on-street parking and transit stops, as well as right turns. Buffered bike lanes can easily be blocked by vehicles double-parking, especially because the buffer actually provides a wider area for vehicles choosing to double-park. However, because they are not separated from the adjacent travel lanes, bicyclists can navigate around these and other obstructions by "taking the lane." While properly sized and marked buffered bike lanes provide adequate space to avoid the "door zone" of parked vehicles, bicyclists are not physically buffered from this zone.

Bike Lanes

Bike lanes are similar to buffered bike lanes as described above, but lack the painted buffer on one or both sides of the bike lane and thus position bicycles closer to moving and parked vehicles. Nevertheless, adequately sized bike lanes create a much safer and more inviting street for people on bicycles that do sharrows. Currently, there are bike lanes on both sides of Telegraph Avenue between 57th Street and Alcatraz Avenue.

Sharrows

Of the four types of bicycle improvements discussed here, sharrows provide people on bikes the least protection from moving vehicles. They are primarily intended for use on low-volume streets, but can be employed on other streets where cycle tracks or bike lanes are not feasible, because of a lack of available right-of-way. When properly implemented, sharrows alert motorists to the presence of bicycles, help position bicyclists in the center of the travel lane and out of the "door zone," and encourage motorists to change lanes when passing bicycles. As with bike lanes, bicyclists using shared lanes are able to maneuver around double-parked vehicles or other obstructions using the full width of the lane, or an adjacent lane if it is present. Brightly colored backings such as blocks or continuous stripes can be used with sharrows to give them a stronger visual presence in the roadway.

Common Interactions and Intersections

Cycle tracks, buffered and standard bike lanes, and sharrows all cross the path of pedestrians entering the street. Therefore, the design of these elements must take into consideration pedestrian safety and ADA detectable warning requirements, and indicate to bicyclists when and where pedestrians have right-of-way, such as at the entry to crosswalks and in accessing transit islands.

Similarly, bicyclists using any of these elements all cross the path of vehicles at intersections, the design of which must take into consideration bicyclist safety, indicating when and where bicyclists have right-of-way.

CROSS SECTION DESIGN OPTIONS

The project team worked closely with City of Oakland staff and consulted with AC Transit staff to develop a selection of potential cross sections for each segment of the corridor. The cross sections show various strategies to incorporate other complete streets improvements, and, as appropriate, alternatives that implement a road diet or do not. There are three (3) primary cross section alternatives for each segment, for a total of nine (9) standard cross section alternatives for the corridor. Within each segment, there are variations to certain cross sections that show how they could be modified to accommodate transit stop improvements as well as safety and mobility enhancements for all modes at the approach to intersections. There are six (6) variant cross sections.

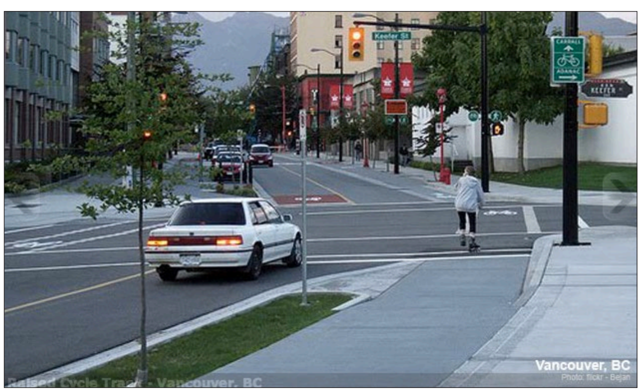
Based on the above description of segment characteristics, the cross section alternatives for each segment generally include the following standard configurations:

- **Segment A alternatives:** maintain four travel lanes, two in each direction, and remove the center turn lane;
- **Segment B alternatives:** maintain four travel lanes, two in each direction, and maintain a center turn lane;
- **Segment C alternatives:** remove two travel lanes, maintain one travel lane in each direction, and maintain a center turn lane.

Table 4 provides an overview of the alternative and variant cross sections. This table indicates the following characteristics:

- **Type:** Which segment(s) each cross section applies to or could be partially applicable to, and curb-to-curb dimensions.
- **Vehicle:** Number of travel and parking lanes, presence of a left turn lane.
- **Transit:** Presence of a dedicated lane for transit stops, potential for improvement of transit stops.
- **Bicycle:** Presence of sharrows (shared lane markings denoting that bikes ride in mixed traffic with vehicles, not in a dedicated bike facility), bike lanes and buffered bike lanes (striping and lane markings demarcating a dedicated lane for bicyclists, generally between the outside travel lane and the parking lane), or cycle tracks (raised or at-grade bicycle facility that is located directly adjacent to the sidewalk and physically separated from the roadway by buffers and/or vehicle parking). See "Bicycle Infrastructure" inset text boxes in this section for a brief description of these various bicycle facilities and markings.
- **Pedestrian:** Potential for placemaking improvements, bulb-outs, and mid-block crossing refuges.
- **Overall:** Potential to advance the goals described in the project purpose statement.

Raised Cycle Track - Concept Illustration



Raised cycle track: Vancouver, BC
Flickr user: Bejan

Raised cycle track: Cambridge, MA
www.westsideaction.wordpress.com

Figure 2: Cycle Tracks

Source for all images on this page:
NACTO Urban Bikeway Design Guide - http://nacto.org/cities-for-cycling/design-guide/cycle-tracks/raised-cycle-tracks/

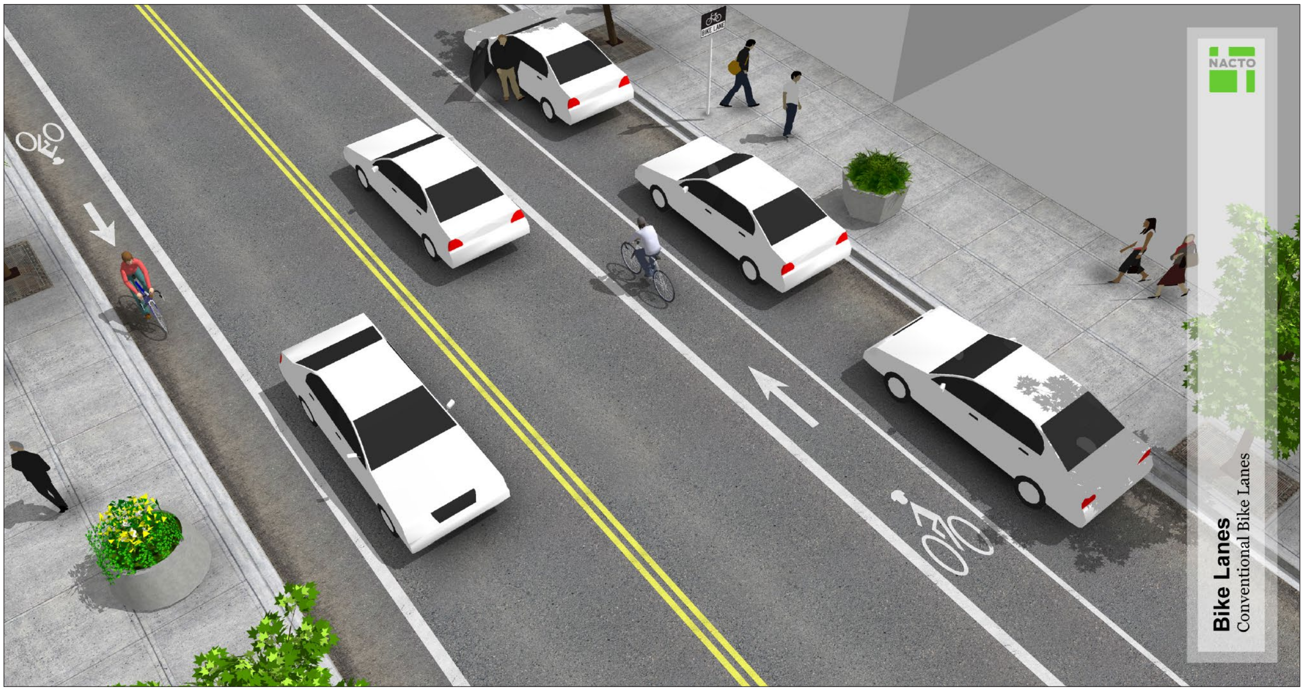
Buffered Bike Lanes - Concept Illustration

Buffered bike lanes: New York, NY

Buffered bike lanes: Portland, OR

Figure 3: Buffered Bike Lanes

Source for all images on this page:
NACTO Urban Bikeway Design Guide - http://nacto.org/cities-for-cycling/design-guide/bike-lanes/buffered-bike-lanes/



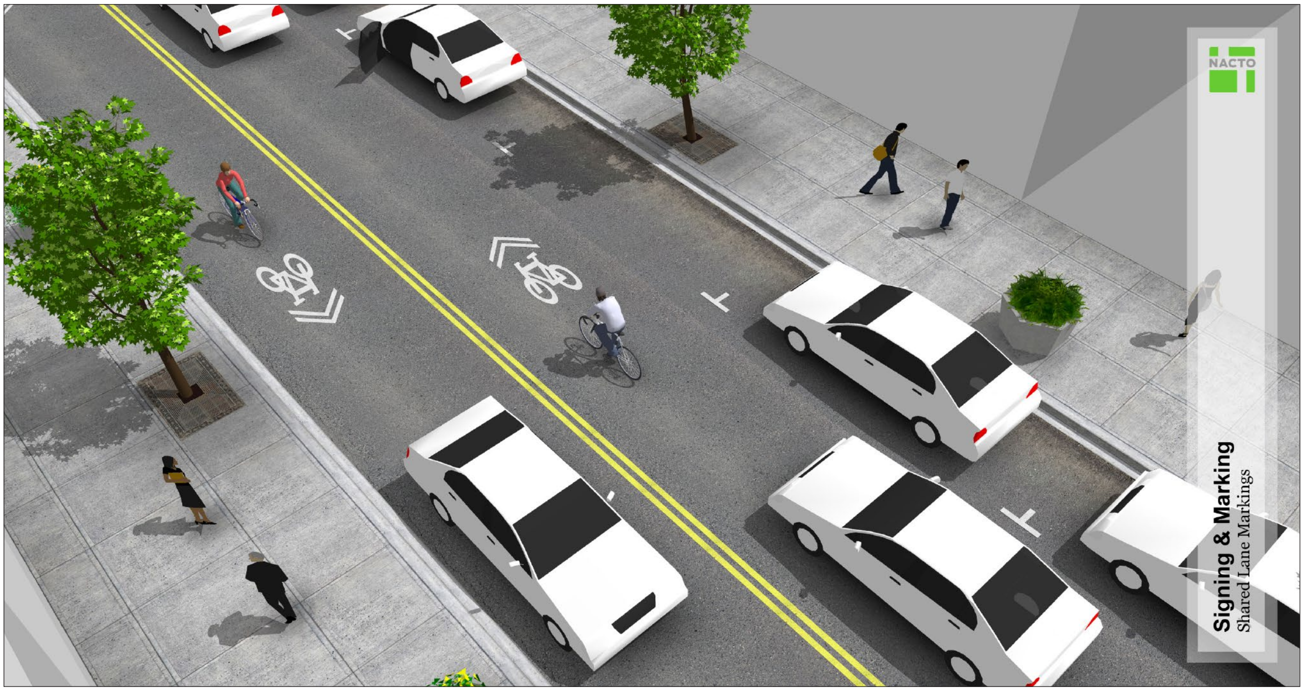
Bike Lanes - Concept Illustration

Bike lanes: Chicago, IL
CDOT

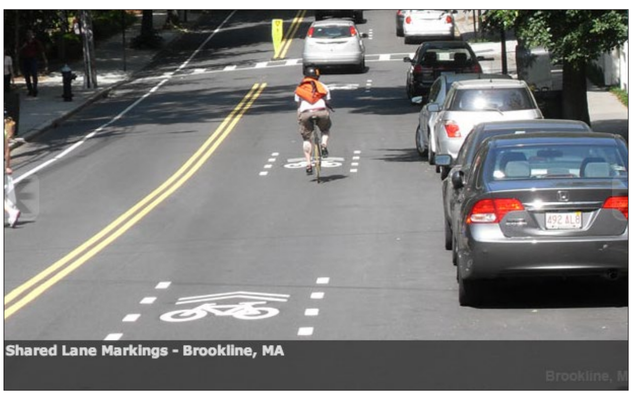
Bike lanes: San Francisco, CA
www.pedbikeimages.org - Dan Burden

Figure 4: Bike Lanes

Source for all images on this page:
NACTO Urban Bikeway Design Guide - http://nacto.org/cities-for-cycling/design-guide/bike-lanes/conventional-bike-lanes/



Shared Lane Markings ("Sharrows") - Concept Illustration



Shared lane markings ("sharrows"): Brookline, MA

Shared lane markings ("sharrows"): Long Beach, CA

Figure 5: Shared Lane Markings

Source for all images on this page:
NACTO Urban Bikeway Design Guide - http://nacto.org/cities-for-cycling/design-guide/bikeway-signing-marking/shared-lane-markings/

Within Table 4, there are additional categories indicating the "potential" for various characteristics. The following descriptions provide additional detail as to how that potential is assessed and its implications. Note that many of the design features mentioned below are described in greater detail in the Streetscape and Urban Design Concepts section of this report.

Transit Stop Improvement Potential

Transit Stop improvement potential is determined by a combination of the proposed bicycle facilities and road diet. In cross sections that feature cycle tracks along with a road diet the potential is rated high, because additional right-of-way can be devoted to creating transit islands (i.e., bulb-outs that allow the bus to remain in a travel lane and approach the stop without shifting into the parking lane). In cross sections that feature buffered or standard bike lanes and a limited or no road diet, the potential is rated medium, because it is more difficult to accommodate transit islands on one or both sides of the street given the combined width of the other elements in the cross section. Therefore, improvements would be limited to stop amenities, furnishings, and upgrading of signal priority systems.

In several cross sections, bicycle facilities are routed behind a transit island, maintaining a separation between buses and bicyclists where they typically conflict with one another—transit stops. These transit stop configurations are illustrated in variant cross sections and the Streetscape and Urban Design Concepts section of this report.

Placemaking Potential

Placemaking potential is determined by the relative capacity in each cross section to accommodate improvements to the pedestrian environment, including safety improvements (see the related bulb-out and mid-block crossing refuge descriptions, below) as well as trees, other landscaping, and public open space. In particular, cross sections that feature a cycle track create an additional buffer between pedestrians and vehicles and improve the sense of place along the street edge, more so than bike lanes and sharrows.

Bulb-out Potential

Bulb-out potential is affected by the presence or absence of on-street parking. Where both sides of the street provide on-street parking, the potential to include bulb-outs is indicated as high; where only one side of the street provides on-street parking, the potential is indicated as medium. In locations where a cycle track is present, but no on-street parking is provided, bulb-out potential is indicated as medium, because the buffering of the cycle track provides the opportunity for a pedestrian refuge that effectively shortens the crossing distance for pedestrians, serving a similar purpose as a bulb-out.

Median Refuge Potential

Median refuges are feasible in cross sections that feature a left turn lane. Throughout the corridor, numerous offset cross streets create T-intersections where only one direction of vehicular travel on Telegraph uses the left turn lane. In place of the left turn lane on the opposite side of the intersection, a painted or constructed refuge can be provided to shelter pedestrians as they cross the street. In addition, median refuges can be provided in locations with low left turn volumes.

Potential to Advance the Project Purpose Statement

Potential to advance the project purpose statement is a summary rating that evaluates each cross section's achievement in improving multi-modal safety, improving transit performance and transit rider experience, accommodating bicyclists, and creating a safer and more engaging pedestrian environment.

ALTERNATIVE CROSS SECTION EVALUATION

The following section describes how the conditions within each segment led to development of that segment's three primary alternative cross sections. This description is followed by a review of the ratings provided in Table 4, and a narrative evaluation of the alternative cross sections' performance.

While each cross section is tailored to a specific segment, it is feasible that certain cross sections may apply in more than one segment, which should be considered in the forthcoming stage of determining the preferred corridor concepts. Cross sections from Segment B could be applicable in Segments A, B, and C, and cross sections from Segment A could be applicable in Segments A and C. However, cross sections from Segment C are likely infeasible in Segments A and B. This is indicated in Table 4 under column titled "Segment."

Additionally, there may be variations beyond the cross sections provided, which could be necessary when transitioning between segments or in accommodating unique circumstances or atypical roadway configurations along the Telegraph corridor. See Figure 6 for illustrations of these cross sections and their variants, labeled A1 through C6, as well as cross sections illustrating existing conditions.

Table 4: Cross Section Evaluation Matrix

SECTION		TYPE		VEHICLE			TRANSIT		BICYCLE				PEDESTRIAN			OVERALL
	NAME	SEGMENT (POTENTIALLY APPLICABLE)	CURB-TO-CURB DIMENSION	TRAVEL LANES	LEFT TURN LANE	PARKING LANE	DEDICATED LANE FOR TRANSIT STOP	TRANSIT STOP IMPROVEMENT POTENTIAL	SHARROW	BIKE LANE	BUFFERED BIKE LANE	CYCLE TRACK	PLACEMAKING POTENTIAL	BULB-OUT POTENTIAL	MEDIAN REFUGE POTENTIAL	POTENTIAL TO ADVANCE THE PROJECT PURPOSE STATEMENT
	EXISTING CONDITIONS - TYPICAL	B, C	70'	4	Y	2	N	M to H	-	-	-	-	M	H	H	L
	EXISTING CONDITIONS - HWY. 24	(A)	80'	4	Y	2	N	L	-	-	-	-	L	L to M	L	L
A1	4-LANE W/ CYCLE TRACK TWO-WAY	A (C)	68'	4	N	1	-	H	✓	-	-	✓	H	H	L	H
A2	4-LANE W/ CYCLE TRACK-SPLIT	A (C)	68'	4	N	1	-	H	-	-	-	✓	H	M	L	H
A3	4-LANE W/ BIKE LANES	A (C)	68'	4	N	2	-	M	-	✓	-	-	L	H	L	M
	A4 (VARIATION ON A2 & A3 @ BUS BULB)	A (C)	68'	4	N	0	Y	-	-	✓	-	✓	H	H	L	H
	A5 (SPECIAL VARIATION @ HWY. 24)	A (C)	80'	4	Y	0	N	-	-	✓	-	-	L	L	M	M
B1	5-LANE W/ CYCLE TRACK-SPLIT	B (A,C)	70'	4	Y	0	-	H	-	-	-	✓	H	M	H	H
B2	5-LANE W/ BIKE LANES	B (A,C)	70'	4	Y	1	-	M	-	✓	-	-	L	M	H	M
B3	5-LANE W/ SHARROWS	B (A,C)	70'	4	Y	2	-	H	✓	-	-	-	L	H	H	L
	B4 (VARIATION ON B1-B2 @ BUS BULB)	B (A,C)	70'	4	Y	0	Y	-	-	✓	-	✓	H	H	M	H
C1	3-LANE W/ CYCLE TRACK TWO-WAY	C	70'	2	Y	2	-	H	✓	-	-	✓	H	H	H	H
C2	3-LANE W/ CYCLE TRACK-SPLIT	C	70'	2	Y	2	-	H	-	-	-	✓	H	H	H	H
C3	3-LANE W/ BUFFERED BIKE LANES	C	70'	2	Y	2	-	H	-	-	✓	-	L	H	H	M
	C4 (VARIATION ON C1)	C	70'	2	Y	1	Y	-	-	-	-	✓	H	H	H	H
	C5 (VARIATION ON C2)	C	70'	2	N	1	Y	-	-	-	-	✓	H	H	H	H
	C6 (VARIATION ON C2 AND C3)	C	70'	2	N	0	Y	-	-	✓	-	✓	M to H	H	H	H

KEY:	
Y	YES
N	NO
L	LOW POTENTIAL
M	MEDIUM POTENTIAL
H	HIGH POTENTIAL

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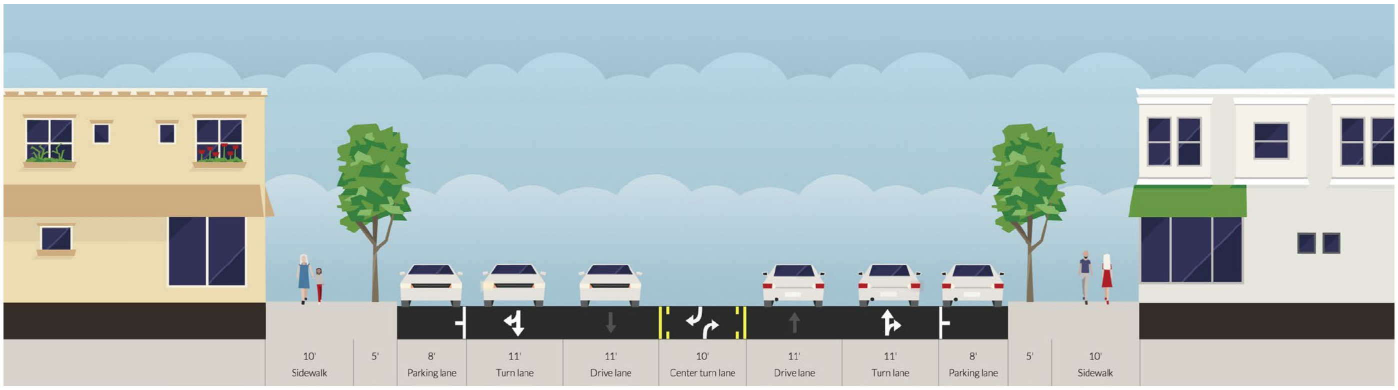
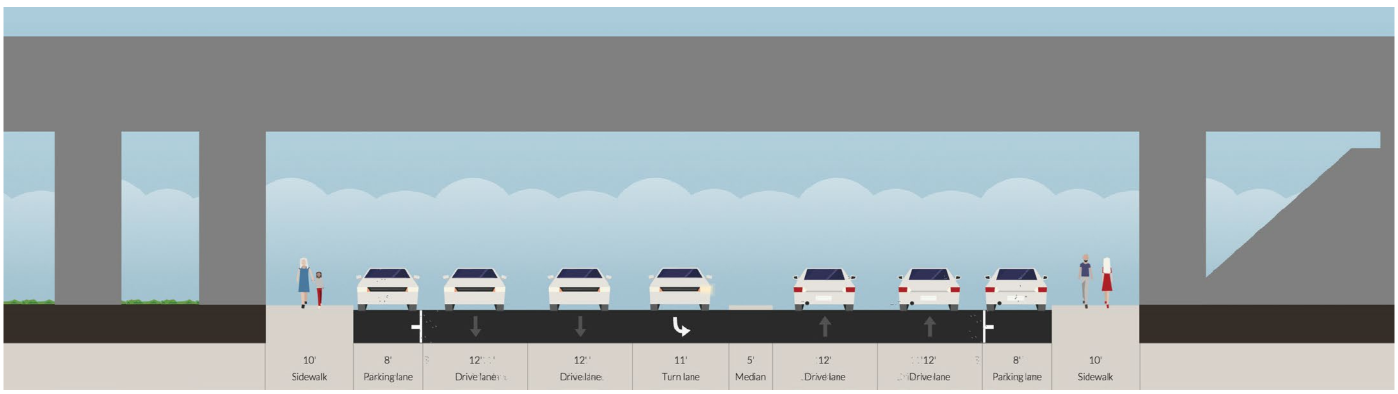
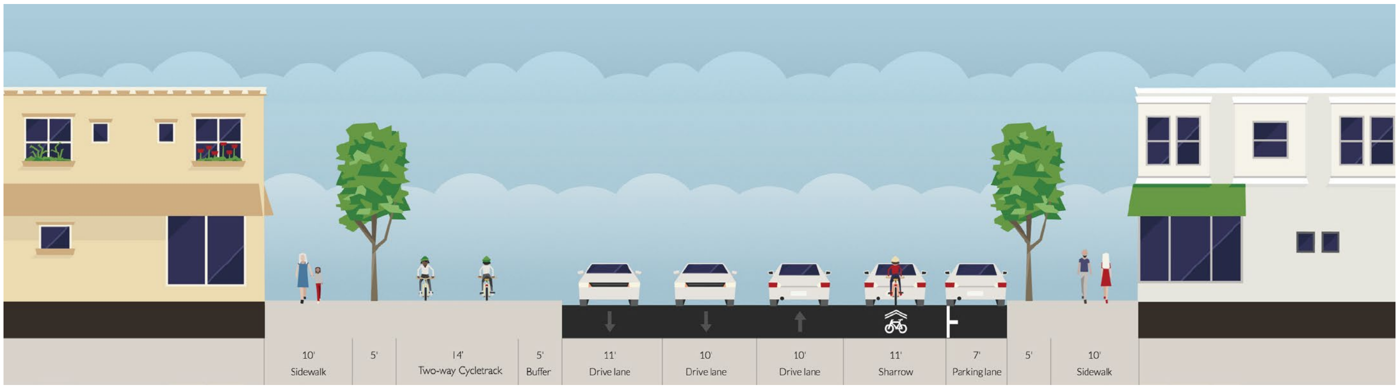


EXISTING CONDITIONS - TYPICAL

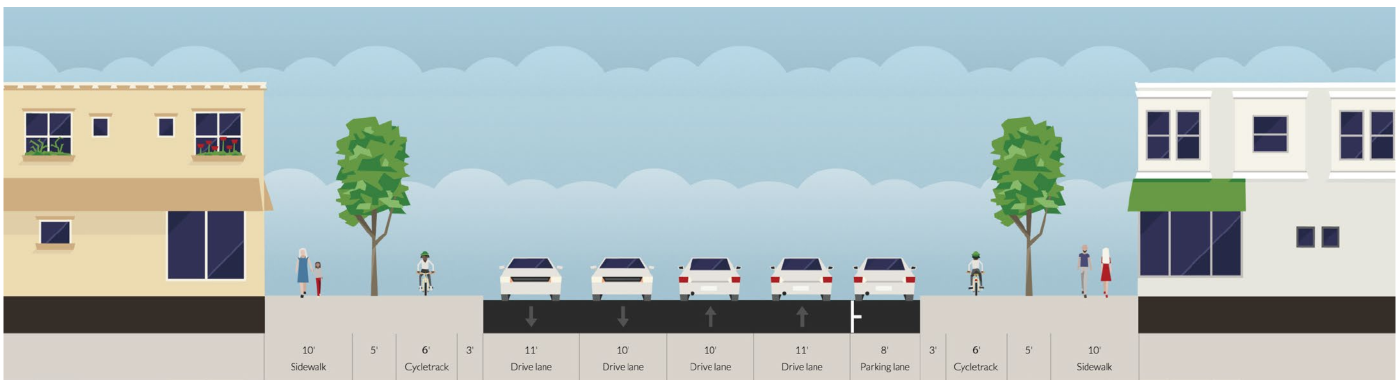


EXISTING CONDITIONS - HWY 24 OVERPASS

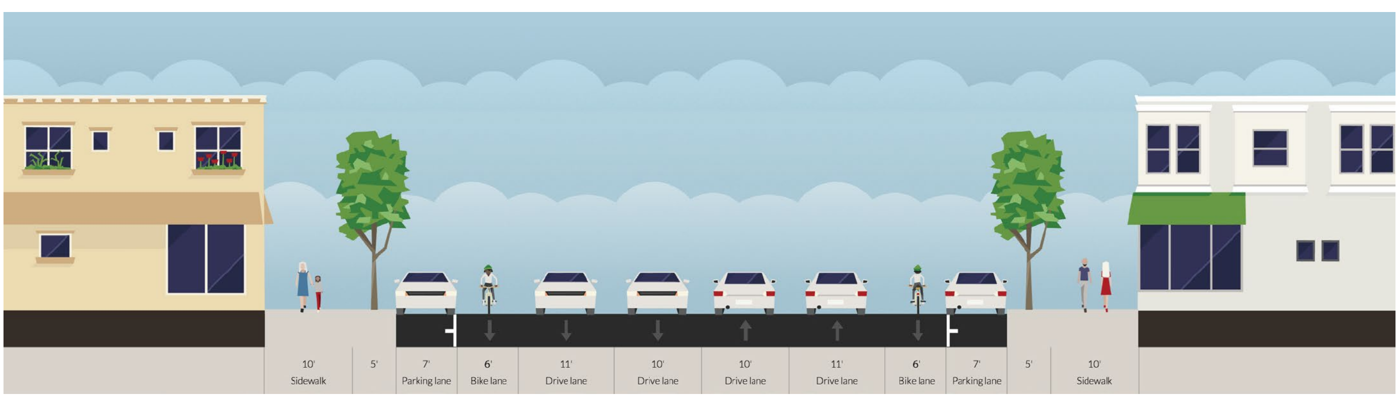
Figure 6 - Part I: Cross Sections Showing Existing Conditions
Note: These cross sections were developed with the aid of www.streetmix.net which allows users to design and share their own streets.



A1 - 4 LANE with CYCLE TRACK (TWO-WAY)

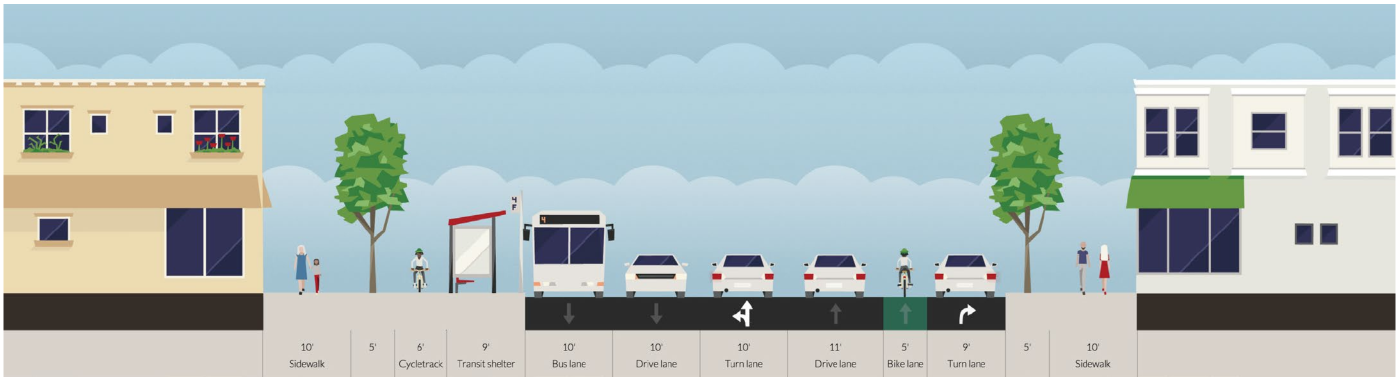


A2 - 4 LANE with CYCLE TRACK (SPLIT)

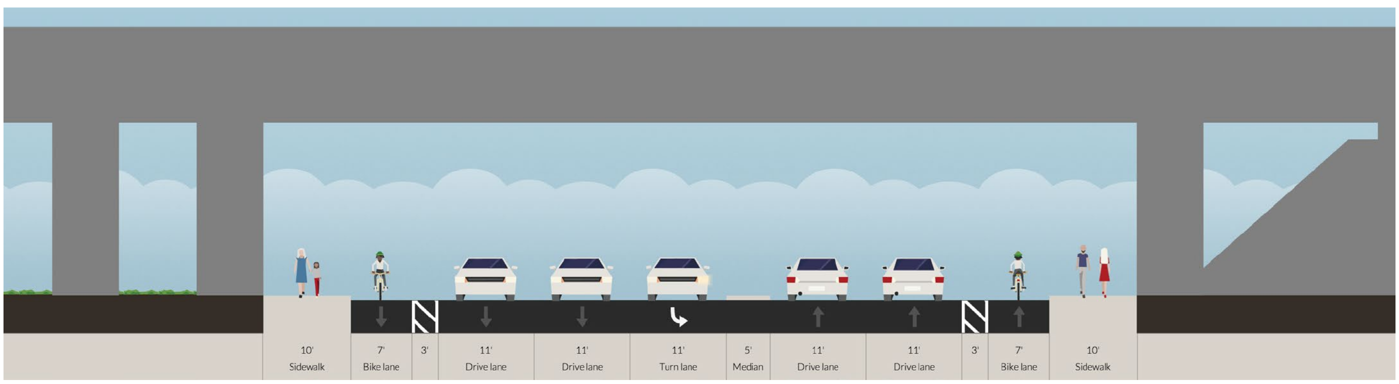


A3 - 4 LANE with BIKE LANES

Figure 6 - Part II: Cross Sections Showing Options for Segment A

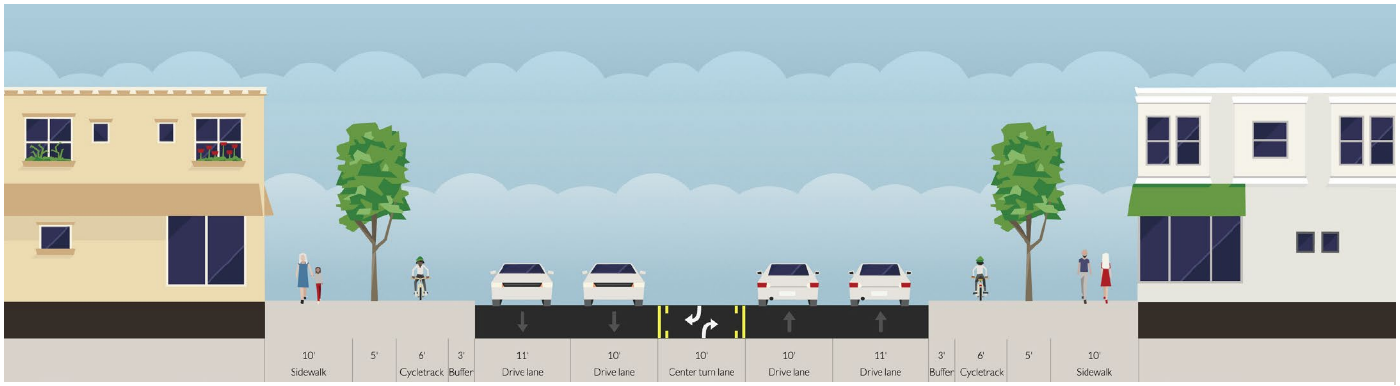


A4 - (VARIATION on A2 & A3 at BUS BULBOUT)

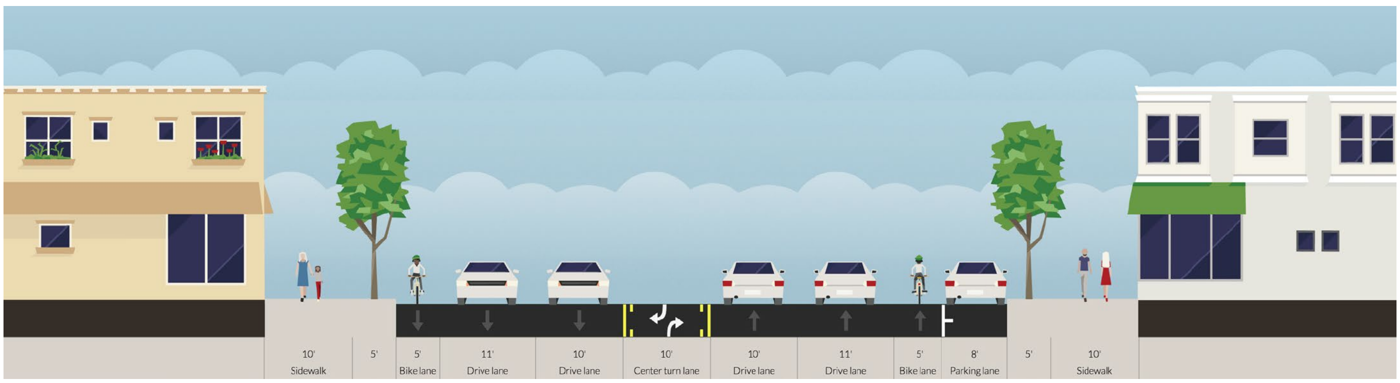


A5 - (SPECIAL VARIATION at HWY 24 OVERPASS)

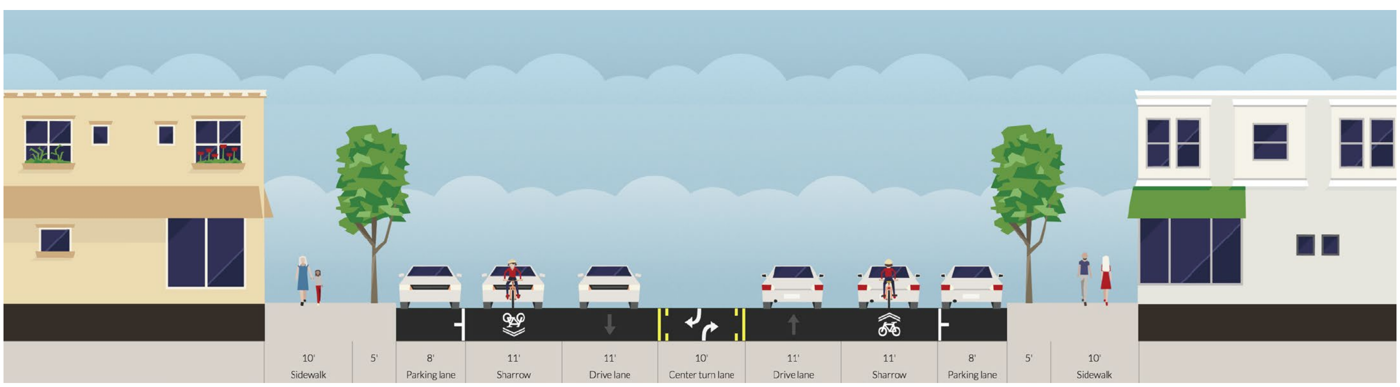
Figure 6 - Part II continued: Cross Sections Showing Options for Segment A



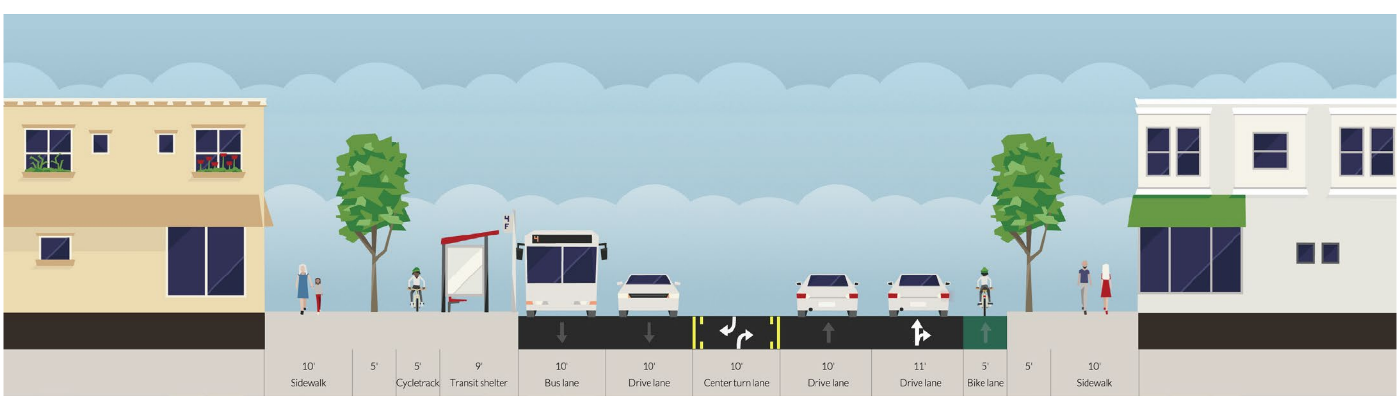
B1 - 5 LANE with CYCLE TRACK (SPLIT)



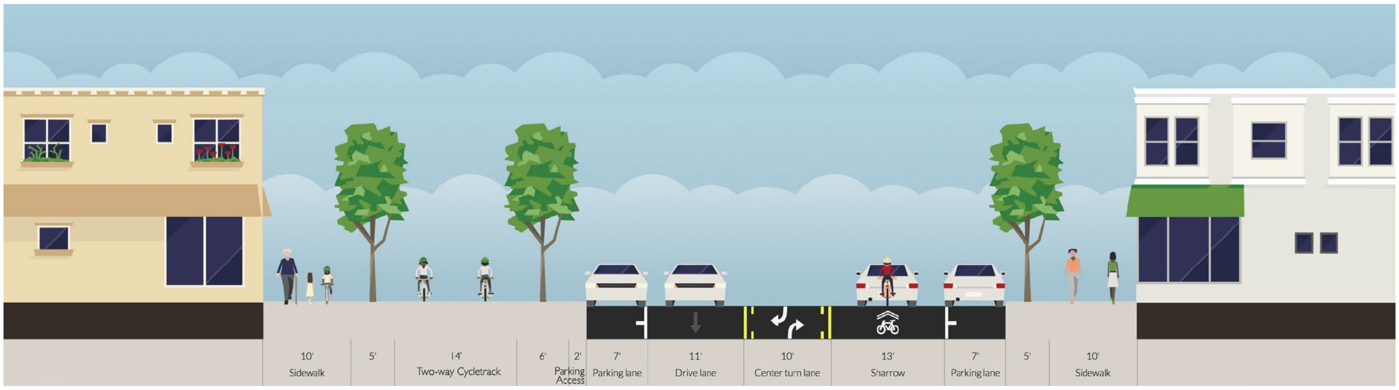
B2 - 5 LANE with BIKE LANES



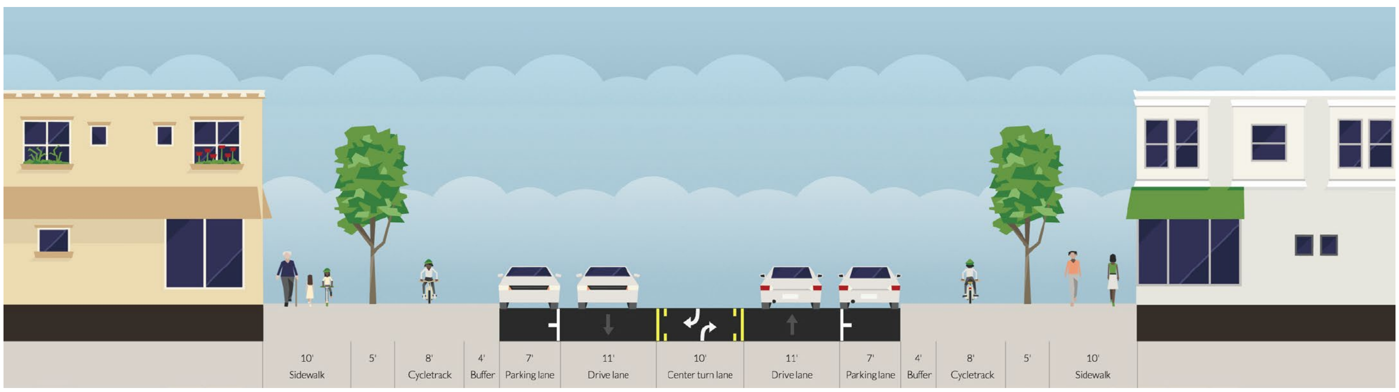
B3 - 5 LANE with SHARROWS



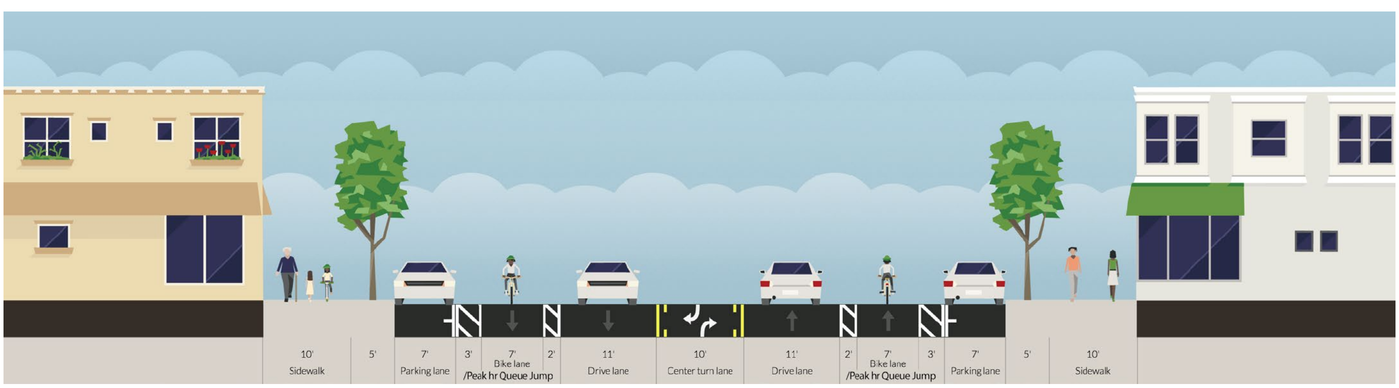
B4 - (VARIATION on B1 & B2 at BUS BULBOUT)



C1 - 4 LANE with CYCLE TRACK (TWO-WAY)



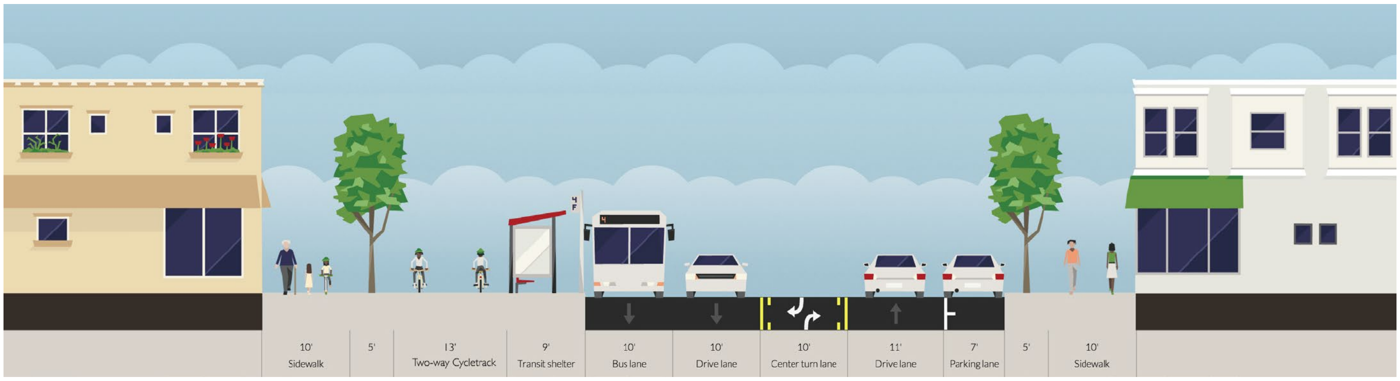
C2 - 4 LANE with CYCLE TRACK (SPLIT)



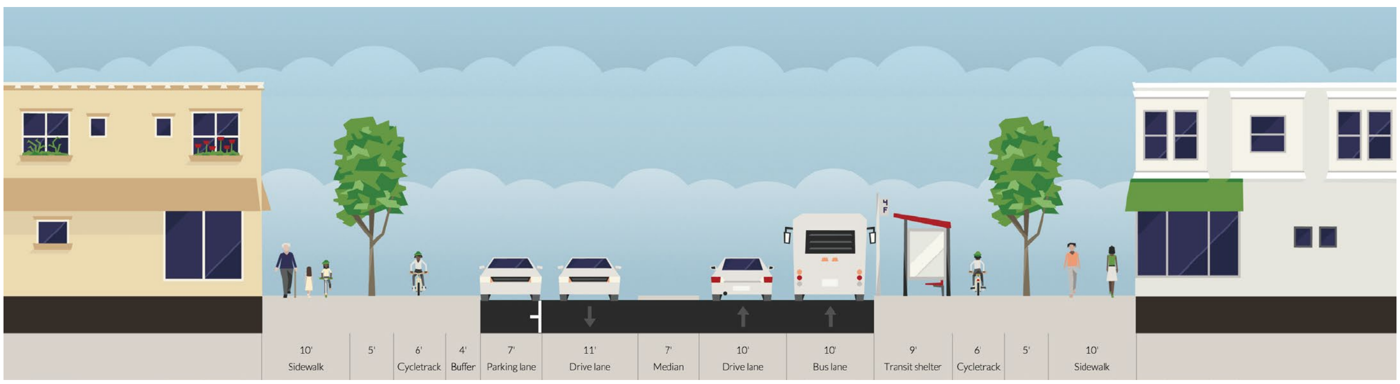
C3 - 4 LANE with BUFFERED BIKE LANES

← *Figure 6 - Part III: Cross Sections Showing Options for Segment B (left)*

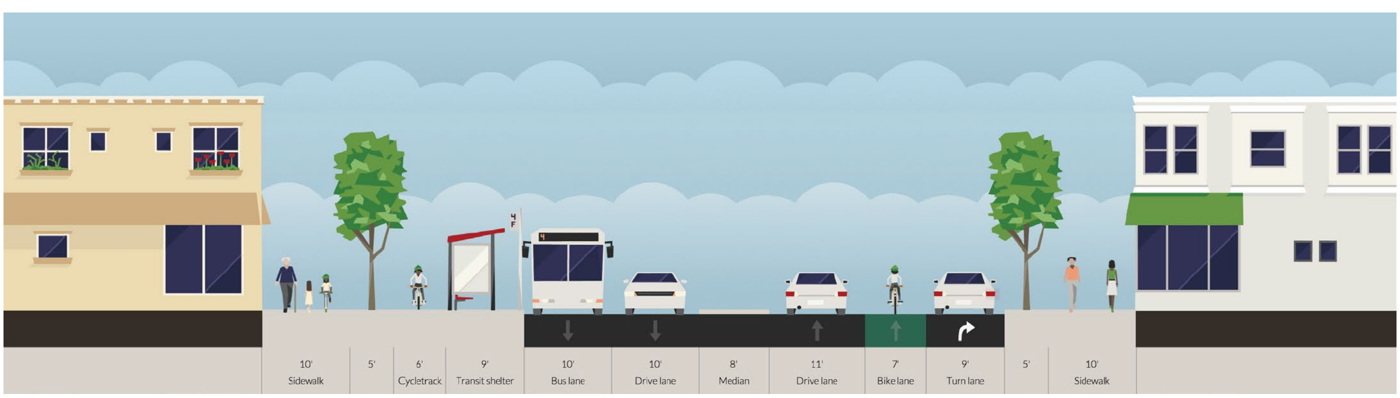
↑ *Figure 6 - Part IV: Cross Sections Showing Options for Segment C (above)*



C4 - (VARIATION on C1)



C5 - (VARIATION on C2)



C6 - (VARIATION on C2 and C3)

Figure 6 - Part IV continued: Cross Sections Showing Options for Segment C

SEGMENT A – CROSS SECTIONS

Description

While Segment A has the highest vehicle volumes in the corridor, intersection LOS is better than in Segment B, in part because there is much lower demand for left turn movements north of the Claremont Avenue/52nd Street intersection. This makes it feasible to remove the continuous left turn lane between that intersection and the Highway 24 on/off-ramps. In addition, there is lower observed demand for on-street parking throughout this segment, and fewer of the uses that typically rely on on-street parking for customers. As such, Segment A can achieve a road diet through removal of the left turn lane as shown in cross section alternatives A1, A2, and A3, and/or removal of one parking lane as shown in cross sections A1 and A2. Under the Highway 24 overpass, a left turn lane is necessary to maintain safe vehicle access to the eastbound Highway 24 on-ramp; however, parking could be removed as shown in cross section variant A5 to allow for bicycle facilities.

Evaluation

Within Segment A, the potential for pedestrian improvements is similar for cross sections A1 and A2. While the absence of a center turn lane precludes a median refuge in all three alternatives, the potential for placemaking afforded by the cycle tracks in A1 and A2 is rated high. Bulb-out potential for A1 is rated high because the two-way cycle track would be combined with a standard bulb-out on the far side where on-street parking is located. A2 is rated medium in this category because the split cycle tracks have the effect of narrowing the pedestrian crossing distance like a bulb-out. A3 has a low rating for placemaking potential, because the presence of bike lanes outside the parking lane does not significantly improve the quality of the pedestrian environment; however, with on-street parking on both sides of the street, bulb-out potential is rated high. Cross sections A1 and A2 receive high overall ratings because of their high pedestrian and transit improvement ratings, and because they both accommodate bicyclists with a protected cycle track. A3 receives a medium overall rating because of more limited transit improvement potential and lower pedestrian ratings, and because it provides unprotected bike lanes to accommodate bicyclists, rather than protected facilities.

Conclusion

The two-way cycle track featured in cross section A1 makes this concept significantly different than A2 and A3. A two-way cycle track generates counter flow bicycle travel (cyclists riding in the opposite direction of adjacent vehicular traffic). These facilities often require bicycle-only traffic signal phases, and require cyclists to cross the street to connect with one-way bicycle infrastructure at either end of the two-way segment. The high volumes of vehicle traffic in this segment would likely be negatively affected by the delays caused by a bicycle-only signal phase and the complexity of linking to one-way bicycle facilities. Considering this, alternative A1 may prove too costly and complex a concept to be feasible, though further study could prove worthwhile if stakeholders and the City's project team determine this concept to have other benefits that outweigh these concerns.

Barring that, it is more likely that cross section A2 or A3 would provide a cost-effective complete street improvement in Segment A. Alternatively, cross section B1, described in the next subsection, could be considered in Segment A, because it provides four through travel lanes and a left turn lane at the Highway 24 eastbound on-ramp and at the Claremont Avenue/52nd Street intersection.

SEGMENT B – CROSS SECTIONS

Description

Segment B is the most constrained segment within the corridor, creating significant challenges to achieving a more complete street. Because of this segment's vehicle volumes and levels of intersection congestion, existing travel lanes and the left turn lane are likely to remain. As such, the designs developed for this segment achieve higher-quality bicycle improvements by removing parking on one or both sides of the street, as illustrated in cross sections B1 and B2. While the demand for on-street parking is high, the Temescal parking study, referenced above, indicates there are opportunities to create additional metered parking on side streets to help facilitate removal of on-street parking to facilitate these design concepts, which create space for dedicated bike facilities. If this cross section becomes a preferred option for Segment B, it may be worthwhile to determine where additional parking could be metered to provide a reduction in on-street parking loss. Cross section B3 illustrates a design that does not include a reduction in the extent of vehicular elements of the cross section, wherein bicyclists are accommodated in the outside travel lanes, shared with autos and buses.

Evaluation

Within Segment B, potential for pedestrian improvements is relatively even across the alternative sections, with all alternatives capable of providing mid-block refuges and bulb-outs. Placemaking potential is rated high for cross section B1, given the presence of the cycle track between the on-street parking and sidewalk, resulting in a more engaging and active pedestrian realm. B2 and B3 have low placemaking ratings, because bike lanes and sharrows provide minimal improvement to the quality of the pedestrian experience. Cross section B1 has the highest potential to advance the project purpose statement due to high ratings for placemaking and transit stop improvement potential, and for accommodating bicyclists in a protected cycle track. B2 has a medium overall rating, because of a low placemaking rating, medium transit stop improvement potential (because significant physical improvements would likely only be possible in one direction, on the side with parking removed), and for accommodating bicyclists with bicycle lanes, but no buffer. B3 has the lowest overall rating, because it has a similarly low placemaking potential and it does not accommodate bicyclists in a dedicated bike facility, despite high potential for improving bus stops with transit islands.

Conclusion

Cross section B1 provides the greatest benefit to pedestrians, bicyclists, and transit patrons within Segment B. If removing parking on both sides of the street were feasible, it would facilitate implementation of a more complete street design, preventing a potential gap in dedicated bicycle facilities through this segment. However, it is unlikely that parking can be removed from both sides of the street because of the high demand from adjacent businesses. Cross section B2 provides continuous bicycle facilities and maintains parking on one side of the street. This approach may prove feasible in conjunction with the implementation of parking strategies such as metering side streets to provide replacement (or potentially even additional) on-street parking capacity for businesses. If removal of on-street parking is deemed infeasible throughout this segment, cross section B3 provides the only solution that acknowledges the desire to provide bicycle facilities through Segment B. While sharrows do not achieve the desired level of bicycle accommodation given project goals, cross section B3 does provide a reminder to roadway users of the presence of bicyclists on the Telegraph corridor, and provides a link between the more robust bicycle facilities proposed for Segment A and Segment C. A bicycle treatment that could be considered in Segment B, called "Super-sharrows", combines sharrow markings with high visibility green backing in blocks or as a continuous strip. The latter format is currently being evaluated through an experiment on 40th Street.

SEGMENT C – CROSS SECTIONS

Description

Segment C is the least constrained segment in the corridor, creating great opportunities for the design of a more complete street. With the relatively low vehicle volumes in this segment, it is feasible for this segment to operate with one travel lane in each direction, a left turn lane, and on-street parking on both sides of the street. A road diet of this nature provides great flexibility for the design of high quality transit, bicycle and pedestrian improvements, as shown in this segment's alternative cross sections: Cross section C1 shows a two-way cycle track, C2 shows a pair of one-way cycle tracks, and C3 shows buffered bike lanes. The flexibility inherent in these cross sections also allows for many variants: Cross section C4 accommodates the two-way cycle track along with a transit island and bus pull-out lane and one lane of on-street parking, C5 shows the same configuration but with one-way cycle tracks, and C6 shows a transit island and bus pull-out lane with cycle track behind, as well as a raised median, through bike lane, and right turn lane.

Evaluation

Cross sections C1, C2 and C3 all receive high overall ratings, because of equally high ratings for transit stop improvement potential, and high bulb-out and mid-block refuge potential. C1 and C2 have high placemaking potential because of the improvements to the pedestrian realm made by the protected cycle track, while C3 has a low rating for placemaking potential because the presence of bike lanes outside the parking lane does not significantly improve the quality of the pedestrian environment.

Note that a road diet of this nature is likely to have dramatic traffic calming effects and improve safety for all roadway users within Segment C. As vehicles are restricted to one through lane in each direction, there is greater reliability in traffic movements and less variability in travel speeds. The dangers associated with changing lanes and speeding are reduced. Maintaining the center turn lane provides space for vehicles accessing cross streets and driveways to wait for a safe break in on-coming traffic, without affecting traffic in the lane behind them. The requirement to cross only one through-lane of traffic in each direction that results from the road diet combined with bulb-outs and median refuges creates a vastly improved pedestrian crossing experience. This will improve the link between opposite sides of Telegraph throughout Segment C, helping to create a more cohesive and walkable corridor which should support the continued improvement of economic vitality in this segment.

Conclusion

Despite the lower traffic volumes and higher intersection LOS in Segment C, the two-way cycle track featured in cross section C1 has the same complex and costly signal design requirements described for cross section B1 above, and the complexities of transitions to one way bicycle infrastructure adjacent to the segment. Thus it is an unlikely candidate for this segment. However, the high performance of both cross sections C2 and C3 make them excellent alternatives for achieving a more complete street in Segment C, as both provide traffic calming through a road diet, and improve the pedestrian, bicycle and transit environment. C2 has the benefit of additional placemaking potential, and avoids the issue of vehicles double-parking in the buffered bike lane, which would affect C3.

ILLUSTRATIVE PLAN VIEW OF CROSS SECTION OPTIONS

Figure 7 presents a Complete Streets example concept plan covering the entirety of Segment B, with transitions to Segments A and C on either end. While the plan depicts a series of specific cross section options, this is **not a recommendation** for those cross sections in these segments; rather, this plan illustrates how some of the cross sections and their variants look and transition between one another. This concept plan further illustrates how certain cross section options can accommodate complete streets features such as bus bulb-outs, pedestrian crossing improvements, streetscape enhancements, and bicycle facilities. On-street parking remains on one or both sides of the street in this example concept plan; however, minor reductions in on-street parking occur to accommodate bulb-outs, adequate length bus stops, and other improvements.

At the north end of the concept plan area, between 55th and 52nd Streets, the plan shows cross section A3 (4-lane roadway with bike lanes). Moving south, the plan transitions on the approach to 52nd Street, adding a southbound left turn lane and transitioning from a bike lane to a shared vehicle/bike lane, while maintaining the northbound bike lane. Bulb-outs are provided where feasible at the 52nd Street/Claremont Ave intersection, with the slip lane onto northbound Claremont Avenue removed and replaced with a new northbound right turn lane/shared bike through lane on Telegraph Avenue. This change provides a significant improvement for bicyclists and pedestrians crossing Claremont Avenue, and creates a new urban plaza space. The segment between 52nd Street/Claremont Ave and 51st Street is a variant on cross section B3 (5-lane roadway with shared bike lanes). The additional shared right turn lane/bike through lane uses the extra right-of-way available to accommodate a “de facto” third northbound lane, which is often observed during the PM peak hour.

At the intersection of Telegraph and 51st Street, bulb-outs are provided on all four corners. This includes two bus bulb-outs on the east side of Telegraph that serve the Line 12. The bulb-outs also shorten the crossing distances at this intersection, a critical link between neighborhoods and the pedestrian-serving commercial activity in this segment of Telegraph Avenue. Bulb-outs would also increase available pedestrian space at several very constrained corners.

South of 51st Street, the concept plan shows cross section B3 (5-lane roadway with shared bike facilities). The consolidated Line 1/IR bus stop is relocated on the far-side of the signalized entry to the Temescal Shopping Center (referred to as 50th Street), reducing conflicts with vehicles making right turns into that parking lot and improving transit performance. Bulb-outs, a median refuge, and a new crosswalk are added at the intersection with 50th Street, with the extended bulb-out on the east side of Telegraph showing a bicycle corral between the crosswalks. These improvements serve to shorten crossing distances, better protect pedestrians, and create additional sidewalk space.

An alternative concept plan shows cross section B2 (5-lane roadway with bike lanes and parking on one side) between 51st Street and 49th Street. This alternative demonstrates how removing on-street parking on the west side of the street provides space to include bicycle lanes in Segment B. Bicycles would share the outside lane with vehicles and buses to pass the bus stop.

South of 50th Street, the relocated southbound 1/IR bus stop is enhanced as a bus bulb-out, facilitating improved stop entry and egress movements for bus operators, and creating more space for passengers and stop amenities. On the east side of Telegraph, the existing uncontrolled crosswalk at 49th Street is removed, and the northbound 1/IR bus stop is relocated to the south of the 49th Street intersection, where it is also enhanced as a bus bulb-out. A new uncontrolled crosswalk is provided south of this bus stop, along with bulb-outs to shorten crossing distances. Landscaped medians are also provided in the center turn lane where possible, as indicated.

On the southbound approach to 48th Street, the outside travel lane (shared between bicycles and vehicles) becomes a merge lane. At the uncontrolled intersection with 48th Street, a new traffic signal is proposed to create a coordinated east-west signal phase with the currently signalized 48th Street intersection further to the south. This will facilitate not only vehicle but also bicycle through travel on 48th Street, which has been designated a cross-town bikeway connector between Shattuck Avenue and Shafter Avenue. The southbound cycle track begins at the northern leg of 48th Street, and bulb-outs are provided at both existing crossings, along with median refuges, and curbed edge islands to protect the end of the northbound cycle track. A bicycle corral is shown on the expanded bulb-out on the west side of Telegraph at this intersection. South of 48th Street, the concept plan shows cross section C2 (3-lane roadway with cycle tracks).

See Figure 7 on the following 2-page spread

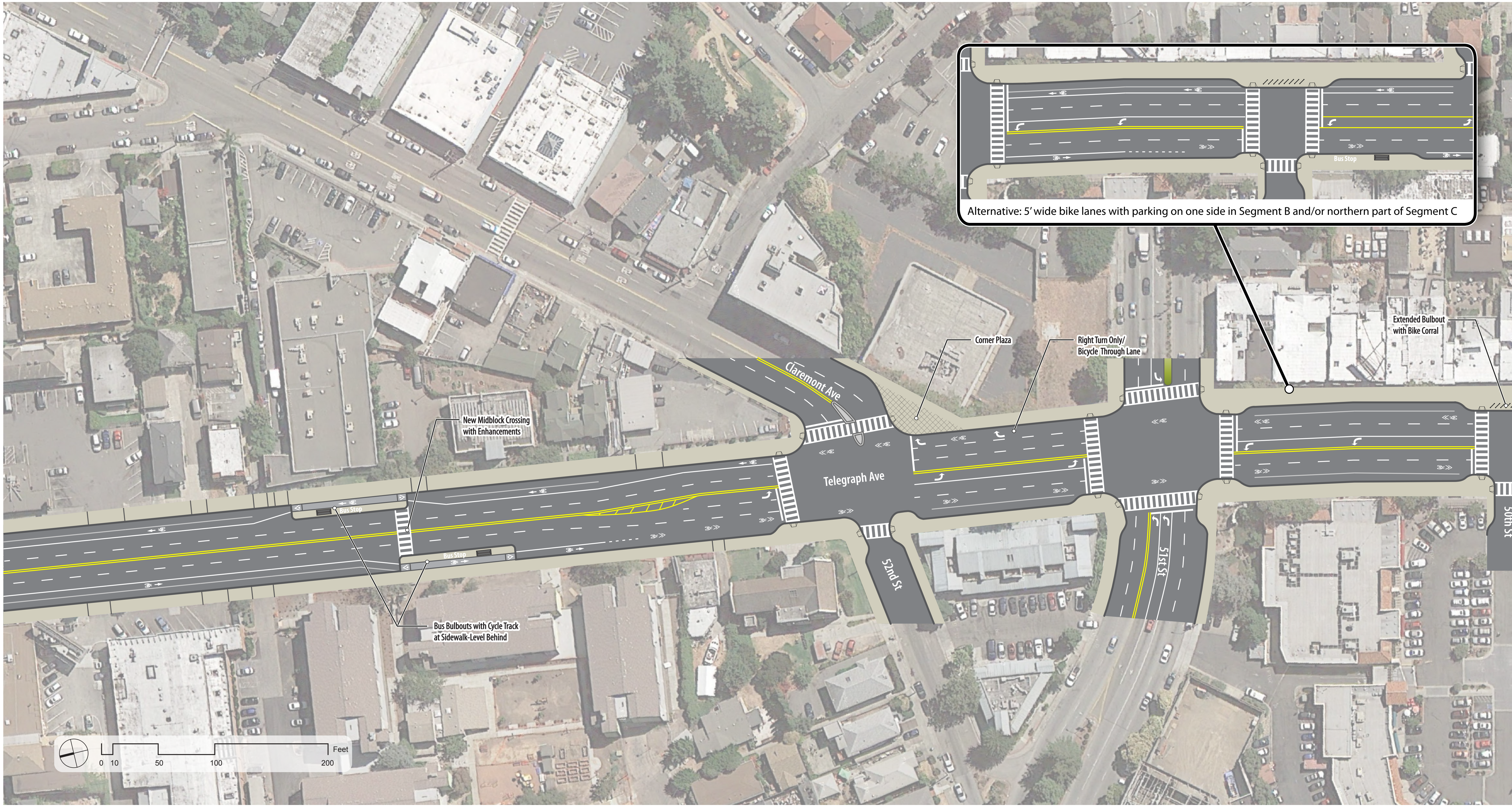


Figure 7 - Part I: Complete Streets Concept Plan

Note: This is not a recommended preferred plan; rather, this is an example to illustrate how various cross section options function in plan, and how they could transition from one segment to another. Also illustrated are various Complete Street features, including bulb-outs, pedestrian crossing improvements, on-street parking, bus bulb-outs and transit islands, landscaping, and pavement-to-parks concepts.

Figure 7 - Part II: Complete Streets Concept Plan

1D
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Yakult Probiotic Drink

BUS STOP AND TRANSIT OPTIONS

The project team evaluated operating speeds of buses on Telegraph Avenue using the equations described in the Transit Capacity and Quality of Service Manual, 3rd Edition (TCQSM). The baseline scenario assumes that lines 1 and 1R will be consolidated into a single line. From the baseline scenario, potential components of the Telegraph Complete Street Project (Project) were added to the bus speed models. These include a road diet, installing transit signal priority (TSP) at all traffic signals, moving bus stops from near-side to far-side at signals, providing queue bypass lanes, and installing bus bulbs where feasible. The analysis proceeds through these components one by one, to clarify the individual and combined effects on bus speed.

In addition to positively affecting speed and reliability, the suite of physical and operational transit treatment options will improve the transit rider (and operator) experience and improve bicycle-transit integration on Telegraph Avenue in several ways:

- **Minimize bus-bicycle conflict in roadway:** A road diet provides sufficient space for separate bicycle lanes or cycle tracks so that bicycles do not have to share the vehicle travel lane with buses. In a shared lane configuration, bus and bicycles "leap-frog" one another (continuously passing each other along the corridor as bicyclists overtake buses at stops and then are passed by the same bus again), which forces buses to change lanes or reduce speed to avoid bicyclists; AC Transit operators who were interviewed as part of this project strongly preferred that bicyclists have their own separate facilities for this reason;
- **Minimize bus-bicycle conflict at bus stops:** Bus bulbs provide opportunities to physically separate bicycles and buses at bus stops by routing bicycles behind the bulb (creating a "transit island"), which provides a lower-stress environment for bicyclists and transit operators;
- **Enable more efficient transit service:** Bus bulbs (and where provided, bus pull-out lanes at stops) provide a more convenient and efficient transit facility for bus operators to access and egress;
- **Enhance pedestrian safety:** A road diet enhances pedestrian crossing safety by reducing crossing distance and eliminating multiple-threat hazards; improving the pedestrian environment is critical for encouraging transit use;
- **Improve transit passenger waiting environment:** Bus bulbs provide additional space for stop amenities and passenger waiting areas, while freeing additional space from existing sidewalks for other amenities, such as landscaping, bike parking, seating and other furnishings;
- **Improve bus speed and reliability:** Transit Signal Priority (TSP) combined with bus stop relocation to the far-side of signals, and queue bypass lanes where implemented, improve service speed and reliability.

As a complete package, the proposed transit and roadway improvements would provide substantial multi-modal benefits to all users of the corridor, including transit riders and operators, pedestrians, and bicyclists, while maintaining or improving transit operating speeds.

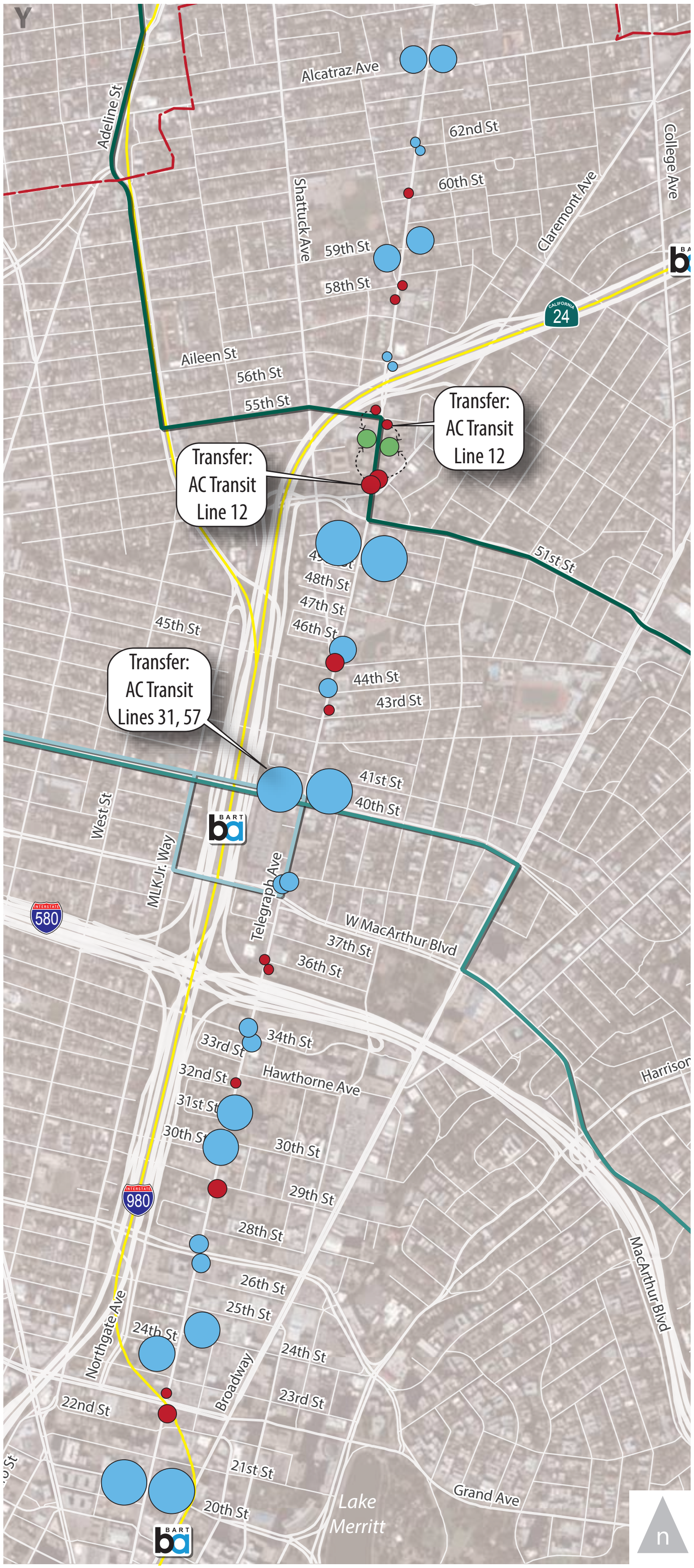

Figure 8: Proposed Line 1 and Line 1R Bus Stop Consolidation

KEY

- Existing Stop to Remain
- Stop Removed
- New Stop

*Average Daily Ridership for Line 1 and Line 1R **

- 0 - 33
- 34 - 92
- 93 - 236
- 237 - 381
- 382 - 700

- AC Transit Line 12
- AC Transit Line 57
- AC Transit Line 31

Notes: Size of circle shows magnitude of daily bus stop ridership

* Daily Ridership (Ons + Offs)

Source: AC Transit, 2013.

BASELINE CONDITIONS

AC Transit plans to consolidate the Line 1 and Line 1R into one line within the timeframe of implementing the Telegraph Complete Street project. The line would serve fewer bus stops than the existing Line 1 but more bus stops than the existing Line 1R. This analysis assumes that the new line would operate at a frequency of approximately 10 buses per hour, which is the combined frequency of Lines 1 and 1R[6].

STOP CONSOLIDATION

AC Transit identified the optimal bus stop spacing of the new line at approximately 4 bus stops per mile. Baseline conditions for the purposes of this study include bus stops with a high existing daily ridership relative to other bus stops in the corridor, while also considering adjacent land uses. Figure 8 presents a map of proposed stop locations for the combined line based on passenger activity of each bus stop. Appendix B provides ridership data.

Baseline conditions assume the following bus stops would be eliminated with the combined line:

- Grand Avenue – both directions
- 29th Street – both directions
- 32nd Street – southbound
- 36th Street – both directions
- 43rd Street – northbound
- 45th Street – southbound
- 60th Street – southbound
- 62nd Street – both directions

The bus stops at 55th Street and Claremont Avenue/52nd Street would be consolidated into mid-block bus stops in both directions.

DWELL TIME ESTIMATE

Dwell time per bus stop (time associated with doors opening/closing and passengers boarding/alighting) is an important source of bus delay and thus a major determinant of bus speed. Since dwell time depends on the number of riders at each stop, riders for the consolidated stops were estimated. The baseline model assumes that the number of riders along the corridor would not change from existing conditions. The model assumes that the Line 1 and Line 1R demand would be combined at all stops and that riders at former bus stops would use the closest remaining bus stops. Passenger demand per bus was adjusted to reflect the increased frequency of the new line.

Using the ridership estimates, the TCQSM methodology was used to estimate future average dwell per bus stop in the baseline models. The models assume that the variation of dwell time does not change between existing Line 1/1R and baseline conditions. The models also assume that 70 percent of passengers would pay with the farebox[7] and that the door opening and closing time would be 3 seconds.

BASELINE OPERATING SPEEDS

Table 5 presents existing segment speeds for Line 1 and 1R and baseline segment speeds for the combined line. Average operating speed generally increases compared to Line 1 but decreases compared to Line 1R. Although Line 1R passengers would experience an increase in in-vehicle travel time with the combined line due to the decrease in speed, they would experience a decrease in out-of-vehicle travel time through an increase in average frequency (from 1 bus every 12 minutes to 1 bus every 6 minutes[8]) and a decrease in walk-access and egress time due to shorter stop spacing. The reduced wait time would more than offset increased in-vehicle travel time for the majority of transit trips on the corridor.

6. Actual frequency will be determined during implementation of the combined route.

7. Based on 30% Clipper Card use across all AC Transit services; Source: AC Transit Staff Report, June 2013

8. Actual change in frequency will be determined during implementation of the combined route.

ROAD DIET

One option under evaluation for Telegraph Avenue within the project area is removal of one through lane in both directions to provide room for enhanced pedestrian and bicycle facilities. This treatment is also known as a "road diet". Increased vehicle delay at traffic signals and increased number of vehicles in the curb lane both affect transit speeds in a lane reduction scenario.

The baseline model was used to test the effect of a road-diet on bus operating speed along the entire study corridor from 20th Street to Alcatraz Avenue. (Note that based on an analysis of auto capacity and level of service (LOS) along the study corridor, a road diet may not be feasible north of 50th Street. However, the analysis includes the entire corridor for completeness.) The road diet was tested for the combined bus line by increasing the auto volume in the curbside lane (one of the inputs to the TCQSM model).

The road-diet would result in a reduction in bus speed in congested roadway segments but would have little effect on speeds in non-congested segments.

Table 6 presents average segment peak hour speeds per direction for baseline conditions with and without a road diet along the study corridor from 20th Street to Alcatraz Avenue. The increase in vehicle volumes in the curbside lane is the only variable that was changed between the two models. Auto volumes in the northbound direction are generally low enough to have a small effect on bus speeds in all segments except from 50th Street to Alcatraz Avenue. Auto volumes in the southbound direction have a substantial effect on bus speeds for almost all of the segments. Various bus treatments can be implemented to mitigate the road diet's impact on bus speed, as described in the following section.

Table 5: Existing Baseline Operating Speeds (in miles per hour)

NORTHBOUND	CORRIDOR AVERAGE		20TH TO 30TH		30TH TO 40TH		40TH TO 50TH		50TH TO ALCATRAZ	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Existing Line 1	10.0	10.3	9.6	9.9	10.9	10.5	9.1	10.1	10.0	10.5
Existing Line 1R	12.5	12.5	11.5	11.5	14.0	13.0	11.5	12.3	12.6	13.1
Baseline (Combined)	11.1	11.4	11.3	11.5	11.8	11.2	10.6	11.4	10.7	11.4
SOUTHBOUND	CORRIDOR AVERAGE		ALCATRAZ TO 50TH		50TH TO 40TH		40TH TO 30TH		30TH TO 20TH	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Existing Line 1	9.8	8.8	10.1	9.3	10.0	8.0	10.1	8.3	9.0	9.0
Existing Line 1R	13.6	11.1	14.3	10.6	13.3	10.6	14.7	11.7	11.7	11.5
Baseline (Combined)	12.0	11.0	11.7	10.9	12.5	11.0	12.8	11.2	11.4	11.1

Table 6: Operating Speeds with Road Diet (in miles per hour)

NORTHBOUND	CORRIDOR AVERAGE		20TH TO 30TH		30TH TO 40TH		40TH TO 50TH		50TH TO ALCATRAZ	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Baseline	11.1	11.4	11.3	11.5	11.8	11.2	10.6	11.4	10.7	11.4
Full Road Diet (without Treatments)	8.7	10.5	11.3	11.2	11.8	11.2	10.6	10.6	**3.8**	9.5
SOUTHBOUND	CORRIDOR AVERAGE		ALCATRAZ TO 50TH		50TH TO 40TH		40TH TO 30TH		30TH TO 20TH	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Baseline	12.0	11.0	11.7	10.9	12.5	11.0	12.8	11.2	11.4	11.1
Full Road Diet (without Treatments)	**6.0**	**3.9**	**4.2**	**3.8**	**4.4**	**3.8**	**4.5**	**3.9**	10.7	**3.9**

BUS TREATMENTS

The road diet scenario presented in Table 6 assumes that there would be no additional changes to the corridor that could improve bus speeds over baseline conditions. Potential transit improvements that are being considered for this project include installation of transit signal priority (TSP), relocation of near-side bus stops to far-side of a traffic signal, and installation of peak-hour queue bypass lanes. In locations where a road diet is not implemented, the project also proposes to install bus bulbs (i.e., curb extensions). These treatments are discussed below and summarized in Table 7.

Transit Signal Priority

The project would implement active TSP at all signals in the study area. At this point in the project, the specifics of the TSP system for Telegraph Avenue have not been determined. Generally, active TSP modifies traffic signal timing as a bus approaches an intersection. The bus would trigger either an extension of the green phase or an early call of the green phase at a TSP-enabled intersection. According to the TCQSM, the green time given to the bus movement is usually no more than 10 percent of the signal cycle. After serving the bus, the signal returns to normal operations within a few cycles. The benefits of TSP include reduction in signal delay and improvement of schedule reliability.

Bus Stop Relocation

Relocating bus stops from near-side to far-side at a traffic signal prevents bus operators from missing a green phase due to passenger boarding and alighting. This is especially important when TSP priority is implemented. A far-side stop also improves the safety of bus operations by removing conflicts between right-turning vehicles and buses, reducing sight-distance issues at intersection approaches, and encouraging pedestrians to cross the street behind the bus.

Peak-Hour Queue Bypass Lanes

Queue bypass lanes are intended to reduce delay associated with traffic signals. The bus would enter a right-turn lane or bus-only lane (bypass lane) upstream of the traffic signal and would continue through the intersection into a far-side stop before pulling back into general traffic. Queue bypass lanes are typically associated with far-side stops. With a bypass lane, the bus would not have a separate signal phase but the treatment could be combined with other TSP treatments such as early green or green extension strategies.

For Telegraph Avenue, right-of-way constraints would require queue bypass lanes to operate in the existing curbside parking lane. The queue bypass lane would only remove parking during the morning and evening when traffic congestion is most heavy. Parking would be restricted at the approach to the intersection to provide sufficient length for a bus to bypass the entire queue. Parking would be restricted downstream of the intersection to provide sufficient space for buses to accelerate and merge with automobile traffic. See Figure 9 for a schematic drawing of the queue bypass configuration. Installing pedestrian crossing bulb-outs would be precluded where peak hour queue bypass lanes are provided because of the need to allow bus access in the parking lane during peak hours.

Bus Bulbs/Curb Extensions

Bus bulbs/curb extensions are generally installed where the existing curb is being used for parking, loading, bus stops, or right-turn lanes. They are often used in areas with high pedestrian activity and high bus ridership because they provide additional waiting area for passengers and space for stop amenities and landscaping. Corridors with high density development generating high pedestrian and transit

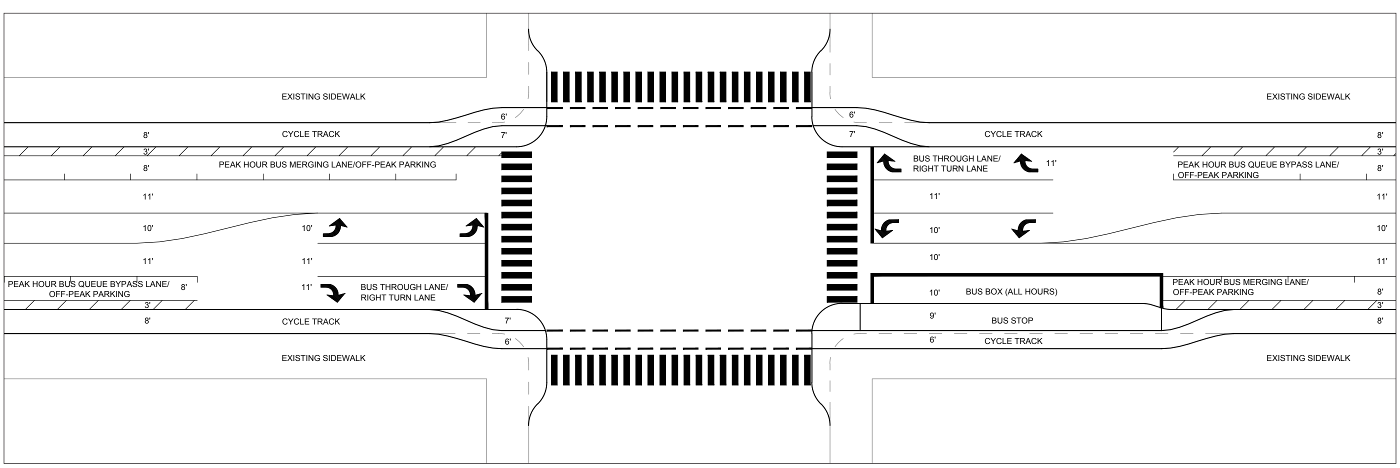

Figure 9: Transit Island with Peak Hour Queue Bypass Lane and Right Turn Lane Option

mode share compared to automobile mode share are also candidates for curb extensions, especially when transit travel time and reliability in the corridor is poor and buses have a difficult time re-entering the traffic flow when leaving bus stops.

Since bus bulbs allow the bus to stop in the travel lane, they impede the flow of traffic in that lane. Therefore, bus bulbs are ideally located on multilane roadways so that traffic can continue to travel in the adjacent lane when a bus is stopped. However, a bus bulb could be installed on roadways with a single lane in each direction if sufficient lane width is provided, allowing traffic to travel around a stopped bus. Examples are shown in Figure 10.

These improvements were applied to the model to quantify their potential to increase bus speeds on the corridor. To account for transit signal priority, the ratio of green time to cycle length at a signal was increased by 10 percent. The models with treatments also assume that all near-side bus stops at a signal would move to far-side with the exception of northbound 50th Street. The project proposes to move the bus stop to near-side of 49th Street. For the scenario with a road diet from 20th Street to 48th Street, the models assume that bus bulbs/curb extensions would be applied at all bus stops north of 48th Street. Within the road diet segment, vehicles will still be able to pass the bus when it is stopped; therefore, bus bulbs were not included south of 48th Street in the speed models.

Table 7: Summary of Bus Treatment Options

TREATMENT	ADVANTAGES	DISADVANTAGES
Transit Signal Priority (TSP)	▪ Reduces traffic signal delay ▪ Improves reliability	▪ Potential signal coordination interruption ▪ Potential impacts on auto delay if intersection is close to capacity ▪ Cross-street traffic and buses might experience higher average delay
Relocating bus stops from near-side to far-side at a traffic signal	▪ Reduces likelihood of missing a green phase at a traffic signal ▪ Improves reliability ▪ Reduces the likelihood of pedestrians crossing in front of the bus	▪ None
Peak-Hour Queue Bypass Lane	▪ Reduces delay associated with traffic signals ▪ Improves reliability	▪ Bus lane must be available and longer than the back of queue ▪ Bus lane is shared with right-turning vehicles at intersection ▪ Requires peak-hour parking removal ▪ Requires enforcement
Bus Bulbs/Curb Extensions	▪ Reduces the time required to serve a bus stop ▪ Provides more room for amenities at bus stops ▪ Reduces pedestrian crossing distance	▪ Blocks one through lane while bus serves passengers ▪ Potential conflicts with bicyclists

Sources: TCQSM, 3rd Edition; Fehr & Peers, 2014

Bus bulb-out concept illustration

Bus bulb-out: San Francisco, CA

Bus bulb-out with bike lane behind: Seattle, WA

Figure 10: Bus Bulb-outs and Transit Island with Bike Facility Integration

Source for all images on this page:
NACTO Urban Street Design Guide - http://nacto.org/usdg/street-design-elements/curb-extensions/bus-bulbs/

PROJECT RESULTS

Table 8 presents average bus speeds for the five scenarios:

- **Baseline:** no project
- **Full Road Diet:** road diet from 20th Street to Alcatraz Avenue
- **Full Road Diet with Treatments:** road diet from 20th Street to Alcatraz Avenue plus TSP and relocating bus stops from near-side to far-side at traffic signals
- **Proposed Road Diet with Treatments:** road diet from 20th Street to 48th Street plus TSP at all signals; relocating bus stops from near-side to far-side at traffic signals; and bus bulbs at all stops north of 48th Street
- **Proposed Road Diet with Treatments including Peak-Hour Queue Bypass Lanes:** road diet from 20th Street to 48th Street plus TSP at all signals; relocating bus stops from near-side to far-side at traffic signals; bus bulbs at all stops north of 48th Street; and peak-hour queue bypass lanes in both directions from 36th Street to 42nd Street (i.e., to serve the approaches to MacArthur Boulevard and 40th Street)

Table 8 shows that the Full Road Diet in isolation significantly decreases bus speeds. Once bus-specific enhancements are added to the corridor (i.e., Full Road Diet with Treatments), overall bus speeds are similar to the Baseline condition, with the exception of the section from 50th Street to Alcatraz Avenue where speeds remain significantly lower than the baseline. With the lane reduction limited to south of 48th St (i.e., Proposed Road Diet with Treatments), estimated bus speeds are almost identical to the Baseline condition. Queue bypass lanes in the vicinity of MacArthur Boulevard and 40th Street would provide additional increases in bus speeds.

The results of the analysis suggest that the proposed bus enhancement treatments would mitigate any impact of the road diet on corridor bus speeds in the AM and PM peak hours. Moreover, the addition of TSP, far-side stops, bus bulbs, and queue bypass lanes to the corridor would result in more reliable operations with less bus bunching.

Table 8: Operating Speeds with Project Improvements

NORTHBOUND	CORRIDOR AVERAGE		20TH TO 30TH		30TH TO 40TH		40TH TO 50TH		50TH TO ALCATRAZ	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Baseline	11.1	11.4	11.3	11.5	11.8	11.2	10.6	11.4	10.7	11.4
Full Road Diet without Treatments	8.7	10.5	11.3	11.2	11.8	11.2	10.6	10.6	**3.8**	9.5
Full Road Diet with Treatments	9.9	11.3	11.3	11.5	11.8	11.2	10.6	11.4	**7.2**	11.0
Proposed Road Diet with Treatments	11.1	11.4	11.3	11.5	11.8	11.2	10.6	11.4	10.7	11.4
Proposed Road Diet with Treatments and Queue Bypass Lanes	11.3	11.7	11.3	11.5	12.4	12.1	11.0	11.9	10.7	11.4
SOUTHBOUND	CORRIDOR AVERAGE		ALCATRAZ TO 50TH		50TH TO 40TH		40TH TO 30TH		30TH TO 20TH	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Baseline	12.0	11.0	11.7	10.9	12.5	11.0	12.8	11.2	11.4	11.1
Full Road Diet without Treatments	6.0	**3.9**	**4.2**	**3.8**	**4.4**	**3.8**	**4.5**	**3.9**	10.7	**3.9**
Full Road Diet with Treatments	11.8	10.4	11.0	9.1	12.5	11.0	12.8	11.2	11.4	11.1
Proposed Road Diet with Treatments	12.2	11.0	12.1	10.9	12.5	11.0	12.8	11.2	11.4	11.1
Proposed Road Diet with Treatments and Queue Bypass Lanes	12.4	11.3	12.1	10.9	12.8	11.4	13.5	12.0	11.4	11.1

PEDESTRIAN CROSSING OPTIONS

The project team has developed an initial set of recommendations for the placement of crosswalks within the Telegraph Avenue corridor. This includes the addition, relocation and removal of crosswalks, as indicated in Figure 11. The proposed crosswalk locations consider adjacent land uses, potential roadway reconfiguration, and transit option recommendations. For the purposes of coordination with transit improvements, Figure 11 shows the proposed bus stop locations that are discussed in greater detail in the previous Bus Stop and Transit Options section of this report.

As detailed in Alternative Roadway Design Options section of this report, Telegraph Avenue is divided into three distinct segments:

- **Segment A**: 57th Street to 52nd Street
- **Segment B**: 52nd Street to 48th Street
- **Segment C**: 48th Street to 20th Street

Each segment has a different set of proposed cross sections. In Segment C, traffic analysis indicates that vehicle travel lanes could be reduced from five lanes to three lanes to provide enhanced pedestrian and bicycle facilities. In Segment C, the additional roadway space allows for protected bicycle facilities, such as cycle tracks. Segment B is proposed as a five-lane cross section, as traffic analysis indicated high demand for automobiles, particularly during the AM and PM peak periods. A four-lane cross section without a center turn lane is proposed for Segment A.

Given the different cross sections and number of travel lanes found in each segment, recommended crosswalk enhancements and tools also vary by segment. The following sections present brief descriptions of the crosswalk enhancement tools recommended for Telegraph Avenue in addition to recommendations regarding crosswalk placement and enhancement by segment.

April, 2014

Pedestrian Crossing Options: Recommendations

Source: CD+A, 2014, City of Oakland, 2013, Telegraph Avenue Pedestrian Streetscape Improvements Project, 2005

Proposed Consolidated Line 1 (On Telegraph Avenue)

Removed Bus Stops (On Telegraph Avenue)

Stop Sign

Traffic Signal

Existing Standard Crosswalk

Existing Sidewalks

Pedestrian generating / attracting uses

Figure 11 - Part I: Pedestrian Crossing Options Recommendations - Alcatraz Avenue to 57th Street

Feet 0 250 500 1000 1500

April, 2014

Pedestrian Crossing Options: Recommendations

Source: CD+A, 2014, City of Oakland, 2013, Telegraph Avenue Pedestrian Streetscape Improvements Project, 2005

- Proposed Consolidated Line 1 (On Telegraph Avenue)
- Removed Bus Stops (On Telegraph Avenue)
- Bus Stop (On cross street)
- Stop Sign
- Traffic Signal
- Existing Standard Crosswalk
- Existing Ladder Crosswalk
- Pedestrian Crossing not allowed
- Existing Sidewalks
- Proposed New Crosswalk
  Locations identified by CD+A and Fehr & Peers
- Proposed Crosswalk Removal
  Locations identified by CD+A and Fehr & Peers
- Previously Proposed Special Intersection Crossing Treatment Areas
  These locations previously identified by the 2005 Telegraph Avenue Pedestrian Streetscape Improvements Project
- Pedestrian generating / attracting uses

Figure 11 - Part II: Pedestrian Crossing Options Recommendations - 57th Street to 20th Street

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PROPOSED UNSIGNALIZED CROSSWALK ENHANCEMENT TOOLS

Standard crosswalk striping is typically sufficient at signal controlled pedestrian crossing locations; however the street design concepts for Telegraph Avenue being developed for this project typically include bulb-outs and may include median refuges to shorten crossing distances and protect pedestrians while crossing, as well as high-visibility striping. At unsignalized crosswalk locations, which occur frequently throughout the project corridor, motorists must legally yield to pedestrians crossing the street but often fail to do so. At these unsignalized crossings, additional design enhancements can be implemented to improve pedestrian safety.

Safety effectiveness studies provide useful data about the various enhancements proposed for Telegraph Avenue. The more minor enhancements are appropriate for situations with lower speeds and traffic volumes and high driver yielding rates. More significant enhancements may be needed on higher speed or volume roadways, wider roadways, and roadways where motorists are less likely to yield to pedestrians. Lower level treatments may be combined with higher level treatments (i.e., flashing beacons with curb extensions). See Table 9 for images of these treatments, which include:

- **High-Visibility Striping and Signs:** consist of a ladder-style crosswalk and pedestrian crossing warning signs, which improve visibility of the crossing itself to motorists. These may be accompanied with advanced yield markings, particularly on multi-lane roadways

- **Curb Extensions:** extend the curb and sidewalks further into the roadway, shortening the length of the crosswalk. These act as a traffic calming device by narrowing the effective width of the roadway. Because they extend into the roadway, often past parallel-parked vehicles, they improve visibility for pedestrians and shorten the distance pedestrians have to cross. Corner bulb-outs can be constructed with reduced curb radii, which further slow the speed of turning vehicles and can accommodate directional curb ramps.

- **Median Refuges:** are placed in the center of the roadway separating opposing lanes of traffic with cutouts or ramps for accessibility along the pedestrian path. Median refuge islands are recommended where right-of-way allows and conditions warrant. Refuges allow pedestrians to cross in two stages during which they can focus their attention on one direction of approaching traffic at a time.

- **Rectangular Rapid Flashing Beacons (RRFBs):** are an enhancement of the flashing beacon that replaces the traditional slow flashing incandescent lamps with rapid flashing LED lamps. The RRFB may be push-button activated or activated with passive detection.

- **Pedestrian Hybrid Beacon (PHB):** is a pedestrian-activated warning device located on the roadside or on mast arms over midblock pedestrian crossings. The beacon head consists of two red lenses above a single yellow lens. The beacon head is "dark" until activated by the pedestrian desires to cross the street, at which point the device flashes the yellow lens to warn drivers of the following stop display of a steady red indication to drivers and a "WALK" indication to pedestrians. This is followed by a flashing red phase during which drivers must stop before proceeding. These are also known as "HAWK" signals.

While other flashing devices exist as alternatives to RRFBs, such as in-pavement flashing lights, these devices are not recommended on Telegraph Avenue due to potential maintenance concerns associated with in-roadway lighting in addition to the better daytime visibility of the RRFB device. Studies have shown higher driver yielding rates are achieved with the RRFB when compared to other flashing devices.

MARKED CROSSWALK PLACEMENT

As reported in the Telegraph Avenue Complete Streets Existing Conditions report, the project corridor from 57th to 20th Street features 30 existing marked crosswalks (counting three- and four-way intersections as one crosswalk and offset intersections with two marked crosswalks as two) over approximately 2.4 miles, for an average spacing of over 400 feet between crosswalks. This interval is slightly larger than that of a typical city block in an urbanized area, and indeed the corridor is predominantly intersected by cross streets at every 250 to 350 feet. A notable exception is the segment under the I-580 overpass where crosswalks are separated by a gap of over 700 feet. Numerous other locations throughout the corridor require pedestrians to travel up to 500 feet to reach a destination directly across the street, using available marked crosswalks.

The recommended crosswalk locations shown in Figure 11 result in a total of 37 marked crosswalks throughout the project corridor. This improves the average spacing between crosswalks to less than 340 feet, within the interval of street intersections indicated above. There are no gaps between crosswalks of more than 400 feet, with the exception of the I-580 overpass, which remains unchanged. Additionally, five previously uncontrolled crosswalks located within 200 feet of a signalized intersection have been relocated to nearby signalized intersections. As discussed in the Alternative Roadway Design Options section of this report, there are many recommended roadway design enhancements that will further improve the safety for all users of both signalized and uncontrolled crossings, including bulb-outs and road diets, which will shorten crossing distances, and median refuges.

UNCONTROLLED CROSSWALK IMPROVEMENT OPTIONS

Based on the preliminary alternative concepts developed for the Telegraph Avenue Complete Streets project, the project team completed an analysis of potential crosswalk enhancements for uncontrolled marked crosswalks consistent with the National Highway Cooperative Research Program (NCHRP) 562 report. Table 9 indicates the extent to which the menu of enhancements possible for unsignalized crosswalks should be applied across the various roadway cross section options developed for project corridor. Warrants do not exist for RRFBs and high visibility striping. Nevertheless, high visibility ladder-style striping is recommended for all proposed and remaining unsignalized crosswalk locations throughout the corridor, consistent with the City's crosswalk policy.

Where PHBs are a preferred treatment, the uncontrolled crosswalk was found to meet PHB warrant per the California Manual of Uniform Traffic Control Devices (MUTCD). The two beacon devices and the high-visibility striping each have differing motorist yielding rates[9] that influence pedestrian delay and comfort (per the 2010 Highway Capacity Manual). As documented in NCHRP 562, pedestrian hybrid beacons have the highest motorist yielding rate at 98 percent, and RRFBs have an 81 percent yielding rate. For high-visibility striping and signing, a yield rate of 20 percent was used[10]. Recommendations by segment are presented in the following sections.

SEGMENT A

Segment A extends between 57th Street and 52nd Street (though crossing improvement recommendations as part of the proposed 5-to-4-lane road diet in Segment B would apply equally to the roadway from 57th to Alcatraz as well). Currently, no unsignalized crosswalks exist in Segment B. One new unsignalized crosswalk is proposed roughly equidistant from existing signalized crosswalks, near the proposed location of relocated bus stops between 55th Street and 52nd Street. At this location, a PHB or potentially a RRFB would be recommended, depending on the final roadway cross section. Pedestrian median refuges and curb extensions are recommended at all crossings where feasible, including the proposed unsignalized crosswalk.

SEGMENT B

Segment B extends between 52nd Street and 48th Street. Through this segment, one relocated uncontrolled crosswalk exists at 49th Street, an offset intersection. Since this segment would remain a multi-lane roadway as proposed under the project, the installation of a pedestrian hybrid beacon is recommended at this uncontrolled crosswalk to manage high volumes of pedestrians and address the potential for multiple threat collisions. Opportunities for median refuges and bulb-outs, some in conjunction with bus bulb-outs, exist throughout this segment.

SEGMENT C

Segment C extends between 48th Street and 20th Street. A lane reduction of Telegraph Avenue from five lanes to three lanes is proposed through this segment, with alternatives providing different types of bikeways. With cycle tracks, it is assumed that at unsignalized side streets the pedestrian crossing distance would be reduced substantially. Where bicycle lanes or other dedicated but not separated bikeways are proposed, the crossing distance is longer, but could still be shortened by implementing bulb-outs, and median refuges in some cases. Despite the varying crossing distances, the lane reduction on Telegraph eliminates the potential for multiple threat collisions, and indicates that yielding rates are likely to be higher along the corridor through a visual and physical narrowing of the roadway. As a result, median refuges, curb extensions, and high-visibility signing and striping are appropriate at these locations. These uncontrolled crossings should be monitored in the future for motorist compliance. Should motorist yielding rates be lower than expected, RRFBs could be considered as these locations.

9. Yielding rate is based on the number of vehicles that yield at a crossing when a pedestrian is present, higher yielding rate indicates an increased likelihood that a vehicle will yield.

10. A yield rate of 20 percent was used based on unstaged studies of pedestrian crossings on 35MPH roadways with high-visibility signs and markings (HCM 2010, Exhibit 19-17).

Table 9: Summary of Pedestrian Crossing Options

LOCATION	PREFERRED OPTIONS
All	▪ High-visibility crosswalk markings; **AND** ▪ Curb extensions (where feasible and cost-effective)
Segment A (52nd - 57th Street)	▪ Rectangular Rapid Flash Beacons (RRFBs); **OR** ▪ Pedestrian Hybrid Beacon
Segment B (48th - 52nd Street)	▪ RRFBs with median refuge island; **OR** ▪ Pedestrian Hybrid Beacon (where refuge island is infeasible)
Segment C (20th - 48th Street)	▪ Median refuge island; **OR** ▪ RRFBs (where refuge island is infeasible)
	High Visibility Striping and Signs *Image source: http://www.pedbikesafe.org/PEDSAFE/*
	Curb Extensions
	Median Refuges *Image source: Mike King*
	Rectangular Rapid Flashing Beacon (RRFB) *Image source: http://carmanah.com/traffic/solar-flashing-beacons*
	Pedestrian Hybrid Beacon (PHB) *Image source: Mike Cynecki, http://www.fhwa.dot.gov/publications/publicroads/11mayjun/03.cfm*


SEARS ROEBUCK
AND COMPANY
TELEGRAPH LOFTS

STREETSCAPE & URBAN DESIGN OPTIONS

2005 PEDESTRIAN STREETSCAPE IMPROVEMENT PROJECT

The 2005 Telegraph Avenue Pedestrian Streetscape Improvement Project recommended a "Streetscape Improvement Concept" plan illustrating the locations where pedestrian-oriented improvements should be implemented. These improvements fall into two primary categories, "Boulevard Area Improvements" and "Neighborhood Commercial Area Improvements" as shown in Figure 12. These recommendations provide an important starting point for the streetscape and urban design options for this Telegraph Complete Streets Implementation Plan.

The recommended "Boulevard" improvements from the 2005 Project represent a base-level of repairs and upgrades to the majority of the corridor as indicated on the plan, including:

- High-visibility ladder-style crosswalk striping and Title 24/ADA-compliant directional curb ramps (one ramp facing the direction of each crosswalk)
- Corner bulb-outs
- Pedestrian countdown signals
- Sidewalk repair/repaving
- Double-head "candelabra" lamps to replace "cobra-head" lamps and additional infill street lights
- Street trees planted to maintain 50 – 100-foot on-center spacing
- Parking meters repaired or replaced

The recommended "Neighborhood Commercial" improvements represent a higher level of streetscape upgrades for the zones indicated on the plan as more pedestrian-intensive, namely the upper Temescal District and the Korea Town/Northgate (KONO) District. The recommended improvements include those indicated for "Boulevard" areas, as listed above, and the following additional elements:

- Street trees planted to maintain 50-foot on-center spacing
- Parking meters removed and replaced with fee kiosk machines
- New and/or renovated decorative paving in the sidewalk furnishing zone (curbside 5-feet of the sidewalk)
- Benches, trash receptacles, bicycle and newspaper racks in the furnishing zone and on bulb-outs
- Special "mini-plaza" bulb-outs with additional space for benches, outdoor café seating and/or other amenities at high-activity locations, with ornamental railings or screen walls protecting these areas from the adjacent street

The 2005 Pedestrian Plan also recommends implementation of additional pedestrian streetscape elements, including pedestrian refuge islands, bus stop bulb-outs, and sidewalk planters/pots.

IMPLEMENTATION STRATEGIES

The Telegraph Avenue Complete Streets Implementation Plan supports all of these concepts and recommends their implementation, with additions and modifications in some cases, as part of creating a more complete street that provides an enhanced pedestrian realm, and general safety and comfort for pedestrians walking along and across Telegraph Avenue. Adding to the lists above, the project team also recommends the corridor-wide integration of:

- Pedestrian-scaled energy efficient lighting, as exemplified by the recent installation of LED lighting by the Temescal BID;
- "Green Streets" features, including:
    - Stormwater planters or rain gardens, which are specialized landscaping installations that serve to retain, filter, and potentially infiltrate stormwater; and,
    - Pervious paving materials that also serve to collect and potentially infiltrate stormwater.

In developing the cross section alternatives described in this report, project team has incorporated and expanded upon many of the 2005 Pedestrian Plan recommendations, including the additions listed above.

Several of these elements are featured in the design concepts described in the following subsections. Among these are detail-level concepts showing how Telegraph Avenue can be reconfigured with cycle tracks that not only provide improved conditions for bicyclists, but also improve multi-modal connections between the roadway and sidewalk for all users; improve the quality of the streetscape for pedestrian and transit riders; and achieve "green streets" planting areas for stormwater management.

A related strategy that is explored in these concepts is the development of "paint and planter" versions of selected concepts. These concepts show how low-cost materials can be use as part of interim designs or as initial phases of implementation.

Finally, this section provides an update to a concept from the 2005 Pedestrian Plan that creates placemaking improvements while reconfiguring the intersection of Shattuck and Telegraph Avenues.

URBAN DESIGN OPTIONS TO ACHIEVE COMPLETE STREETS

The introduction of a cycle track into Telegraph Avenue requires reconsideration of many common elements of the street. The sidewalk, pedestrian crossings, driveways, access to parked cars, and bus stops must be designed differently when a bike facility is placed between the sidewalk and the parking lane and at sidewalk grade.

In reshaping Telegraph Avenue, the cycle track creates many opportunities for urban design, placemaking, and additional pedestrian comfort. The following design studies illustrate some of these opportunities.

"Paint and Planter" Concepts

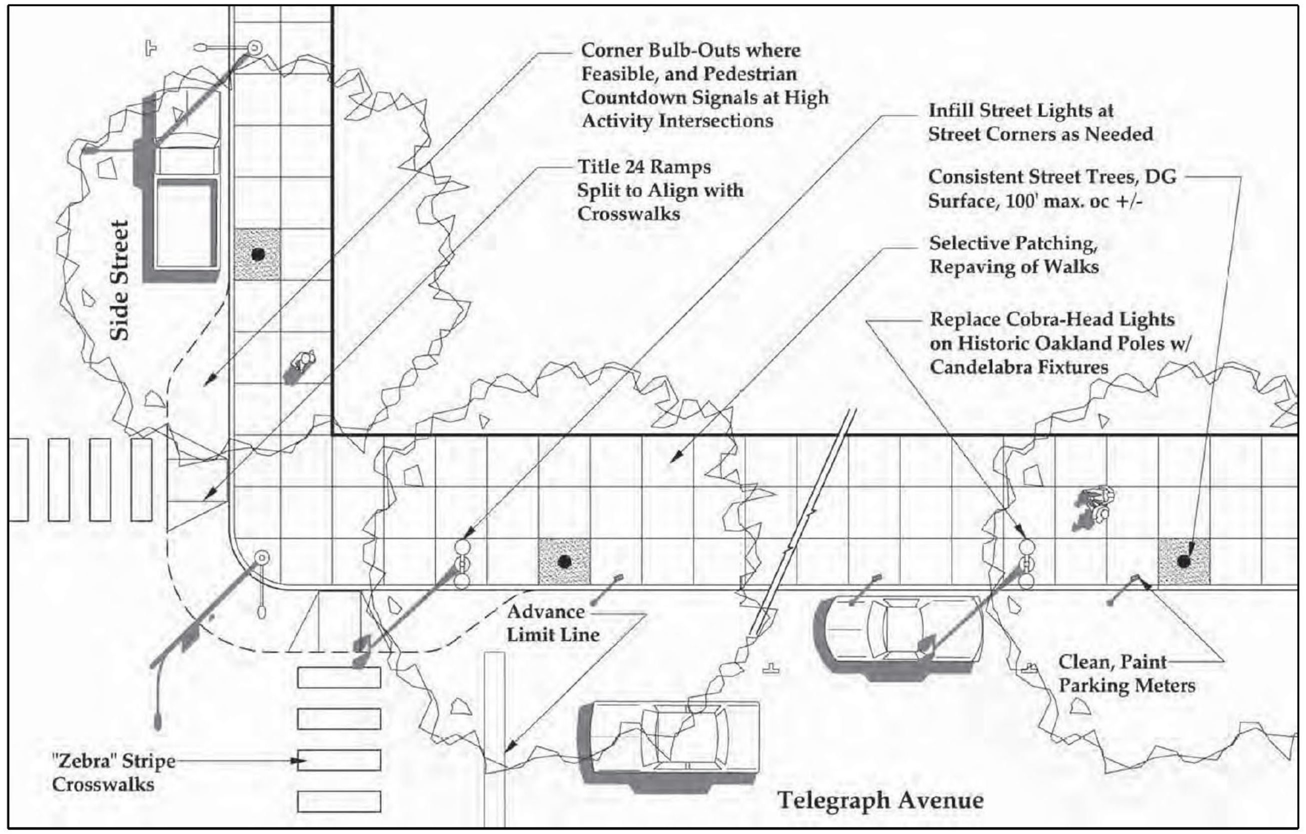
The "paint and planter" approaches illustrated for some of the concepts allow low-cost, interim tests of different strategies, as well as lower cost methods for implementing improvements sooner than might be possible with more expensive full development concepts. This affords project proponents the opportunity to modify elements during an interim phase as various design elements are evaluated. This approach can result in a stronger commitment to full-scale and permanent implementation of improvements.

Figures 13 through 19 illustrate how common aspects of streets can be treated with the cycle track, and the opportunities that arise.

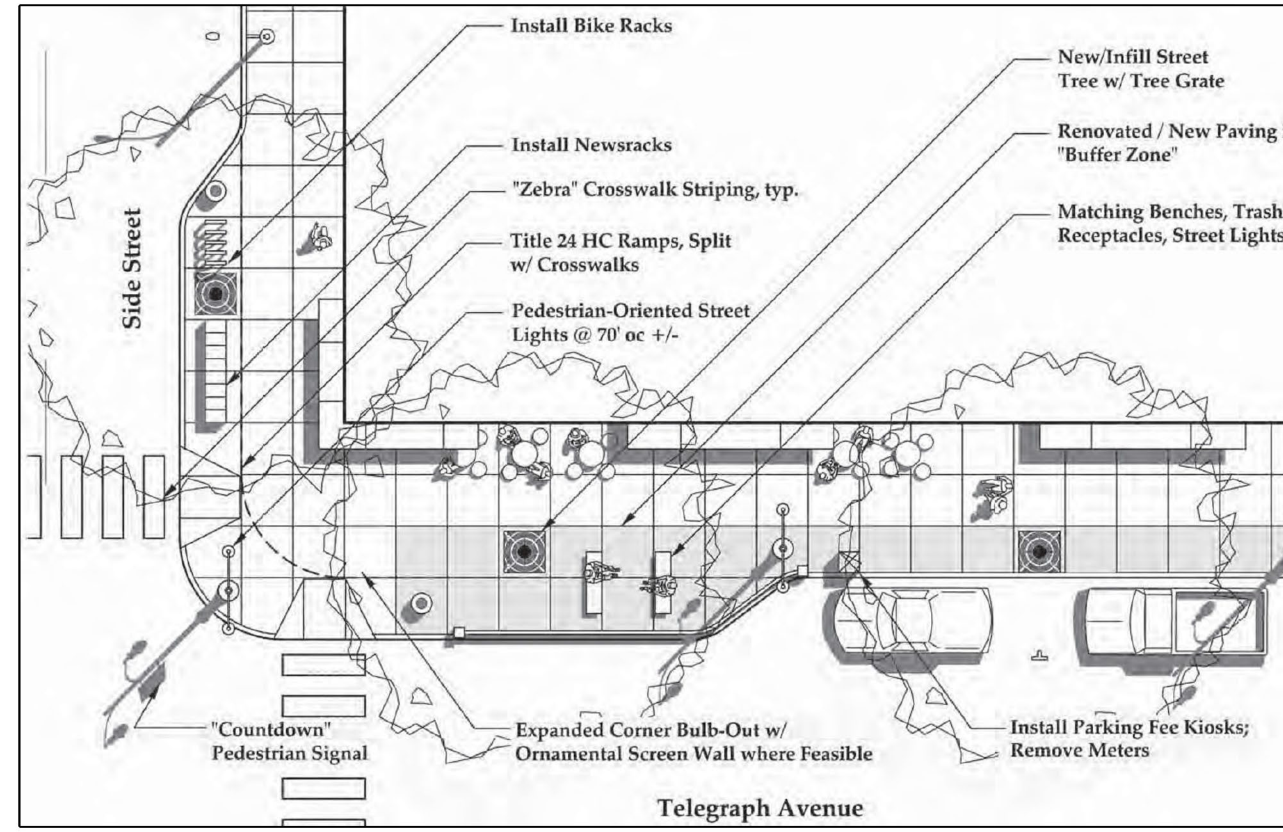
Figures 13 and 14 show how bus stops could be configured with a cycle track. Figure 13 shows a permanent bus "island" constructed in the parking lane, along with designated places for bus passengers to cross the cycle track. Figure 14 shows an interim version of this bus island concept, which includes a raised cycle track surface to facilitate pedestrian crossing of the bike facility. A custom or off-the-shelf shelter would be necessary in both versions, so as to accommodate the required ADA clear width allowing travel from one end of the platform to the other. In both concepts, the bus island addresses the bus-bike conflict more effectively than a standard bike lane. Figures 15 and 16 show how a pedestrian crossing at one of the many "T" intersections along Telegraph Avenue could be configured with the cycle track, both as an interim project, and permanently. In both cases, while pedestrians would have to cross the cycle track, they would also face a much shortened crossing distance of the main roadway. Pedestrians also would have the benefit of refuges between the cycle track and the travel lane and in the street median. In the permanent version (Figure 15), the pedestrian space is extended through bulb-outs into the parking lane, which create opportunities for landscape at the crossings. In the interim version (Figure 16), the extended pedestrian space is defined by bollards, movable planters and paint.

Figure 17 shows how driveways could be configured with the cycle track. The most important aspect of incorporating driveways with the cycle track is maintaining adequate sight lines between drivers turning into or out of driveways and cyclists. Placing the parking lane between the travel lane and the bike lane creates more distance between cyclists and vehicles turning into driveways, which is an advantage as long as the adequate sight lines are maintained. In addition, driveway crossings create the opportunity for green infrastructure. To maintain sight lines, plants in rain gardens would be limited to low-height varietals.

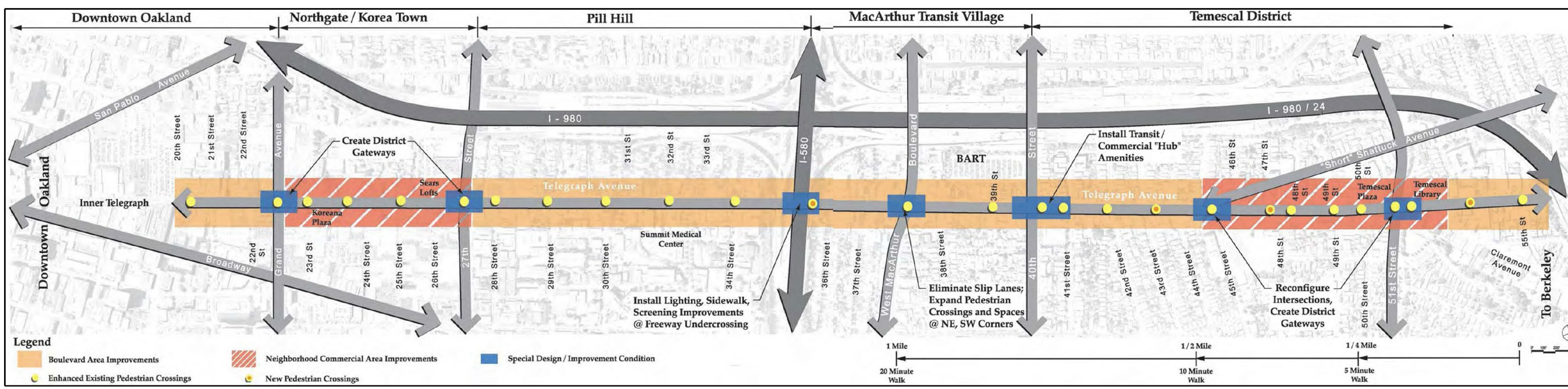
All these concepts show how the sidewalk can be buffered from the cycle track – an important aspect of the street since cyclists and pedestrians would be at the same level. The design concept addresses this issue by designating a 5-foot-wide "furnishing" strip (the outer edge of the existing 15-foot-wide sidewalk) that could vary depending on the community context and needs of the street. For example, in the bus stop design concepts, the furnishing strip shown in Figure 13 is defined by a combination of alternative paving materials, landscaped areas, and bike parking. This works in an interim stage, as shown in Figure 14, with movable planter boxes buffering the sidewalk from the cycle track. News racks, benches or planter boxes with built-in seating, stormwater planters, and other amenities can be provide in this furnishing zone as well. As such, the buffer adds human scale, identity, and comfort to the Telegraph streetscape.



Boulevard Area Improvements



Neigborhood Commercial Area Improvements



Streetscape Improvement Concept Plan

These concepts and drawings are from the 2005 Telegraph Avenue Pedestrian Streetscape Improvement Project

Figure 12: 2005 Telegraph Avenue Pedestrian Streetscape Improvement Project – Boulevard and Neighborhood Commercial Area Design Concepts

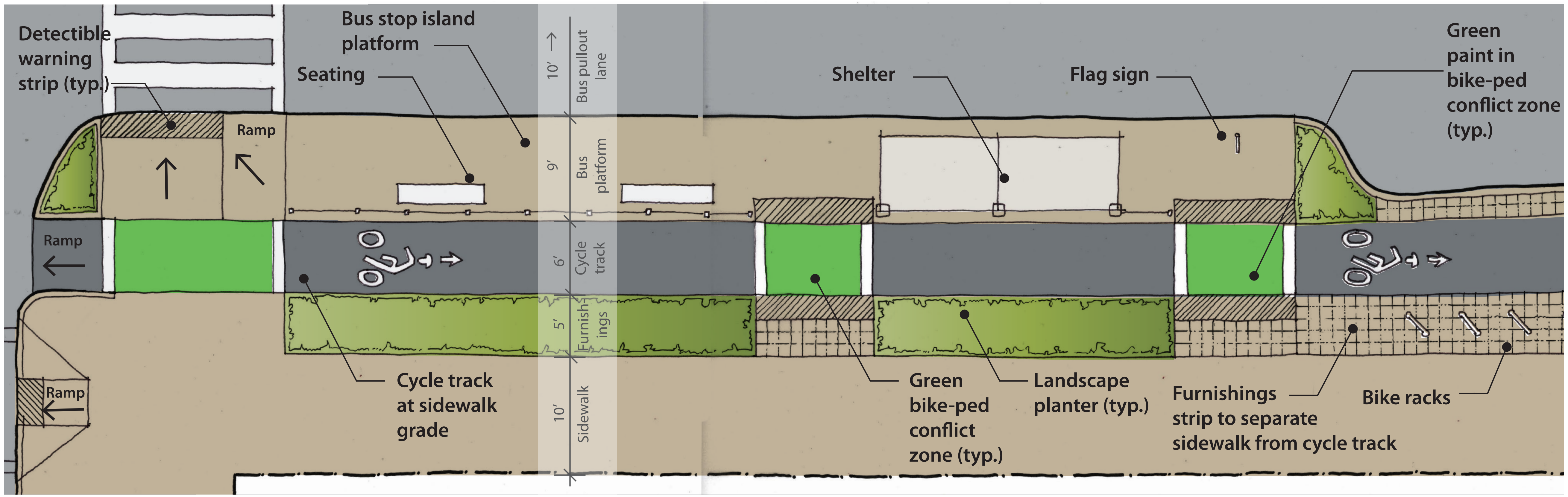


Figure 13: Transit Island with Cycle Track and Planters – Permanent Format

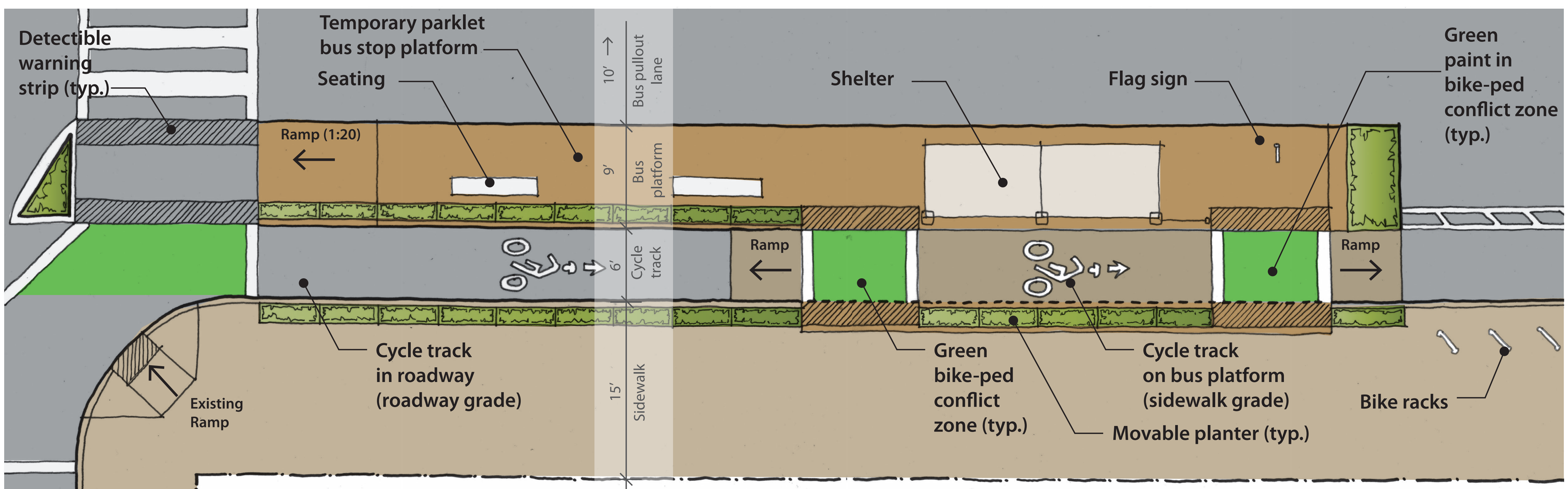


Figure 14: Transit Island with Cycle Track and Planters – Interim Format

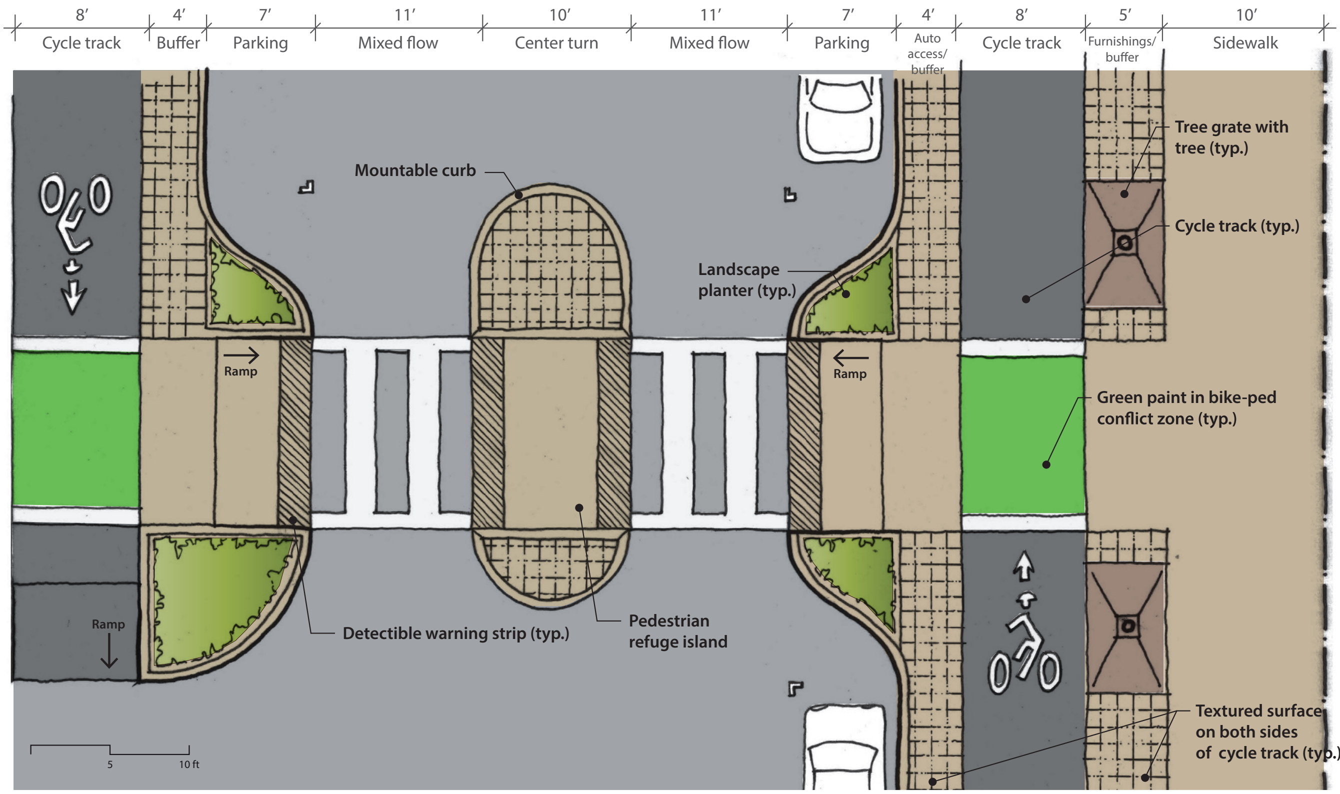


Figure 15: Pedestrian Crossing at T-intersection – Permanent Format

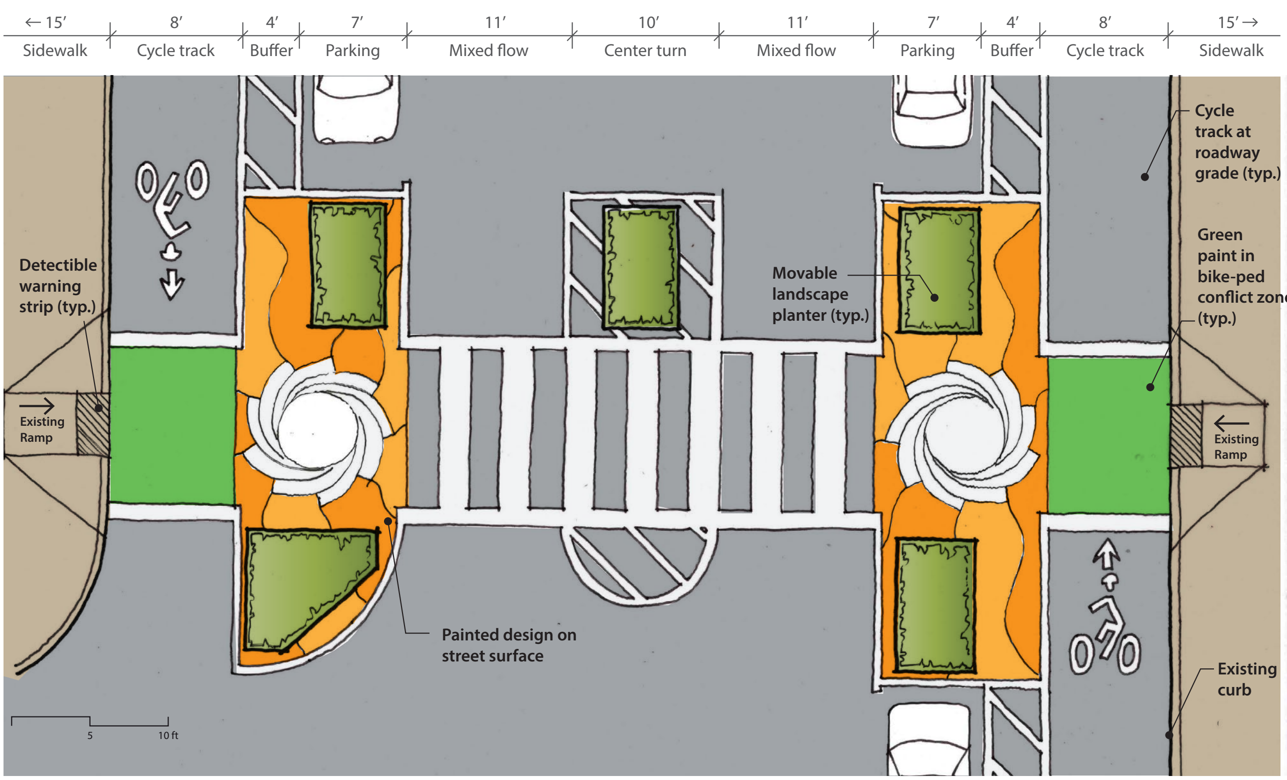


Figure 16: Pedestrian Crossing at T-intersection – Interim Format

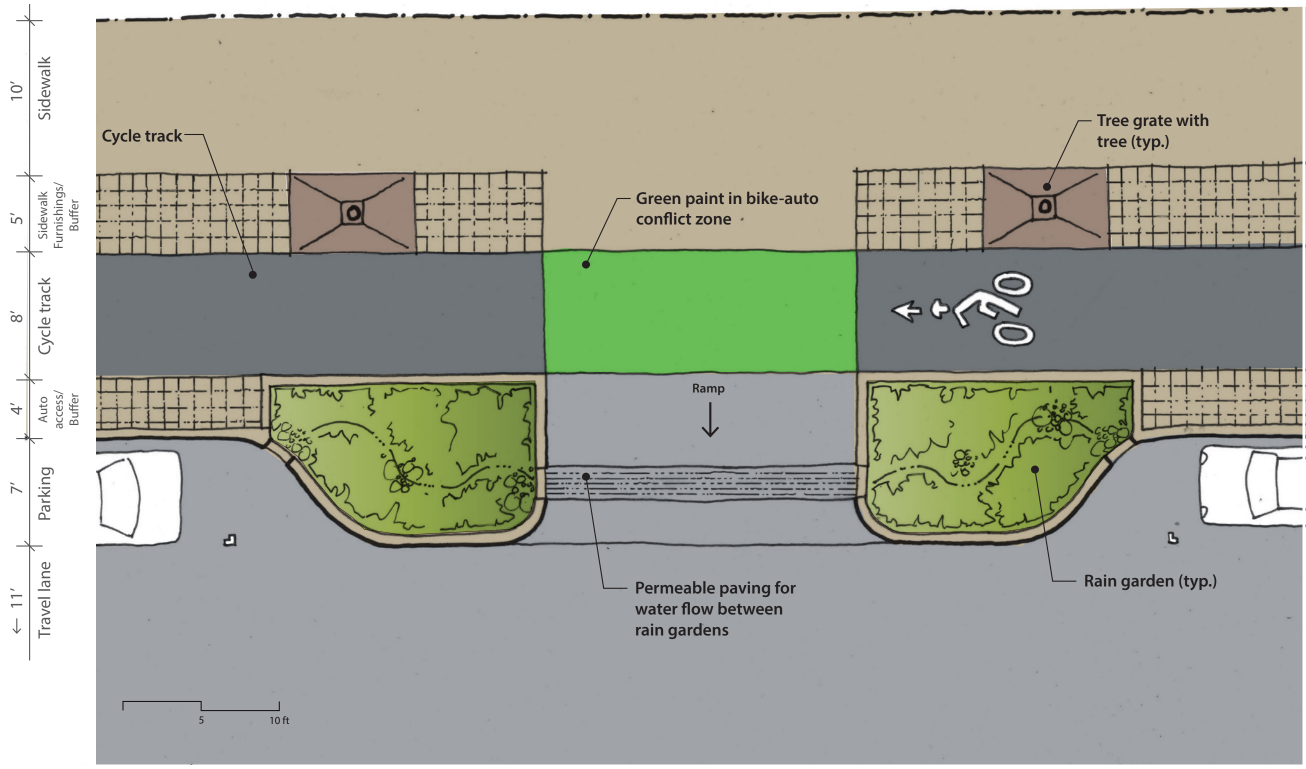


Figure 17: Cycle Track at Driveway with Rain Gardens

Figures 18 and 19 show how the functions of additional public space and green infrastructure can be integrated with the Telegraph Avenue concept; these too make for a rich and unique streetscape because of the cycle track:

Figure 18 shows how "green streets" could be integrated into Telegraph Avenue alongside a cycle track. In this concept, a trench drain carries stormwater from the curb to a long infiltration trench between the cycle track and the sidewalk. "Boardwalks" cross over this planted area, which also serves as a buffer between cyclists and pedestrians.

Figure 19 shows how a 6-1/2-foot-deep "parklet" can be added to the edge of the Telegraph Avenue curb. This parklet can be merged with the existing 15-foot sidewalk to create additional public space for pedestrians. The cycle track is diverted around the parklet, maintaining its 8-foot width; temporary planters maintain the separation from mixed traffic. The cycle track enriches the parklet, too, with cyclist movement and the planters helping to create a compelling new human-scale place and separation between vehicle traffic and people using the parklet.

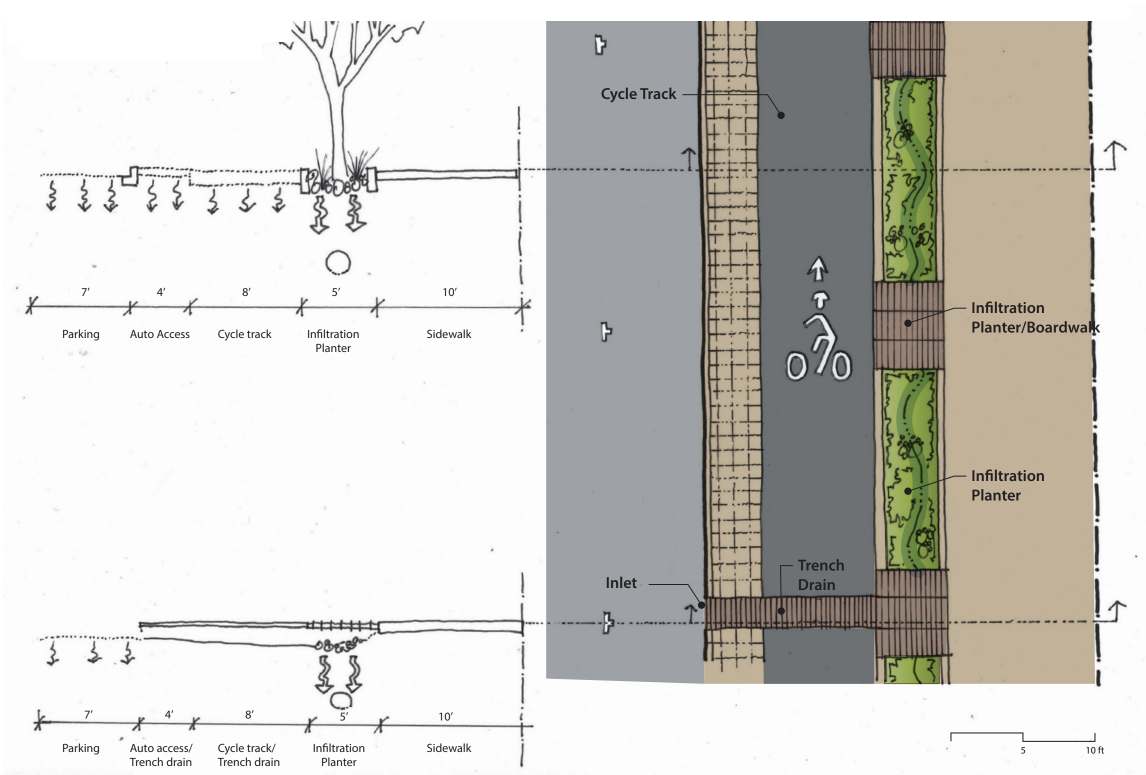


Figure 18: Cycle Track with Green Infrastructure

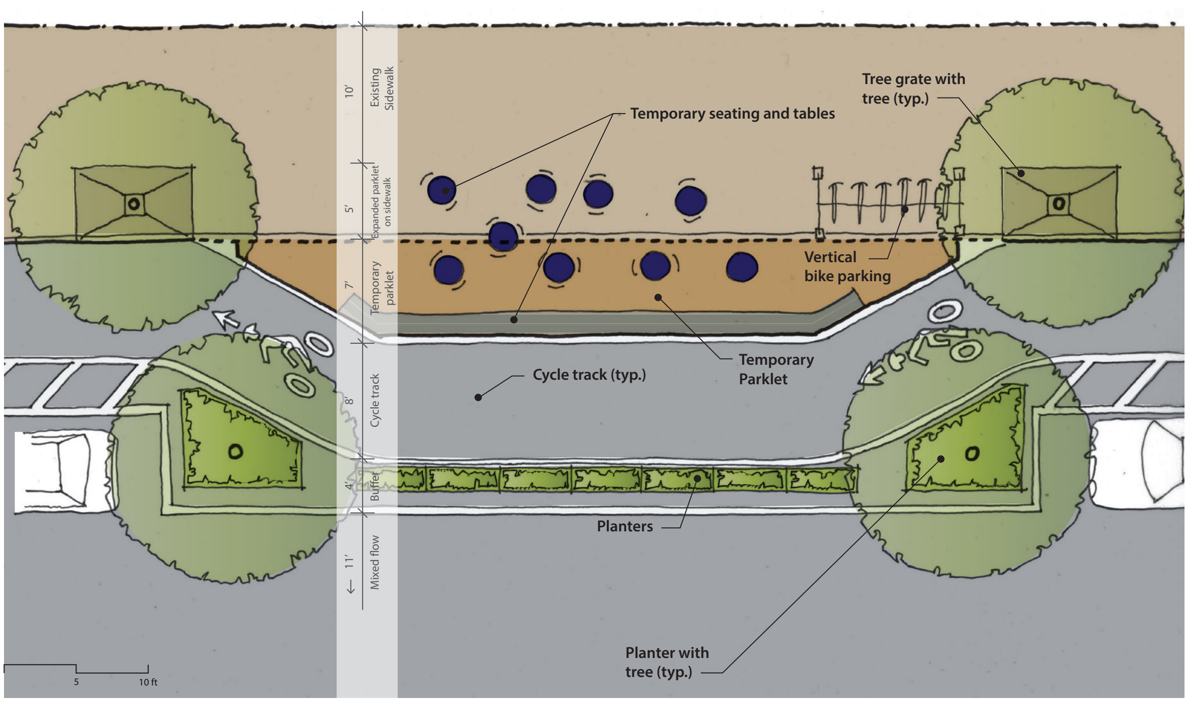


Figure 19: Cycle Track with Parklet Integration

PAVEMENT-TO-PARKS

Shattuck Avenue intersects Telegraph Avenue at 45th Street, creating an awkward and dangerous intersection with numerous vehicle collisions.[11] Vehicles traveling southbound on Shattuck often neglect to obey their yield signal when merging into Telegraph Avenue, in part because there is a receiving lane on Telegraph. The 2005 Telegraph Avenue Pedestrian Streetscape Improvement Project identified Shattuck Avenue between 45th and 46th Streets as a potential street segment for closure, as shown in Figure 20. In the proposed concept, the adjacent triangular parcel is expanded into the street right-of-way and shown with new development.

As the Telegraph Avenue Complete Streets Implementation plan seeks to improve the safety and comfort of all modes, and seeks to implement the recommendations of the 2005 Streetscape Project, closing this segment of Shattuck is a worthwhile endeavor. The project team has developed a conceptual rendering of this location reimagined as an expanded public plaza with seating, stormwater planters with boardwalks to provide access across both sides of the plaza, reuse of the existing Kasper's building for a café or similar use, and additional space for food trucks that also permits emergency vehicle access through the site, as shown in Figure 21 (the same image appears in Figure 7).

The design provides improvements to the intersections at Telegraph and 46th Street, creating a two-way configuration on 46th Street to provide access to Telegraph Avenue from Shattuck Avenue and 46th Street. Pedestrian access to the plaza is improved with a new crossing and sidewalk edge on the east side of the Kasper's building. The intersection of 45th and Telegraph is also improved, with bulb-outs to shorten crossing distances, and better-aligned high visibility crosswalks.

11. See the Telegraph Avenue Complete Streets Existing Conditions Report, Figure 3.

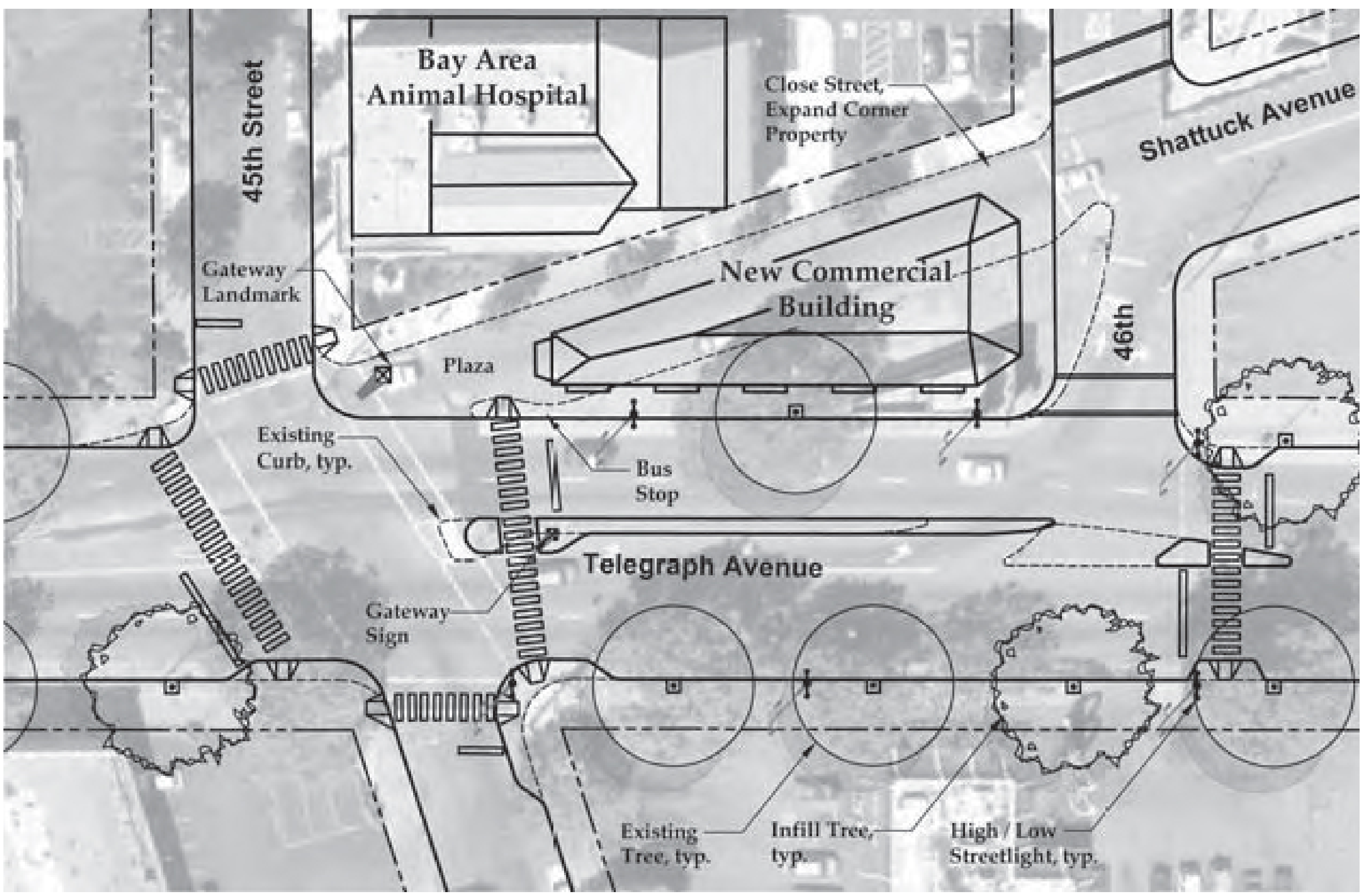


Figure 20: Concept for Shattuck Avenue Vacation and New Development from the 2005 Telegraph Avenue Pedestrian Streetscape Improvement Project

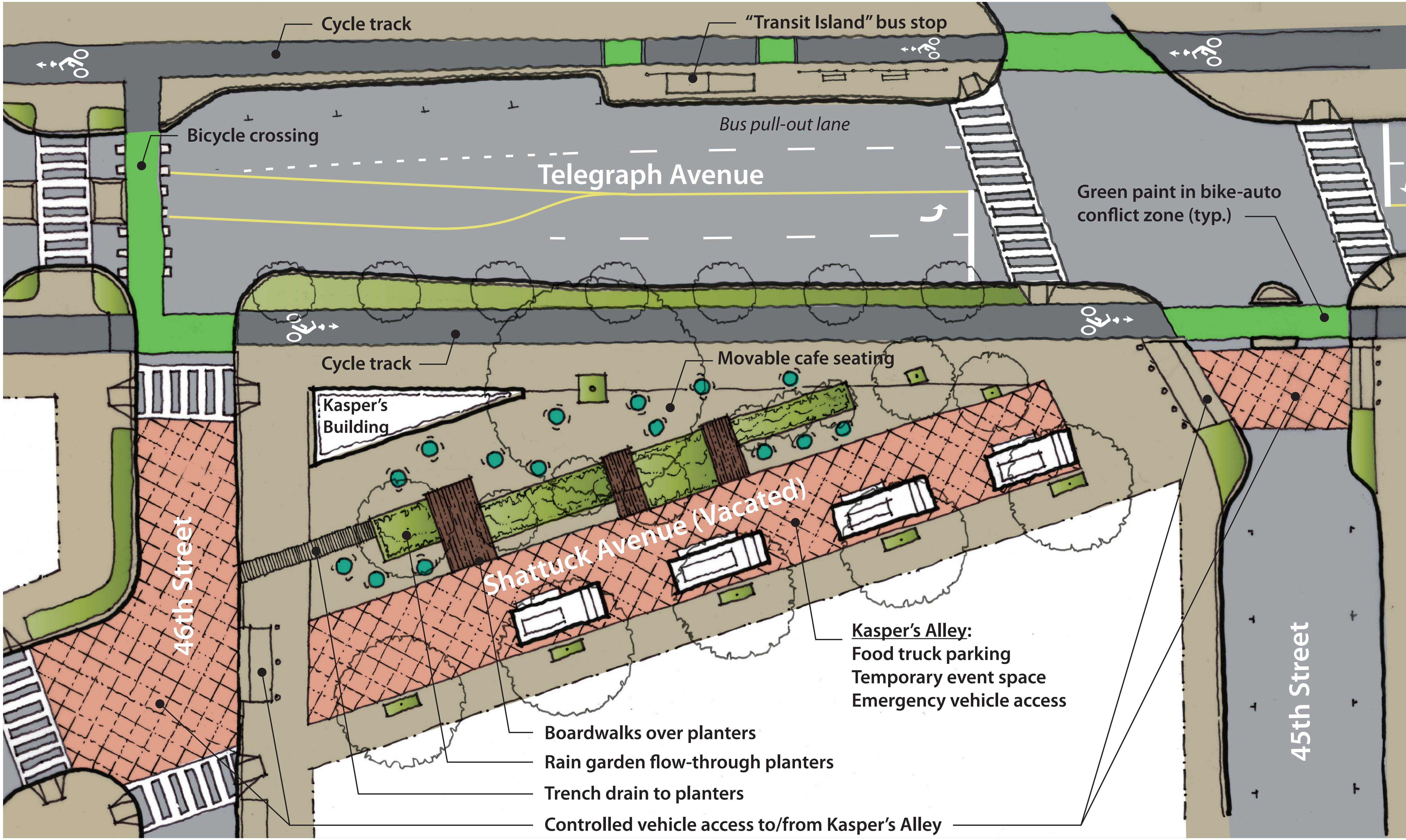


Figure 21: "Kaspers Korner" Design Concept Update – Based on 2005 Telegraph Avenue Pedestrian Streetscape Improvement Project

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