Title
Improving first/last mile conditions near highways: An investigation of access and coordination barriers

Author
Russell, Adam

Publication Date
2019

DOI
doi:10.17610/T6PP4P

Peer reviewed

Improving first/last mile conditions near highways:

An investigation of access and coordination barriers

PROJECT LEAD	Adam Russell
FACULTY SUPERVISOR	Anastasia Loukaitou-Sideris
CLIENT NAME	Jacob Lieb, Senior Director, Metro First/Last Mile Planning

UCLA Institute of Transportation Studies

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
	N/A	N/A
4. Title and Subtitle Improving first/last mile conditions near highways: An investigation of access and coordination barriers		**5. Report Date** 2019 **6. Performing Organization Code** UCLA-ITS
7. Author(s) Adam Russell		**8. Performing Organization Report No.** LAS1913
9. Performing Organization Name and Address Institute of Transportation Studies, UCLA 3320 Public Affairs Building Los Angeles, CA 90095-1656		**10. Work Unit No.** N/A **11. Contract or Grant No.**
12. Sponsoring Agency Name and Address The University of California Institute of Transportation Studies www.ucits.org		**13. Type of Report and Period Covered** **14. Sponsoring Agency Code** UC ITS
15. Supplementary Notes DOI: doi:10.17610/T6PP4P		

16. Abstract

In considering how transit riders must walk or bike near highways to reach transit stations, highway infrastructure becomes a significant barrier to transit access and an impediment to a safe and comfortable transit trip experience. As such, areas surrounding highways can be priority pathways for first/last mile improvements, which is in turn complicated by the California Department of Transportation's management of highway right-of-way. In planning first/last mile infrastructure improvements, Metro's First/Last Mile Planning program must coordinate with Caltrans to understand traffic and freight factors in a station area and implement any first/last mile interventions. This study examined three case study station areas for common first/last mile barriers at highways and interviewed staff to understand inter-agency coordination experiences. It finds that policies, such as criteria that dictate when to include Caltrans in planning processes, that seek to yield predictability in both inter-agency communication and first/last mile improvement design can aid in overall coordination at highway-adjacent sites. In addition, ramps typically create the most dangerous and difficult-to-improve conditions and largely lack clear guidance for bikeway and pedestrian crossings. The study examines potential street improvements to improve comfort and safety and explores possible design and policy barriers for implementation.

17. Key Words	18. Distribution Statement
pedestrian planning bicycle planning	No restrictions.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	55	N/A

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Disclaimer

This report was prepared in partial fulfillment of the requirements for the Master in Urban and Regional Planning degree in the Department of Urban Planning at the University of California, Los Angeles. It was prepared at the direction of the Department and of Metro First/Last Mile Planning as a planning client. The views expressed herein are those of the authors and not necessarily those of the Department, the UCLA Luskin School of Public Affairs, UCLA as a whole, or the client.

Acknowledgements

Thank you to my client, Jacob Lieb of Metro First/Last Mile Planning, as well as the entire the First/Last Mile Planning staff, for inspiring the project and introducing me to the first/last mile planning landscape. I am grateful to my advisor, Anastasia Loukaitou-Sideris, for her guidance and insight. I would also like to thank Shannon Simmonds of Caltrans Division of Rail and Mass Transportation for her support and background connections from the state level.

Thank you to staff at Caltrans District 7, LA Más, and Metro's First/Last Mile Planning, Parking Management, Transit Corridors, and Goods Movement programs for taking the time to share their experiences and perspectives. Lastly, thank you to the UCLA Institute of Transportation Studies for their generous support of this applied research project.

Table of Contents

Improving first/last mile conditions near highways:

An investigation of access and coordination barriers

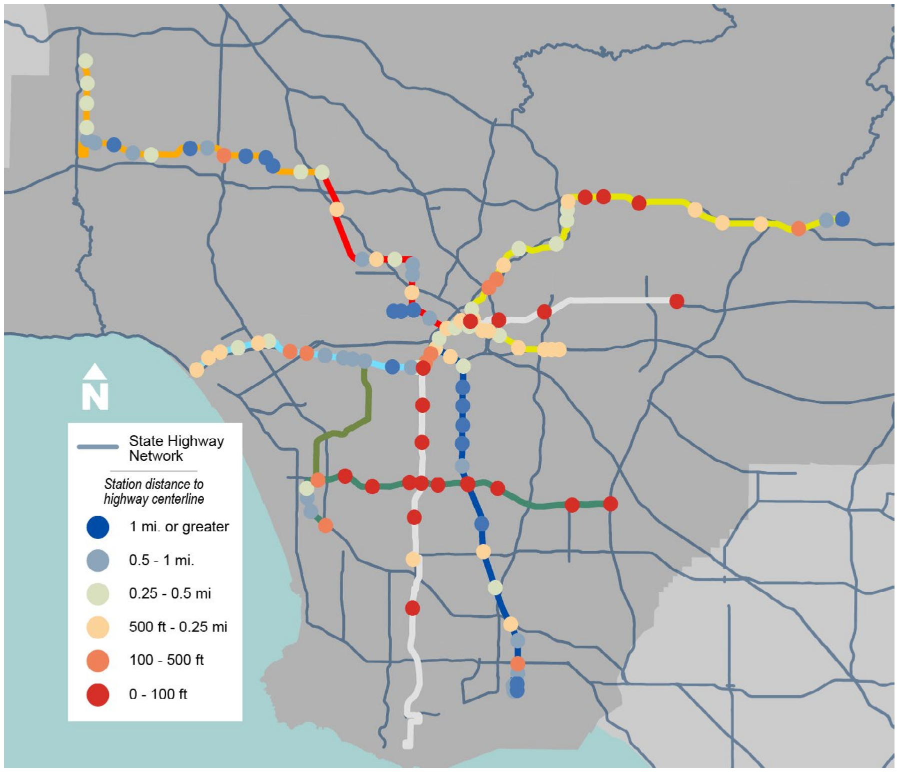
I. Executive Summary

As their designs center on rapid vehicle throughput and minimal interference from other modes of travel, highways create significant physical and safety barriers to biking and walking. For riders wishing to access transit, highway infrastructure may limit first/last mile connections to stations, forcing them to cross on- and off-ramps or navigate dark underpasses. The California Department of Transportation (Caltrans) holds jurisdiction over the streets and freeways that comprise the State Highway Network. As such, the Los Angeles County Metropolitan Transportation Authority's (LA Metro) First/Last Mile Planning program must coordinate with Caltrans through its work to improve the biking and walking conditions near highway-adjacent transit stations.

First/last mile planning expands on the traditional concepts of transit planning to incorporate the initial and concluding trips to and from a station as part of the overall transit trip. Despite Los Angeles' car-dominated design, the most recent ridership survey indicates that 82 percent of LA Metro riders reach stations by methods other than driving or being dropped off (LA Metro, 2018). In 2016, the LA Metro Board of Directors instructed the agency to conduct first/last mile plans for its rail and busway stations and highest-ridership bus stops and improve street conditions in order to support sustainable access modes. The board direction specifies that first/last mile planning should focus on safety and comfort improvements oriented towards transit connections and active transportation modes.

While the First/Last Mile Planning program, the client of this project, is currently integrating first/last mile planning into the Metro transit corridor planning process, several standalone plans have been also drafted. The Blue Line First/Last Mile Plan, published in 2018, addressed the 22 stations along the Metro Blue Line, the system's oldest rail line. During the planning process, walk audits of some station areas revealed particularly poor walking and biking conditions near highways. Reaching the Del Amo Station, for example, from east of the I-710 freeway requires that pedestrians transverse a underpass with extremely narrow sidewalks and lacking crosswalks or curb ramps, a route impassable for most people and wholly unsafe due to the heavy traffic exiting the freeway. However, staff conversations with Caltrans District 7 found that changes such as a widening of the Del Amo Blvd underpass to create room for adequate sidewalks were infeasible in the near term given traffic needs and ongoing planning efforts for the corridor. Looking at the 125 Metro Rail and busway stations in Los Angeles County, more than two-thirds sit within a half-mile (the radius commonly utilized to estimate

Figure 1. Metro Rail and Busway station distance from the State Highway Network



an acceptable walk to transit), of a state-owned street or highway (Figure 1) and mainly are located within highway right-of-way. This juxtaposition of state highway and urban transit networks places particular urgency for Metro on developing process and design approaches to improving conditions for bicyclists and pedestrians in these locations.

As the project addresses two aspects of first/last mile planning - the design improvements that aid biking and walking trips to stations, and the coordination and review of improvements between LA Metro and Caltrans - its methodology is split into two approaches. In the first, a series of case studies explain common station-highway relations, how highways impact first/last mile safety and accessibility, and the feasibility of highway-centered improvements. As a station's proximity to highways influences the types of barriers that affect its access, case study stations were chosen to reflect groups of station typologies arranged by distance to highways. These typologies were: median stations (in the median of highways), adjacent stations (zero to 500 feet from highways), and nearby stations (500 feet to 0.25 miles - 1320 feet - from highways). Stations meeting these definitions make up 16 percent, 9 percent, and 43 percent of all stations, respectively. Each chosen station also has at least one of the common highway barriers the client identified: ramps with geometry oriented toward vehicle speed and throughput and either an underpass or overpass crossing the highway(s). Respectively, the case study stations are Manchester Station in South LA, Palms Station in Palms/Cheviot Hills, and Maravilla Station in East LA.

In order to understand the past history of LA Metro-Caltrans coordination, interviews were conducted with agency staff and other experts in transit access and active transportation. As each interviewee was an expert in one aspect of the investigation, questions varied among subjects. Interview questions were selected to explore key questions of the project:

- What issues arose with highway-related improvements during previous first/last mile plans?
- How transit access is balanced with other planning goals?
- Which design solutions might work best in a highway context?

Staff on non-active transportation programs within LA Metro were asked about their own coordination with Caltrans, and how that might serve as a model for future planning projects. The interviews generated key overlapping themes and trends, as well as recommendations for elements associated with successful inter-agency work.

Across staff interviews, knowledge of when and to what extent to integrate Caltrans into jurisdictional communications differed slightly, but the respondents' attitudes revealed increased engagement yielding better, more predictable experiences. Repeated interactions allowed staff from both agencies to better understand each other's needs, ultimately expediting the process. Staff also noted that the existence of frameworks governing regular communication and roles aided in the predictability and transparency of coordination procedures. Both institutionally through policies and guidance, and within department staff, Metro and Caltrans aim to remove barriers to transit access and to adapt car-oriented streets for people biking and walking.

In all three case study station areas, excess right-of-way within the established lane widths was rare, meaning additional bicycling facilities and improved sidewalks would necessitate converting travel lanes from automobile use to pedestrian and bicyclist use. Interviews suggest that these improvements are more difficult, but conditions at Palms offered options for improving walkability and navigation with lighting and wayfinding signage, thereby not affecting automobile traffic. While every off-ramp near case study stations was controlled to some degree by a signal or stop sign, on-ramps posed consistent problems in their interaction with crosswalks. Even in instances where ramps come to a perpendicular "T" with the local street, a large turning radius at the corner frequently allows drivers to maintain high speeds while turning onto the ramp. Lastly, highway-scale signage along sidewalks typically signals the presence of Caltrans-managed land, and often harms visibility or narrows the passable width of the sidewalk.

This project recommends that Metro formalizes criteria for station areas through which it can determine whether, and at what stage, Caltrans should become involved in the project. Regular, predictable contact should allow each agency to anticipate and understand the other's needs. Likewise, a toolkit of common street improvements that meet Caltrans' standards would increase the predictability of the planning process, allowing Metro staff to develop plans without unnecessary rounds of review from other agencies. These should include bulb-out and corner treatments for on-ramps, lighting for underpasses, wayfinding signage that meets California Manual of Uniform Traffic Control Devices standards, and changes to Caltrans' broader design policies. Such interventions would aid in strengthening active transportation access to stations. Bikeways in particular could benefit from flexibility in design, allowing designs such as median lanes that separate bicyclists from ramp traffic. Where possible, dedicated bicycle signals could separate potential bicyclist-driver conflicts at ramps. Elsewhere, bikeways and crosswalks that cross rams at right angles would improve visibility. Lastly, the agency should emphasize the proximity to transit as a rationale for weighing high-quality bicycling facilities above minor delays to non-highway traffic flows.

Further research is required to draw conclusions regarding the efficacy and feasibility of some improvements. Traffic engineers should investigate the impacts of reducing on-ramp lane widths and consolidating lanes in various street type contexts. Understanding the extent of delay that certain changes create for drivers could, if the delay is small or inconsequential, be an essential part of making the case for such improvements. More clarity, too, should be brought to the specific traffic conditions that might support perpendicular ramp crossings. Ultimately, a better understanding of how different types of environmental conditions impact first/last mile planning expands the capability of the program to address them. As the program works more often with Caltrans, this project offers an avenue for staff to hone procedures and develop an effective and expedient path toward addressing the most critical access barriers.

II. Introduction

The automobile-oriented policies and standards that inform highway design create dangerous and uncomfortable routes for people walking and bicycling near them. In considering how people must pass under, beside, and over highway to reach transit stations, highway infrastructure becomes a significant barrier to transit access and an impediment to a seamless transit trip experience. As such, areas surrounding highways can be priority segments for first/last mile improvements, which is in turn complicated by the California Department of Transportation's ownership of highway right-of-way. The goal of this project is to identify policy and coordination barriers to improving first/last mile conditions in transit station areas containing highways and propose design solutions to highway features that commonly impact conditions affecting first/last mile access.

Context and need

For the typical transit rider, the actual trip extends beyond the portion spent on transit vehicle: the segments to and from stations or stops, referred to as the "first and last miles," together with the transit segment form the complete trip. These paths may be taken by a variety of transportation modes, and their quality plays a role in communities' overall access to nearby transit service. Major automobile infrastructure, however, can form a significant barrier to first/last mile access, forcing riders to cross uncomfortable under- and overpasses, weather fast-moving high traffic volumes, and endure unsafe crossings of on- and off-ramps.

Despite Los Angeles' car-dominated design, the most recent ridership survey indicates that 82 percent of LA Metro riders reach stations by methods other than driving or being dropped off (LA Metro, 2018). In 2016, the LA Metro Board of Directors passed Motion 14.1, which instructed the agency to conduct first/last mile plans for its rail and busway stations and highest-ridership bus stops and improve street conditions in order to support sustainable access modes. The motion identifies suitable first/last mile infrastructure, including improvements such as "ADA-compliant curb ramps, crosswalk upgrades, traffic signals, bus stops, carshare, bikeshare, bike parking, context-sensitive bike infrastructure (including Class IV and access points for Class I bike infrastructure), and signage/wayfinding" (LA Metro, 2016). The exact improvements depend on multiple contextual conditions, such as surrounding land-use context, density, and the availability of existing active transportation facilities.

While the First/Last Mile Planning program within LA Metro currently integrates first/last mile planning into the overall transit corridor planning process, several standalone plans have been drafted. The first plan, published in 2018, addressed the 22 stations along the Metro Blue Line, the system's oldest rail line. During the planning process, walk audits of some station areas revealed particularly poor walking and biking conditions near highways. Reaching the Del Amo Station, for example, from east of the I-710 freeway requires that pedestrians transverse a underpass with narrow sidewalks and no crosswalks or curb ramps, a route impassable for most people and wholly unsafe next to traffic exiting the freeway. However, staff conversations with Caltrans District 7, which oversees Caltrans operations in Los Angeles and Ventura Counties, found that changes such as a widening of the Del Amo Blvd underpass to create room for adequate sidewalks were infeasible in the near term given traffic needs and ongoing planning efforts for the corridor. The Del Amo Station, and the Blue Line First/Last Mile Plan more broadly, identified early and clear state-level coordination as a necessity in future first/last mile plans. State guidance on the topic is still forthcoming and expected in 2019. Of the 125 Metro Rail and busway stations in Los Angeles County, more than two-thirds sit within a half-mile (the radius commonly utilized to estimate an acceptable walk to transit) of a state-owned street or highway. Many stations now being constructed and planned, which will be the first to receive first/last mile plans, are also within a half-mile of highways: the Purple Line subway extension and West Santa Ana Branch and Eastside Gold Line Extension light rail lines are prominent examples.

Transportation research, broadly, appears to agree that highways limit transit access and are a common barrier to transit ridership (Loutzenheiser, 1997). Changes to dangerous traffic conditions can improve feelings of walkability, contributing to higher walking rates. High volumes of turning traffic, for example, can hurt the overall walking experience, forcing pedestrians to delay or take longer routes on safer paths (Hubbard et al., 2007). This barrier is especially common near highways, as on- and off-ramps create constant flows of vehicles across pedestrian paths. Studies indicate that people are more likely to take a first/last mile trip to or from transit by foot if there are comfortable conditions. In Washington, DC, a survey of riders found narrow streets and consistent sidewalks near stations to be significant predictors of walking trips from stations (Cervero, 2001). For bicyclists, research routinely ranks safety as a significant determinant for biking rates, which is in turn dependent on infrastructure and traffic conditions. Safe biking infrastructure can enlarge the catchment area for rapid transit stations, allowing people to reach stations from further away (Flamm and Rivasplata, 2014). Traditionally, research into specific actions that transit agencies take concerning first/last mile access has involved on-site station changes or accommodating bicycles on transit vehicles or through long-term parking.

As such, research into transit access typically operates on the assumption that transit providers are not able to affect significant changes in the built environment and streets surrounding stations. Metro's First/Last Mile Planning program represents a new perspective in transit service, extending the agency's focus from trips on transit vehicles to transit trips on a door-to-door basis. The document that establishes the program's methodology, the First/Last Mile Strategic Plan, includes suggestions for possible street improvements that may be applied to common conditions near highways. As the program's focus expands, so does the need to adopt consistent procedures for coordination with the California Department of Transportation.

Research question

This project incorporates a multi-pronged study of first/last mile transit access near highways, addressing the built environment considerations of access and walkability and the design interventions necessary to address the barriers highways impose.

First, what are the major design barriers to improving first/last mile station accessibility for stations near highway rights-of-way? Second, how might the coordination necessary to implement those improvements be improved, given the jurisdictional landscape?

The investigation employs two approaches to better understand the design and policy environments governing these questions. Three first/last mile case studies were conducted at the Palms and Maravilla light rail stations and the Manchester busway station. The stations were chosen to capture a variety of spatial relationships between a nearby highway and the transit station: Manchester Station is located on the highway median itself, Palms Station is located adjacent to the I-10, and Maravilla is 500 feet from a major interchange. Each has at least one under- or overpass, and at least one on- or off-ramp. Together, these provide a thorough perspective of how highway design choices affect walking and bicycling safety and comfort, and on how feasible improvements are to them under current state design standards. Each case station is examined through a re-created first/last mile planning methodology - charting rider access pathways by looking at current conditions and surrounding land uses - but with a focus on where pathways intersect with the highway rights-of-way. Semi-structured interviews with Metro and Caltrans staff provide context to past coordination efforts and outline the current process and narrative for first/last mile planning near highways. These are used to outline coordination strengths and weaknesses, as well as recommendations for possible processes in future first/last mile planning projects.

Outline

The remainder of this report consists of the following: First, a literature review surveys existing research on transit travel behaviors near highways and best practices on improving active transportation safety and transit access in challenging highway contexts. In the findings, a collection of policy and coordination patterns from LA Metro-Caltrans coordination outlines how both agencies have worked in the past and how inconsistent processes have impacted first/last mile plans. In the subsequent section, case studies for Palms, Maravilla, and Manchester Stations detail the existing first/last mile conditions with a particular focus to interactions between how first/last mile “pathways” intersect highway-associated barriers such as ramps and underpasses. Each case study contains proposed street improvements that would mitigate traffic conditions to increase comfortable and safe first/last mile access. Based on results from interviews and the case studies, the last section proposes a series of recommendations for planning processes and improvements within station areas that include segments of the State Highway Network.

III. Literature Review

For the typical transit rider, it is rare that a trip by subway, light rail, or bus takes them directly from their origin to their intended destination. Rather, each rider must find ways to navigate to their local stop or station and, from their final stop, to the end of the journey. This concept, known as the first-mile, last-mile problem (or “first/last mile”), can pose a barrier to potential riders, who may not be able to complete their trips to and from stations and therefore choose less sustainable transportation modes. For transit-dependent riders, a lack of first/last mile options may add significantly to their total travel time, limit the times they may feel safe walking to transit, and expose them to unsafe traffic conditions. Solving this problem expands the catchment area of riders who would be able to utilize a nearby transit station. First/last mile solutions may include any mode from driving and car drop-offs to transit connections, but the Los Angeles County Metropolitan Transportation Authority has prioritized active transportation modes for first/last mile access, positioning its first/last mile policy as an extension of its Active Transportation Strategic Plan. Following the LA Metro Board Motion 14.1, which instructed the agency to begin first/last mile plans for many of its stations, the range of accepted solutions now includes improvements such as “ADA-compliant curb ramps, crosswalk upgrades, traffic signals, bus stops, carshare, bikeshare, bike parking, context-sensitive bike infrastructure (including Class IV and access points for Class I bike infrastructure), and signage/wayfinding” (LA Metro, 2016). The exact improvements depend on multiple contextual conditions, such as surrounding land-use context, density, and the availability of existing active transportation facilities.

Within this context, highways can create significant barriers to walking and bicycling access. Across the eight railway and busway lines in Los Angeles County, dozens of stations are either located within highway medians or within a quarter-mile of a highway. Barriers may arise through routing, as the highways disconnect streets and force circuitous paths to a station, or through associated traffic conditions that threaten pedestrian safety and comfort. Passing under, over, or near highways also exposes pedestrians and bicyclists to noise and air pollution, underlit passages, and poor sidewalk conditions that may differ from the adjacent city sidewalk conditions. As the California Department of Transportation (Caltrans) owns and maintains highway rights-of-way, maintenance may differ from the surrounding area’s facilities. This overlap of ownership - LA Metro addressing broad station area accessibility and Caltrans overseeing changes upon its property - creates coordination issues for implementing first/last mile improvements, especially at the cost of vehicle speed and throughput.

The following literature review examines the existing academic literature on transit and first/last mile access, related walkability aspects of transit-oriented development, and the metrics academics and agencies utilized to assess these. In addition, current California state active transportation standards are investigated.

Relevant literature

The first/last mile problem

The first/last mile problem is a relatively new topic in transit literature, as few academic studies prior to the 2000s investigate it explicitly. The topic has historically been applied to supply chain logistics, referring to methods by which shipping companies move freight from the major highway routes to the recipient's door. Notably, as shared mobility options such as bikeshare and carshare emerged and gained popularity in the late 2000s, planners and academics recognized that the new modes might be best employed in support of transit systems, shuttling riders to and from stations.

In a 2009 analysis of international bikeshare systems, Paul DeMaio discusses the complementary nature of bicycling and transit usage in Paris, whose pioneering bikeshare system is called Velib. "In 2008, 21 percent of survey respondents used Vélib' to reach the subway, train, or bus, and 25 percent used Vélib' on the return trip from other transit modes," he noted. The following year, one-quarter of respondents reported using bikeshare to reach and make transit trips (DeMaio, 2009). DeMaio notes that these connective successes and the increase in transit mode shares in cities with bikeshare suggest the mode is a useful first/last mile option for users. Similarly, Shaheen and Chan discuss first/last mile modal solutions in the context of the suite of options provided through the "sharing economy," including bikeshare with carsharing and ride-hailing (2016). The authors agree that bikeshare, and similar modes such as scooters, expand the reach of transit, but note that in major cities with crowded transit conditions riders may substitute bikeshare for transit trips. While the focus on shared mobility options does involve transit and wayfinding information availability, the investigations focus on programmatic aspects of first/last mile rather than infrastructure improvements.

While not explicitly addressing the broader question of mode-neutral first/last mile access, a number of studies center on bicyclists' access to and egress from transit lines. Krizek and Stonewater, in a 2010 analysis bridging bicycling to potentially higher transit access and usage, coin the term "cycling transit users," or CTUs. Here, the issue of capacity of transit vehicles in accommodating numerous bicycles emerges as a key barrier, leading the authors to investigate the feasibility of secure bicycle parking at stations and transit stops. In this study, the availability of safe and low-stress bicycling infrastructure was largely considered a background issue that provides context to comparing transit-oriented facilities against dedicated bicycling facilities. The authors discuss the relation of the transit catchment area to accommodations for bicycles, noting that CTUs will travel farther for high-speed transit and that bicycle programs will effectively expand the catchment area by offering a reliable first/last mile option (Krizek and Stonewater, 2010). Building upon this study with extensive surveys of transit and bicycle riders, Flamm and Rivasplata confirm the enlarged catchment area, and observe that many people rely on bicycles solely as a link to transit (Flamm and Rivasplata, 2014). However, this portion of the literature reveals the general assumption that bicycling infrastructure - and by extension the general accommodations, design, and orientation of the street and public realm - exists outside of the purview of a transit agency.

Studies exploring walking access to transit tend to be broader in scope, analyzing variables from the density of an area and its land use types, to neighborhood sociodemographic characteristics. In a study of trips to Bay Area Rapid Transit (BART) stations in that transit system's service area, David Loutzenheiser conducted a statistical analysis based on survey data from riders (1997). Combining the rider survey results, which captured riders' first-mile travel modes, with land-use characteristics and station design attributes, he ascertained statistically significant variables that influence decisions to walk to stations. These included urban and station design-related variables that affected walks to transit included distance, residential density, and parking availability at stations. Notably, Loutzenheiser found that variables connected to car-oriented infrastructure - such as the presence of freeways and arterials near a station - discouraged walking. The number of interchanges near stations, interestingly, had no effect on the choice.

Cervero (2001) similarly addresses data from BART and its station areas, and adds some nuance and contradictions to the previous work. Like Loutzenheiser, Cervero found that parking availability, incentivizing a substitute to walking, negatively impacted walk-to-transit first-mile rates. Controlling for parking and other factors, though, his analysis saw that "terminal and near-terminal stations tended to have higher levels of access trips by foot, despite their freeway and highway orientations" (p. 8). Cervero attributes this to several high-density developments located near terminal stations, and notes that for egress trips, stations in highway medians saw 7 percent fewer walking trips. Applying this methodology to Washington Metropolitan Transit Authority Metro Rail stations in Montgomery County, Maryland, Cervero observed that walking egress correlated well with urban streetscape characteristics, such as narrow curb-to-curb widths and the presence of sidewalks on both sides of the street. This supports the theory of the role that "comfort" plays for choosing to walk to transit, as wide, car-oriented streets would be uncomfortable for pedestrians.

Walkability

While Loutzenheiser and Cervero take a broad statistical approach to walking factors, walkability, separate from transit access, has been quantified and observed in a number of other ways. In a 2009 review, Ria Lo documented the gamut of walkability metrics, noting the strengths and weaknesses of each. Pedestrian Level of Service (LOS) mirrors the traditional automotive LOS and similarly focuses on capacity and throughput. Lo notes that it is generally "anti-social," as it neglects land-use factors and social contexts, but might be helpful in addressing crowding and "defining failing grades for high-pedestrian volume locations such as in and around transit interchanges" (p. 146). Portland and Kansas City defined more contextually- aware parameters for their versions of Pedestrian LOS, connecting those to physical variables: "directness, sidewalk continuity, street crossings, visual interest and amenity, and security" (p. 154). This effectively ties the land-use of an area to its walkability score: a circuitous route through a suburban context, with few marked crossings, would therefore score poorly. Lastly, Lo adds that urban design-oriented metrics include even more expansive, qualitative factors, such as the degree of complexity, building articulation, and enclosure. In all, studies from a number of disciplines and approaches identify metrics including land-use density, direct paths, separation from traffic, sidewalk continuity, and related physical characteristics as useful walkability metrics (Lo, 2009).

The urban design implications of transit-oriented development (TOD) emphasize walkability in order to facilitate denser residential land use, connections to transit, and ultimately overall ridership. John Renne's study of contrasting transit-oriented station areas against "transit-adjacent development" near BART stations sheds light on the metrics useful for quantifying characteristics that support transit access (2008). Renne's built environment indicators include: "number of street links [within a half-mile buffer], number of intersection nodes, typical block dimensions" and ratings on station design, and pedestrian and bicyclist access (2008, p. 8). The case station with the most connected street grid and highest ratings, downtown Berkeley, also attracted the highest shares of riders by walking and biking.

Relevant interventions

A separate discourse exists on street modifications and improvements that enable the level of first/last mile access detailed above. The concept of "complete streets" emerged in 2003 from an America Bikes campaign, and has grown to cover the development of streets and public spaces that accommodate modes including and beyond car traffic. As of 2012, at least 500 American cities have passed complete streets policies, setting goals for streets that include wider sidewalks, curb ramps, bulb-outs, protected bike lanes, and transit improvements such as bus lanes (Peiser and Zehngebot, 2014). Specific complete streets interventions most relevant to bike and pedestrian access near highways include curb ramps, reduced turning radii, signalized crossings, protected bicycle infrastructure, and sidewalk widening.

An analysis by Hubbard et al. addressed the stress that high-traffic crossings can add to the pedestrian experience. Utilizing the Pedestrian Level of Service metric mentioned above, Hubbard and her co-authors determined that high volumes of turning traffic can negatively impact crossings, delaying or forcing a pedestrian to change paths, and hurting PLOS (Hubbard et al., 2007). Separated signal phases, such as a leading pedestrian interval that allows pedestrians to "claim" the crosswalk space ahead of turning drivers, may improve the walkability of those crosswalks. This conflict is especially relevant to this study given the importance of on-ramp turns near stations, which can generate high numbers of turning movements across crosswalks.

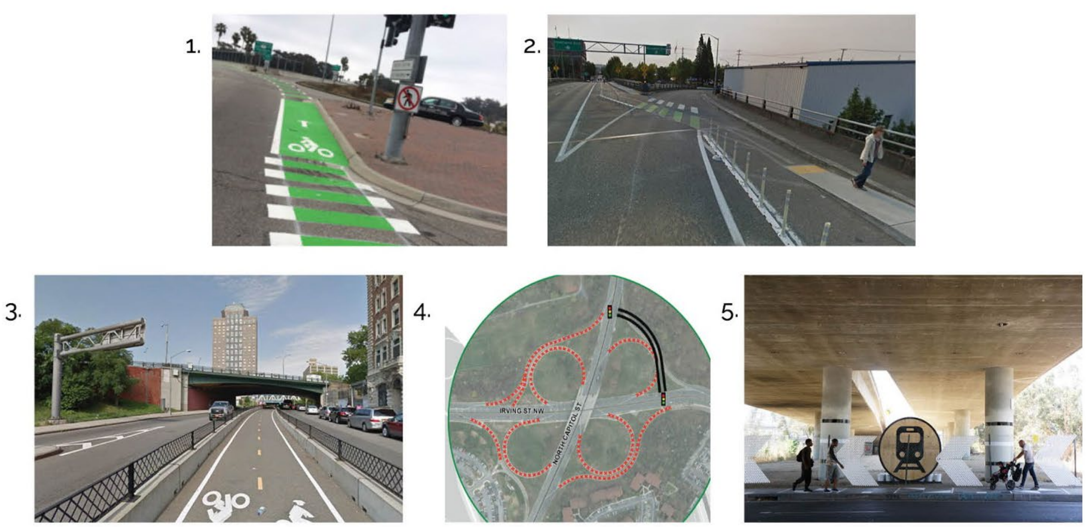
Existing access examples

Though both Caltrans and Metro emphasize flexibility and a suite of suggested improvements near highway conditions, few such improvements have been implemented in LA County. Some Metro median stations, such as Allen Station on the Gold Line, have pedestrian-oriented lighting and accompanying art, but do little to address traffic safety. Design treatments in the region and in a number of other cities in the United States, however, provide a number of options for calming traffic and protecting people biking and walking near dangerous highway conditions and other major vehicle infrastructure (see Image 1, below). Though few pertain explicitly to increasing transit access, all address unique barriers that highways pose to safe and comfortable bicycling and walking. A few examples are discussed below.

1. Seaward Avenue; Ventura, California. In 2017, Caltrans, in cooperation with the city of Ventura, implemented upgrades to existing striped bicycle lanes that ran above I-101 and through two complex intersections that incorporated ramps to the interstate. While the geometry of the lanes remained largely the same, bright green paint was added to the length of the bike lane, and a combination of the paint and hashed “elephants feet” design (paint dashes spaced several feet apart) improves the visibility of conflict zones (Caltrans District 7 Bicycle Advisory Committee, 2017).

2. Hawthorne Bridge; Portland, Oregon. Many bridges in Portland are essential east-west connections for bicyclists, yet they incorporate feeder on-ramps similar to highways. Improvements made in 1997 and 2013 to Hawthorne Bridge not only expanded the separated raised paths for bicyclists and pedestrians, but also added new protected ramp crossings

Image 1. Existing types of improvements oriented towards addressing safety or access near highways.



Sources: Caltrans District 7 (1), Google Maps (2, 3), District Department of Transportation Crosstown Multimodal Tranposrtation Study (4), LA Más Go Ave 26 (5).

(Birk, Smith and Mead, 2013). The crossings shift both the ramp traffic and the bicycle and pedestrian paths so the two intersect at right angles in order to maximize visibility. A continental crosswalk marks the pedestrian crossing, and an accompanying green dotted marking shows the adjacent bicyclists' alignment.

3. Sands Street, New York City, New York. The New York City Department of Transportation completed improvements to Sands Street in Brooklyn in 2009, as an effort to connect bicyclists to the Manhattan Bridge. A two-way, multi-use path was constructed in the center of the street as it passes below the Brooklyn-Queens Expressway as a way to separate people biking and walking from on-ramps (Eckerson, 2009). The preceding block has no vertical separation between the path and the street, save for a buffer area with a slope that allows bicyclists to comfortably merge onto the center lane.

4. Irving Street NW/NE; Washington, DC. In a configuration similar to Sands Street, in 2016 the District Department of Transportation recommended a median protected bike lane be added to Irving Street in order to avoid turning conflicts with the "cloverleaf" on-ramps to North Capitol Street (DDOT, 2016). The same study, the Crosstown Multimodal Transportation Study, also recommended reconfiguring the intersection to eliminate three ramps, and convert the last one to a signalized connector street.

5. Avenue 26, Los Angeles, California. A transit- and pedestrian wayfinding-oriented project, "Go Ave 26" added distinctive signage to an underpass and sidewalk near the Lincoln/Cypress Gold Line Station. Black and white signage painted on sidewalks and adjacent fencing guides transit riders from the bus stops on the corner of Figueroa Boulevard and Avenue 26, above SR-110 and on-ramps from I-5, to the Gold Line light rail station (LA Mas, 2017). The designs serve a dual purpose, making the walk more comfortable and engaging while also clarifying the paths to the respective transit stops.

Many of these examples highlight the need to physically separate people biking and walking from merging traffic. In the case of Ventura and Portland, where the separation is not feasible, efforts were made to ensure visibility and predictable interactions between street users. Lastly, cost, permanence, and feasibility were often factors that shaped the intervention design: the Irving Street center bike lane, for example, is proposed as a temporary change while DDOT seeks FHWA approval for the broader intersection redesign.

National standards

Design guidance documents from various agencies and national bodies agree that special considerations must be made for protecting pedestrian and bicyclist access at interchanges with highways, but there is little agreement and exact guidance as to the best street improvements cities should apply. The Federal Highway Administration's "Separated Bike Lane Planning and Design Guide" offers a "menu" of improvements for intersections and mixing zones with traffic, such as through-lanes and signalization, but none that apply specifically to on-ramps. Regarding ending a protected lane near high-volume areas such as highways, the guide encourages "design flexibility," noting cities should explore all options to keep bicyclists safe, “even if it requires a change in local law to allow cyclists to use sidewalks, or involves other unique treatments (2015, p. 132). Similarly, the American Association of State Highway Transportation Officials (AASHTO) and an FHWA course recommend a focus on creating predictable, perpendicular intersections between highway ramps and bicycle facilities (AASHTO, 2012; FHWA, 2006). When a bicycle lane crosses a ramp, the former recommends it be marked as a dotted through-lane. AASHTO also recommends controlled signalization to separate turning phases from bicycle riders in the lanes.

Agency guidance

This project builds upon LA Metro’s First/Last Mile Strategic Plan and Guidelines, which establishes a methodology for first/last mile needs assessment and planning. The Strategic Plan echoes and supports much of the above research regarding barriers to transit access such as long blocks, missing crosswalks, sidewalk maintenance, and gives special consideration to highways: “freeways carve our region into a number of ‘pedestrian islands.’ Links between these islands are effectively broken by dark and unpleasant underpasses or equally challenging overpasses” (LA Metro, 2014). Likewise, the document’s street improvement toolkit includes suggestions oriented toward highways such as underpass lighting, vegetation and shade on overpasses, and public art that creates visually engaging places. It also suggests ways that these may be integrated with transit, such as through Metro signage and paving treatments. Sidewalk widenings are also identified as a potential treatment for freeway barriers. Despite these classifications, the Strategic Plan makes clear its toolkit is intended to be flexible, and that “each component can be applied where appropriate depending on the urban condition” (LA Metro, 2014). A later case study of North Hollywood, for example, suggests not only improved lighting in an underpass, but also bollards to ensure street user separation from fast-moving traffic.

The policy guidance on design for Caltrans facilities, meanwhile, stems from Chapter 100 of the state’s Highway Design Manual. The manual, though predominantly focused on highway design speeds and throughputs, provides some guidance on pedestrian facilities. Sidewalks along bridges, for example, must be a minimum of six feet wide, but the language does not account for pedestrian comfort, with items such as buffers from fast-moving traffic (Caltrans, 2018). Similarly, Chapter 100 acknowledges that “pedestrian use near transit facilities should be considered during the planning phase of transportation improvement projects,” but no specific standards are enumerated for transit access (Caltrans, 2018). “Quality of service” and capacity are identified as priorities for pedestrians and bicyclists.

The department has shown an openness to accommodate design choices for non-driving modes, as a 2014 memo entitled “Design Flexibility in Multimodal Design” makes clear that Caltrans and its regional divisions may utilize some design methods of the National Association of City Transportation Officials and other organizations in order to create safer bicycling and walking facilities. The memo notes a “one size fits all” concept is not department policy, and that design flexibility may be particularly helpful in cities (Craggs, 2014). Importantly, the

Highway Design Manual recognizes and reflects on the history of car-oriented interchange design, observing new guidance as an “evolution in design philosophy.” For interchanges with local streets, “pedestrian and bicycle traffic needs are to be considered along with the motorized traffic” and ramps in new construction should only be perpendicular to streets in order to allow for safer crossings (Caltrans, 2018).

Conclusion

First/last mile implementation in the context of highways comprises a small portion of broader research, formed in the overlap of first/last mile travel behavior, transit access, walkability, and complete streets improvements. Studies such as Cervero (2001) and Loutzenheiser (1997) agree that the presence of highways near stations discourages walking trips to stations. The same body of research also enumerates key urban design elements that correlate with walking-transit access: sidewalk continuity, narrower streets, and a connected street grid. A survey of walkability metrics confirms the utilization of these and related design criteria in walkability analyses.

Little research exists on the exact design “best practices” necessary to increase transit accessibility specifically near highways, and implementation details are unclear. Broadly, however, movements toward complete streets and campaigns addressing street safety such as Vision Zero have identified design interventions that slow traffic, prioritize safe pedestrian and bicyclist movements, and foster comfortable walking spaces. Many of these interventions work together to calm fast-moving traffic and offer greater comforts for active transportation modes, but are generally applied in an urban context, away from highway-like traffic flows. Where guidance exists in specific relation to highway ramps, there are few definite recommendations. Signalization and right-angle facilities appear as key themes, but the exact configuration depends on the design of each intersection and the traffic flows involved. Further, the through-lane mixing zones do not provide consistent protection a rider might expect when riding on a protected bike lane, as drivers still pass through the bike lane when merging onto a ramp.

Gaps in research

Generally, research into multi-modal transit connections regards transit service as separate from the condition of the surrounding street network and urban form. Studies such as Krizek and Stonebraker (2010) propose recommendations regarding transit vehicle capacity for bicycles and on-site bike parking at stations, which are indeed relevant logistical barriers for bicycle-transit transfers. However, they and others consider on-street bicycle infrastructure as a static portion of the built environment, and therefore outside the scope of their analyses. While a traditional transit agency may be limited the designs within the right-of-way of its rail system, as a county transportation authority LA Metro has a broader mobility purview. The Transit Oriented Communities Policy sets clear goals that extend beyond the rail system, to neighborhood stabilization, joint development of affordable housing near stations, and to safety and improved access for riders. This disconnect requires some extrapolation from studies addressing city and state street design policies towards those examining transit access and ridership.

Currently, a majority of research tests for observational correlations between built environments and travel behaviors, but a gap exists in bridging the statistically significant elements that influence walking to transit with the design changes that explicitly encourage and facilitate them. Further research might attempt a longitudinal study to quantify the ridership and travel behavior impacts of complete streets interventions. A multimodal approach might attempt to connect bicycling and walking investments to transit modes as well, recognizing the overlapping role those investments serve for riders attempting to reach a stop or station. Ultimately, this project attempts to bridge a portion of this, with an eye towards implementation processes and agency standards. Reducing the barriers that highways pose to first/last mile access would carve away at the aforementioned “pedestrian islands” of Los Angeles County and offer improved connections and mobility for numerous sustainable modes.

IV. Methodology and Data

This project investigates two key elements of first/last mile planning: street improvements that address safety and comfort along first/last mile access pathways and coordination between LA Metro and Caltrans. As such, the methodology includes two complementary techniques. In one, descriptive case studies explore the ways in which highways typically impact first/last mile accessibility and safety and the ways in which improvements may address them. In another, interviews with agency staff and planning professionals seek to understand the factors that affect past and current LA Metro-Caltrans coordination and experiences on similar projects.

Case studies

Of the 123 Metro Rail and Busway stations within the Metro system, 67 rail stations and 20 busway stations sit within a half-mile of the State Highway Network. As the station's proximity to highways influences the types of barriers that affect station access, case study stations were chosen to reflect groups of station typologies arranged by distance to highways. These typologies were: median stations (in the median of highways), adjacent stations (zero to 500 feet from highways), and nearby stations (500-1000 feet of highways). Stations meeting these definitions make up 16 percent, 9 percent, and 43 percent of all stations, respectively. Choosing stations by those typologies allowed the study to capture and observe potential conditions shared at a large number of stations throughout the system. Each chosen station also has at least one of the common highway barriers the client identified: ramps with geometry oriented toward vehicle speed and throughput and either an underpass or overpass crossing the highway(s).

Case studies were proposed to the project client, and factors such as previous planning efforts and ongoing projects were incorporated into final case study decisions. The Blue Line First/Last Mile Plan, completed in 2018, already created plans for each of the 22 stations on that line, including many within a half-mile of the I-710, I-105, or I-10 highways. The Inglewood First/Last Mile Plan, adopted in winter of 2019, and a prior first/last mile case study had also examined the Crenshaw and Long Beach stations on the Green Line, which have quintessential median-type station layouts. This process introduced a degree of selection bias, but also ensured that the case study stations would not produce information made redundant from interviews, which addressed past first/last mile plans. Additionally, the months-long station shutdown along the southern portion of the Blue Line during early 2019 eliminated the feasibility of observing riders at those stations. The chosen studies are listed below and in Figure 2:

- **Median: Manchester Station; Metro Silver Line; South LA, Los Angeles.** As with almost all off-street bus rapid transit stations on the Silver Line, Manchester Station lies within the median of a highway, the 110 Freeway. Access is only possible through an underpass beneath the station. The underpass and four on/off-ramps that intersect each sidewalk leading to the station comprise the main first/last mile barriers.
- **Adjacent: Palms Station; Expo Line; Palms, Los Angeles.** Palms Stations shares a wall with the I-10 Freeway. Access impacts are concentrated to the northern side of the station area, where an off-ramp creates a hazardous crossing condition and a long underpass discourages walking. The area adjacent to Palms Station has the highest density among the case studies, and its proximity to the Expo Line Bike Path offered further opportunity to identify connective interventions to that infrastructure ("Mapping LA," 2009).
- **Nearby: Maravilla Station; Gold Line; East Los Angeles, Los Angeles County.** Though slightly further from a highway centerline, the barriers for Maravilla light rail station are dispersed over a large area given the space the SR-60 and I-710 interchange occupies. The barriers include an overpass, underpass, and four off-ramps. The variety of ramp types include signalized, curved (i.e. a high design speed), and perpendicular to local streets, providing examples of multiple design options for improvements.

Figure 2. Selected case study stations

The case study evaluation was modeled closely to the existing first/last mile planning methodology outlined in LA Metro's 2014 First Last Mile Strategic Plan. Following that methodology, a station area of interest is identified as the area within a half-mile radius from a station, considered as the maximum distance a person is willing to walk to rapid transit. The Strategic Plan also considers bicycle access at a three-mile radius, but, given the concentrated highway focus of this project, bicycle connections are focused to the interactions with highways. Overlay data was collected from each station to inform the location and necessity of "pathways," or critical biking and walking routes to a station. See Figure 3 below for the components and sources of the station area overlays. Land uses, for example, aid in informing the likely station pathways and areas of high pedestrian activity.

Figure 3. Case study overlay data

Data	Source
Active transportation	//////////////
Pedestrian- and bicyclist-vehicle crash rates	Transportation Injury Mapping System (UC Berkeley and California Highway Patrol)
Street, sidewalk dimensions near highway right-of-way	Google Maps measurements
Walking/bicycling facilities	Observation, City and County of LA planning documents, Google Maps
Planned facilities	LA City Mobility Plan 2035, LA County 2012 Bike Master Plan
Lighting	Observation (qualitative)
Noise levels	Observation (qualitative)
Rider-driver conflict points	Observation (qualitative)
Transit	//////////////
Transit service and connections	LA Metro, Montebello Transit, LA County
Traffic conditions	//////////////
Traffic volumes (highways, ramps, intersecting streets)	LADOT, Caltrans
Posted and perceived traffic speeds	Observation
Built form	//////////////
Points of interest (churchs, schools, parks, civic buildings)	Observation
Zoning and land use	Zone Information and Map Access System (ZIMAS), SCAG, observation

Rather than identify improvements along the entire length of pathways, this project focused only on the intersection of pathways with highways and Caltrans-operated right-of-way. Drawing from the “flexible improvements” listed within the First/Last Mile Strategic Plan, and best practices identified within the LA County Model Design Manual for Living Streets, specific interventions were proposed at the key sites of highway-pathway conflict. These included improving lighting in underpasses, realigning on-ramps, reducing crossing distances, and providing low-stress bicycle facilities.

Interviews

Staff interviews were conducted to construct a better understanding of past coordination between LA Metro and Caltrans on issues affecting first/last mile access, and to identify challenges and potential solutions within that process. As the First/Last Mile Planning program was only established in 2016, and as of February 2019 has only produced one public plan, staff interviews were necessary to fully document the prior coordination process. Additionally, the first/last mile planning process is currently being integrated into corridor-level transit planning through pending guidelines, meaning the prior process is not codified and requires staff perspectives. Interviewees were selected from within LA Metro and Caltrans staff for their expertise in one of the overlapping areas of interest: inter-jurisdictional (county-state) processes, active transportation, first/last mile planning, and corridor planning. In addition, one non-agency expert, from urban design non-profit LA Más, was selected due to their experience on the “Go Ave 26” first/last mile demonstration project in the Lincoln Heights neighborhood of Los Angeles/last.

A total of seven semi-structured face-to-face or phone interviews took place between January and February 2019. Each interview lasted between 30 and 60 minutes, and was recorded on a cell phone for later transcription. As each interviewee was an expert in one aspect of the project, questions varied. Interview questions were selected to explore key questions within the project: what issues arose with highway-related improvements during the Blue Line First/Last Mile Plan? How transit access is balanced with other planning goals? What design solutions might work best in a highway context? Staff working on non-active transportation programs within LA Metro were asked about their own coordination with Caltrans, and how that might serve as a model for future planning projects.

Interviews revealed a broad agreement within Metro and Caltrans staff for the integration of access concerns into multimodal corridor transportation planning. Caltrans staff recommended the adoption of some temporary improvement types, such as lane striping and delineators, in order to accommodate safer streets that may be affected through other long-term plans. Other Metro staff provided key examples of successful ongoing coordination that an established maintenance and operations framework has allowed. Given the ongoing role Caltrans plays within corridor-level transit planning, staff suggested that the integration into corridor planning provides a key opportunity to set regular contact points for scoping street improvement implementation.

Figure 4. Interviewed staff

Name	Agency / Department or Speciality
Katie Lemmon	Metro / First/Last Mile Planning
Ivan Gonzalez	Metro / Mobility Corridors
Shannon Hamelin	Metro / Parking Management
Akiko Yamagami	Metro / Goods Movement
Dan Kopulsky	Caltrans / Multimodal Systems Planning
Dale Benson	Caltrans / Bicycle and Pedestrian Engineering
Abby Stone	LA Más / Urban Design

Analysis

Though the results of the case studies and interviews were analyzed separately, together they informed recommendations that could work to standardize first/last mile planning near highways. For case studies, the project determined proposed access pathways for each station, then noted where those intersected with highway rights-of-way. Street improvements and proposed interventions at each station were referenced against existing Caltrans standards and guidance for feasibility of implementation. The California Manual on Traffic Control Devices and the California Highway Design Manual provide the traffic devices and standards for Caltrans, respectively. This evaluation highlights the strengths and weaknesses within the agency's existing standards, and suggests elements to be integrated into standardized toolkit for LA Metro to deploy in future planning efforts.

Interview transcripts were ultimately evaluated for common narrative threads affecting challenges and opportunities in coordination. These were compared across agencies and programs to assess points of agreement or conflict. Conclusions drawn were also identified as possible recommendations to submit to the Caltrans Division of Rail and Mass Transportation to inform future guidance. External interviewees' feedback regarding lessons learned from their prior first/last mile projects provided guidance on which specific challenges would be most useful to address in the resulting recommendations.

V. Findings

When the LA Metro Board of Directors passed Motion 14.1 in May 2016, calling for the agency to address first/last mile planning issues, it directed those efforts to focus on 661 priority transit station areas across Los Angeles County. The scale of the directive, and of LA Metro's existing transit system, mandates staff work closely with the numerous local jurisdictions that comprise the county. As the built form of Los Angeles has, through development and transit planning decisions over the past 60 years, been tied to automobile infrastructure, much of that planning involves addressing its effects on transit riders and working closely with agencies - namely, the California Department of Transportation - that own and oversee it. Though LA Metro and Caltrans both share priorities in creating complete streets for all users, they work within differing purviews.

Interviews with staff at LA Metro and Caltrans revealed a number of broad themes and lessons for inter-agency coordination, both in the specific context of first/last mile planning efforts and with other project management. These include engagement, funding complications, competing priorities, and frameworks. However, the application of these lessons will likely change given the specific contexts and needs of first/last mile planning, as elaborated in the case studies section. Indeed, the contextual characteristics of case study sites explain why the variety of station area-highway interactions cause pre-established processes and standards to be more difficult for first/last mile planning.

Staff experiences

Staff interviews looked beyond the First/Last Mile Planning Program to integrate perspectives from transportation, programming, and design experts who work regularly with Caltrans and have successfully coordinated past projects involving highways or Caltrans-owned right-of-way. These included Metro staff within the Mobility Corridors and Parking Management departments, Caltrans staff in multimodal and active transportation planning roles, and an urban designer who led a first/last mile-oriented demonstration project. A past case of coordination issues at the Blue Line Del Amo Station, where improvements were introduced addressing critically deficient biking and walking conditions under an I-710 underpass in Carson, provides a lens through which to position common themes.

Levels of inter-agency engagement

Across Metro staff interviews, knowledge of when and to what extent to integrate Caltrans staff into jurisdictional communications differed slightly, but interviewees agreed that increased engagement yields better, more predictable experiences. In the case of Del Amo Station, which was already a "confluence of jurisdictional boundaries," according to First/Last Mile Planning transportation planning manager Katie Lemmon, LA Metro and the stakeholder jurisdictions met with Caltrans District 7 representatives after developing the community-supported pathways that would guide project selection. It was then that Caltrans staff provided a number of options of how that corridor might be improved. This has changed some for first/last mile projects since then: should a station area intersect a highway, Lemmon notes “[t]hat’ll be a conversation we’ll have to have with Caltrans this time around … flagging the added layer of coordination that we’ll have to do in our plans now.”

In planning broader transit corridors and their alignments, a more regular process exists for engaging with Caltrans on issues in their right-of-way. Identifying how and where a project intersects with Caltrans facilities is the first step in establishing a coordination process for that project, according to Mobility Corridors transportation planning manager Ivan Gonzalez. Once that is set, check-in meetings are scheduled throughout the planning process, and administrative details such as invoicing are cleared from the beginning.

“Communication is huge in that process,” noted Shannon Hamelin, senior director of Parking Management at LA Metro. By staying in regular contact with particular staff members in Caltrans District 7, Hamelin’s team is able to shorten what were previously longer processes. This included, he observed, Caltrans staff predicting and preemptively generating renewals for encroachment permits that had lapsed after their one-year duration. After “rinsing and repeating” some of the same processes, “the process becomes easier, because you’re dealing with the same people.” LA Más’ Abby Stone echoed this, observing that a major part of their coordination process involved identifying the proper liaisons within the agency. One staff member-liaison in particular become integral for connecting the non-profit to the appropriate processes, “help[ing] us through some of the tricky bureaucratic navigations.”

Frameworks

More successful instances of frequent inter-agency engagement appear to draw from consistent working frameworks that govern how often, and on what topics, that communication must occur. Metro Parking Management, for example, operates under an Operation and Maintenance agreement with Caltrans, allowing Metro to take over operations of park-and-ride lots that reside on Caltrans-owned land near highways. The agreement, which went into effect in January 2017, spells out what Metro is and is not allowed to do on a parking lot, granting the agency the ability to bypass earlier processes that may have slowed down any projects, changes, or improvements. Additionally, as the operator of the lots, Metro is now responsible for upgrading them to code by adding ADA-accessible facilities, a series of changes that Hamelin describes as an incentive for Caltrans to enter into the agreement. Similarly, the project management process builds coordination into its scope of work for contractors, and has a set process that covers the process for check-ins and coordination.

However, the parking management agreement differs greatly from first/last mile planning processes in that it covers 17 set locations. As the first/last mile planning areas vary per station and street conditions, it would likely be impossible to establish broad coordination agreements in the same way. Hamelin acknowledges that this is a distinct challenge for other types of coordination, and that it reduces the likelihood of repeat interactions formulating the same kinds of relationships his team has established.

As of the first half of 2019, Metro is generating first/last mile planning guidelines to ultimately integrate that planning process into the overall transit corridor project process. This will, to some degree, tie first/last mile improvements more closely to the transit project scopes.

Funding complications

Funding for implementation of street improvements is a key restriction for a number of active transportation street improvements. For the Blue Line First/Last Mile Plan, LA Metro provided technical grant assistance to local jurisdictions, submitting Active Transportation Program Cycle 4 grant applications to the state's funding program for packages of station-area proposals. Though the ATP cycle is a key opportunity to secure funding, a tension appeared between the grant deadlines and Caltrans' planning needs. ""It wasn't so much that they were saying it was infeasible," said Katie Lemmon, "it's that the prognosis of working with them under the time requirements of the grant application and the timeline for implementation didn't align with a timing that they would be able to work with, in a way that would be phased with their other work." Including the I-710 underpass improvements in the grant application threatened to derail other proposed improvements, as it could not be considered a guaranteed improvement under the grant. As such, it was removed in order to preserve the other aspects.

Caltrans staff similarly identified funding as a major constraint and challenge for multimodal improvements along freeway corridors. One main concern for biking and walking conditions near highways, the prevalence of "free right turns" - or on-ramps with wide turns that lead to high-speed conflicts with pedestrians - requires major long-term investments to realign the roadway. Bicyclist and pedestrian coordinator Dale Benson noted that often some temporary treatments, such as concrete "k-rails," might be appropriate for interim improvements.[1] The standardized form of k-rails, which can be removed easily at a later date, make them cheaper and more flexible than adding new curbs or sidewalks. However, there was no simple answer to resolving competing priorities with complications such as grant timelines.

Priorities: Shared and constrained

Both institutionally through policies and guidance, and within department staff, Metro and Caltrans aim to remove barriers to transit access and to adapt car-oriented streets to people biking and walking. ""It seems like we have similar goals of improving safety, - we do - it's that [Caltrans also has] the added goal of highway performance," said Katie Lemmon." So how do we align that with bicycle facilities? That's the added layer." Dan Kopulsky and Dale Benson agreed, noting that resistance from traffic engineers can be a major limitation in implementing street improvements that affect the traffic flow of facilities. For multi-modal system planning, Kopulsky emphasized that removing barriers to access for non-driving modes was a key

1 A k-rail, also known as a Jersey barrier, is a temporary vertical barrier, often concrete, typically used in medians, shoulders, or other highway contexts.

priority. Caltrans staff also noted that, for new facilities and modern highway reconstruction, past highway interchange designs that prioritized high-speed merges from local streets - and were thus dangerous to cross - have been officially phased out statewide. The preferred design format, perpendicular intersections at local streets, are safer for bicyclists and pedestrians to cross and is documented in the state Highway Design Manual.

The focus on traffic throughput even affects parking management. As Metro operates and maintains the Caltrans-owned lots near highways, many changes are approved under the shared agreement, but those potentially affecting traffic flow require feasibility studies. Generally, Metro staff recognize this as Caltrans protecting its jurisdictional responsibilities. Gonzalez observed the ability to later expand or modify highway lanes on a highway adjacent to a planned rail line had been a point of discussion in state coordination for that line.

From a design standpoint, this focus on controlling traffic effects is evident in the historical layout of the parking lots Metro Parking Management now oversees. Hamelin observed that these were established with few lot access points, to limit drivers parking in the neighborhoods then walking to the station, but it carries the added effect of broadly limiting pedestrian access to the station. This suggests that first/last mile strategies for stations with parking must look beyond street conditions and consider the highly specific parking concerns that yielded the existing design.

Though none of the traffic flow concerns affected the Go Ave 26 project, concerns about visibility for drivers did ultimately change a proposal for a ramp-adjacent activation. Signage issues - such as proposed wayfinding for people making transit transfers - have also created difficulties for improving conditions on Caltrans land. During Go Ave 26, project lead Abby Stone found that the intended artistic signage did not comply with Caltrans' standards. As such, LA Más integrated artistic elements that suggested wayfinding in broad strokes - primarily through triangular designs that might subtly imply directions - without having to install standardized Caltrans signage. The non-profit achieved this through securing an art permit, rather than a wayfinding and signage one.

Challenges with standards notwithstanding, Stone and LA Más concluded that their project provided Caltrans an opportunity to act on planned improvements that were "already in the works, but did not have high visibility/accountability" ("Go Ave 26 - Final Report" 2017). Caltrans installed a new chainlink fence in the I-5 underpass and upgraded five crosswalks to more visible continental striping. This impetus role of the project extended to LADOT, as well, giving the agency a chance to respond to previous community feedback and install a traffic signal just outside the study area.

Case studies

As discussed in the Methods and Data section, each case study captures a highway-station proximity typology common across the LA Metro stations near highways. Each also demonstrates a variety of specific design barriers to walking and biking access within the half-mile planning radius, as well as the factors that might impede implementation. Taken together, the studies show that the exact role of a highway as a barrier is less a function of a station's proximity, but more the function of the design of that highway.

Manchester Station

Located in South Los Angeles, the Manchester Station of the Silver Line embodies the median station-highway typology common on the Silver, Green, and Gold Lines. The station sits within the median of the I-110 Harbor Freeway, which runs from Pasadena and downtown Los Angeles to San Pedro, and serves the Silver Line Bus Rapid Transit Line that runs in its center expressway lanes. These expressways, called the Harbor Transitway, were built in 1995 and serve a number of north-south bus routes beyond the Silver Line, including other operators such as Torrance Transit. Notably, when LA Metro added the transitway station, aerial photographs show the ramp configuration was not changed to accommodate people walking to the new station ("Historic Aerials"). Four ramps surround the intersection, two of which carry five lanes (two onto the highway, three off of it).

The station platforms are split between southbound and northbound, and riders may access them from either the southern or northern sides of Manchester Blvd as it passes beneath the I-110 overpass. The area near these entrances serves as the station's "mezzanine," housing ticketing and information kiosks.

Overlays

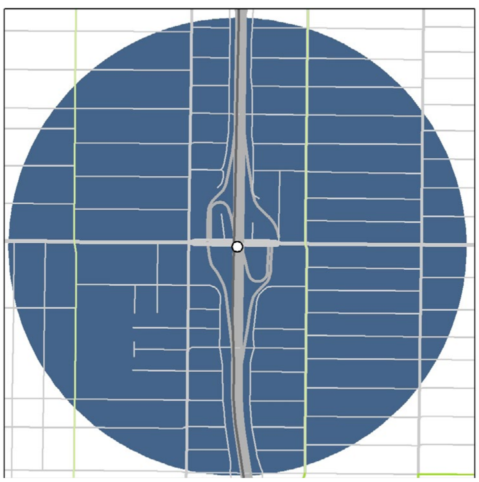
The area around Manchester Station is primarily medium density residential, with heavy commercial presence in small businesses and some car-oriented shopping malls. The area is notable for the large number of small churches and community spaces. Other major destinations include Algin Sutton Recreation Center, KIPP Academy, and Manchester Elementary, all on the eastern side of the highway.

Manchester Station is well-served by a number of LA Metro routes running parallel and perpendicular on the adjacent street grid. The 745 rapid bus runs north-south along Broadway, a corridor one block from the station. The LADOT DASH bus also serves a circular route that runs primarily north-south. The only route that runs through Caltrans property near Manchester is the Norwalk-to-Playa del Rey 115 line. The stop at the I-110 serves as a key feeder for the Silver Line, but only the eastbound stop directly serves the station in a curbside bus bay. The rightmost westbound curb in the underpass is a dedicated right turn lane, and riders making westbound transfers must walk outside the underpass to do so.

Bicycle infrastructure is rare in the Manchester station area: only two signed routes run near the station. Both are north-south: Broadway on the eastern side of the station, and Hoover St on the western. These routes only incorporate “Bike Route” signs at major intersections, and provide no other guidance or protection for bicyclists. The Manchester Blvd corridor is of special concern following a high-profile crash in 2018 that took the life of Woon Frazier approximately a mile from the station (Sulaiman, 2019). In February 2018 another cyclist was killed by a driver in the same area.

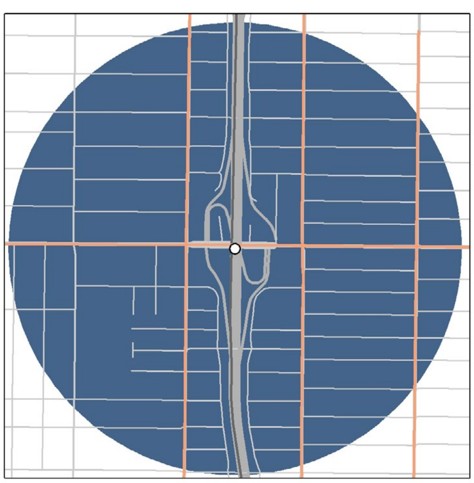
The crash overlay bears this out: Manchester Station had significantly more crashes in the 10-year period than the two other case studies. These are primarily clustered along Manchester Blvd, in particular the western side. It is unclear if recorded crashes along the I-110 relate to passengers walking from the Silver Line station.

Figure 5. Transportation and land use elements at a half-mile radius from Manchester Station (continues on subsequent pages)



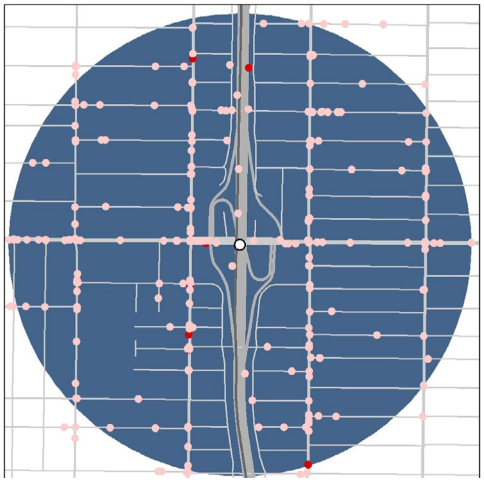
Manchester Station Bike Facilities

Class III routes



Manchester Station Transit Service

LA Metro Bus, LADOT DASH

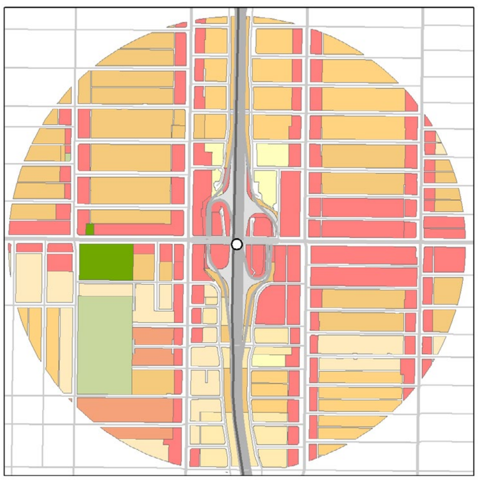


Manchester Station Bike-Ped Crashes

2006 - 2015

Injury

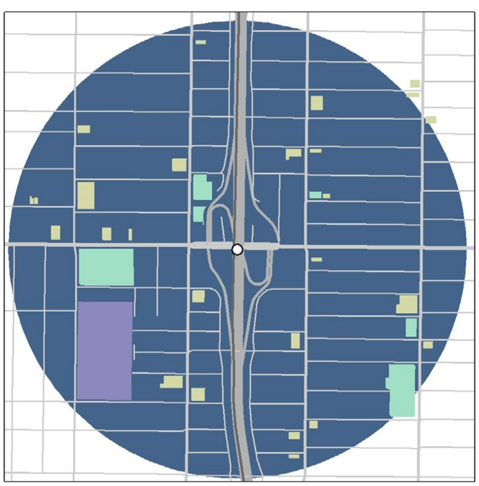
Fatality



Manchester Land Use

C2 R1 R3 RD1.5 RD3

R2 R4 RD2 RD5



Manchester Points of Interest

church civic park school

Key barriers

The main focus areas of Manchester Station are at the intersection of the on-ramps and Manchester Blvd. Though three of the four are signalized (Image 2), long waits and a short crossing time of 30 seconds led some pedestrians to cross into oncoming traffic. Even when crossing with a signal, drivers turning right on red conflicted with people walking. A pedestrian leading interval at these locations would allow pedestrians to enter the crosswalk before right-turning traffic, claiming the space and becoming more visible. More drastically, lower turning radii at these ramps would force drivers to slow down in order to navigate the turn. They would also reduce some of the crossing distance for those crosswalks, which are up to 100 feet wide.

The LA Mobility 2035 Plan notes that a protected bike lane is planned for Manchester Blvd, which would protect those riding to the station from the high speed differential along that corridor. This is limited, however, by two constraints: lanes are already fairly narrow (10 to 12 feet each), and the highway support columns in the center median limit how the lanes might be rearranged to accommodate protected bike lanes. As a result, adding those lanes would likely require the removal of the rightmost turning lane on both sides, necessitating a thorough traffic study on the impacts on highway traffic. However, these intersections are almost all signalized already, a condition that would aid in navigating and timing ramp-bike lane interactions.

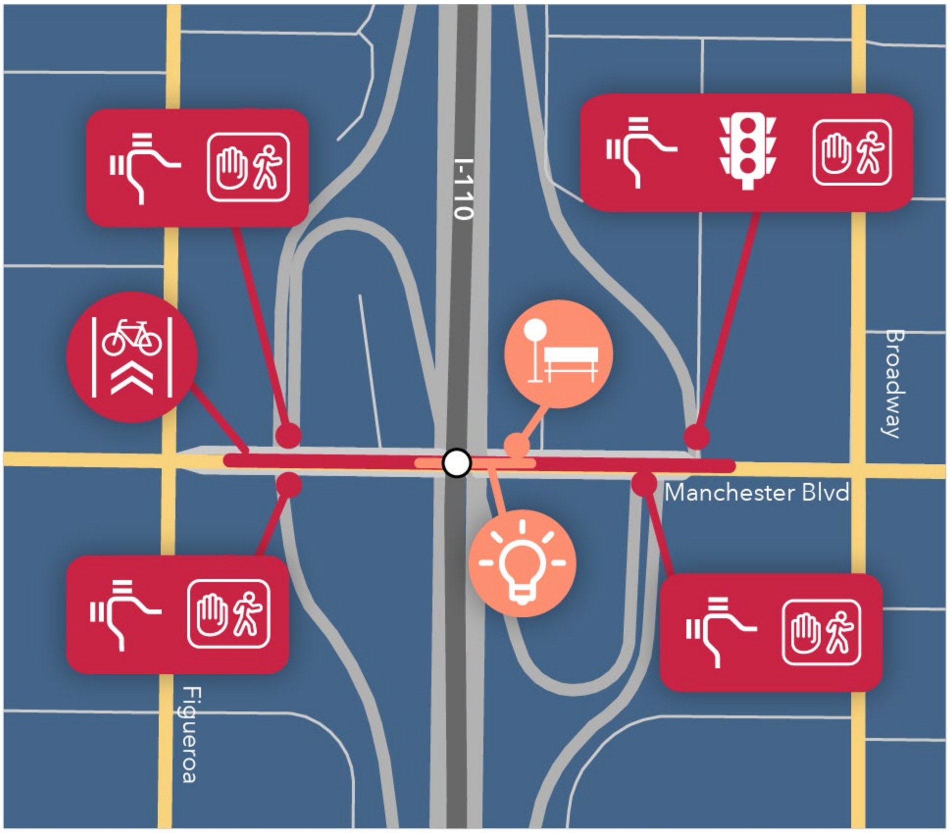
As detailed in Figure 5, improvements are focused at the ramp intersections directly east and west of the Silver Line Station. Applying a leading pedestrian interval would allow pedestrians to begin crossing the intersection before any turning traffic, allowing them to "claim" the street space and become more visible. Changes to the turning radius at the on- and off-ramps would also prevent drivers from turning too quickly as the intersect with crosswalks

Additionally, the high traffic volumes - over 51,000 average daily trips last recorded in 2005 -, number of lanes, and density of crashes suggest a bicycle lane is necessary along Manchester Boulevard. The Mobility Plan 2035-compliant lane could utilize the existing signal cycles. New signal heads could be added to the intersections for bicycles with dedicated bicycle signals that would separate bicyclists from turning traffic that might otherwise create conflicts.

Image 2. Ramp crosswalk at Manchester Station

Pedestrians only receive 30 seconds to cross 100-foot ramp intersections. (Photo by author)

Figure 5. Pathway network and table of proposed improvements at Manchester Station



See appendix for icon legend.

Street	Location	Type	Recommendation	Traffic Impact
Manchester Blvd	On/off-ramp (Northbound I-110)	Safety	Crosswalk enhancement, signal timing	Major
Manchester Blvd	On-ramp (Northbound I-110)	Safety	Crosswalk enhancement, signal timing	Major
Manchester Blvd	On/off-ramp (Southbound I-110)	Safety	Crosswalk enhancement, signal timing	Major
Manchester Blvd	On-ramp (Southbound I-110)	Safety	Crosswalk enhancement, signal timing	Major
Manchester Blvd	(Corridor)	Safety	Protected bikeway	Major
Manchester Blvd	I-110 underpass	Comfort	Lighting, art	None
Manchester Blvd	East of underpass	Transit	Transit wayfinding, enhanced bus stop	None

Palms Station

As the “adjacent” station layout, Palms Station has approximately the same proximity to a highway as Manchester Station does, but its layout is vastly improved by the different location of ramps. The station, which is only three years old, sits on the southern side of the I-10 freeway, at the corner of Palms and National Blvds. The ramps to and from the I-10 are further from the station’s entrance: both connect to Manning Ave on the north side of the station area. Additionally, highway access and egress are limited to only eastbound traffic entering the highway and westbound exiting traffic.

Overlays

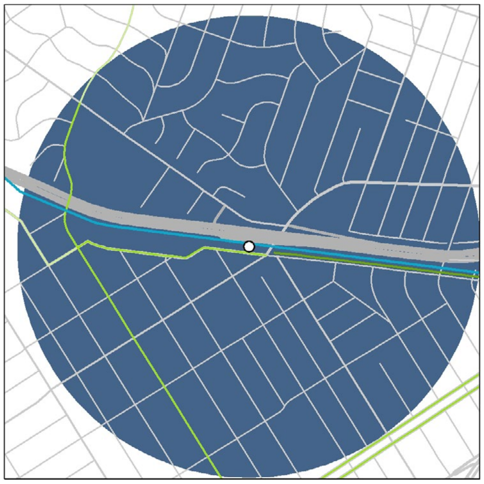
The I-10 forms a distinct line in the built form, as the area north of it is largely single-family (Rancho Park) and the Palms area to the south is dense multi-family residential. Major destinations include a number of schools to the south and west, and some small parks and churches within the residential portions of Palms.

Big Blue Bus provides the most direct transit service to the station, with two routes that connect to downtown Santa Monica and UCLA/Westwood. These have stops either at the station or one block away, past the underpass on Manning Ave. Culver City Bus 3 also runs nearby on Motor Ave toward Westwood.

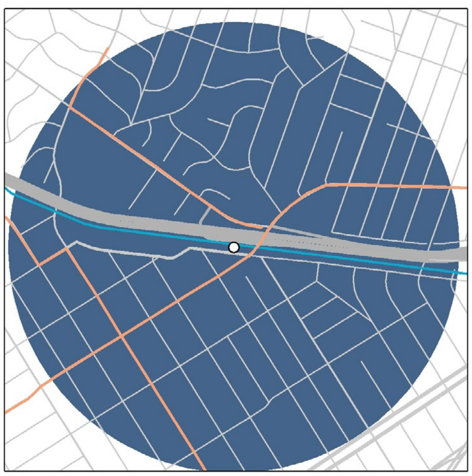
Palms is notable for the presence of a Class I multi-use bike path that runs parallel to the Expo Line east of the station. At the intersection with National Blvd, the bikeway transitions into an on-street Class II, with striped lanes that continue toward Motor Ave. Motor Ave also has wide, Class II striped lanes that connect Palms to Rancho Park north of the I-10. No such accommodations exist underneath the National Blvd. underpass adjacent to the station.

Many fewer bicyclist- and pedestrian-involved crashes occurred in Palms, and those that did were centered along National and Palms Blvds. However, data is only limited to the years prior to the opening of the Expo Line Phase 2 and the accompanying Expo bikeway. It is likely that the additional foot and bike traffic would have increased crashes somewhat, especially at the station’s main intersection.

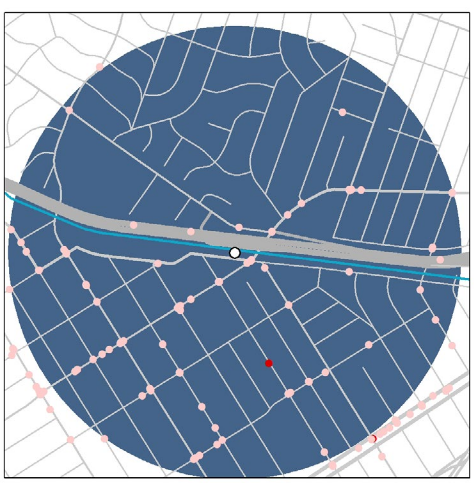
Figure 7. Transportation and land use elements at a half-mile radius from Palms Station



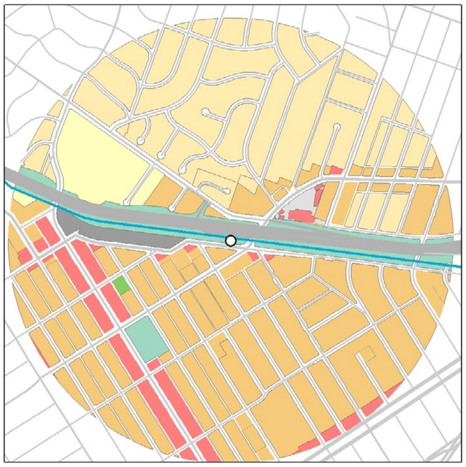
Palms Station Bike Facilities
Class I and Class II lanes



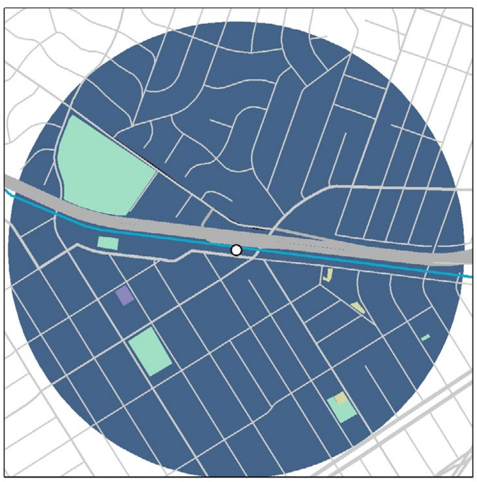
Palms Station Transit Service
Santa Monica Big Blue Bus



Palms Station Bike-Ped Crashes
2006 - 2015
Injury
Fatality



Palms Land Use



Palms Points of Interest

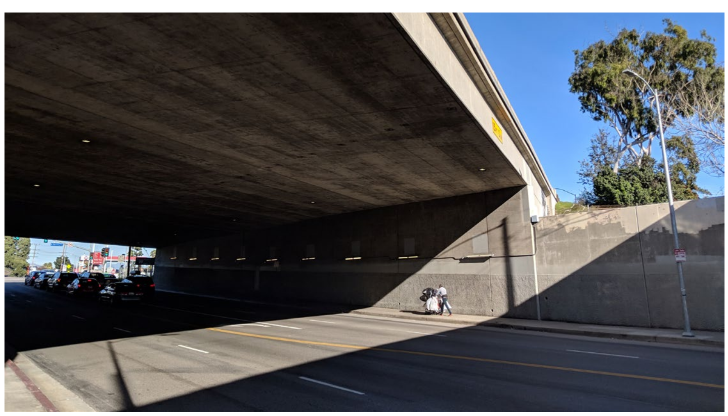
Key barriers

Though the high-traffic National/Palms intersection is a barrier to station access, that section falls under the City of Los Angeles's jurisdiction. The main street segments that Caltrans controls are the underpasses beneath the I-10 on National Blvd, Motor Ave, and Blagley Ave. All are priority pathways given their connections to bicycle infrastructure and the lack of other I-10 crossings. Sidewalks on these underpasses are typically 10 feet, which is satisfactory. The main issues are generally the lack of pedestrian-scale ornamentation and lighting in these passageways. Without these, the walk through the underpass, especially at National (Image 3), might feel exposed and daunting.

The underpass conditions and comfort are also critical given the transit connections that exist just past it or within it. Crowds can be seen on mornings queueing for the 17 Big Blue Bus to Westwood, occupying the full width of the sidewalk. Given the potential for transfers to Big Blue Bus and the Expo Bikeway, wayfinding along the blank concrete walls would be useful in guiding riders between facilities. Figure 8 details that intersection as a key comfort-based improvement for transfers, as improvements to the underpass would also support transfers to the Big Blue Bus 5 route on the northern side of the I-10.

As the westbound off-ramp to Manning ends at a "T" intersection, the overall ramp geometry is already fairly safe for pedestrians and bicyclists to cross. Here, however, some highway-scale signage poses visibility issues for pedestrians. Removing or elevating these would create a clearer path for pedestrians and allow drivers to see them more clearly before they cross. The crosswalk at Manning and the I-10 East on-ramp is critically deficient, as it lacks curb ramps and high visibility paint. Though this should be a priority improvement for its non-compliance with ADA standards, the pathway along Manning is less of a priority given the lack of housing and destinations near it.

Image 3. Underpass at Palms Station



The I-10 underpass is loud and feels hostile for those walking to/from the north. (Photo by author)

Figure 8. Proposed pathways and table of street improvements at Palms Station

Street	Location	Type	Recommendation	Traffic Impact
Manning Ave	I-10 eastbound on-ramp	Safety	Continental crosswalk, curb ramps	None
National Blvd	Underpass	Wayfinding	Signage	None
National Blvd	Underpass	Comfort	Art	None
National/ Manning	Off-ramp	Safety	Relocate signage	None
National/ Manning	Off-ramp	Safety	Reduce turning radius	Minor
National/ Manning	Off-ramp	Safety	Enhanced crosswalk	None
Bagley Ave	Underpass	Wayfinding	Signage	None
Bagley Ave	Underpass	Comfort	Pedestrian-scale lighting	None

Maravilla Station

Maravilla Station opened in November 2009 as part of the Gold Line Eastside Extension. The station serves a section of unincorporated East Los Angeles through which the I-710 and SR-60 highways run. Though the station is more than 500 feet from the I-710, the sprawling design of the nearby interchange means it occupies a massive amount of space - more than 1.5 square miles - and has extensive effects on the surrounding street network. Unlike Manchester Station, the ramps near Maravilla are spread throughout neighborhoods, as are multiple over- and underpasses.

Overlays

The Maravilla/Belvedere neighborhood is dominated by small-lot single-family homes, though the overall built environment is a patchwork of other uses. The abovementioned interchange occupies much of the half-mile station area, and multiple cemeteries break up the neighborhoods. A business center along 3rd Street - King Taco at 3rd and Ford is a popular destination - and Cesar Chavez Ave is another commercial corridor just to the north. Closer to the next station to the east, East LA Civic Center, a hospital, courthouse, and park function as a central public space. A number of schools are also scattered throughout the area, largely to the north of the SR-60, forcing students taking the Gold Line to navigate an underpass.

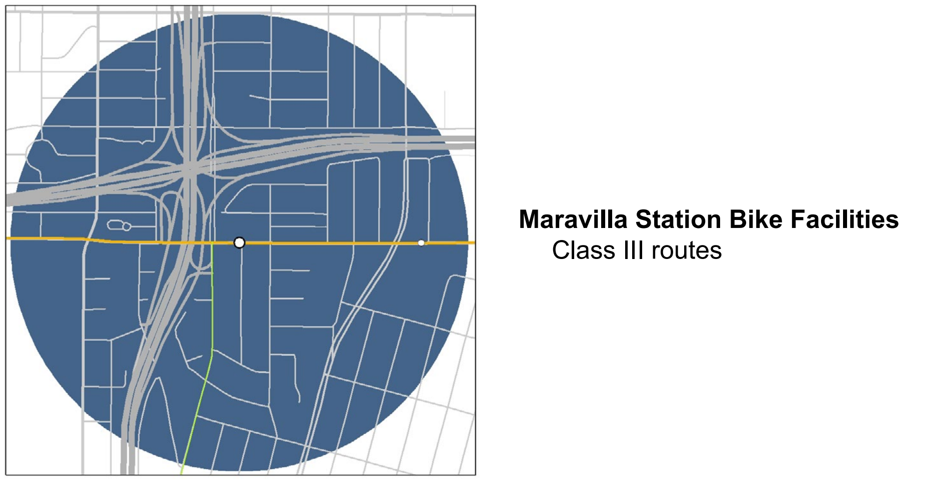
In addition to the street-running Gold Line, LA Metro and several other operators - Montebello Transit and the East LA Sol shuttle - serve the area. These routes, especially the shuttle, tend to be circuitous, but largely follow the major streets in the area: 3rd Street, 1st Street, Eastern Ave, and Medlink Blvd. The Metro 256 and Montebello 40 buses both offer direct transfers to Maravilla Station, though the stop is cater-cornered to the station.

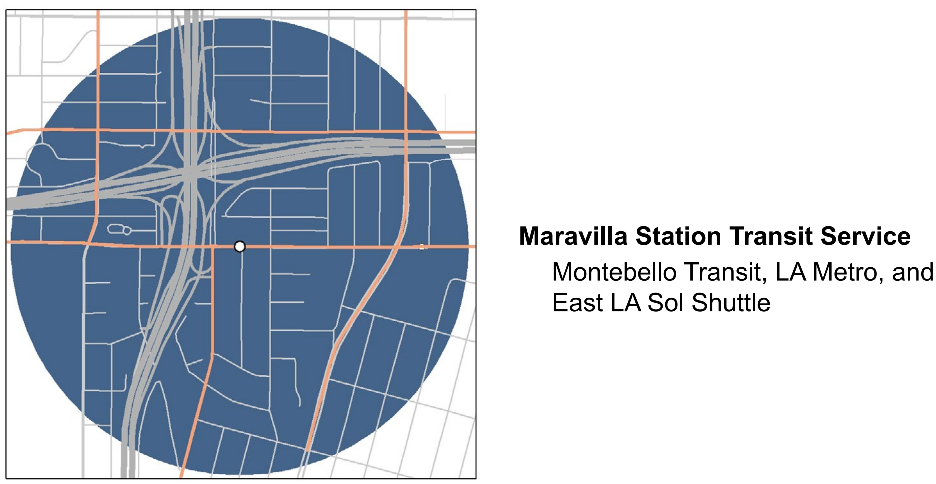
Though the LA County 2012 Bike Master Plan lists multiple planned bikeways in the area, only a portion of one has been implemented. Google Maps imagery show that, in 2018, a segment of Ford Blvd south of 3rd Street received “sharrows” to become a Class 3 bikeway.[1] These guide residents and visitors of Humphreys Avenue Elementary to the station, but offer no protection against speeding drivers exiting the I-710.

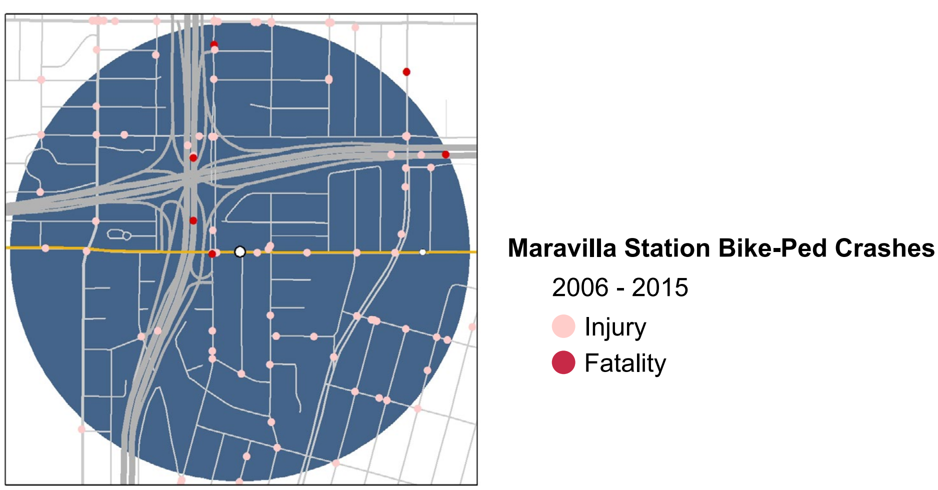
Maravilla has few crashes compared to the other study sites, but a relatively high proportion of fatalities. This may be indicative of fewer people walking (lower exposure risk) and high vehicle speeds (crashes more likely to result in serious injuries or death). Some crashes do cluster along 3rd Street near the station. Indeed, the King Taco on the corner boasts protective concrete bollards to prevent drivers from crashing into the storefront.

1 “Sharrows,” or shared path arrows, are a type of street marking used to denote bicycle routes and where in a shared travel lane bicyclists should ride.

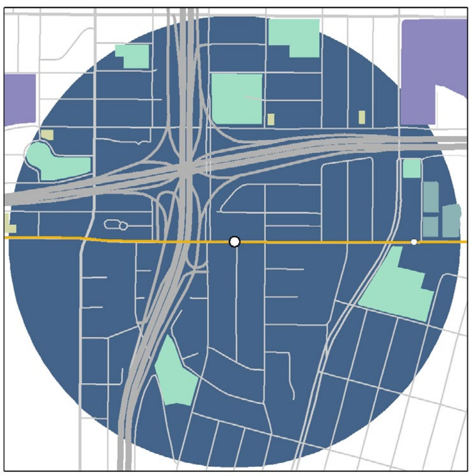
Figure 9. Transportation and land use overlays at a half-mile radius from Maravilla Station







Maravilla Land Use (Form-Based Zoning)



Maravilla Points of Interest

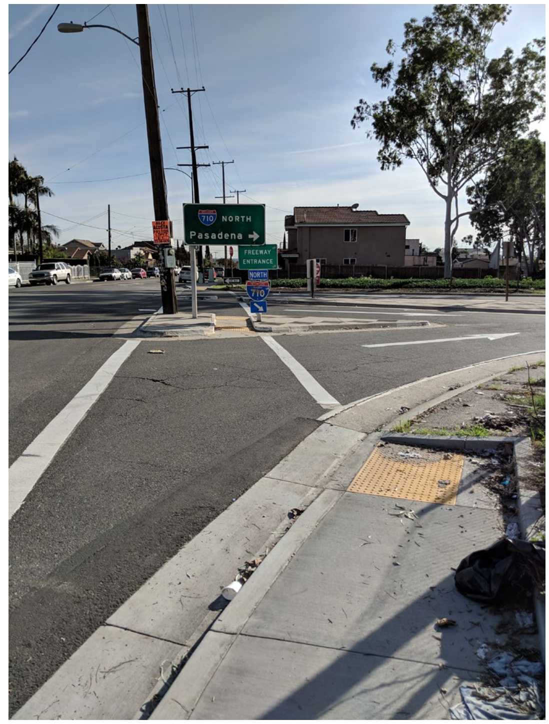
Key barriers

Though there are four ramps in the station area, two are critical for improvements given their presence along key access pathways and their proximity to the station. The northbound on- and off ramp (Image 4) to I-710 from Ford Blvd is just south of the station and sits between the station and Humphreys Avenue Elementary. To cross the ramps, pedestrians must walk 125 feet, though they do have two narrow refuges. The off-ramp is stop-controlled, though drivers turning right were observed rolling through the intersection. Narrowing the four lanes to two - on in each direction - and reducing the turning radius would reduce the potential for conflict. Likewise, the on-ramp from 3rd Street to I-710 southbound poses a danger to pedestrians, as it is not stop- or signal-controlled and features a wide turning radius.

Calming the Ford Blvd ramps through tighter turning radii and consolidated lanes also supports the proposed bikeway along Ford Blvd, which is integral to station access as it connects the school to the south and multiple schools to the north to the station. A bikeway would also provide protection along the fast-moving traffic in the SR-60 underpass (Image 5). The parking lanes along the underpass are underutilized, meaning there is ample room to convert eight feet per side to a protected bike lane. Nearby, the southwestern corner of Ford and 3rd St offers opportunities for better transfers to the station. A bike parking area on a concrete pad there is hidden from view by overgrowth and feels unsafe for long-term parking due to the lack of visibility and connection to the street. Transfers to the Montebello Bus, El Sol Shuttle, and Metro Bus could be improved through further station identification, seating, and lighting enhancements, as well as reconfiguring the low interstate sign that encroaches on the bus stop's sidewalk space.

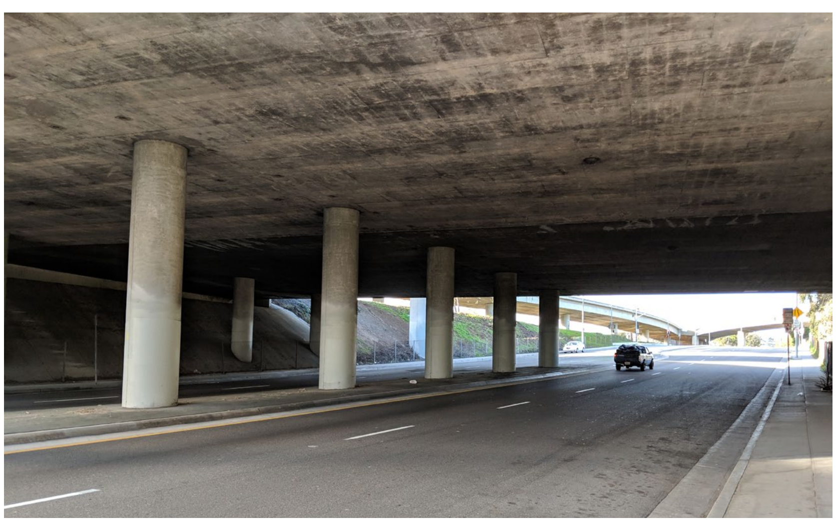
Figure 10 details the above improvements, as well as less-critical improvements further from the station. The expansive nature of the interchange means that more collector pathways intersect with the two highways. Improvements along collectors include canopy, a bikeway, and a bus shelter along 1st Street and canopy and crosswalk improvements to the east at Eastern Ave.

Image 4. Ramp one block south of Maravilla Station



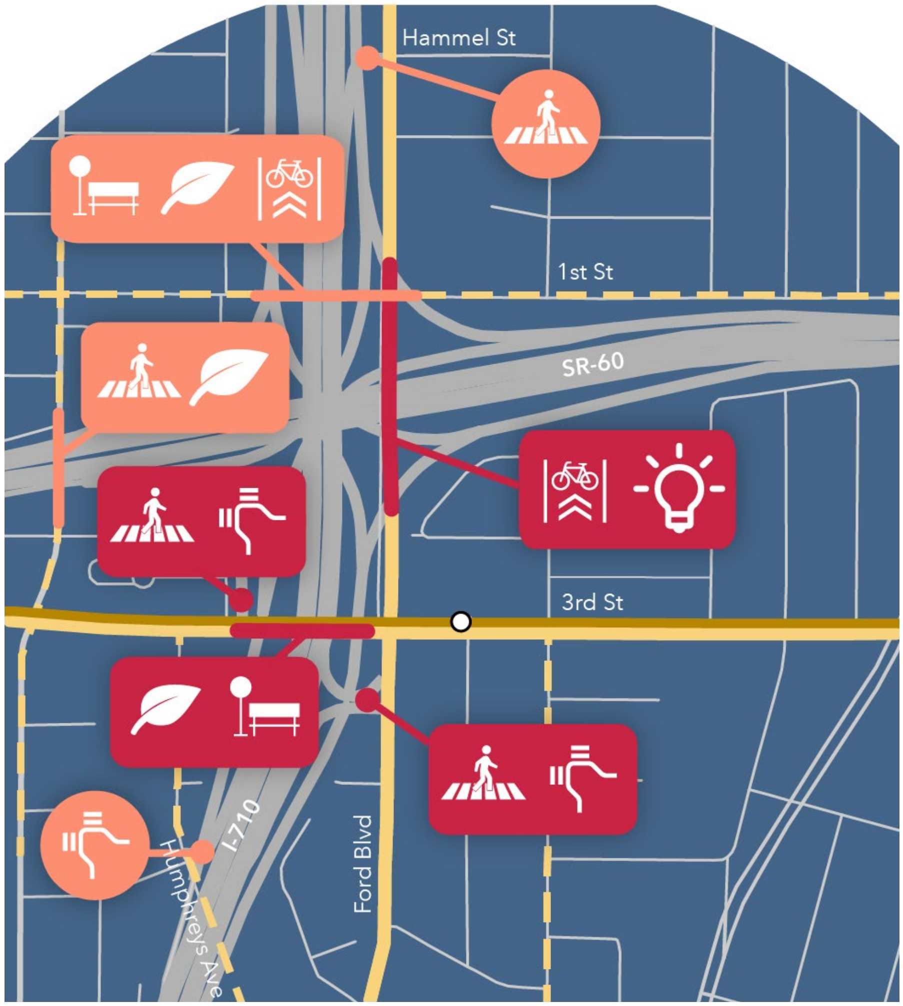
The 125-foot ramp crossing at Ford Blvd. features a wide turning radius for the on-ramp. (Photo by author)

Image 5. Underpass north of Maravilla Station



Excess space on Ford Blvd, seen here in the outer lanes, could be used for a bikeway connection. (Photo by author)

Figure 10. Pathway network and table of proposed improvements at Maravilla Station



Street	Location	Type	Recommendation	Traffic Impact
Ford Blvd	On/off-ramp (I-710)	Safety	Crosswalk enhancement	Minor
3rd Street	On-ramp (I-710 southbound)	Safety	Crosswalk enhancement	Minor
3rd Street	Overpass	Comfort	Canpoy, enhanced bus stop	None
Ford Blvd	Underpass	Safety	Protected bike lane	Major
Ford Blvd	Underpass	Comfort	Lighting, artwork	None
1st Street	Overpass	Comfort	Canopy	None
New York Street	Off-ramp (I-710 northbound)	Safety	Crosswalk enhancement	Minor

Takeaways

Though a variety of conditions exists near transit stations, a number of shared themes emerge in the identified first/last mile barrier types. Across the case study station areas, excess right-of-way within the established lane widths is rare, meaning additional bicycling facilities and improved sidewalks would necessitate removing travel lanes. The proximity of these local streets to major highways - the I-710, SR-60, I-10, and I-110 - complicates this option. In many cases, the highway on-ramps funnel additional traffic to the arterial roads, increasing flows in the area immediately adjacent to the ramps. At Manchester and Palms station, site visits revealed that the presence of highway ramps within 100 feet of the station created heavy traffic conditions in the streets that transit riders were most likely to utilize on their ways to and from the station. Removing lanes at National Blvd, for example, could impact the flow of traffic exiting the I-10 westbound there. Those additional traffic flows and speeds, however, mean that protected accommodations for people walking or biking are all the more necessary.

As interviews consistently suggest that potential impacts on traffic flow require a high degree of time and investigation in order to justify any changes, these improvements may prove the most difficult to implement. While some precedent for bicycle infrastructure crossing highways exists in Southern California - Seaward Avenue in Ventura, the Expo Trail in West Los Angeles, and Culver Boulevard Bike Path in Culver City - these largely occupy previously unused right-of-way from historic streetcars or do not substantially affect travel lanes.

The Palms Station case study suggests further options for improving the first/last mile experience in ways more feasible in the short term. Wayfinding connections to the Expo Bike Path on the southern side of the I-10, as well as signage cautioning pedestrians of possible conflicts, would likely only necessitate encroachment permits and a maintenance agreement with the City of Los Angeles. Current conditions in the underpass are likely better than other stations for two factors. First, Palms Station is on the most recently open segment of the Metro Rail system and benefits from the recent political visibility associated with Measure R-funded projects. Second, much of the underpass is within 300 feet of the platform, meaning it fell within the improvement area focus of Metro's transit construction team, which also improved sidewalks and curb ramps immediately adjacent to the station.

Ramp conflicts

Across all three case study areas, highway on-ramps proved more problematic in design than off-ramps. Every off-ramp was controlled to some degree, by either a stop sign or a traffic signal. Interviews with Caltrans staff confirmed that the agency is concerned with the prevalence of uncontrolled "free right turns" near pedestrians and is broadly looking to create "T" intersections with turning geometry that slows drivers further. However, even in instances where ramps come to a perpendicular "T" with the local street, the turning radius at the corner allowed drivers to maintain high speeds while turning onto the ramp and crossing a marked crosswalk. The large turning areas and high design speeds also make these ramps, as constructed now, incompatible with protected bicycle lanes. Installation of bicycle lanes -- an improvement this project recommends for Ford Blvd, below right -- would then require the simultaneous consolidation of the ramp lanes, tying the two improvements together. In order for a driver to turn onto the ramp, they would have to cross the bike lane in a mixing zone or dashed through lane.

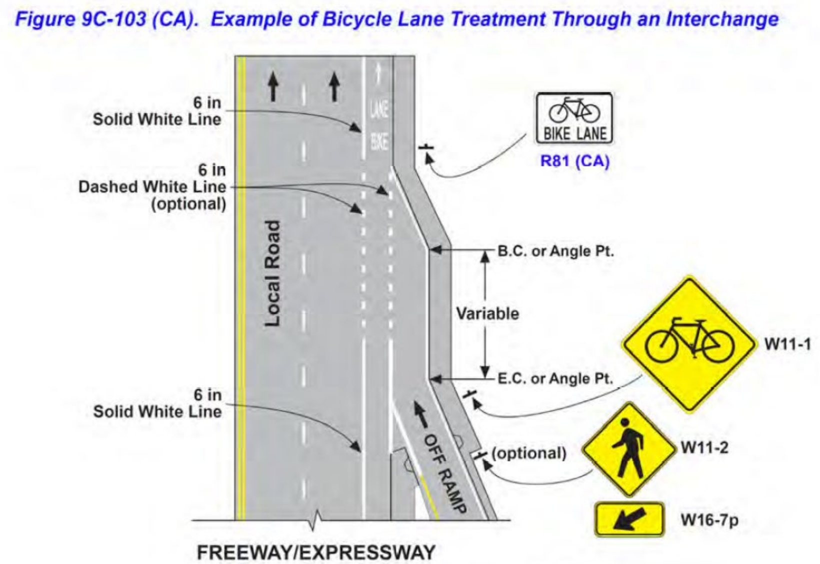
Image 6. Ramp examples near Maravilla Station

On-ramps in Maravilla. At left, 3rd St to southbound I-710; at right, Ford Blvd to northbound I-710. Source: Google Maps

In an interview, Caltrans staff noted that the best way to manage the conflicts between bike lanes and on/off highway ramps is through traffic signals. Dedicated signals for people on bicycles, which either give bicyclists a separate phase to move through the intersection or an advance leading interval phase to become visible by “claiming” the space, are already employed in some instances in Los Angeles, such as the Expo Bike Path and Figueroa Boulevard. This approach appears most likely in an urban environment such as Manchester Station, where the ramps are already controlled via signals and form a more traditional intersection with the boulevard. The I-10 west off-ramp at National Boulevard is also signalized. However, in less constrained highway interchange designs, ramps occur in mid-block locations that may be too close to intersections to signalize. The northbound I-710 ramp at Ford Blvd near Maravilla Station exemplifies this.

The California Manual on Uniform Traffic Control Devices offers guidance on this specific type of intersection treatment. In general, the CA MUTCD is clear that there may be no bike lanes to the right of a turn lane at an intersection unless a bicycle signal is being used. For Class II bike lanes, the preferred treatment at ramps depends on the angle of intersection. For a 90-degree, compact ramp, Caltrans suggests a configuration in which traffic crosses a gap in the bike path, and where the ramp angle is more acute, the gap and resulting mixing zone are much longer (CA MUTCD, 2014).

Image 7. Through-lane at ramp diagram



A suggested bicycle lane-highway ramp interchange design treatment utilizing a dashed "through-lane" mixing zone. Source: CA MUTCD

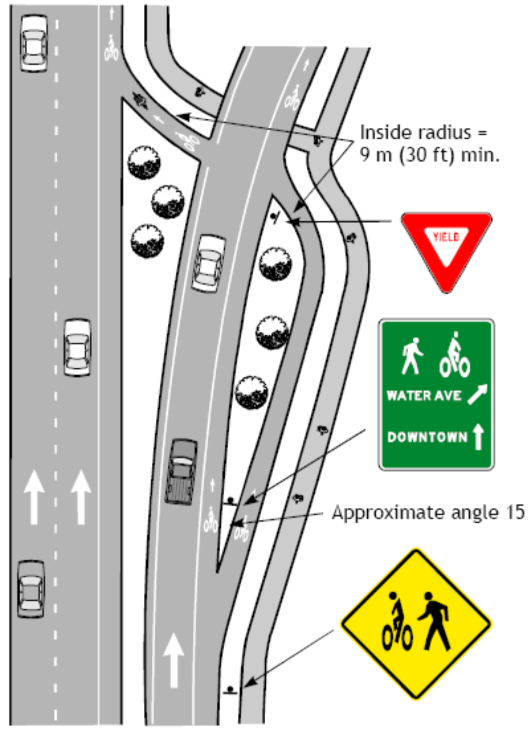
This through-lane treatment, however, is not reflective of the increased design speeds associated with the highway interchange and does not include factors that would otherwise slow drivers as they interact with people biking. A 2017 meta-analysis of bicycle treatments by Fehr & Peers found through bike lanes to be a "low confidence" treatment, meaning it was less likely to result in safer results, and recommended they be implemented with delineators that clarify where drivers may cross into the bike lane (Fehr & Peers, 2017). A more separated treatment that would reduce the space bicyclists are exposed to highway traffic would be through a curved right-angle crossing (see Image 8). Here, the bike lane curves away from the street and intersection before crossing the on-ramp midway.

This allows people biking and driving to meet at a 90-degree angle, which when combined with high-visibility crossing markings, would increase their visibility (FHWA, 2015). This is akin to the Portland bridge ramp treatment noted above, which has the added advantage of accommodating both pedestrians and bicyclists in designated spaces in the crossing. Though the CA MUTCD forbids bicycle lanes to the right of turn lanes at intersections, interviews with Caltrans staff identified one version of this treatment in Thousand Oaks, California, at Lindero Canyon Road and the I-101, where a Class I shared-use bikeway bends to cross an on-ramp. In these situations, consideration must be given to where along the ramp the crossing and crosswalk is located. Crosswalks too far from the street might be situated in a position where drivers feel they are encouraged to accelerate by other design cues, such as the curve of the on-ramp. This configuration also requires additional space to the right of the bikeway.

Signage impacts

Conflict points in the case sites are often dominated by highway-oriented signage, an indicator of the transition from city or county property to Caltrans right-of-way. The scale and placement of these signs harms the walkability of some ramp areas by narrowing the passable width of the sidewalk and blocking crucial sight lines for pedestrians. Highway traffic-facing signs are often lower to the ground than municipal street sights and are situated on thick wooden posts within the sidewalk right-of-way rather than on a lightpost. In Section 2.04A of the CA MUTCD, the "Excessive Use of Signs" warning reflects on the potential for signs to lose effectiveness with overuse, but does not include overlap with the pedestrian realm as a consideration for the signs' impacts (CA MUTCD, 2014). The manual does note that signs in "alleys with restrictive physical conditions" may be reduced in height and width by six inches each, and that in other conditions engineers must determine the proper size and placement for visibility. In the specific case of excessive signs

Image 8. Ramp crossing diagram



An example shows bikeway turning to encounter the ramp at a 90-degree angle. Source: FHWA, Oregon Department of Transportation

at the Humphreys Ave/I-710 southbound off-ramp, the 2014 MUTCD update reveals that the additional "Do Not Enter" signs, are no longer necessary. A Maravilla first/last mile plan would have a strong case to consolidate signage in that location and would provide Caltrans with an impetus to bring the ramp to compliance with standards.

VI. Recommendations and Conclusion

The above case studies reveal a recurring set of challenges for improving biking and walking conditions near highways. Similar to the interviews, the case studies elaborated some common procedural challenges. Chief among them is the extent of communication and bureaucratic navigation that past efforts have necessitated from project managers. The following recommendations seek to both address the unique design considerations that highways require and to aid in the process of planning across jurisdictional boundaries.

Establish station area criteria to determine whether Caltrans should be involved early in a first/last mile project. Past first/last mile planning experiences have encountered difficulties when bringing specific projects into the Metro first/last mile planning methodology and have occurred on an as-needed basis in differing points in the project. This research project recommends a more standardized approach for projects within a half-mile of Caltrans rights-of-way. Metro staff should ensure that planning consultants schedule regular meetings with Caltrans in order to gain a full understanding of the traffic and freight issues at the site and receive feedback on draft pathways and improvement ideas. Criteria for involving Caltrans in project scopes should look to the proximity of highways, the number of ramps and underpasses within a half-mile of the station, and the land use types near the highways.

This recommendation acknowledges that the typical structure of first/last mile planning may change with the release of pending First/Last Mile Guidelines, which will instruct Metro programs on how to integrate first/last mile improvements into the existing mobility corridor planning process. Mobility corridor planning already includes regular meetings with Caltrans agency staff, so these would only need to be adapted to include the typical steps of first/last mile planning and to ensure that the scope looks to the surrounding area of the transit corridor.

Create a toolkit of improvements that may be quickly applied to a plan, including temporary ones. Given that each transit station area is unique, many of the interventions applied to settings near highways must change to adapt to the specific context of the area. Interviews indicated that the process of understanding what kinds of interventions would be acceptable to Caltrans and meet their standards was a significant step in the process.

A pre-sorted toolkit of interventions (Figure 11) that meet Caltrans standards would expedite the planning process, allowing Metro and jurisdictions to choose from a list with the knowledge that minimal adjustments would be made in order to implement them. In order to address the most common and problematic conditions in the case study sites, the toolkit should include the following, assigned as treatments to frequent barrier conditions.

Figure 11. Improvements and considerations for a highway first/last mile toolkit

Area Type	Improvement	Considerations
Under- and overpasses	Pedestrian-scale lighting	Maintenance, utilities
	Murals and artwork	Maintenance, signage standards
	Canopy, shade structures	Maintenance, sight lines
Ramps	Striping	
	Continental crosswalks	
	Leading pedestrian interval	Signal phases
	Corner geometry	Freight turning needs
	Dedicated bike signal	Cost, existing signal phases
	Conslidate lanes	Traffic volumes
Transit	Seating	Sidewalk space
	Shade/shelter	Sight lines
	Wayfinding	Signage standards
Bikeways	Protected lanes	Intersection infrastructure, signals
	Green-painted confict zones	Ramp speeds
	90-degree ramp intersection	Ramp speeds, space to the right of bikeway

Explore how temporary/interim improvements might be applied and maintained. Implementing temporary improvements addresses multiple issues in the coordination process. First, it assuages the return-on-investment concerns of when one planning process may be later undone by a longer-term plan. The interim improvement will likely cost less and have a shorter project life, meaning there is no great loss when it is removed. Second, temporary improvements allow some flexibility in funding, as they might use standardized materials - such as concrete “k-rails” that could function as barriers between traffic and a bike lane - that cost less. Currently, interim improvements do not fit within the First/Last Mile Planning methodology and project portfolio, but they might be incorporated into projects where later transit projects might create conflicts with possible long-term improvements.

Caltrans should explicitly weigh transit proximity in its bike guidance, as it does with pedestrian guidance. In the California Highway Design Manual, several design standards cite transit proximity and pedestrian volumes as rationale for increased sidewalk width and enhanced curb ramps. The manual already acknowledges that "connections between different modes should be considered when designing highway facilities" (Caltrans, 2018). Transit is not considered in the same way as bicycles, and doing so would provide justification for emphases on high-quality and continuous infrastructure, especially in the cases that they conflict with traffic movement.

Caltrans should explore revising its guidance against median bike lanes and bikeways to the right of turn lanes. Median bike lanes offer a potential intervention to physically separate people on bikes from complex, fast-moving traffic conditions that highway ramps create on the outer edges of a roadway. Currently, Topic 1000.3 of the California Highway Design Manual rightly forbids median bike paths in freeways, but also discourages them in medians of local roads. Lanes to the right of turn lanes are forbidden. In the context of highway conditions, bicycle safety and comfort should be prioritized over intersection delay that separate signal phases may create (Caltrans, 2018). New York City and Washington, DC, either currently employ or plan to implement this design in cloverleaf ramp-style interchanges. For situations where there are especially long blocks that intersect high-traffic ramps, median bike lanes on a local street might be an option to eliminate any possibility of conflict. Turning movements as riders enter and exit the median, then, must be given special consideration. This could be conducted through a separate bicycle signal phase and wayfinding, or through a combination of wayfinding and existing crosswalk signal phases.

Conclusion

Highway infrastructure is a major component of the transportation system in Los Angeles County, and its associated effects will continue to play a large role in active transportation planning as the area moves forward with safety-oriented programs such as first/last mile planning and Vision Zero. This project aims to create more certainty through standardization in how Metro addresses critical first/last mile conditions, both in the improvements applied to those streets and in the process of planning them with Caltrans. It found that the conditions of barriers largely depend on design qualities of the adjacent highway, but that on-ramps in particular pose key safety barriers.

Highway-transit rider interactions are not limited to the greater Los Angeles region. The Bay Area Rapid Transit system also contains a number of stations situated on highway medians or adjacent to highways. Recommendations for coordination with Caltrans and design suggestions could be implemented in those situations as well. The Caltrans Division of Rail and Mass Transportation could also incorporate elements of these recommendations into their ongoing guidance for transit facilities. Though this project is limited by the vast variety of station types and urban contexts for transit across the county, the barriers and solutions for each station do share commonalities.

Further research is required to draw conclusions regarding the efficacy and feasibility of some improvements. Traffic engineers should investigate the impacts of reducing on-ramp lane widths and consolidating lanes in various street type contexts. Understanding the extent of delay that certain changes create for drivers could, if the delay is small or inconsequential, be an essential part of making the case for such improvements. Additional research should also compare the safety impacts of bikeway and crosswalk designs that cross highway ramps at right angles with other treatments, such as through-lane mixing zones for bike lanes.

Ultimately, a better understanding of each type of environment that impacts first/last mile planning expands the capability of the program to address them. As the program coordinates more often and frequently with Caltrans, too, this project offers an avenue for staff to hone procedures and develop an effective and expedient path toward addressing the most critical access barriers.

VII. Works Cited

"10 Year Summary 2001-2010 - Traffic Volume Book." Los Angeles Department of Transportation. https://ladot.lacity.org/what-we-do/traffic-volume-counts/current-count-data.

American Association of State Highway and Transportation Officials, ed. 2012. Guide for the Development of Bicycle Facilities. Fourth edition. Washington, DC: American Association of State Highway and Transportation Officials.

"Bicycle Master Plan." March 2012. Los Angeles County Department of Public Works. https://dpw.lacounty.gov/pdd/bike/masterplan.cfm

Birk, Mia, Jeff Smith and Jill Mead. 2014. "A Tale of Portland Bridges." Bicycle Safety Guide and Countermeasure Selection System. http://pedbikesafe.org/bikesafe/casestudies_detail.cfm?CS_NUM=106.

Boarnet, Marlon G., Genevieve Giuliano, Yuting Hou, and Eun Jin Shin. 2017. "First/Last Mile Transit Access as an Equity Planning Issue." Transportation Research Part A: Policy and Practice 103 (September): 296–310. https://doi.org/10.1016/j.tra.2017.06.011.

"California Manual on Uniform Traffic Control Devices, Revision 3." March 9, 2018. California Department of Transportation. http://www.dot.ca.gov/trafficops/camutcd/

Cervero, Robert. 2001. "Walk-and-Ride: Factors Influencing Pedestrian Access to Transit." Journal of Public Transportation 3 (4). https://doi.org/10.5038/2375-0901.3.4.1.

Craggs, Timothy. "Memorandum: Design Flexibility in Multimodal Design." California Department of Transportation. http://www.dot.ca.gov/design/stp/memo/2014-04-10_Flexibility-in-Design.pdf.

"Crosstown Multimodal Transportation Study." District Department of Transportation. October 2016. http://dccrosstownstudy.com/projectresources/media/Crosstown_Study_FinalReport.pdf.

DeMaio, Paul. 2009. "Bike-Sharing: History, Impacts, Models of Provision, and Future." Journal of Public Transportation 12 (4). https://doi.org/10.5038/2375-0901.12.4.3.

Eckerson, Clarence. "Sands Street Gets a Sassy, Center-Median Cycletrack." September 24, 2009. StreetFilms. https://www.streetfilms.org/sands-street-gets-a-sassy-center-median-cycletrack/

"Separated Bike Lane Planning and Design Guide." May 2015. Federal Highway Administration. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/separatedbikelane_pdg.pdf

"First/Mile Strategic Plan and Planning Guidelines." March 2014. Los Angeles County Metropolitan Transportation Authority. https://media.metro.net/docs/First_Last_Mile_

Strategic_Plan.pdf

Flamm, Bradley, and Charles Rivasplata. 2014. “Perceptions of Bicycle-Friendly Policy Impacts on Accessibility to Transit Services: The First and Last Mile Bridge, MTI Report 12-10.” Mineta Transportation Institute Publications, February. https://scholarworks.sjsu.edu/mti_publications/72.

“Highway Design Manual Chapter 100.” July 2, 2018. California Department of Transportation. http://www.dot.ca.gov/design/manuals/hdm/chp0100.pdf.

“Highway Design Manual Chapter 200.” July 2, 2018. California Department of Transportation. http://www.dot.ca.gov/design/manuals/hdm/chp0200.pdf.

“Highway Design Manual Chapter 500.” July 2, 2018. California Department of Transportation. http://www.dot.ca.gov/design/manuals/hdm/chp0200.pdf.

“Highway Design Manual Chapter 1000.” July 2, 2018. California Department of Transportation. http://www.dot.ca.gov/design/manuals/hdm/chp1000.pdf

“Historic Aerials.” Historic Aerials by NETROnline. https://www.historicaerials.com/viewer

Hubbard, Sarah M. L., Ramzi J. Awwad, and Darcy M. Bullock. 2007. “Assessing the Impact of Turning Vehicles on Pedestrian Level of Service at Signalized Intersections: A New Perspective.” Transportation Research Record 2027 (1): 27–36. https://doi.org/10.3141/2027-04.

Krizek, Kevin J., and Eric W. Stonebraker. 2010. “Bicycling and Transit: A Marriage Unrealized.” Transportation Research Record 2144 (1): 161–67. https://doi.org/10.3141/2144-18.

Lo, Ria Hutabarat. 2009. “Walkability: What Is It?” Journal of Urbanism: International Research on Placemaking and Urban Sustainability 2 (2): 145–66. https://doi.org/10.1080/17549170903092867.

Loutzenheiser, David. 1997. “Pedestrian Access to Transit: Model of Walk Trips and Their Design and Urban Form Determinants Around Bay Area Rapid Transit Stations.” Transportation Research Record: Journal of the Transportation Research Board 1604 (January): 40–49. https://doi.org/10.3141/1604-06.

“Lesson 15 - Federal Highway Administration University Course on Bicycle and Pedestrian Transportation.” July 2006. Federal Highway Administration. https://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/chapt15.cfm.

“Mapping LA.” 2009. The Los Angeles Times. http://maps.latimes.com/neighborhoods/.

Martens, Karel. 2007. “Promoting Bike-and-Ride: The Dutch Experience.” Transportation Research Part A: Policy and Practice 41 (4): 326–38. https://doi.org/10.1016/j.tra.2006.09.010.

“Mobility Plan 2035.” September 7, 2016. City of Los Angeles. https://planning.lacity.org/documents/policy/mobilityplnmemo.pdf

"Motion 14-1." Los Angeles County Metropolitan Transportation Authority. May 18, 2016. http://metro.legistar1.com/metro/attachments/530ed98d-323a-49de-a509-1bb581aeb1db.pdf.

"On-Board Customer Satisfaction Survey." Fall 2018. Los Angeles Metropolitan Transportation Authority. http://media.metro.net/projects_studies/research/images/annual_survey_results/system_results_fall_2018.pdf.

Peiser, Richard, and Corey Zehngebot. "Complete Streets Come of Age." May 2014. American Planning Association. https://www.planning.org/planning/2014/may/completestreets.htm.

Renne, John L. 2009. "From Transit-Adjacent to Transit-Oriented Development." Local Environment 14 (1): 1–15. https://doi.org/10.1080/13549830802522376.

"Safety Efficacy Confidence Levels for Bike-Ped Treatments." Fehr & Peers. 2017. http://www.fehrandpeers.com/wp-content/uploads/2017/07/2017SafetyEfficacyConfidenceLevelsForPedBikeTreatments.pdf

"Seaward Green Lanes Project." Caltrans District 7 Bicycle Advisory Committee. July 2017. Staff presentation.

"Separated Bike Lane Planning and Design Guide." Federal Highway Administration. May 2015. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/separatedbikelane_pdg.pdf

Shaheen, Susan, and Nelson Chan. 2016. "Mobility and the Sharing Economy: Potential to Facilitate the First- and Last-Mile Public Transit Connections." Text. Winter 2016. https://doi.org/info:doi/10.2148/benv.42.4.573.

Sulaiman, Sahra. 2019. "A Year after Losing Her Only Son in a Hit-and-Run, a Mother Wonders When Justice Will Be Served." Streetsblog LA. April 6, 2019. https://la.streetsblog.org/2019/04/06/a-year-after-losing-her-only-son-in-a-hit-and-run-a-mother-wonders-when-justice-will-be-served/.

"Statewide Integrated Traffic Records System." Transportation Injury and Mapping System - University of California, Berkeley. 2019. https://tims.berkeley.edu/

VIII. Appendix

Legend for first/last mile pathway and improvement maps