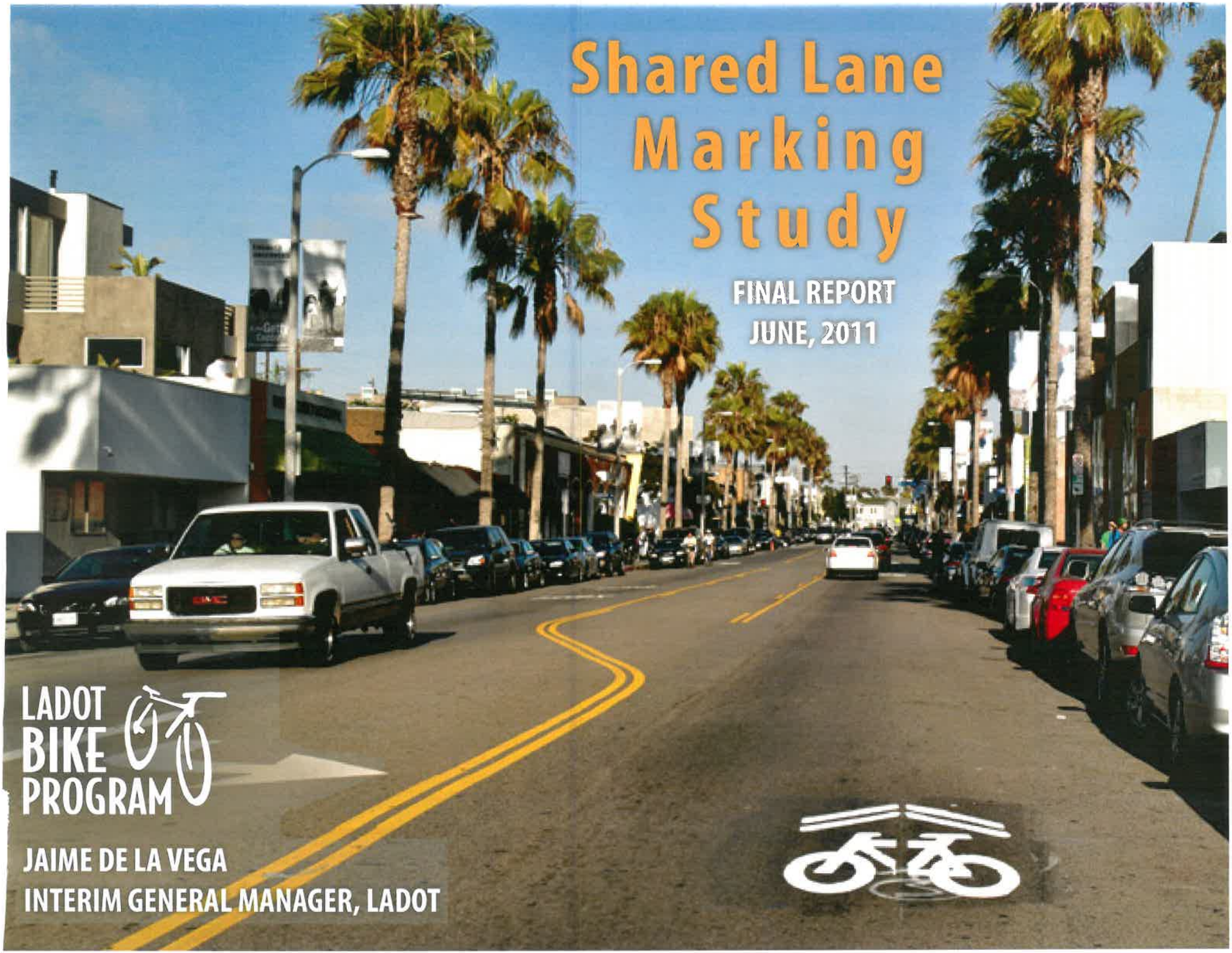

Shared Lane Marking Study

FINAL REPORT
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LADOT BIKE PROGRAM

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Executive Summary

Shared Lane Markings (SLMs) are pavement markings installed to direct bicyclists where to ride on roadways shared with motor vehicles. The SLM is typically used along corridors with insufficient width for bike lanes. The marking is intended to direct bicyclists in terms of positioning, provide guidance to motorists for awareness of bicyclist presence, and reduce the chance of bicyclists striking abruptly opened doors of motor vehicles on a shared roadway with on-street parking.

The goal of the study is to determine where the SLM would work best in the City of Los Angeles by performing trials at locations with characteristics representative of roadways throughout the City. Upon completion of the study, the City plans to prioritize installation locations of SLMs based on performance characteristics.

The initial phase ("Before" study) measured driver response to bicyclists without pavement markings, at all six locations where the SLM was to be installed. The second phase ("After" study) took place approximately one month after SLM installation and measured the impact of the markings on driver-bicyclist interactions. Data were measured through field observations as well as later analysis of videofiles of the interactions.

After completing the study, the City has found the SLM to be effective on most streets in increasing the distance between motorists and bicyclists when motorists are passing bicyclists on their left. In addition, motorist behavior was found to be less aggressive after the SLMs were installed. In summary, the following recommendations for usage are presented:

interactions, but aims to determine the level of performance associated with locations with varying characteristics. In this study, performance of the SLM was considered to be based on factors associated with motorist behavior when passing a bicyclist (the bicyclist being a control element of the study). Upon completion of the study, the City plans to prioritize installation locations of SLMs based on performance characteristics.

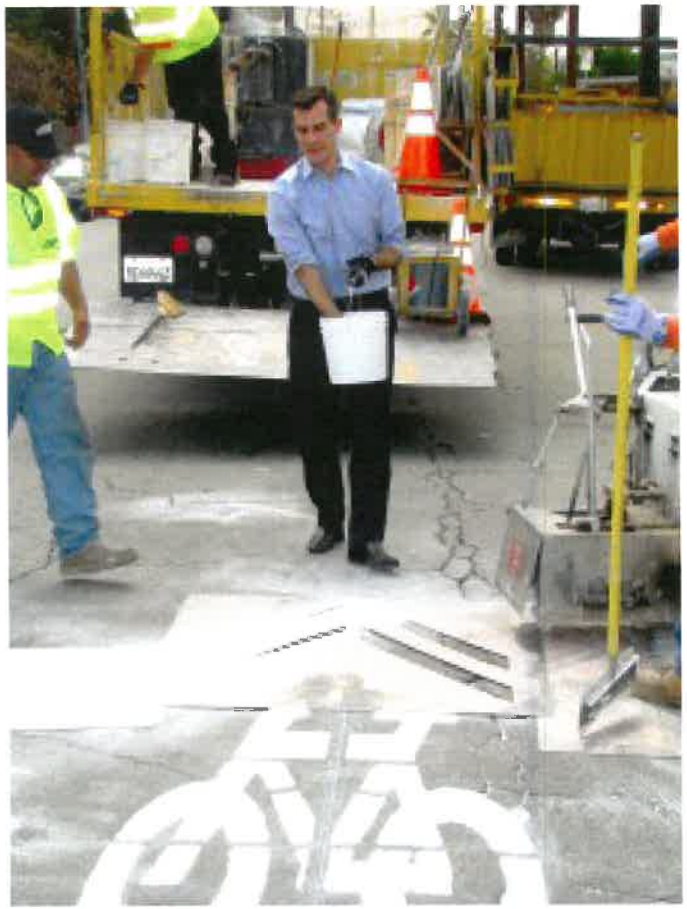

Figure 1
Councilmember Eric Garcetti assists in shared lane marking installation

Background

As early as 2005, LADOT began meeting with the Los Angeles County Bicycle Coalition (LACBC) to discuss the use of the SLM in Los Angeles. Initially, the LACBC conducted an online survey of their membership to seek recommendations for streets in Los Angeles where they would most like to see SLMs installed by the City. These roadways were considered in the initial selection of streets for the study by City staff. It was determined that the study conducted in San Francisco could not be readily transferred to Los Angeles and that a variety of types of roadways and conditions needed to be considered to truly gauge the effectiveness

sis, San Francisco determined that the marking: increased bicyclists' distance from parked cars; increased vehicle passing distance by 2 feet; caused no change in negative behavior from drivers; and resulted in less sidewalk bicycling (San Francisco Department of Parking & Traffic 2004).

While Denver pioneered the used of the SLM with the bike-in-house design, Bellevue, Washington was the first municipality to make use of SLMs for limited roadway space (Latt 2009). Bellevue used their bike plan to determine which roads would be designated for SLM installation. Some placements occurred on streets without on-street parking—something not then authorized in the Federal MUTCD. The bulk of the analysis focused on bicycle and vehicle volumes through counts made via road tubes and video recording. The roadway area used by bicyclists was also recorded to review passing interactions. Even though this study occurred five years after San Francisco's, Bellevue found similar results. Overall, Bellevue found the average lateral distance between bicyclists and parked cars increased after SLM installation. They also found reduced numbers of undesirable behaviors between drivers and bicyclists. The study also mentions dynamic changes in weather, adding a level of uncertainty in the overall study results.

One study in Cambridge, Massachusetts conducted a before-and-after evaluation of bicyclists and drivers with 10-foot SLM spacing from the curb with parallel parking (Hunter et al. 2011). Investigators conducted this study to determine whether 10-foot spacing acts as a suitable substitute for the 11 feet indicated by the MUTCD. Through video recording, surveys noted the following motor vehicle characteristics: vehicle proximity, lane changes and passing behavior. For bicyclists the following behaviors were noted: SLM proximity, bicycle position, bicyclist taking full lane, and interactions with parked vehicles. The Cambridge study resulted in statistically significant findings

that included fewer bicyclists taking the lane, more bicyclists moving safely, fewer bicyclists yielding to vehicles, safer overtaking from drivers, decreases in lane changes, and decreases in motor vehicle speed. This study found 10-foot spacing to improve safety.

Table 1 is a summary of SLM installations conducted in California. Although a variety of studies and installations have been conducted throughout California to analyze the effectiveness of the SLM, the City of Los Angeles determined that conducting its own study would provide a more comprehensive and extensive analysis, and would also tailor to the defining and varying characteristics of the megalopolis to best determine prioritization for installation of the marking.

Standards

The State of California was the first to adopt standards for the installation of the SLM. Standards for the use of the marking are as follows:

> *The shared roadway bicycle marking shall only be used on a roadway (Class III Bikeway (Bike Route) or Shared Roadway (No Bikeway Designation) which has on-street parallel parking. If used, shared roadway bicycle markings shall be placed so that the centers of the markings are a minimum of 3.3 m (11 ft) from the curb face or edge of paved shoulder. On State highways, the shared roadways bicycle marking shall be used only in urban areas.*
>
> Section 9C.103(CA), CA MUTCD

When the SLM was adopted for use in California it was anticipated that the marking would be almost simultaneously approved at the national level in the Federal 2003 MUTCD. While the marking was reviewed, recommended for inclusion by the bicycle committee, and considered by the membership, it was ultimately rejected for inclusion in the 2003 Manual. However, when the manual was revised in 2007 the marking was included. In

Methodology

Preliminary Assessment

A preliminary assessment was conducted at each prospective SLM location to determine lateral placement of the SLMs—a factor that would remain constant for all installations in the study. Staff conducted sample rides with markings placed at 11, 12, and 13 feet from the curb. Staff tested comfortability of these placements beside a parked wide vehicle with an open door. Finally,

Table 2
Final SLM test locations

Location Name	Limits
1. Fountain Ave	Western Ave to Vermont Ave
2. Adams Blvd	Vermont Ave to Figueroa St
3. Westholme Ave	Santa Monica Blvd to Hilgard Ave
4. 4th St	Wilton Pl to Commonwealth Ave
5. Abbot Kinney Blvd	Venice Blvd to Main St
6. Reseda Blvd	Vanowen St to Nordhoff St

Figure 3
Map of the six selected study locations

Figure 4
Adams Blvd SLM installation with orange markings to help guide video analysis measurements

- An additional observer in the follow van operated recording equipment
- One coordinator facilitated bicyclist movement through the Zone of Interaction (ZOI)

The following equipment was utilized in the study:

- Two LADOT vans
- Five street-legal standard bicycles with computers (all bicyclists wore helmets)
- Two video cameras
- Two camera tripods
- Four radios (one for each staff member)
- One measuring wheel used to measure curb-lane width and the Zone of Interaction (ZOI)
- Two cans of orange mark out paint to mark bicyclist curb-width during Before studies and the Zone of Interaction (see Figure 4)
- Safety cones
- Sunscreen
- Refreshments
- Measuring tape
- Volunteer release forms (Appendix A)

Materials

Various materials were researched for use with the installation of the SLM. Paint, Thermoplastic, and Methyl Melacrylate were all considered in the application of the marking for the pilot study. Methyl Melacrylate was removed from consideration due to its toxicity and the fact that the City's field crews no longer utilize the material. While most locations were installed with poured thermoplastic on a stencil cut to CA MUTCD requirements, one location – Reseda – was installed with paint to determine how long a marking installed with paint

Figure 5
Adams Blvd before (top) and after (bottom) shared lane marking application

pavement marking at the direction of the observer/data recorder in the LADOT vans placed before and after the ZOI. The bicyclists were instructed to ride at a constant 12 mph, along guide markings 12 feet from the curb face where SLMs were to be installed for the "After" study.

City staff observed the interactions from inside the LADOT vans, next to the video camera but out of sight of approaching vehicles. During the study, observers used radios to communicate, coordinate speed and coordinate interactions.

Interaction Process

The LADOT SLM study team studied one location per day and conducted a set of data collection for both AM and PM peak motor vehicle volume periods. Each peak hour study took between two and four hours to set up, conduct, and videotape. The City conducted the "Before" and "After" studies at approximately the same time of day and on the same day of the week at each location, with the "After" study taking place at least one month after installation of the SLMs.

At each location, a group primarily composed of LACBC volunteers alternated bicycling within the ZOI to induce car-bicyclist interactions with motor vehicle traffic in the corridors. The City defined an interaction as a vehicle moving beside a bicyclist and either laterally sharing the lane with the bicyclist, passing the bicyclist, or staying behind the bicyclist within the ZOI. The driver's behavioral response was also noted, such as braking, lane encroachment, speed variations, honking, and/or yelling at bicyclists.

A target of 100 car-bicyclist interactions at each site for each trial period ensured a valid sample size. To account for error and/or missed interaction opportunities, a maximum of 150 interactions were recorded. Counted interactions had to occur within the camera view, or during the designated location's ZOI. The observer/data recorder and

Braking: Braking was recorded when it occurs before and during an interaction

Lane encroachment: Lane encroachment was considered to occur only when a tire from the car completely crosses over the lane line. If the car's tire is on the line, then no encroachment is considered. The levels of encroachment were determined as follows:

a) *Low encroachment:* 1+ tire crosses over into the adjacent/opposite lane
b) *Medium encroachment:* Nearly half of the car crosses over into the adjacent/opposite lane
c) *High encroachment:* Half or more of the car crosses over into the adjacent/opposite lane

Platoon: A platoon is defined as a group of cars traveling together and in the same direction from a signalized intersection, as well as when cars simply follow each other in the same lane.

Videofile Review

Review of video of the "Before" and "After" studies verified written observations and allowed the City to record other measurements, such as lateral vehicle-bicyclist distance. To do this, staff paused and reviewed the video. Staff reviewed the video twice per interaction to ensure accurate lateral distance measurements.

The ZOI was established at a location within the future SLM installation area, far enough beyond the beginning of the markings for drivers to recognize and process the meaning of the markings, once installed. Staff parked the "lead" LADOT van roughly 100 to 200 feet beyond the start of the ZOI, but still within it. The "follow" van was located at the beginning of the ZOI. The video cameras mounted atop the tripods inside the LADOT vans were out of sight of approaching vehicles but in

Examples of excluded interactions are as follows:

A. ***Complete deletion:***
Eligible for full deletion from the dataset:

1) Interaction does not occur within video camera view.
Reason: Unable to laterally measure car-bicyclist distance.

2) Interaction not entirely visible when reviewing (i.e. interaction too far away or too close-up on the video)
Reason: Increase in error, unable to laterally measure car-bicyclist distance.

B. ***Distance not measured:***
Eligible for deletion of distance measurements from the dataset:

1) Driver slows down and avoids interaction within the ZOI.
Reason: No interaction to measure.

"Before" and "After" Study Statistics

Results compiled from data collection and observations were statistically analyzed to determine the performance levels of the SLMs. Statistics were graphed for visualization and are presented on the following pages.

Findings

Passing Distance

Most streets in the study experienced statistically significant increases in passing distances after SLM installation - Abbot Kinney Boulevard being the exception. Fountain Avenue and 4th Street experienced an increase of approximately one lateral foot in average passing distance after installation of the SLMs. Fountain Avenue experienced the highest percent change, with an approximate 28% increase in average lateral passing distance. Although Abbot Kinney Boulevard did not experience a significant increase in passing distance after the SLM installation, the "Before" data support the assumption that motorists on Abbot

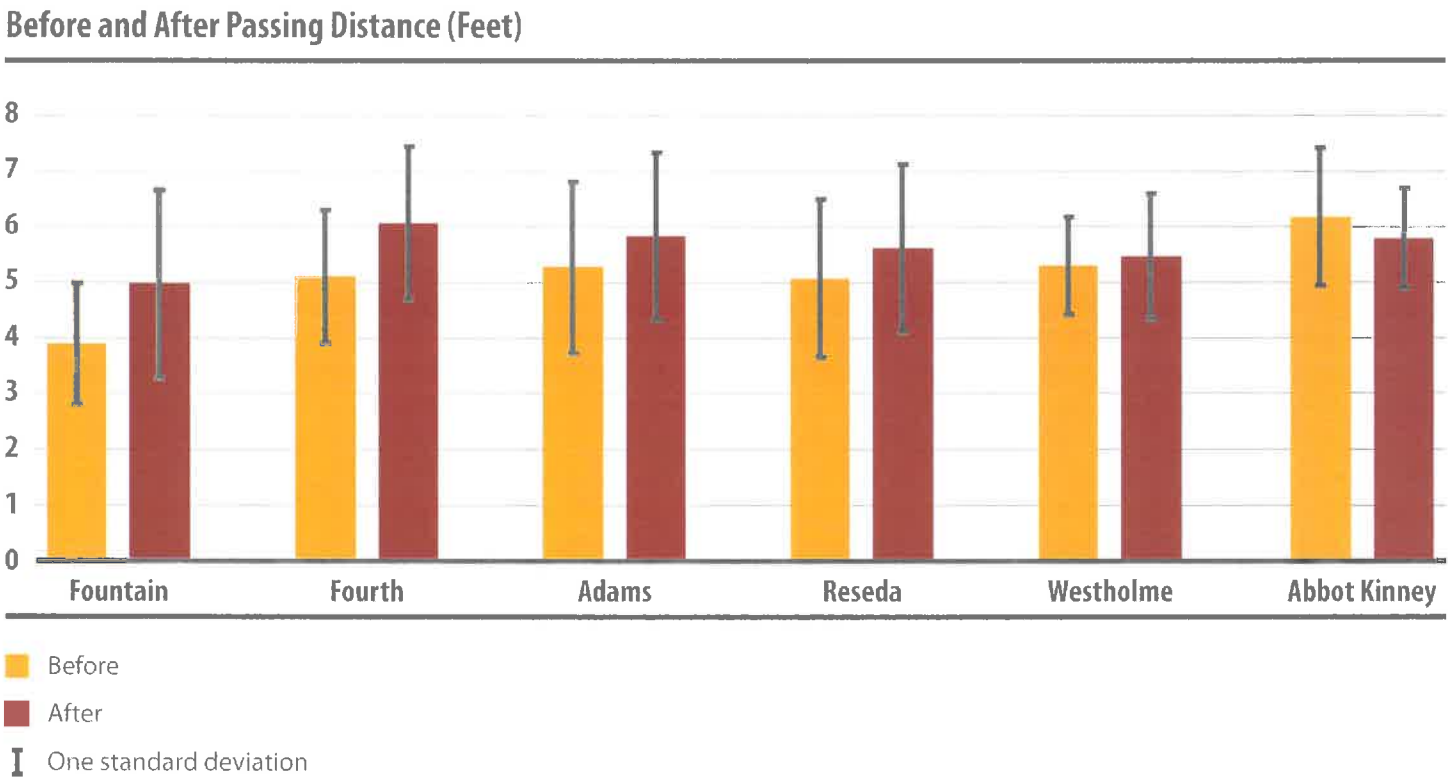

Figure 6
Changes in "Before" and "After" passing distance

- Tailgated less
- Made fewer lane changes, when applicable
- Exhibited less aggressive behavior

Figure 9 shows how the behavior of non-passing vehicles changed between the "Before" and "After" studies. Behavior changes on specific corridors before and after SLM installations do not yield any significant differences except in one category: decreased lane changes on Reseda Ave (significant at the 0.002 level).

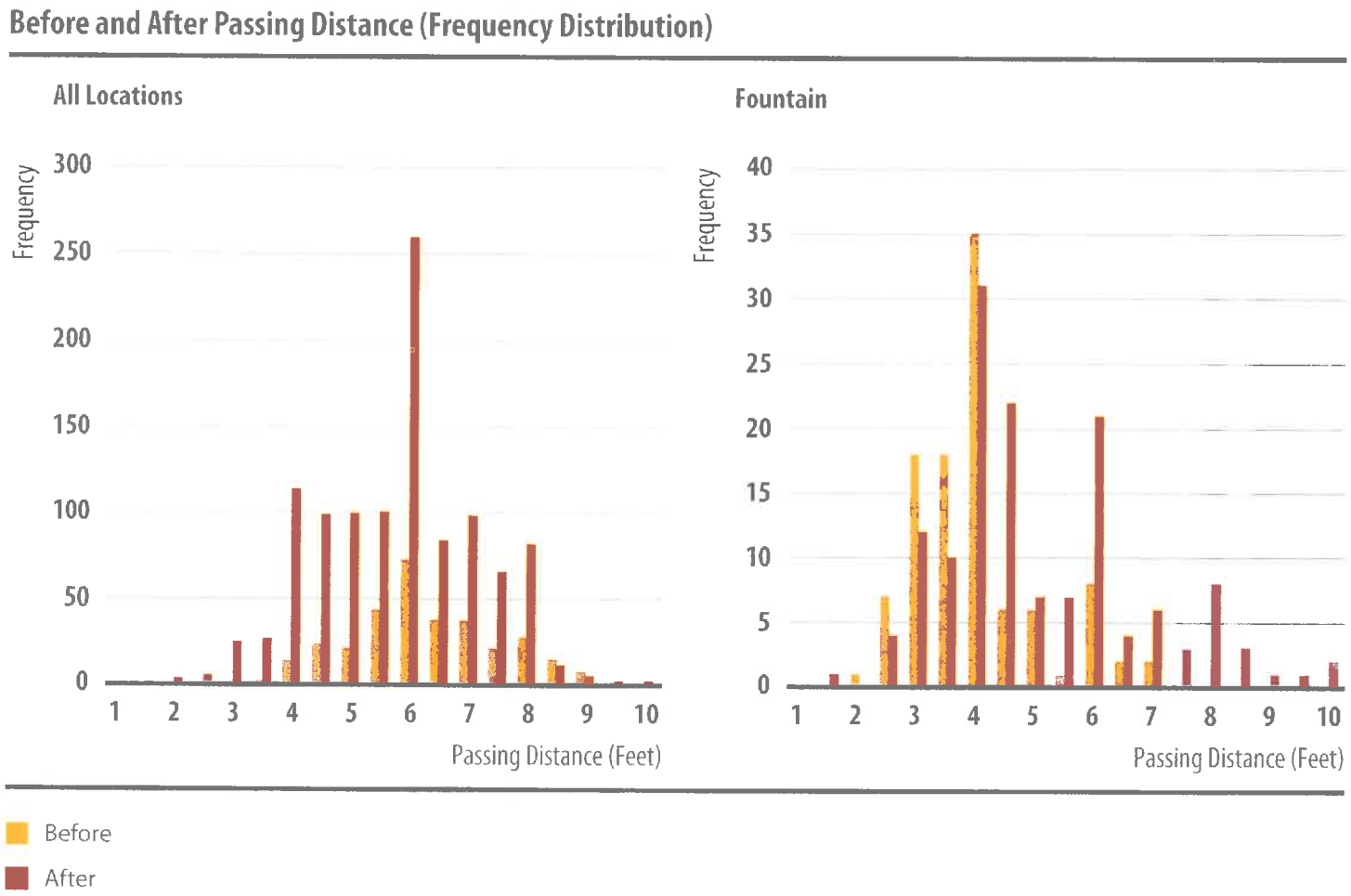

Figure 8
Changes in "Before" and "After" passing distances at all locations and Fountain Ave

Before and After Driver Behavior

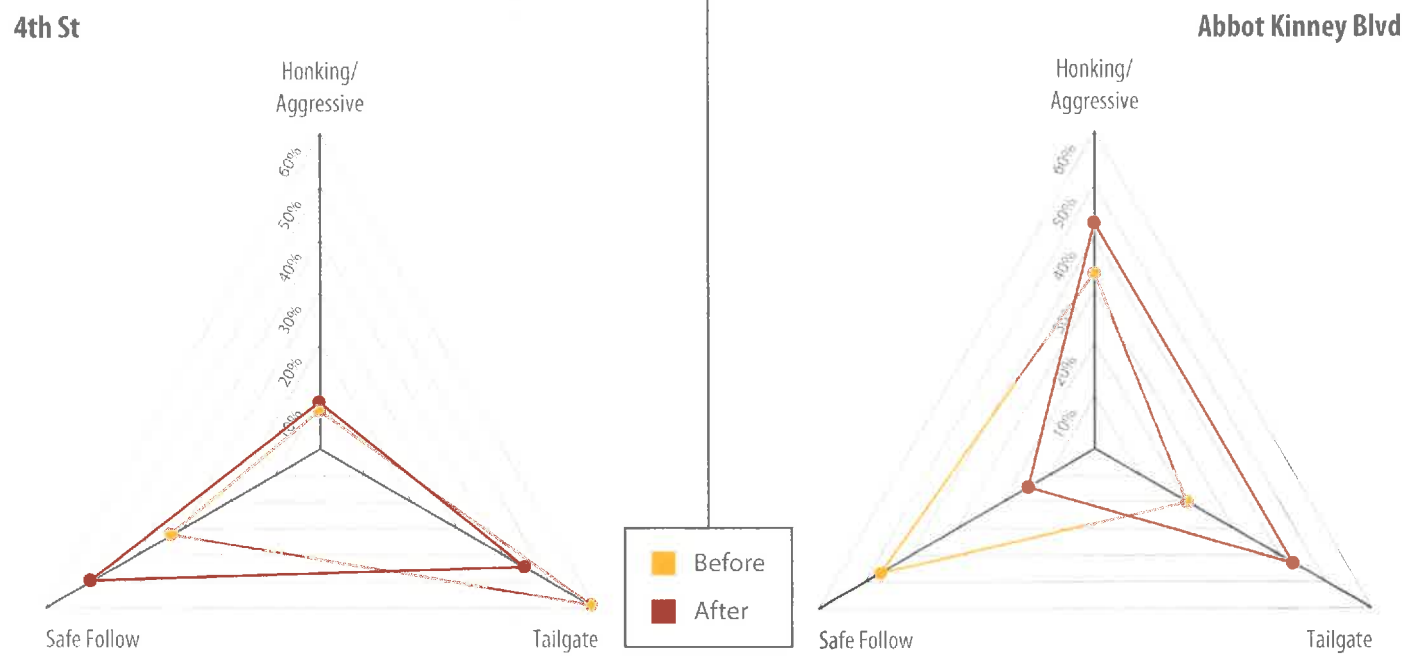

Figure 9 (continued)
Changes in "Before" and "After" non-passing vehicle behavior

age of street configurations throughout the City, there are still certain configurations that might benefit from the installation of markings.

Also, the video data collected in the "follow" van was not useful in the review of the bicyclists/motorist interactions. Often times, other vehicles that come into view of the video camera obscured a clear vision of the interactions. This data was ultimately disregarded.

Low traffic volumes also limited the number of samples, particularly on Westholme Avenue. On the other hand, traffic congestion on Abbot Kin-

functions: first, it can be used along corridors with the purpose of guiding bicyclists along a specified route. In this case it supplements signage for guidance and way finding. This performance of the marking is less applicable because its intent is not primarily concerned with the lateral placement of the bicyclist, or even motorist behavior. The second function is to define the desired lateral positioning for bicyclists while increasing motorist awareness of bicyclist presence along a corridor. As such, the performance of the SLM along these corridors is key because the bicycle-motorist interaction is the target of effectiveness. For these applications, study results indicate that the SLM is most effective on a street such as Fountain Avenue, with narrow single lane operation in each direction separated by a dashed centerline. Though less dramatic, the SLM also proved effective along arterial roadways such as Reseda Boulevard and Adams Boulevard, and low-volume local streets and collectors such as Westholme Avenue and 4th Street. While the SLM did not have significant results along Abbot Kinney Boulevard, possibly due to geographic locations, the use of the SLM along corridors like Abbot Kinney can still be useful for the purposes of guidance, way finding, and closing gaps between bicycling facilities such as Class II Bike Lanes and Class III Bike Routes. Furthermore, it is recommended that complimentary signage, such as a "Bikes May Use Full Lane" sign, be used for additional way finding and awareness for roadway users to increase the effectiveness of the SLM installation.

The City recommends the following measures for other agencies looking to implement Shared Lane Markings into the bike infrastructure toolbox:

- Placement of SLMs not less than 12 feet from the curbface
- Markings should be aligned in such a manner as to encourage bicyclists to ride in a straight line and to discourage weaving
- SLM implementation in conjunction with "Bi-

References

Brady, J. et al. (2011). Operational and Safety Implications of Three Experimental Bicycle Safety Devices in Austin, TX. *2011 Annual Meeting of the Transportation Research Board.*

Hunter, W. et al. (2001). Evaluation of Shared Lane Markings in Cambridge, Massachusetts. *2011 Annual Meeting of the Transportation Research Board.*

Latt, K. (2009). City of Bellevue Sharrows Project Pilot Study for 161st Ave SE. City of Bellevue, Transportation Department.

San Francisco's Shared Lane Pavement Markings: Improving Bicycle Safety. (2004). *San Francisco Department of Parking & Traffic.*

other party or parties in defending, unless the other party or parties are finally adjudged liable on such claim.
This contract may not be modified orally, and a written waiver of any provision shall not be construed as a modification of any other provision herein, nor as a consent to any subsequent waiver or modification.
Every term and provision of this contract is intended to be severable. If any one or more of the terms or provisions of this contract is found to be unenforceable or invalid, the remaining terms and provisions shall not be affected and shall remain binding and enforceable.

By signing this contract, I certify that I have carefully read this contract, that I understand what it means, and that by signing I am agreeing to be bound by the terms and provisions of the contract. This contract shall be binding on me and on my Successors.

Name (print):_____

Address:_____

E-Mail Address:_____

In case of emergency, notify:_____Phone:_____

SIGNATURE:_____

Date:_____

Appendix C: Shared Lane Marking Pilot Project BEFORE Car-Bicyclist Interactions

Location (Check one)

- ☐ Fountain
- ☐ Adams
- ☐ Westholme
- ☐ Fourth
- ☐ Abbot Kinney
- ☐ Reseda

Date: ________

Day: ____________

@ Site: Start time _______ Finish _______

@ Site: Total time ________

Bikers:

Interaction #	Car Type	Biker	Platoon?		Adj/Opp Lane	Lane Encroach	Distance (from Video)						Braking?		Comments	Video time	Delete?	Notes
	Type/Color		Platoon?	# of vehicles		No/Low/Med/High	Bicyclist Height (in.)	Bicyclist-car width (in.)	Curb-lane dist. (in.)	Bicyclist Height (ift.)	Bicyclist-car dist. (ft)	Bicyclist-car dist. error						