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Fast, Furious & Fatal: An Assessment of Speed-Setting Methodology in California

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An Assessment of Speed-Setting Methodology in California

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16. Abstract

Speed is a key factor in roadway safety. As vehicle speed increases, the probability of a crash and the severity of the resulting injury increase. Recognizing this relationship, the City of Los Angeles updated speed limits on over 800 miles of streets in 2017 as part of its Vision Zero program. California's methodology for setting speed limits, known as the 85th percentile rule, caused Los Angeles to increase speed limits on over 90 miles of streets with a history of known collisions.
This report focuses on California's current methodology for speed limits and investigates the following questions:
1. What is the current methodology for setting speed limits in California?
2. What is the relationship between this methodology and roadway safety, particularly in urban areas?
3. Are there other approaches to setting speed limits that would improve roadway safety in California, particularly in urban areas?
To answer these questions, I employed a mixed-methods approach that included: a literature review of past research into speed, speed limits, and roadway safety; an analysis of text pertaining to California speed limits in the California Vehicle Code (CVC) and the California Manual on Uniform Traffic Control Devices (CA MUTCD); an analysis of 2017 speed survey data from the City of Los Angeles; a review of case studies of alternative speed limit methodologies in Washington, Oregon, and Sweden; and a summary of legislative action in California since 1996 pertaining to the speed limit methodology.
I found that the current laws for setting speed limits incorporate safety by relying mostly on the 85th percentile speed and allowing for adjustments for context, though only to a limited degree. The case study of Los Angeles revealed the shortcomings of the current methodology for setting speed limits in California, particularly in urban areas, such as non-normal distribution of traffic flow, increasing operating speeds, the practice of using a single day of data and the overused discretion of the 5 mph reduction. The Washington and Oregon case studies illustrated that there are many ways to increase flexibility for local jurisdictions to set speed limits in urban areas, including setting a statewide maximum speed limit for urban areas, authorizing local jurisdictions to set speed limits on their streets, and employing pilot projects to test alternative methods for setting speed limits in cities. The Swedish case study provided insight into a different approach to setting speed limits that is not based on operating speed of vehicles but on the potential for fatalities and severe injuries on streets.
I conclude that California should end its practice of setting speed limits based on the 85th percentile speed and shift the authority for setting speed limits to local jurisdictions. Local jurisdictions should set speed limits using methods, such as the injury minimization method, that focus on safety outcomes, rather than solely on operating speed. Speed limits should be paired with the adoption of automated speed enforcement, which would increase compliance with speed limits.

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Fast, Furious & Fatal

An Assessment of Speed-Setting Methodology in California

A comprehensive project submitted in partial satisfaction of requirements for the degree Master of Urban and Regional Planning

By Ribeka Toda

Client: Lilly Shoup, Nelson\Nygaard

Faculty Chair: Professor Martin Wachs

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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 Lilly Shoup of Nelson\Nygaard 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.

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
AB	Assembly Bill
ASE	automated speed enforcement
Caltrans	California Department of Transportation
CTCDC	California Traffic Control Devices Committee
CVC	*California Vehicle Code*
E&TS	engineering and traffic survey
FHWA	Federal Highway Administration
HIN	High Injury Network
ITE	Institute of Transportation Engineers
km/h	kilometers per hour
mph	miles per hour
LA	Los Angeles
LADOT	Los Angeles Department of Transportation
LAPD	Los Angeles Police Department
LAVZ	Los Angeles Vision Zero
MUTCD	*Manual on Uniform Traffic Control Devices*
NACTO	National Association of City Transportation Officials

NCUTCD	National Committee on Uniform Traffic Control Devices
NHTSA	National Highway Traffic Safety Administration
NMSL	National Maximum Speed Limit
NTSB	National Transportation Safety Board
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
PBOT	Portland Bureau of Transportation
RCW	Revised Code of Washington
REIR	Rules, Elections & Intergovernmental Relations
SDOT	Seattle Department of Transportation
SMC	Seattle Municipal Code
TRB	Transportation Research Board
U.S.	United States

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Executive Summary

Speed is a key factor in roadway safety. As vehicle speed increases, the probability of a crash and the severity of the resulting injury increase. Recognizing this relationship, the City of Los Angeles updated speed limits on over 800 miles of streets in 2017 as part of its Vision Zero program. California's methodology for setting speed limits, known as the 85th percentile rule, caused Los Angeles to increase speed limits on over 90 miles of streets with a history of known collisions. Concerned about these speed limit increases, two Los Angeles City Councilmembers introduced a resolution to have the City support state legislation that would change California's methodology for setting speed limits to provide more local authority for cities to set their own speed limits. Motivated by these concerns, this report focuses on California's current methodology for speed limits and investigates the following questions:

1. What is the current methodology for setting speed limits in California?
2. What is the relationship between this methodology and roadway safety, particularly in urban areas?
3. Are there other approaches to setting speed limits that would improve roadway safety in California, particularly in urban areas?

To answer these questions, I employed a mixed-methods approach that included: a literature review of past research into speed, speed limits, and roadway safety; an analysis of text pertaining to California speed limits in the *California Vehicle Code* (*CVC*) and the *California Manual on Uniform Traffic Control Devices* (*CA MUTCD*); an analysis of 2017 speed survey data from the City of Los Angeles; a review of case studies of alternative speed limit methodologies in Washington, Oregon, and Sweden; and a summary of legislative action in California since 1996 pertaining to the speed limit methodology.

The 85th percentile rule is a rule-of-thumb for setting speed limits that has been popular among transportation engineers since the 1950s. The literature review found roadway safety is a primary goal in setting speed limits. Supporters of the 85th percentile methodology see it as a safe and fair way to set the speed limit based on the driving behavior of the majority (85 percent) of drivers that drive in a reasonable and prudent manner. Critics of the methodology disagree with setting speed limits based on existing driver behavior, claiming that it will create unsafe road conditions, especially for vulnerable roadway users like pedestrians and bicyclists. They suggest that drivers are not always reasonable and prudent, that the method would continuously cause operating speeds to increase over time, and that most of the research justifying the use of the 85th percentile rule was conducted on rural roads and therefore the method is not appropriate on urban roads.

Researchers have studied the relationship between speed and safety extensively, and there are three characteristics of speed that influence roadway safety: magnitude of speed; variance of speed; and context-sensitivity of speed. The research also showed that there is low compliance with speed limits unless there is adequate enforcement. Speed limits can be a highly effective countermeasure to speeding and speed-related crashes, especially with consistent enforcement using technology like automated speed enforcement.

Analysis of the *CVC* and the *CA MUTCD* found that the law does prioritize safety in the methodology for setting speed limits but does not provide enough flexibility for urban areas to set speed limits that are appropriate for complex environments. For example, the current methodology allows a 5-mph reduction from the 85th percentile speed if there is a history of bicycle and pedestrian collisions, but not for the presence of these vulnerable users. The data from the City of Los Angeles revealed that urban areas are constrained in their ability to adjust posted speed limits by changing the 85th percentile speed beyond a simple 5-mph reduction that is applied almost universally in the city.

The Washington and Oregon case studies illustrated that there are a many ways to increase flexibility for local jurisdictions to set speed limits in urban areas, including setting a statewide maximum speed limit for urban areas, authorizing local jurisdictions to set speed limits on their streets, and employing pilot projects to test alternative methods for setting speed limits in cities. The Swedish case study provided insight into a different approach to setting speed limits that is not based on operating speed of vehicles but on the potential for fatalities and severe injuries on streets.

A summary of past legislative efforts to change the speed limit methodology in California showed that there have been minor changes, mostly changing whether the 85th percentile speed could be rounded up or down. Assemblymember Laura Friedman recently proposed AB 2363, which would change the methodology so that more consideration is given to roadway safety. This bill is currently in the midst of a significant re-write, making its future uncertain.

California should end its practice of setting speed limits based on the 85th percentile speed and shift the authority for setting speed limits to local jurisdictions. Local jurisdictions should set speed limits using methods, such as the injury minimization method, that focus on safety outcomes, rather than solely on operating speed.. Speed limits should be paired with the adoption of automated speed enforcement, which would increase compliance with speed limits.

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I. Introduction

Speed is a key factor in roadway safety. Higher vehicle speeds correlate with the increased likelihood of a crash occurring and its severity (Forbes, Gardner, McGee, & Srinivasan, 2012; NTSB, 2017). According to the National Transportation Safety Board (NTSB) (2017), nearly one-third of traffic fatalities in the United States are speed-related. Facing this public health issue, cities like Los Angeles are adopting strategies to eliminate roadway fatalities. In 2015, the City of Los Angeles launched Los Angeles Vision Zero (LAVZ), an initiative to eliminate traffic fatalities in the city by 2025.[1] This initiative is spearheaded by the Los Angeles Department of Transportation (LADOT) in collaboration with the Los Angeles Police Department (LAPD), as well as several other city departments. To reduce the more than 200 traffic fatalities that occur every year in the city, Los Angeles employs three main strategies of Vision Zero – engineering, enforcement, and education (LADOT, 2018b). To focus policy interventions on the most dangerous streets, the LADOT established the high-injury network (HIN), a group of streets with a higher incidence of severe and fatal collisions. While road design is often the most direct way to influence roadway speed and safety, speed limits are also a key element of Vision Zero.

However, at the launch of LAVZ, over 80 percent of the streets in Los Angeles had unenforceable speed limits because of expired speed surveys in 2016 (Reynolds, 2017). A speed survey is a recording of the operating speed of vehicles on a roadway. To regain the ability to enforce the speed limits on city streets, in 2017 the city conducted speed surveys on 825 miles of streets, focusing on streets on the HIN. As a result, the city proposed increasing, decreasing, or maintaining the existing speed limit. Of the surveyed streets, the city proposed to maintain the existing speed limits on over 80 percent of those

[1] More information on Vision Zero can be found at http://visionzero.lacity.org/

streets (678 miles), to decrease the speed limit on 53 miles and to increase the speed limit on 94 miles (City of LA, 2018).

The LADOT presented these recommendations to the City Council. While the council supported increasing the mileage of enforceable streets in the city from 19 percent to 68 percent, many councilmembers opposed the increase in speed limits on over 90 miles of streets. Knowing the relationship between increased speed and increased likelihood of crashes and fatalities, it seems counterintuitive to increase the speed limit in the name of roadway safety and Vision Zero. Ultimately the council approved the updated speed limits on 98.4 percent of the HIN. One councilmember opposed the adoption of the new speed limits in his district where the speed limit increased, and thus the speed limits on these streets were not updated.[2] This decision, while understandable, comes at a cost because the speed limits in these speed zones cannot be enforced since the updated surveys were not adopted. These speed zones remain vulnerable to speeding vehicles with no consequences for those drivers.

The process of updating speed limits in Los Angeles highlights the current methodology for setting speed limits in California. Under the police power granted to states by the U.S. Constitution, speed limits are regulated by the state, rather than federal or local governments. This means that each state has its own laws regarding the setting and posting of speed limits. California has laws that outline the methodology for setting speed limits and these laws apply to all local jurisdictions, including Los Angeles.

Feeling constrained by the state's methodology, two Los Angeles City Councilmembers introduced a resolution in February 2018 to have the city take an official position supporting state "legislation and/or administrative action that

[2] The City did not approve updating speed limits on three street segments – one on Olympic Boulevard and two on Overland Avenue – due to opposition by the Councilmember of this district. This reduced the mileage of streets where speed limits were increased from 94 miles to 89 miles.

would increase local control of speed limit setting and enforcement." The resolution is pending before the City Council's Rules, Elections & Intergovernmental Relations (REIR) Committee (The resolution and corresponding Chief Legislative Analyst report appear in Appendix A). The REIR Committee recently approved a similar resolution in May 2018 supporting California Assemblymember Laura Friedman's bill, which is discussed in Chapter V of this report (The resolution and corresponding Chief Legislative Analyst report appear in Appendix B). This paper explores the relationship between California's methodology for speed limits and roadway safety, particularly in urban areas.

Speed limits in California

In California, the principles and methodology for setting speed limits are outlined in the *California Vehicle Code* (*CVC*) and the *California Manual on Uniform Traffic Control Devices* (*CA MUTCD*). The *CVC* contains statutes adopted by the California Legislature relating to the operation, ownership, and registration of vehicles in California, and changes to it are made through state legislation. The *CA MUTCD* is a technical document published by the California Department of Transportation (Caltrans) and changes to this document are made through recommendations from the California Traffic Control Devices Committee (CTCDC), an advisory board for Caltrans comprised of local transportation authorities.

Based on the *CVC* and the *CA MUTCD*, there are two types of speed limits – statutory speed limits and posted speed limits. Statutory speed limits are set by state law on certain types of streets, such as residential streets, school zones, and state highways. Posted speed limits are set by local jurisdictions (such as cities and counties) based on speed surveys, in which traffic engineers measure the operating speed of vehicles on a roadway to determine the appropriate speed limit. More specifically, posted speed limits are set based on what is known as the 85th percentile rule. A common practice in the United States, the 85th percentile rule sets the speed limit at the speed at which 85 percent of the vehicles are traveling at or under on a given roadway. California state law requires an up-to-date speed survey for a speed limit to be enforceable. Traffic officers cannot legally pull over speeding drivers on streets where the speed surveys have expired.

In general, the *CVC* and the *CA MUTCD* include the following information regarding speed limits:

- Statutory speed limits (*CVC §§ 22348-22413*)
- Definition of "engineering and traffic survey" and factors to be considered in the survey (*CVC § 627*)
- Rounding based on 85th percentile speed (*CVC § 21400*)
- Definition of "speed trap" and evidence required for speed citation (*CVC § 40800-40834*)
- Setting speed zones, speed limits, and speed signs (*CA MUTCD § 2B.13*)
- Conducting and documenting an engineering and traffic survey (*CA MUTCD § 2B.13*)

A more complete description of these sections can be found in Appendix C.

National Discussion

The situation in Los Angeles highlights the tension between a standardized methodology for setting speed limits statewide and the desire for local control to set speed limits that reflect local preferences and needs, particularly in urban areas. Speed limits have become a topic of national conversation regarding local authority and a fundamental questioning of whether the methodology properly prioritizes safety (Anderson, 2018).

In July 2017, the National Transportation Safety Board (NTSB) published a comprehensive report on roadway safety in the United States. In its report, the NTSB challenged the notion that the 85th percentile speed is the safest operating speed and stated that there is “no strong evidence” that traveling at this speed would result in lower crash involvement rates (NTSB, 2017). This is a significant finding, given the long-standing acceptance of the 85th percentile rule as the engineers’ rule-of-thumb for setting speed limits. The NTSB recommended the Federal Highway Administration (FHWA) remove the guidance for speed limits based on the 85th percentile rule and consider alternative methodologies for setting speed limits. In addition, the NTSB noted the challenges of setting speed limits in urban areas and recommended that jurisdictions employ a “safe system approach”[3] on urban roads to “strengthen protection for vulnerable road users.”

In reaction to the NTSB recommendations, the FHWA developed a task force within the National Committee on Uniform Traffic Control Devices (NCUTCD)[4] to review and explore changes to the speed-setting methodology. As a first step, the NCUTCD task force distributed a survey on March 7, 2018, to transportation practitioners across the country to seek information on the speed-setting methodology in the states and what respondents would like to see changed in the methodology (The survey questionnaire appears in Appendix D).

To further explore the complexities of speed limits in urban areas and on lower speed streets, the National Association of City Transportation Officials (NACTO)

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[3] This approach sets speed limits based on the highest acceptable speed in a collision that would not result in a fatality or severe injury.

[4] The NCUTCD is an organization which provides recommendations to the FHWA for matters related to traffic control devices and changes to the Manual on Uniform Traffic Control Devices (MUTCD).

sent a follow-up survey on March 8th that included questions about local authority in setting speed limits and other tools and policies that have been used to set speed limits in urban areas (The follow-up survey questionnaire appears in Appendix E).

The results from these surveys were not yet available at the time of this report.

Research Question

These national reports and surveys indicate the high level of interest in speed limit laws across the country. This research seeks to provide an analysis of current speed limit laws in California from the perspective of roadway safety and to provide recommendations for changes to the laws to better serve urban areas. Specifically, the research questions are:

1. What is the current methodology for setting speed limits in California?
2. What is the relationship between this methodology and roadway safety, particularly in urban areas?
3. Are there other approaches to setting speed limits that would improve roadway safety in California, particularly in urban areas?

This report will provide a review of the literature related to speed and safety, followed by a summary and analysis of the existing methodology for speed-setting in California. It will consider the relationship between this methodology and roadway safety in the law and in practice, particularly in urban areas, and will address whether California can change its laws to improve safety based on examples from other states and countries.

II. Literature Review

This research seeks to understand the safety implications of the existing speed limit methodology, particularly in urban areas. The literature review summarizes four areas of research in the realms of speed, speed limits, and safety:

1) History and purpose of speed limits in the United States;

2) History, rationale, and critiques of the 85th percentile rule;

3) Research on the relationship between speed and safety; and,

4) Research on the effectiveness of speed limits.

Brief History and Purpose of Speed Limits in the United States

The United States started using speed limits to manage speeds before the introduction of the automobile. In 1648, the first speed limit in the United States was set for horses in Newport, Rhode Island (Joscelyn, Jones, & Elston,1970). The first speed limit for automobiles was set in 1901 in Connecticut.

A 1970 report by the National Highway Safety Bureau declared that the primary purpose of speed limits is to “reduc[e] [] the risk of highway travel,” or put simply, safety (Joscelyn et al.,1970). This is still the case today, as the current *California Manual for Setting Speed Limits* states, “Roadway safety is the primary consideration in establishing speed limits,” (California Department of Transportation [Caltrans], 2014).

85th Percentile Rule

The 85th percentile rule is the practice of setting the speed limit at the speed below which 85 percent of vehicles travel in a distribution of speeds of vehicles in a given speed zone. The 85th percentile is one standard deviation above the 50th percentile in a normal distribution. By setting the speed limit at the 85th percentile, the speed limit will be at or above the speed of 85 percent of the vehicles on the roadway (Forbes et al., 2012).

Many people attribute the 85th percentile rule to a 1964 study by David Solomon, the chief of the Safety Research Branch of the Bureau of Public Roads (the predecessor of today's Federal Highway Administration [FHWA]) that studied the relationship between crashes and speed, the driver, and the vehicle, on rural highways (Solomon, 1964). However, there are references to the 85th percentile rule as far back as 1956 in an excerpt from Nation's Business, a magazine from the U.S. Department of Commerce, in which the author J. Edward Johnston states:

> *"*Many traffic authorities agree that a limit which includes 85 per cent of the drivers is reasonable.*"* (Johnston, 1956)

However, Johnston viewed the speed limit as a maximum speed limit, rather than a recommendation of the speed at which most drivers should drive:

> *"*A speed limit should seem too high to the majority of drivers.*"*

A few years later, in 1961, a report from the Joint Highway Research Project at Purdue University stated:

> *"*The 85th percentile speed at which drivers travel on a road is recognized as the proper speed limit for that location unless reasons which the driver cannot see warrant a lower speed limit" (Petty, 1961).

By 1970, the Institute for Research in Public Safety at Indiana University published a report for the National Highway Traffic Safety Administration (NHTSA), in which it recommended that maximum speed limits in the United States should be set based on the 85th percentile of travel speeds (Joscelyn et al., 1970). Since then, the 85th percentile rule remains the rule-of-thumb among traffic engineering practitioners for setting speed limits for roads in the United States and continues to be taught as the standard method for setting speed limits, such as in the Institute of Transportation Engineers' (ITE's) *Manual of Transportation Engineering Studies*, in schools and in the industry (Schroeder, Cunningham, Findley, Hummer, & Foyle, 2010).

Rationale

The 85th percentile rule is built on the fundamental assumption that drivers are *reasonable* and *prudent*, as explicitly stated in the *California Vehicle Code* (*CVC*) *§* 22350. It is based on the assumption that drivers on a roadway understand the risks associated with operating a vehicle in the environment in which they are driving, and that they choose to drive at the appropriate speed for the given roadway. According to the *California Manual on Uniform Traffic Control Devices* (*CA MUTCD*) *§ 2B.13*, speed limits set based on the 85th percentile speed, "conform to the consensus of those who drive highways as to what speed is reasonable and prudent, and are not dependent on the judgment of one or a few individuals."

Given this assumption, two main benefits for the rule are widely cited by its defenders – safety and enforceability.

First, the 85th percentile speed is considered the safest speed for vehicles on a roadway. According to *CA MUTCD § 2B.13*, establishing a speed limit lower than the 85th percentile speed "generally results in an increase in collision rates." The 85th percentile speed is considered to be safer than an extremely low speed, such as 15 mph, because the difference in speed between the slower vehicle and the rest of the traffic flow is believed to create dangerous conditions.

Second, the 85th percentile speed is considered the limit at which it is fair to criminalize those who exceed it. The *CA MUTCD* describes this perspective in multiple ways in *§ 2B.13*. It states that speed limits, like most laws, depend on "the voluntary compliance of the greater majority of motorists," and that setting the speed limit below the 85th percentile speed would "make violators of a disproportionate number of the reasonable majority of drivers" and that such a law "would not command the respect of the public."

Critiques

Recently, there have been critiques of the 85th percentile rule which challenge the notion that the 85th percentile speed is the safest operating speed, noting there is "no strong evidence" that traveling at this speed will result in lower crash involvement rates (National Transportation Safety Board [NTSB], 2017).

Critics of the rule challenge the concept of setting a legal standard based on existing behavior. A writer from the Bicycle Coalition of Greater Philadelphia cheekily compares this method to a parent a setting a diet for their children based on what most children eat voluntarily (Oreo cookies instead of greens), and a 2005 Los Angeles Times article compares this to the IRS collecting taxes based on what 85 percent of people are willing to pay (LoBasso, 2017; Vartaberian, 2005). In addition to opposing setting speed limits based on existing behavior, critics have three specific concerns about the 85th percentile rule: the contextual differences between driving in rural and urban areas; speed creep as a potential outcome; and disputes over the validity of the assumption that drivers are "reasonable and prudent."

The 85th percentile methodology was established based on research primarily conducted on rural roads. However, rural roads are generally long stretches of uninterrupted roadway, while urban areas are generally characterized by frequent interactions between cars and vulnerable users of the roadway, such as pedestrians and bicyclists. In addition, urban streets have other conditions and activities such as traffic signals, on-street parking, cross-street traffic, and driveways. While it may be reasonable to assume that drivers behave in a “reasonable and prudent” manner on rural roads, drivers in urban areas may not have sufficient information to behave reasonably and prudently.

Speed creep is the cyclical phenomenon in which increasing the speed limit based on the 85th percentile speed leads to drivers increasing their speed on the road, which would then lead to an even higher 85th percentile speed, and this would continue in an upward cycle. The NTSB warned that raising speed limits to match the 85th percentile speed may “lead to higher operating speeds and thus a higher 85th percentile speed.” Ezra Hauer, a leading researcher in roadway safety at the University of Toronto, sought to investigate how driver behavior shapes the evolution of speeds over time. While it is known that speeds change over time, he found the evolution of speeds over time is poorly documented (Hauer, 2009). He speculated that speeds may increase over time due to the self-image of drivers, a majority of whom believe that they are better than average drivers and thus drive faster than the posted speed limit, and due to speed creep from applying the 85th percentile methodology.

The 85th percentile methodology assumes that drivers are “reasonable and prudent,” and behaving in a way that is reasonable and prudent for themselves as individuals will result in improved outcomes for society. However, Norwegian road safety researcher Rune Elvik studied the rationality of drivers in speed choice and found that it is not “objectively” rational, meaning the speed choices of people driving are not optimal from a societal perspective (Elvik, 2010). He found that drivers underestimated the increase in safety risks associated with increased speed, underestimated impact speed in situations where braking is necessary to reduce crash severity, and that drivers had different thresholds for speeds they consider to be safe to drive. With these findings, Elvik concludes that speed limits should be set based on speeds that are optimal for society and not based on methodologies like the 85th percentile rule that are based on drivers’ speed choices.

Speed and Safety Relationships

Three main characteristics of vehicle speed affect roadway safety outcomes. The first is the magnitude of speed, which is how fast a vehicle travels. The second is the variance of speed, which is how the speed of vehicles on a roadway differ from one another. And the third is the context-sensitivity of speed, which is how travel speed is adjusted according to the characteristics of the surrounding environment.

Magnitude of Speed

The magnitude of speed, or the absolute vehicle speed, impacts safety in two ways – the crash severity and the crash frequency. Numerous studies with consistent findings have established these relationships between speed upon impact and crash severity, but the relationship between speed and crash frequency has not been as clear and is debated in the engineering community (Transportation Research Board [TRB], 1998).

Nearly fifty years ago, a study published by the U.S. Department of Transportation (USDOT) stated that it is “generally accepted by experts” that crash severity increases with speed (Joscelyn et al., 1970). The NTSB confirmed this relationship in a recent report, adding that pedestrians are particularly vulnerable to severe injury and death in collisions with speeding vehicles (NTSB, 2017). The NTSB explained that the likelihood of fatality for a pedestrian struck by a vehicle increases with vehicle speed: 5 percent of pedestrians struck by vehicles at 20 mph are fatally injured, and this likelihood increases to 45 percent at 30 mph and to 85 percent at 40 mph.

Road design and operating factors like traffic signals obscure the role of speed in crashes, making it challenging to establish the relationship between speed and crash frequency (Forbes et al., 2012). However, a meta-analysis of over 100 studies conducted by Norwegian Institute of Transport Economics found a “strong statistical relationship between speed and crash risk” for operating speeds between 15 mph and 75 mph (Elvik, 2004). The studies included data from a variety of roadway types, including urban streets, and the findings did not differ based on roadway type. In 2006, the journal *Accident Analysis & Prevention* published a review of speed and safety studies that found that the crash rate increases exponentially as the speed of an individual vehicle increases, and that crash rates also increase as the average speed of vehicles along a roadway increases (Aarts, 2006). In an informational report regarding the methods and practices for setting speed limits, FHWA states that the research “fairly definitively indicates that, all other factors being equal, increased speeds increase crash occurrence,” (Forbes et al., 2012).

Variance of Speed

The variability of speed refers to the difference between vehicles traveling at the highest and lowest speed on a roadway. The aforementioned 1964 study by Solomon of the Bureau of Public Roads found that the probability for an individual vehicle to be involved in a crash increased as the speed of the vehicle differed from the average speed of the other vehicles on the roadway (Solomon, 1964). The speed at which involvement rate in a crash is the lowest (i.e., safest speed for an individual driver) is between the average speed and approximately 8 miles per hour higher than the average speed.

Based on these findings, the study concluded that even vehicles traveling at relatively low speeds had a higher risk of being involved in a crash compared to a vehicle traveling at a higher speed but closer to the average speed. However, this claim has since been disputed because many of the vehicles involved in crashes while traveling at relatively low speeds in Solomon’s study were slowing down to make a turning maneuver at an intersection (Elvik, 2009). The Solomon study also found that the severity of crashes increased as speed increased, especially at speeds exceeding 60 mph.

Since the Solomon study, several engineering studies have corroborated this relationship between speed variance and crash frequency. *Synthesis of Safety Research Related to Speed and Speed Management* published by the FHWA in 1998 included numerous studies that found, as Solomon did, that variance from the average speed is correlated with crash risk, though there was no evidence that extremely low speeds are correlated with higher crash risk (FHWA, 1998). The synthesis also found that changing the speed limit on low to moderate speed roads led to little to no change in safety outcomes.

Context-Sensitivity of Speed

Context-sensitive planning and design is an approach to projects that takes into account the surrounding environment and does not view the project in isolation. For setting speed limits on roadways, context-sensitivity refers to setting speeds that are appropriate for the intended use of the road (e.g., mobility, access)[5] and the environment in which the roadway is located. Traffic engineers often use the rural versus urban designation and the functional roadway classification system (i.e., arterial, collector, local street) to determine the range of speeds that are appropriate on a given roadway.

It is generally accepted that driving conditions differ between roads in rural areas and those in urban areas. *A Policy on Geometric Design of Highways and Streets* (commonly referred to as the "Green Book"), a national roadway design manual published by the American Association of State Highway and Transportation Officials (AASHTO), distinguishes between these two types of areas with respect to factors such as density and types of land use, density of street and highway networks, nature of travel patterns, and the way in which these elements are related (AASHTO, 2011). AASHTO recommends lower design speeds in urban areas and states that it is important to "limit speeds to

[5] Mobility refers to the efficient movement of people and goods, while access refers to the ability for people and goods to reach services and activities (Litman, 2008).

reduce the risk of crashes and to serve local traffic." In rural contexts, design speeds should reflect environmental and terrain conditions, and in urban contexts, design speeds should reflect additional factors, such as the spacing between signalized intersections, medians, roadside curbs and gutters, access to the street (driveways and cross-streets), pedestrian presence and adjacent development.

AASHTO further categories roadways under these urban and rural designations with the functional classification of the roadway. Functional classification divides roadways into a hierarchy of roads based on length, traffic volume, and role in the greater roadway network. The classification consists of principal arterials, minor arterials, collectors, and local roads and streets, from higher to lower classification. Higher classification roadways can accommodate higher speeds due to the roadway design (i.e., wide cross-section with multiple lanes) and their role in providing regional mobility by transporting vehicles across long distances. Lower classification roadways are designed for lower speeds because their primary role is to provide access to various destinations.

The Institute of Transportation Engineers (ITE) published a recommended practice report on context sensitivity in road design, focusing on urban areas (ITE, 2010). ITE adds additional contextual considerations for urban areas, including land use, site design and urban form (e.g., building orientation and setback, parking type and orientation, block length), building design (e.g., building height, width, scale and variety, entries), and context zones, which describe the intensity of development. ITE recommends design speeds that reflect the characteristics of and along a roadway and "emphasize multimodal safety and mobility."

Effectiveness of Speed Limits

The effectiveness of speed limits can be measured in two ways – rate of compliance and safety outcomes. Generally, rates of compliance with speed limits are low, but increasing or decreasing speed limits have effects on safety outcomes.

The 1998 FHWA synthesis of safety research regarding speed and speed management concluded that rates of compliance with speed limits are generally low, citing multiple studies showing that approximately 70 percent of drivers in a representative sample on urban and rural roads exceeded the speed limit (FHWA, 1998). A 2009 report by NHTSA found that over 50 percent of drivers on major arterials and minor arterials/collector roads exceeded the posted speed limit, and over 10 percent of drivers exceeded the speed limit by 10 mph or more on these roads (NHTSA, 2012b).

While compliance with speed limits is low, the 1998 FHWA synthesis also found that changing speed limits results in changes in operating speeds, though the effects are relatively small (FHWA, 1998). One study analyzed the effects of increasing and decreasing the speed limit based on numerous international studies. It found that the mean operating speed on a segment changed by one-fourth of the change in the posted limit, meaning that a decrease of the posted speed limit by 5 mph would result in a decrease of operating speed by 1.25 mph.

Regarding the effectiveness of speed limits and safety, the 1998 FHWA synthesis reviewed the safety outcomes of changing the speed limit based on multiple international studies and found that increases in speed limits lead to increases in crashes and decreasing speed limits lead to decreases in crashes (FHWA, 1998). In 2012, the FHWA reiterated this position by stating, “It is evident that lowering the speed limit will reduce crash risk and raising the speed limit will increase crash risk,” (Forbes et al., 2012).

A unique opportunity to study relationships between speed limits and crash rates arose when the federal government set a National Maximum Speed Limit (NMSL) of 55 mph in 1974 to reduce gasoline consumption during the 1973 oil crisis, and when it later repealed the NMSL in 1995. Special Report 204 by TRB researched the benefits and costs of the NMSL, which had been in place for 10 years at the time (TRB 1984). The report compared compliance and crash rates between 1974 and 1983 to see the long-term effects of the NMSL. It found that long-term, speeds mildly increased from 57.6 mph to 59.1 mph and the number of lives saved decreased from approximately 3,000 to 5000 fewer fatalities in 1974 to approximately 2,000 to 4,000 fewer fatalities in 1983. However, the speeds were still lower than 1973 levels and the number of lives saved was significant. As such, the report concluded that the NMSL should continue in effect for the safety improvements that result from the lower speed limit. This study was conducted mostly on rural highways. After the NMSL was repealed, TRB Special Report 254 studied the aftermath of the repeal and found that 49 states had raised speed limits on Interstate highways and other major roads (TRB, 1998). The study found that most states that had raised speed limits observed higher 85th percentile speeds and statistically significant increases in fatalities and crashes had occurred on rural Interstate highways.

In a list of countermeasures against speeding, NHTSA listed speed limits as a highly effective countermeasure, with the caveat that these limits require active enforcement to be effective (Goodwin., Thomas, Kirley, Hall, O'Brien, & Hill, 2015). NHTSA listed two enforcement tactics with varying degrees of effectiveness – automated speed enforcement (ASE) as highly effective, and high visibility enforcement as undetermined in its effectiveness. For ASE, automated cameras are installed and take photos when vehicles exceed a certain speed threshold; this can reduce crash frequency by 20 to 25 percent. For high visibility enforcement, police increase enforcement in high-crash or high-violation geographical areas. The literature on the effect of high visibility enforcement has shown varying results but are that these tactics are generally promising for reducing operating speed.

Summary

This literature review found that the United States introduced the first speed limit laws to promote safety as new roadway users began to share the roadway. By the 1950s, the 85th percentile methodology emerged as the most common method for setting speed limits for automobiles and continues to be the rule of thumb for setting the speed limit in most states.

Supporters of the 85th percentile methodology see it as a safe and fair way to set the speed limit based on the driving behavior of the majority (85 percent) of drivers that drive in a reasonable and prudent manner. Critics of the methodology disagree with setting speed limits based on existing driver behavior, claiming that it will create unsafe road conditions, especially for vulnerable roadway users like pedestrians and bicyclists. They suggest that drivers are not always reasonable and prudent, that the method would continuously cause operating speeds to increase over time, and that most of the research justifying the use of the 85th percentile rule was conducted on rural roads and therefore the method is not appropriate on urban roads.

The research on speed and safety indicates that the magnitude, variance, and context-sensitivity of speed affect safety. Compliance with speed limits is low – over 70 percent of drivers exceed the speed limit – but changes in speed limits have some effect, about 25 percent, on changes in driving speed. Speed limits can be a highly effective countermeasure to speeding and speeding-related crashes, especially with consistent enforcement using technology like ASE.

III. Methodology

This research aims to assess whether speed limit laws in California support roadway safety and to explore alternative methods that would enhance safety outcomes. To address these issues, I will answer the following questions:

1. What is the current methodology for setting speed limits in California?
2. What is the relationship between this methodology and roadway safety, particularly in urban areas?
3. Are there other approaches to setting speed limits that would improve roadway safety in California, particularly in urban areas?
   a. What have other communities done? And what does data show about their effectiveness?
   b. What efforts have been attempted to improve safety in California, and what happened? And are there current efforts?

The analysis was conducted in two parts. A qualitative approach was used to examine legislative text to determine the extent to which it incorporates safety considerations in setting speed limits. A quantitative approach analyzed data from recent speed surveys conducted by the City of Los Angeles and interpreted what this reveals about the design and effectiveness of existing policies. The final section of the analysis explored alternative speed-setting methodologies implemented in other states and countries that focus on safety and summarized the past and current legislative efforts in California to change the current methodology.

Qualitative Analysis

It is difficult to directly link specific policies and practices to safety outcomes because roadway safety is a complex issue influenced by a variety of factors in addition to roadway speed and speed limits. However, since policies set the framework for how decisions are made by local authorities and practitioners, this section evaluated whether existing policies effectively address safety, explicitly and implicitly, based on the current research.

The *California Vehicle Code* (*CVC*) and the *California Manual of Uniform Control Devices* (*CA MUTCD*) contain the laws and methodology for setting speed limits in the State of California. I analyzed these texts to assess the extent to which they incorporate known factors that influence roadway safety.[6] For example, one factor that influences roadway safety is the magnitude of speed of an individual vehicle on a roadway, which is the speed itself or how fast a vehicle is traveling. The *CVC* and *CA MUTCD* texts were analyzed to assess the extent to which they explicitly and implicitly address speed magnitude in the setting of speed limits. This section also identified what is lacking and proposed potential improvements in the laws and speed-setting methodology.

Quantitative Analysis

I also analyzed historical and current speed survey data provided by the Los Angeles Department of Transportation (LADOT). I studied speed zones to better understand how the 85th percentile speed is used to arrive at a posted speed limit and gain insight into the application of the speed limit laws. I used data from speed surveys that the City conducted in 2017 because they provide the most

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[6] The literature review identified three measures of safety in speed – magnitude, variance, and context-sensitivity of speed. Magnitude of speed measures how fast a vehicle is traveling. Variance measures how much the speeds of various vehicles on a roadway differ from one another. Context-sensitivity is whether the speed is appropriate for the roadway given its design, roadway classification, location, surrounding land uses, and other environmental factors.

recent snapshot of the high-risk corridors in the city. Of these data, I selected a subgroup of speed zones to study, because it was infeasible and unnecessary to conduct an analysis of all speed zones for over 800 miles of streets within the timeline of this research. For the analysis, I focused on speed zones for which the posted speed limits were amended (increased or decreased) as a result of the speed surveys. I chose these speed zones because a change of the posted speed limit would theoretically indicate a change in road design, operations, and/or driving behavior, which would provide insight into the application of the 85th percentile in accommodating changes on the roadway.

Alternative Methodologies

Finally, I explored policies in other states and countries that use methodologies other than the 85th percentile speed, and how safety is achieved with these methodologies. In addition, this section summarized past and current legislative efforts to change the speed-setting methodology in California.

IV. Analysis

California Methodology for Setting Speed Limits

The methodology for setting speed limits in California, based on the *California Vehicle Code* (*CVC*) and the *California Manual on Uniform Traffic Control Devices* (*CA MUTCD*), can be summarized in eight steps:

1. **Identify speed zone**
   A speed zone is a segment of a road in which a certain speed limit applies. A speed zone generally has consistent roadway conditions, roadside development, and land use. Where these conditions change, a new speed zone should be created. The speed zone should be as long and consistent as possible. They are generally at least 0.5 miles long.

2. **Conduct speed survey**
   A surveyor conducts the speed survey at locations that represent the roadside development, pedestrian and bicycle traffic, and other physical conditions of the speed zone. These locations should be at 0.25-mile intervals in urban areas, or further apart in rural areas, and either midway between signals or at least 0.2 miles away from signals. A surveyor uses radar or lidar to measure the speed of at least 100 vehicles. The surveyor should take these measurements during the daytime under free flow conditions under dry conditions and clear visibility.

3. **Determine 85**th **percentile speed**
   The 85th percentile speed, also known as the critical speed, is the speed at or under which 85 percent of the vehicles in a speed zone are driving. In a normal distribution of 100 vehicles driving at various speeds and listed in order of speed from lowest to highest, the 85th percentile speed is the speed at which the 85th vehicle is driving.

4. **Round to nearest 5-mph for posted speed limit**
   The 85th percentile speed is rounded to the nearest 5-mph increment.

5. **Reduce by 5 mph, if appropriate**
   There are circumstances under which a 5-mph reduction can be applied to the rounded speed limit. These circumstances, outlined in *CVC § 627*, include crash history, pedestrian and bicycle safety, residential density, and other highway, traffic, and roadside conditions not readily apparent to the driver.

6. **Set speed limit based on engineering and traffic survey**
   Steps 1-6 must be documented in an engineering and traffic survey (E&TS). The ET&TS must include measurements of prevailing free flow speeds, a review of collision history using data from the police department, and a review of roadside conditions. It should document compliance with *CVC § 627* and identify conditions not readily apparent to drivers. The E&TS should include a strip map (a map that shows the entire length of the segment including information such as roadway configuration, existing speed limit, and roadside zoning and development), a justification memo of the proposed speed limit, and the ordinance documenting the speed limit.

7. **Enforce speed on street**
   A traffic officer may use radar or lidar to issue speeding tickets to drivers who drive in excess of the new posted speed limit.

8. **Repeat every 5, 7, 10 years**
   The E&TS is only valid for five years until it expires, at which time it must be updated (starting at Step 1) for the speed limit to be enforceable in the speed zone. If someone receives a speeding ticket in this speed zone, they may contest the ticket and if the speed survey has expired, the ticket will be deemed invalid and the charges dismissed. This five-year period

can be extended to seven or ten years if it meets certain requirements such as up-to-date training for traffic officers and equipment.[7]

For example, the City of Los Angeles recently conducted a speed survey for a segment of Foothill Boulevard.

1. The speed zone is the segment of Foothill Boulevard between Lowell Avenue and Sunland Boulevard, approximately 3.7 miles long. Prior to the 2017 speed survey, the posted speed limit for this speed zone was 35 mph.

2. A speed survey was conducted on April 7, 2017 by a prequalified traffic engineering consultant hired by the City.

3. The survey found that the 85th percentile speed in this speed zone ranged between 43 and 46 mph, with an average critical speed of 44 mph

4. This critical speed of 44 mph was rounded to the nearest 5-mph increment of 45 mph.

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[7] The renewal period can be extended to seven years if either:

1) The original speed data were collected with radar and “the citing officer has successfully completed a minimum of 24 hours of certified radar operator course training, and the radar used to measure the speed meets or exceeds the minimal operational standards of the National Traffic Highway Safety Administration, and has been calibrated within three years of the alleged violation;” or,

2) The original speed data were collected with laser or other electronic devices (other than radar) and “the citing officer has successful completed a minimum of 24 hours of certified operator course training, the citing officer has successfully completed a minimum of 2 hours of additional approved certified training, and the device used to measure the speed meets or exceeds the minimal operational standards of the National Highway Safety Administration, and has been calirated within three years of the alleged violation.”

The renewal period can be extended to ten years if all of the conditions (for 7 years) are met and that “no significant changes in roadway or traffic conditions have occurred, including major changes in adjacent property or land use, roadway width, or traffic volume” (Caltrans, 2014).

5. The rounded critical speed of 45 mph was reduced by 5-mph based on pedestrian and bicyclist safety, since this segment is on the City's High Injury Network (HIN) and between 2012 and 2014 there were 19 collisions involving pedestrians or bicyclists on the High Injury Corridor that includes this segment of Foothill Boulevard.

6. This information was documented in an engineering and traffic survey and LADOT recommended the posted speed limit increase from 35 mph to 40 mph. The Los Angeles City Council approved these recommendations on October 12, 2017 and the new speed limit became effective on January 20, 2018.

7. Now the Los Angeles Police Department (LAPD) can enforce the new speed limit on 40 mph on this segment of Foothill Boulevard.

8. This speed limit is valid for seven years (the survey was conducted by radar by a certified data collector with up-to-date equipment) and is set to expire on January 20, 2025.

A copy of the engineering and traffic survey, which includes the speed survey and a strip map, for Foothill Boulevard is available in Appendix F.

Analysis of California Methodology

As discussed in the literature review, there are three components of speed that relate to safety – magnitude, variance, and context-sensitivity. This analysis focuses on the relevant sections of the *CVC* and the *CA MUTCD* to determine to what extent the speed limit laws consider and include each of these factors. The analysis also identifies potential improvement areas where safety can be more effectively prioritized in each of these three categories.

Table 1 shows a summary of the relevant *CVC* and *CA MUTCD* text and an analysis of how effectively safety is prioritized for each of the three categories (magnitude, variance, and context-sensitivity of speed).

Of the three components, context-sensitivity of speed was most addressed by the *CVC* and *CA MUTCD*. The methodology incorporates context-sensitivity by including considerations for prevailing speed, school zones and senior zones, and conditions that are not readily apparent to the driver such as driveways. However, despite these context-sensitive considerations, the posted speed limit is largely determined by the 85th percentile speed, with the ability to make minor adjustments (up to 5 mph) based on the context. The methodology allows for adjustments based on conditions such as pedestrian and bicycle safety, residential density, and driveways, but if all these conditions are present, the allowable adjustment is the same as if only one of the conditions were to be present.

For example, if there is a history of pedestrian and bicycle safety issues in a speed zone, the posted speed limit can be reduced by 5 mph from the 85th percentile speed; and if the speed zone has numerous driveways that may not always be visible to drivers, the posted speed limit can be reduced by 5 mph. However, if there is a history of pedestrian and bicycle safety issues *and* numerous driveways, the maximum adjustment remains 5 mph. The methodology accounts for numerous types of context-sensitive adjustments, but the total adjustment that can be made is limited to 5 mph.

The *CVC* indicates traffic engineers should consider pedestrian and bicyclist safety when setting speed limits by allowing a 5-mph reduction if there is a history of pedestrian and bicycle crashes and injuries in the speed zone. However, there is no similar adjustment for the *presence* of pedestrians and bicyclists in a speed zone. The current methodology is a reactive approach to pedestrian and bicycle safety and could be improved by developing a more proactive approach by allowing a 5-mph reduction for the presence of pedestrian and bicycle activity.

For magnitude of speed, the texts acknowledge that higher speeds are dangerous by deeming the act of exceeding 100 mph an infraction. However, the posted speed limit is still largely determined by the 85th percentile speed, which may not produce safe outcomes, especially for vulnerable users like pedestrians and bicyclists. Variance of speed was addressed the least of the three components in the *CVC* and the *CA MUTCD*. There is no direct regulation of the variance of speed by these two documents.

Overall, the current laws for setting speed limits incorporate safety by relying mostly on the 85th percentile speed and allowing for adjustments for context, though only to a limited degree. Given the National Transportation Safety Board's (NTSB's) findings (2017**)** that there is "no strong evidence" that traveling at the 85th percentile speed results in safer outcomes, California may improve roadway safety by shifting away from a speed-setting methodology that is based on the 85th percentile speed and toward a methodology that either provides greater flexibility to adjust the posted speed limit from the 85th percentile speed, or a methodology that does not rely on the 85th percentile speed at all.

Table 1. Summary of Safety Findings in CVC *and* CA MUTCD

Safety Measure	Relevant CVC and CA MUTCD Text	Analysis
Magnitude of Speed	• Speed limits should be set based on prevailing speed, or 85th percentile speed (CVC § 627). • The 85th percentile speed should be rounded to the nearest 5mph increment to determine the posted speed limit (CVC § 21400). • No matter the conditions, a vehicle driving at a speed greater than 100 mph will be guilty of an infraction (CVC § 22348). • Prevailing speeds that differ between directions should be averaged or the higher speed should be used to set the speed limit for both directions of travel (CA MUTCD § 2B.13).	The CVC and CA MUTCD acknowledge that higher speeds are dangerous but the speed limit methodology that is outlined in these documents does not allow sufficient flexibility to local jurisdictions to opt for lower speed limits when there is discretion.
Variance of Speed	• Drivers shall not drive at a speed that is slow enough to impede traffic (CVC § 22400). • Traffic engineers may time signals such that vehicles drive at similar speeds (CVC § 22401).	The CVC and the CA MUTCD do not address speed variance in laws about speed limits that would prioritize safety.
Context-Sensitivity of Speed	• The speed limit should be set based on prevailing speeds, crash history, conditions not apparent to the driver, residential density, and pedestrian and bicycle crash history (CVC § 627). • Drivers shall drive at a speed that is reasonable and prudent for the roadway (CVC §§ 22350 and 223585). • There are statutory speed limits for certain roadways such as school zones and senior zones (CVC § 22352). • Speed limits may be set lower than the statutory speed limit if the statutory speed limit is more than reasonable or safe (CVC §§ 22354-22360). • Speed limits may be set higher than the statutory speed limit if the proposed speed limit reasonable and safe and if the higher speed limit facilitates movement of traffic (CVC §§ 22356-22357). • A five-mph reduction may be applied to the rounded 85th percentile speed if there are conditions not readily apparent to the driver (CA MUTCD § 2B.13).	Context sensitivity is included in several ways throughout the CVC and the CA MUTCD, but there are potential areas of improvement that would better accommodate the context of urban areas. Urban areas have more roadway activity and more considerations "not readily apparent to the driver," such as pedestrians, bicyclists, signals, parked vehicles, driveways, and transit vehicles. These considerations are not explicitly included in the CVC and CA MUTCD and improvements could be made so that these laws can be applied in an appropriate manner in urban areas.

California Methodology in Practice in Los Angeles

Using data and practices of the City of Los Angeles as examples, this section includes analysis of the application of the current methodology for setting speed limits in California and a discussion of the implications for the effectiveness of current policies in prioritizing safety. The City of Los Angeles ranks first among California cities in area, population, miles of roads, and daily vehicle miles of travel (State of California, DOF, 2018; Caltrans, 2016). The diversity of the geography, the demographics, and types of roads in Los Angeles likely reflect the diversity found among other cities in the state and the findings likely represent what would be found in many of the other cities in California.

Finding 1: Speed Limits are based on a non-normal distribution of vehicle speeds

Statistically, the concept of the 85th percentile is based on a normal distribution of vehicle speeds. However, traffic is often not normally distributed. For example, Hubbard Street[8] is a street in Los Angeles with segments that are part of the city's HIN due to a history of pedestrian and bicycle collisions. In 2016, the posted speed limit was 35 mph. In February 2017, the City of Los Angeles conducted a speed survey and the distribution of the individual vehicle speeds is shown in in Figure 1. The distribution of vehicles speeds on Hubbard Street is not normal; it is skewed left.

[8] This section is located in the Sylmar neighborhood of the San Fernando Valley.

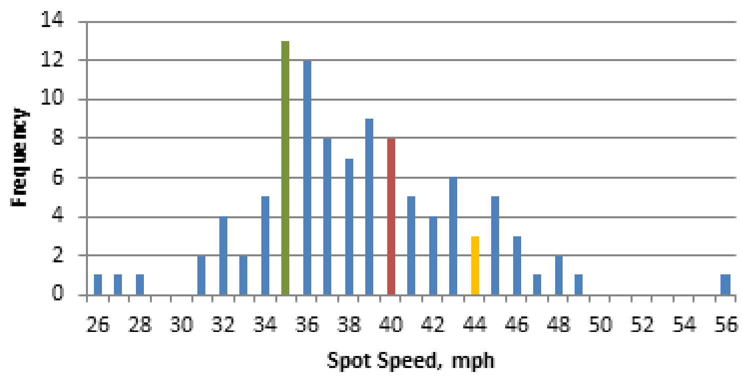

Figure 1. Frequency Distribution of Speeds along Hubbard Street.

The speed survey shows that the 85th percentile speed was 44 mph (shown in gold). Based on the current methodology for setting speed limits, the City rounded the 44-mph critical speed to the nearest 5-mph increment, which was 45 mph. Then the City applied a 5-mph reduction based on its history of pedestrian and bicycle crashes and proposed the new posted speed limit of 40 mph (shown in red). This is 5 mph higher than the previous speed limit of 35 mph (shown in green), and also the speed at which the greatest number of vehicles was traveling (the mode). The speed survey for Hubbard Street appears in Appendix G.

This example highlights how the application of the 85th percentile methodology assumes a normal distribution of vehicle speeds even in cases when the distribution is skewed. Supporters of the 85th percentile methodology claim that the methodology considers the behavior of vehicles (emphasis on the plural) on a roadway. But in reality, the 85th percentile speed methodology only addresses the speed of one vehicle - the 85th percentile vehicle - while ignoring the speed of all other vehicles. An 85th percentile speed of 40 mph does not reveal the speeds of the other vehicles. The vehicles within the first 84 percent of vehicles could be evenly distributed, or they may all be operating below 30 mph (significantly lower than the 85th percentile speed), but the 85th percentile speed would be 40 mph in both cases. A more informative measure of the speed distribution could be “pace,” which is the 10 mph increment in which the most number of vehicles are driving (Schroeder et al., 2010). Instead of the 85th percentile speed which alone cannot describe the distribution of most vehicles, the pace would provide a range in which the most number of vehicles are driving.

Finding #2: Speed surveys include limited speed data

The Los Angeles Department of Transportation (LADOT) is responsible for maintaining up-to-date speed surveys for thousands of miles of streets. Because of this major responsibility, the city has simplified its data collection process so that speed data is only collected at one location on one day instead of in multiple locations on multiple days, as they have done historically. For example, the recent survey on Balboa Boulevard between Rinaldi Street and Victory Boulevard[9] shows that data was collected on one day (1/30/2017) at one unspecified location between Rinaldi Street and Victory Boulevard, whereas the previous speed survey conducted in 1997 collected data at 11 locations in this speed zone and averaged the 85th percentile speeds.

With this simplified data collection process, the new speed surveys do not account for traffic flow at a given location varying from day to day, influenced by factors such as weather, special events, and unexpected incidents (i.e., crashes). A 2007 report by NHTSA (2012a) finds that 85th percentile speeds can differ by day of week by almost 5 mph on major arterials and almost 10 mph on minor arterials, as shown in Figure 2.

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[9] This section is located in the Granada Hills neighborhood of the San Fernando Valley.

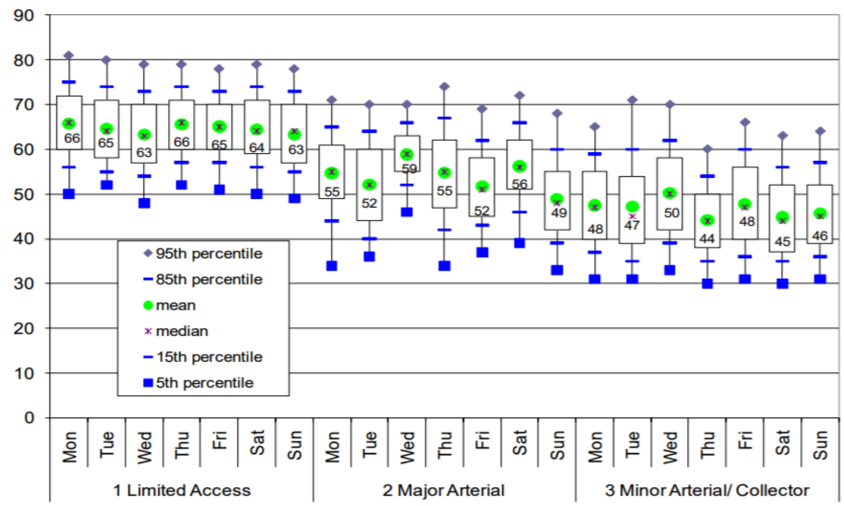

Figure 2. Speed by Road Type and Day of Week (NHTSA, 2012a).

This variability of speed across days of the week means that the 85th percentile speed measured at one location on one day may be up to 10 mph higher or lower than one measured the next day. Given the current practice of establishing the 85th percentile speed based on one day of measurements in the City of Los Angeles, the posted speed limit may not reflect the most typical day for speeds along the corridor, yet these speed limits stay in effect for five years or longer. If a local authority sets the speed limit based on the 85th percentile speed, it should collect data on multiple days to find an 85th percentile speed that is reflective of traffic conditions throughout the week. Improved data collection technologies, such as Bluetooth or GPS, would allow transportation departments to collect data continuously instead of during certain periods of the day.

Finding #3: Operating speeds are increasing on LA streets - But why?

As discussed in the introduction, the new speed surveys conducted on 825 miles of streets in Los Angeles in 2017 resulted in increased speed limits on 23 speed zones (89 miles of streets) and in decreased speed limits on 45 speed zones (52 miles of streets). Table 2 shows the 23 speed zones where the speed limits were increased and Table 3 shows the 45 speed zones where the speed limits were decreased.

Table 2. Speed Zones where Speed Limits Increased in Los Angeles in 2017.

				Previous Speed Limit			2017 New Speed Limit				
Number	Segment ID No.	Segment	Length (miles)	Year of Study	85% Speed[1]	Speed Limit	85% Speed	Speed Limit	5-mph reduction	Reason for reduction	Change in 85% Speed[2]
1	64.3	Balboa Bl bw Rinaldi St and Victory Bl	6.4	1997	40-45	**35**	46	**40**	Yes	Pedestrian and Bicyclist Safety	+4
2	91.2	Broadway bw Manchester Av and CL s/o 120th St	2.54	2009	38-42	**53**	46	**40**	Yes	Not Readily Apparent Conditions, Pedestrian and Bicyclist Safety	+6
3	37.1	Burbank Bl bw CL at Clybourn Av and San Diego Fwy	6.2	1999	33-43	**35**	44	**40**	Yes	Pedestrian and Bicyclist Safety	+6
4	117	Central Av bw Florence Av and CL s/o 120th St	3.6	2006	37-40	**35**	43	**40**	Yes	Pedestrian and Bicyclist Safety	+5
5	123.1	Chandler Bl bw Lankershim Bl and Coldwater Cyn Av	2.1	2002	37-43	**35**	45	**40**	Yes	Pedestrian and Bicyclist Safety	+5
6	205.1	Foothill Bl bw Lowell Av and Sunland Bl	3.7	2003	38-40	**35**	44	**40**	Yes	Pedestrian and Bicyclist Safety	+5
7	225.3	Glenoaks Bl bw Osborne St and Hollywood Wy	4.7	2002	46-52	**45**	56	**50**	Yes	Not Readily Apparent Conditions, Pedestrian and Bicyclist Safety	+7
8	261.2	Hubbard St bw Foothill Bl and Laurel Cyn Bl	2.15	2007	37-39	**35**	44	**40**	Yes	Pedestrian and Bicyclist Safety	+6
9	281.1	La Tijera Bl bw La Cienega Bl and 74th St	0.77	2009	39-42	**40**	44	**40**	Yes	Rounding down instead of up, Pedestrian and Bicyclist Safety	+4
10	369.2	Osborne St bw Foothill Bl and San Fernando Rd	1.7	2007	41-48	**40**	49	**45**	Yes	Pedestrian and Bicyclist Safety	+5
11	369.3	Osborne St bw San Fernando Rd and Woodman Av	2.2	2007	37-42	**35**	44	**40**	Yes	Pedestrian and Bicyclist Safety	+5
12	374	Oxnard St bw Clybourn St and Sepulveda Bl	5.8	2007	36-42	**35**	47	**40**	Yes	Pedestrian and Bicyclist Safety	+8
13	407.1	Rodeo Rd bw Exposition Bl and La Brea Av	2.46	2009	32-40	**35**	43	**40**	Yes	Pedestrian and Bicyclist Safety	+7
14	418.1	San Fernando Rd (SW Roadway) between Fox St and Clybourn Av	6	1998	36-43	**35**	47	**40**	Yes	Not Readily Apparent Conditions, Pedestrian and Bicyclist Safety	+8
15	431.3	Sawtelle Bl bw Pico Bl and Palms Bl	1.2	2001	39-44	**35**	44.5	**40**	Yes	Pedestrian and Bicyclist Safety	+3
16	434.2	Sepulveda Bl bw Plummer St and Valley Vista Bl	6.5	2003	40	**40**	44	**40**	Yes	Pedestrian and Bicyclist Safety	+4
17	441.3	Sherman Way bw Shoup Av and Platt Av	1.5	1998	42-48	**35**	44	**40**	Yes	Pedestrian and Bicyclist Safety	-1
18	494	Vanowen St bw Haskell Av and Valley Circle Bl	10.4	2001	37-44	**35**	47	**40**	Yes	Not Readily Apparent Conditions, Pedestrian and Bicyclist Safety	+8
19	497.3	Venice Bl bw Cadillac Av and Crenshaw Bl	2.8	1999	39-46	**35**	44	**40**	Yes	Pedestrian and Bicyclist Safety	+2
20	506.1	Victory Bl bw CL e/o Clybourn Av and San Diego Fwy	6.6	2007	35-42	**35**	44	**40**	Yes	Pedestrian and Bicyclist Safety	+6
21	507.3	Vineland Av bw Stagg St and Chandler Bl	3	2009	28-36	**30/35**	44	**40**	Yes	Pedestrian and Bicyclist Safety	+12
22	534.1	Whitsett Av bw Roscoe Bl and Riverside Dr	4.4	1995	36-43	**35**	45.5	**40**	Yes	Pedestrian and Bicyclist Safety	+6
23	557.2	Zelzah Av bw Chatsworth St and Nordhoff St	2	2008	41	**40**	48	**45**	Yes	Pedestrian and Bicyclist Safety	+7

Source: The Los Angeles Department of Transportation provided me this data in the form of engineering and traffic surveys.

[1] The historical speed surveys presented the 85th percentile speed as a range, rather than as an average of 85th percentile speeds collected at various points along the corridor, which is what surveys do today.

[2] I calculated the change in 85th percentile speed by subtracting the average 85th percentile speed of the previous speed surveys from the 85th percentile speed of the new speed surveys from 2017.

Table 3. Speed Zones where Speed Limits Decreased in Los Angeles in 2017.

Number	Segment ID No.	Segment	Length (miles)	Previous Speed Limit: Year of Study	Previous Speed Limit: 85% Speed	Previous Speed Limit: Speed Limit	2017 New Speed Limit: 85% Speed	2017 New Speed Limit: Speed Limit	2017 New Speed Limit: 5-mph reduction	2017 New Speed Limit: Reason for reduction	Change in 85% Speed[5]
1	7.2	7th St bw Vermont Av and Catalina St	0.2	1991	30-41	**30**	24.5	20	**Yes**	Rounding down instead of up	-11.0
2	8.2	8th St bw Irolo St and Lucerne Bl	1.4	2004	32-35	**35**	37	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	+3.5
3	16.2	54th St bw Western Av and Crenshaw Bl	1.2	2007	36-40	**35**	37.5	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-0.5
4	34	Alexandria Av bw Santa Monica Bl and Melrose Av	0.5	1997	37-39	**30**	28	25	**Yes**	Rounding down instead of up	-10.0
5	36.1	Alla Rd bw CL s/o Washington Bl and Maxella Av	0.43	2008	28	**30**	31	25	**Yes**	Accidents, Pedestrian and Bicyclist Safety	+3.0
6	40.2	Alma St bw 27th St and 37th St	0.5	2005	38	**35**	34	30	**Yes**	Rounding down instead of up, Accidents, Pedestrian and Bicyclist Safety	-4.0
7	54	Avalon Bl bw Manchester Av and Imperial Hwy	2	2009	37-40	**35**	37	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-1.5
8	56	Ave 26 bw Pasadena Av and SF Rd	0.9	2011	36-38	**35**	36.5	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-0.5
9	58	Ave 36 bw Eagle Rock Bl and Fletcher Dr	0.1	2009	36-38	**35**	35.5	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-1.5
10	140	Colden Av bw Clovis Av and Vermont Av	2	2007	34-37	**30**	26	20	**Yes**	Accidents	-9.5
11	144.1	Coliseum St bw Rodeo Rd and Hauser Bl	2.4	1999	32-40	**35**	36	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	0.0
12	147	Commonwealth Av bw Beverly Bl and Wilshire Bl	0.8	2002	32-36	**30**	31	25	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-3.0
13	155	Coronado St bw Sunset Bl and Temple St	0.6	2005	32	**30**	28.5	25	**Yes**	Rounding down instead of up, Accidents, Pedestrian and Bicyclist Safety	-3.5
14	158	Crescent Av bw Beacon St and 21st St	0.38	2003	27-31	**30**	26	20	**Yes**	Accidents	-3.0
15	171	Del Moreno Dr bw Ventura Bl and Wells Dr	0.8	Unknown[1]	40-43	**30**	29	25	**Yes**	Rounding down instead of up, Accidents, Pedestrian and Bicyclist Safety	-12.5
16	176	Dodson Av bw 9th St and Western Av	0.56	2011	26-28	**30**	28	25	**Yes**	Rounding down instead of up	+1.0
17	188	Electra Dr bw Mt Olympus Dr and Hercules Dr	0.3	1993	36-41	**30**	Local[3]	25	**Local**	Rezoned to Local	N/A
18	202	Fletcher Dr bw Ave 36 and SF Dr	0.7	2009	36-38	**35**	35.5	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-1.5
19	205.5	Foothill Bl bw Clybourn Av and Van Nuys Bl	1.9	2003	45-47	**45**	45	40	**Yes**	Pedestrian and Bicyclist Safety	-1.0
20	225.2	Glenoaks Bl bw Van Nuys Bl and Osborne St	0.83	2000	37-45	**40**	41	35	**Yes**	Not Readily Apparent Conditions, Pedestrian and Bicyclist Safety	0.0
21	242.4	Hauser Bl bw Washington Bl and Jefferson Bl	0.9	Missing[2]	Missing[2]	**30**	32	25	**Yes**	Accidents	N/A
22	249	Hercules Dr bw Apollo Dr and Electra Dr	0.43	2000	33-37	**30**	Local[3]	25	**Local**	Rezoned to Local	N/A
23	254	Hillhurst Av bw Los Feliz Bl and Hollywood Bl	0.9	2004	36-38	**35**	35.5	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-1.5
24	256.3	Hollywood Bl bw La Brea Ave and Laurel Canyon Bl	1.2	2006	32-38	**35**	34	30	**Yes**	Rounding down instead of up, Pedestrian and Bicyclist Safety	-1.0
25	260	Hoover St bw Manchester Av and El Segundo Bl	3	2001	37-40	**35**	36	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-2.5
26	263	Huston St bw Hazeltine Av and Cedros Av	0.75	2003	30-33	**30**	29	25	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-2.5
27	278	La Brea Av bw CL at Romaine St and Olympic Bl	2.2	2007	33-37	**35**	33.5	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	-1.5
28	336.3	Motor Av bw Manning Av and CL s/o Venice	1.2	2001	36-41	**35**	34.5	30	**Yes**	Rounding down instead of up	-4.0

Number	Segment ID No.	Segment	Length (miles)	Previous Speed Limit: Year of Study	Previous Speed Limit: 85% Speed	Previous Speed Limit: Speed Limit	2017 New Speed Limit: 85% Speed	2017 New Speed Limit: Speed Limit	2017 New Speed Limit: 5-mph reduction	2017 New Speed Limit: Reason for reduction	Change in 85% Speed[5]
		Bl									
29	346	Neptune Av bw Lomita Bl and C St	1.83	2004	33-36	**30**	30	25	**Yes**	Accidents	-4.5
30	369.1	Osborne St bw Foothill Bl and CL n/o Garrick Av	0.6	2002	44-45	**35**	36	30	**Yes**	Pedestrian and Bicyclist Safety	-8.5
31	385.3	Parthenia St bw Lindley Av and Tampa Av	1.5	2007	36-41	**40**	42	35	**Yes**	Not Readily Apparent Conditions	+3.5
32	401.1	Reseda Bl bw Sesnon Bl and Rinaldi St	1.6	2008	48-51	**50**	51.5	45	**Yes**	Accidents	+2.0
33	431.2	Sawtelle Bl bw Olympic Bl and PIco Bl	1.3	2008	25-26	**35**	33	30	**Yes**	Accidents, Pedestrian and Bicyclist Safety	+7.5
34	464	Sunset Bl bw Virgil Av and Crescent Heights Bl	4.5	2004	28-37	**35**	33	30	**Yes**	Not Readily Apparent Conditions, Pedestrian and Bicyclist Safety	+0.5
35	471	Thurman Av bw Venice Bl and Washington Bl	0.5	Missing[2]	Missing[2]	**35**	34.5	30	**Yes**	Accidents	N/A
36	474.1	Townsend Av bw Hill Dr and Colorado Bl	0.35	2001	33-34	**30**	28	25	**Yes**	Rounding down instead of up	-5.5
37	501.3	Vermont Av bw Hollywood Bl and Clinton St	1.3	Missing[2]	Missing[2]	**35**	33	30	**Yes**	Rounding down instead of up, Accidents, Pedestrian and Bicyclist Safety	N/A
38	501.4	Vermont Av bw Clinton St and Oakwood Av	0.3	Missing[2]	Missing[2]	**35**	33	30	**Yes**	Rounding down instead of up, Accidents, Pedestrian and Bicyclist Safety	N/A
39	501.5	Vermont Av bw Oakwood Av and Beverly Bl	0.1	Missing[2]	Missing[2]	**35**	33	30	**Yes**	Rounding down instead of up, Accidents, Pedestrian and Bicyclist Safety	N/A
40	501.6	Vermont Av bw Beverly Bl and Olympic Bl	1.6	Missing[2]	Missing[2]	**35**	33	30	**Yes**	Rounding down instead of up, Accidents, Pedestrian and Bicyclist Safety	N/A
41	502	Vernon Av bw Alameda St and CL w/o Crenshaw Bl	5.2	2008	33-37	**35**	36	30	**Yes**	Accidents, Not Readily Apparent Conditions, Pedestrian and Bicyclist Safety	+1.0
42	504	Via Dolce bw Washington Bl and CL w/o Marquesas Wy	0.4	2005	36	**35**	36.5	30	**Yes**	Accidents	+0.5
43	507.1	Vineland Av bw SF Rd and Lorne St	0.16	2009	28	**30**	29	25	**Yes**	Rounding down instead of up	+1.0
44	548	Woodley Av bw Magnolia Bl and Ventura Bl	0.59	2002	30-31	**30**	29	25	**Yes**	Rounding down instead of up, Pedestrian and Bicyclist Safety	-1.5
45	553	York Bl bw CL e/o San Pascual Av and Eagle Rock Bl	2.72	2007	33-39	**35**	30	30	**No[4]**	Pedestrian and Bicyclist Safety	-6.0

Source: The Los Angeles Department of Transportation provided me this data in the form of engineering and traffic surveys.

[1] The study did not provide a date.

[2] I could not find historical studies for these segments.

[3] Local means these streets were designated a "local" street. Local streets have a maximum speed limit of 25 mph based on CVC § 2232.(b).(1). The 85th percentile methodology does not apply to local streets when setting speed limits.

[4] The study says that the speed limit "rounded down" to 30 mph based on pedestrian and bicycle safety, but it did not actually round down because the 85th percentile speed was 30 mph.

[5] I calculated the change in 85th percentile speed by subtracting the average 85th percentile speed of the previous speed surveys from the 85th percentile speed of the new speed surveys from 2017.

All but one of the 23 speed zones where speed limits increased experienced an increase in 85th percentile speed compared to the previous speed surveys, which were conducted between 1995 and 2009 . A comparison of aerial images of these corridors between the late 1990s and today shows that very little has changed along these corridors in 20 years in terms of roadway configuration or roadside development. Figure 3 and Figure 4 are images of Oxnard Street at Cahuenga Boulevard in 2007 and in 2018.[10] This segment is in a speed zone where critical speeds rose from a range of 36 to 42 mph in 2007 to 47 mph in 2018, or an increase of 5 to 11 mph.

Figure 3. Oxnard Street, 2007.

Figure 4. Oxnard Street, 2018.

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[10] This section is located in the eastern part of the San Fernando Valley.

Speeds increased even in some speed zones where the speed limits were decreased. Of the 45 speed zones in which the speed limit was decreased in 2017, 10 of them experienced increases in operating speeds since the previous speed survey. This is due to the 5-mph reduction in the speed setting methodology. For speed zones where the operating speeds increased, the City applied the 5-mph reduction where they previously had not applied this reduction. For example, the critical speed along 8th Street between Irolo Street and Lucerne Boulevard[11] increased from a range of 32 to 35 mph in 2004 to 37 mph in 2017. In 2004, the posted speed limit was set at 35 mph, and in 2017 the posted speed limit was decreased to 30 mph because the 5-mph reduction was applied because of its crash history.

A potential reason for this increase in critical speeds may be lack of enforcement. The streets on which the city is updating the posted speed limits are streets on which the posted speed limits were unenforceable by law enforcement because the speed surveys had expired. With no enforcement of speeding on these streets, drivers may have noticed the absence of traffic enforcement officers and felt comfortable driving well above the speed limit without fear of consequences, leading to an overall increase in speed.

Finding #4: Overused Discretion - The 5-MPH Reduction

The 5-mph reduction to the rounded 85th percentile speed is intended to provide flexibility for traffic engineers to set speed limits that are context-appropriate. The 5-mph reduction is justified by an engineering and traffic survey, which per *CVC § 627* must include information such as prevailing speeds, collision history, residential density, pedestrian and bicycle safety, and roadside conditions not readily apparent to the driver. Urban areas generally have all these factors. The

[11] This section is located in central Los Angeles in the Koreatown neighborhood.

5-mph reduction effectively becomes an “urban factor” that can be almost uniformly applied to most streets in a city.

Recent speed surveys in the City of Los Angeles show that the 5-mph reduction is applied in almost every speed survey. All but one of the 45 speed zones where the city decreased the speed limits[12] applied the 5-mph reduction (see Table 3), and all of the 23 speed zones where the speed limits were increased applied the 5-mph reduction (see Table 2). These reductions were mostly justified by collision history and concern for pedestrian and bicyclist safety.

The data highlight the unique nature of urban streets and bring into question the purpose of the discretionary 5-mph reduction when it is universally applied. Urban areas clearly have different requirements than rural areas when setting speed limits and the methodology should address this need in a more direct way than the overuse of a discretionary tool, such as by providing an explicit urban reduction factor.

Conclusion

This case study highlights the shortcomings of the current methodology for setting speed limits in California, particularly in urban areas like Los Angeles. The non-normal distribution of traffic flow and increasing operating speeds illustrate the challenges of using the 85th percentile for setting speed limits in California. Moreover, the practice of using a single day of data and the overused discretion of the 5-mph reduction in the City of Los Angeles indicate the lack of representative data to set appropriate speed limits when applying the 85th percentile methodology in urban areas.

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[12] The City converted two of these 45 speed zones to the “local street” designation, which has a maximum speed limit of 25 mph according to CVC § 22352.(b).(1). and where the 85th percentile method is not applicable.

The 85th percentile methodology sets speed limits based on the behavior of drivers, with slight adjustments for urban factors that are perceived to be related to safety. However, the data from Los Angeles suggest that a new methodology may be needed given the gradual increase of speeds and the evolving nature of urban environments over the last 70 years.

V. Potential Alternative Speed Limit Setting Procedures

The previous analysis highlighted how the California methodology for setting speed limits is not appropriate for urban areas. Cities in California need greater authority in order to set speed limits that are safe for all roadway users. This section explores alternative speed limit methodologies employed by other states and countries and summarizes recent legislative efforts in California to change the speed limit laws.

Alternate Methods

While California's use of the 85th percentile methodology is consistent with most states, there are states that rely less on the operating speed and prioritize safety by allowing greater local control, particularly in urban areas. In addition, other countries like Sweden take an entirely different approach to setting speed limits in the name of safety.

Examples from Other States

Washington, Oregon, New York, and Massachusetts have granted cities the authority to develop their own methodology for setting speed limits. Seattle and Portland have explored alternative methods to setting speed limits that are not based on the 85th percentile rule.

Washington

Seattle set default speed limits for arterial streets and non-arterial streets (i.e., collectors and local streets) in the city. Recognizing that consistency may improve compliance with speed limits, the City of Seattle informs those entering its boundaries that the default speed limits apply unless a different limit is posted (Figure 5).

Figure 5. Gateway Sign (Mah, 2016).

In the *Revised Code of Washington* (*RCW*), the State of Washington specifies maximum speed limits that apply on certain types of streets: 25 mph on city and town streets, 50 mph on county roads, and 60 mph on state highways (Washington State Legislature, 2018). However, it also allows local jurisdictions to override these maximum speed limits and set the speed limits on streets within their jurisdictions. The *RCW* grants local authorities in their respective jurisdictions to determine the maximum speed limit[13] on arterial streets by an "engineering and traffic investigation," and to establish the maximum speed limit of non-arterial streets within a residence district or business district at 20 mph,[14] which does not require an engineering and traffic investigation.

With the power granted to local jurisdictions by the state, the City of Seattle set default arterial and non-arterial speed limits, which are stated in the *Seattle Municipal Code* (*SMC*). Prior to 2016, the default arterial speed limit was 30 mph and the default non-arterial speed limit was 25 mph. In 2016, the city passed an ordinance to reduce the default arterial and non-arterial speed limits to 25 mph and 20 mph, respectively (Mah, 2016; City of Seattle, 2016). Seattle adopted its Vision Zero program in 2015 and the Seattle Department of Transportation

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[13] This maximum speed limit cannot exceed 60 mph.

[14] This local authority to set speed limits on non-arterial streets was the result of the 2013 Neighborhood Safe Streets Law in the state, which authorized municipalities to lower speed limits on non-arterial streets to 20 mph (Washington State Legislature, 2013).

(SDOT) cited safety as the main reason for the change in the speed limit. In a study justifying the reduction of the speed limits, SDOT explained that prior to the ordinance, they changed the signal timing on over 300 signals in the downtown area and were able to reduce operating speeds on these streets to 20-23 mph (where the default speed limit decreased from 30 mph to 25 mph) (SDOT, 2016).

Oregon

Oregon, like California, requires posted speed limits in the state to be set using the 85th percentile methodology (Oregon Department of Transportation [ODOT], 2014). However, the Portland Bureau of Transportation (PBOT) requested to be allowed to set speed limits using an alternative method that would "place[] greater emphasis on vulnerable users and the risk of a future crash." PBOT justified the request noting, "the 85th percentile method is not supported by evidence and is not part of PBOT practice" (PBOT, 2018). In October 2016, PBOT obtained permission from ODOT to test an alternative method to set speed limits, based on a law in the Oregon Administration Rule (OAR) Section 734-020-0015(3) that allows the City of Portland to propose an "experimental alternative investigation to replace the standard engineering study" (Pappe, 2016; Oregon State Legislature, 2018).

Under the alternative process, the following speed limits apply in Portland (PBOT, 2018):

- 40 mph maximum on streets without a center median barrier and edge clear zone, and where people walking and biking are physically protected.
- 30 mph maximum on streets with busy intersections experiencing high crashes, on streets with sidewalks or shoulders next to travel lanes, and on streets with bike lanes next to motor vehicle lanes.
- 20 mph maximum on shared space streets (driving, biking, and walking) that do not meet school, business, or neighborhood greenways statute for 20 mph.

ODOT granted Portland a four-year trial period[15] for this alternate methodology, and PBOT must produce an evaluation report at the end of the four-year period, focusing primarily on changes in the number of injury and fatal crashes on streets where the alternative method was used to set the speed limit. The four-year period will end at the end of 2018, at which time the merits of this program and its applicability to other cities like Los Angeles may become clear.

The new methodology does not apply to federally classified arterial streets and highways, as stated in law, or on any other streets with speed limits below 25 mph. For residential streets, a 20-mph speed limit for Portland was approved by the Portland City Council on January 17, 2018, and took effect on April 1, 2018 (PBOT, n.d.). Residential streets account for approximately 70 percent of Portland's street network, and this new policy is part of Portland's Vision Zero program.

International Example

Countries on the forefront of global roadway safety, including Sweden, the Netherlands, and Norway, are implementing speed setting methodologies that prioritize safety above efficiency and cost (Forbes et al., 2012). Known as the injury minimization or safe systems approach, this method was founded on the belief that it is unethical to allow speeds that may result in death or serious injury. These countries set speed limits based on the types of crashes likely to occur on a road and the impact that these types of crashes can have on the human body.

Sweden

Sweden is a global leader in roadway safety. In 1997, it launched Vision Zero, a program designed to reduce roadway fatalities to zero (Vision Zero Initiative,

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[15] OAR 734-020-0015(3) allows the City of Portland to propose a two-year program, but since there is a lag in the availability of crash data, ODOT and the City of Portland agreed to extend the trial period from two years to four years (Pappe, 2018).

n.d.). Since the introduction of this program, Sweden has reduced the number of roadway fatalities from 591 in 2000 to 260 in 2013 (Government Offices of Sweden, 2016). Sweden recognized that vehicle speeds had a large impact on roadway safety, and researchers developed the injury minimization approach for setting speed limits (Tingvall & Howarth, 1999). This approach acknowledges that crashes are caused by a multitude of factors (only one of which is speed) and are difficult to eliminate completely, but that speed can determine the severity of injury associated with the crash. With the goal of minimizing severe injuries and fatalities, the approach assesses the most common crash types on certain road types and determines speed limits that would result in no severe fatalities in the event of a crash.

Tingvall and Howarth (1999) calculated the appropriate speed limit for different road types using the injury minimization method, and these values are presented in Table 4.

Table 4. Speed Limits for Injury Minimization (Forbes et al., 2012).

Road type	Speed Limit, mph (km/h)
Roads with a mix of motorized and unprotected road users (i.e., pedestrians and cyclists)	20 (30)
Roads with uncontrolled access where side impact crashes can result	30 (50)
Undivided roads where head-on crashes can result	45 (70)
Controlled access facilities with a physical median separation, where at-grade access and non-motorized road users are prohibited	>60 (>100)

For example, streets with pedestrian traffic would have a speed limit at a speed at which a pedestrian could get hit but survive without serious injury (20 mph). Streets having no pedestrians and that are undivided between the two directions of travel have a risk of head-on collisions and thus would lead to a speed limit at which a driver or passenger involved in a head-on collision would survive (45 mph).

Sweden updated its speed limits in 2008 based on the principles of injury minimization (Swedish Road Administration, 2009). Between 2008 and 2009, the

Swedish Transport Administration (Trafikverket) changed the speed limit on approximately 20,500 km of roads. On 2,700 km of roads the limit increased and on 17,800 km the limit decreased. A study of the traffic safety effects of the new speed limits between 2008 and 2013 found that driver compliance with speed limit changes was approximately 25 percent (Vandeby & Forsman, 2018). Researchers found that a 10 km/h decrease in speed limits led to a decrease of mean speeds of 2 to 3 km/h and that a 10 km/h increase in speed limits led to an increase of mean speeds of 3 km/h. This is consistent with the literature on speed limit compliance (Federal Highway Administration [FHWA], 1998). They found that overall, 17 lives per year were saved because of these changes in speed limits. There was no significant change in the number of serious injuries. The authors proposed combining speed limit changes with other measures, such as speed cameras, to obtain larger safety reductions.

Applicability in California

California should develop a new process for setting speed limits informed by recent experience in Washington, Oregon, and Sweden. The case studies in Washington and Oregon suggest that urban areas are complex and setting speed limits at the local level may result in speed limits that are more appropriate for specific contexts, as opposed to applying the 85th percentile methodology as a one-size-fits-all. The Swedish example provides insight into a completely different approach to setting speed limits by focusing on minimizing the potential for fatalities and severe injuries in the event of a collision.

Like Washington, California could grant speed setting powers to local governments, and could provide separate maximum speed limits for cities and towns as opposed to rural areas. For cities like Los Angeles, this would prevent the posting of high speed limits (Los Angeles currently has speed limits as high as 55 mph)[16] and allow city engineers to determine the speed limits that are appropriate for their streets, given their knowledge and experience.

California state legislators could also work with interested cities to establish a pilot project that would set speed limits that are specific to certain cities, like Portland's experimental alternative speed zone investigation method. The City of Los Angeles adopted a resolution in February 2018 to announce its support for "legislation and/or administrative action that would increase local control of speed limit setting and enforcement," and would be a potential candidate for such a pilot project. If the pilot project is successful, the state may choose to expand the program to other cities.[17]

California could also follow Sweden and adopt the injury minimization approach. Generally, speed limits with the injury minimization approach (Table 4) are lower than those used in the United States for comparable road types. In an informational report about the methods and practices for setting speed limits, the FHWA claims that this approach would be "problematic" since it would set speed limits lower than the 85th percentile speed and would not be feasible in the United States (Forbes et al., 2012). It states "[t]he road authority cannot simply lower the speed limit and expect immediate or substantial compliance. Drivers are unlikely to fully respond except in the face of almost constant enforcement."

Enforcement is a significant issue in speed limit compliance in the United States. The National Transportation Safety Board (NTSB) interviewed enforcement officers nationwide and found that the challenges associated with enforcing speed limits are lack of resources (e.g., number of officers, time that officers can dedicate to speed limit enforcement among their numerous enforcement

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[16] Pershing Drive between Westchester and Imperial Highway, located along the western border of LAX, has a posted speed limit of 55 mph, though this speed limit is currently unenforceable because the speed survey expired.

[17] This would require additional legislative action.

obligations) and the cost of enforcement (e.g., costs of equipment, data processing systems, court time, staffing) (NTSB, 2017). Given these challenges, the NTSB recommended that states and local jurisdictions employ automated speed enforcement (ASE) to encourage speed limit compliance. ASE combines a vehicle speed detection system and a camera to identify speeding drivers, and has many advantages over current enforcement practices: it reduces the cost of enforcement because fewer enforcement officers are needed (enforcement officers would be needed to review the video footage to confirm that the vehicles were speeding); it enables enforcement in locations that would be difficult or dangerous for traffic stops; and it has a high rate of speeding detection[18] which may have a deterrence effect future speeding. Most of the countries that use the injury minimization method also employ ASE. If California were to adopt the injury minimization approach, it would be optimal to also adopt automated speed enforcement,[19] as recommended by the NTSB.

All of these changes would require legislative action to change the *California Vehicle Code* (*CVC*) and the *California Manual on Uniform Traffic Control Device* (*CA MUTCD*), per *CVC § 21400*.

Legislative Proposals for Change in California

In California, the speed-setting methodology has not changed significantly since 1996 when local jurisdictions set speed limits at the 5-mph increment below the 85th percentile speed. The methodology was changed in 2000, 2003, 2004, 2009, and 2011, but these changes primarily focused on whether the 85th

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[18] According to FHWA and NHTSA (2008), ASE units can “detect and record multiple violations per minute,” and that this high rate of detection is “likely to increase drivers’ perceived risk of being caught, and therefore increase the deterrence of speeding behavior.”

[19] ASE is not without complications or problems. It has been challenged on several constitutional grounds in the United States (NTSB, 2017). ASE should be thoroughly studied by the California Legislature before adoption to ensure that there is sufficient outreach to stakeholders, many of whom may oppose ASE, and its adoption is consistent with best practices.

percentile should be rounded up or down to arrive at the posted speed limit. There have been several additional attempts to change the methodology in California, detailed below.

Senate Bill 848 (2007)

In 2007, Senator Ellen Corbett introduced SB 848, which proposed allowing the posted speed limit to be set by rounding the 85th percentile speed down to the nearest 5-mph increment, which has been the methodology since 1996 until it was amended in 2000 and again in 2003 and 2004. The bill was short-lived, and the topic of the bill was amended to speed traps. It later died[20] as an inactive bill.

Assembly Bill 766 (2009)

In 2009, Assemblymember Paul Krekorian introduced AB 766, which proposed the addition of a new section (§ 22358.2) to the *CVC*, to allow local authorities to retain the posted speed limit on a street if public hearings showed that a higher speed limit would not promote a safe environment. This bill would have changed the methodology for setting speed limits so that local authorities would not have to increase the speed limit in a speed zone based on an engineering and traffic survey if local and community input indicated that higher speed limits would create dangerous street conditions. This bill would not have eliminated the requirement to conduct a speed survey as part of the engineering and traffic survey, but it would have given greater emphasis to community input. The City of Glendale sponsored this bill, and the City of Los Angeles registered support for it. This bill was opposed by the Automobile Club of Southern California, the California State Automobile Association, and the California Teamsters Public Affairs Council who claimed that it would create speed traps in which more drivers would be cited for speeding although actual speed on the road would not

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[20] In legislative language, a bill that "died" refers to a bill that did not move forward in the process to be adopted into law.

change. This statement may be true under current practices where enforcement is sparse and inconsistent, but improved enforcement strategies, such as ASE, would likely increase compliance with the speed limit according to the NTSB (NTSB, 2017). The bill died in the Assembly Transportation Committee.

Assembly Bill 2363 (2018)

On February 14, 2018, Assemblymember Laura Friedman, representing the 43rd District in the California State Assembly, introduced AB 2363. As introduced, the bill proposed a change to *CVC §§ 22358, 22358.3*, and *22358.4* enabling local authorities to lower speed limits based on an "accident survey,"[21] in addition to the engineering and traffic survey which is currently the document used to justify the posted speed limit. In addition, the bill would have changed *CVC § 21400* to allow traffic engineers to set the speed limit by rounding the 85th percentile speed up or down to the next 5-mph increment (the current law only allows rounding to the *nearest* 5-mph increment). In an op-ed for the Glendale News Press, the Assemblymember described the 85th percentile methodology as "this one-size-fits-all prescription [that] does not provide adequate safety in modern urban environments." She further noted that this bill "will empower municipalities by giving them the tools and authority they need to set the speed limits that are appropriate for their plans and the actual safety requirements for their streets" (Friedman, 2018). The bill, current as of May 28, 2018, is available in Appendix H.

The California Teamsters and the Amalgamated Transit Union, the Automobile Club of Southern California, and the Automobile Club of Northern California oppose this bill. On April 23rd, the bill was heard by the Assembly Transportation Committee, at which time it was announced that the bill was being amended and

[21] It should be noted that the term "accident" is no longer used in the transportation community, based on the term's implication that crashes are unpreventable, and the terms "crash" or "collision" are preferred alternatives.

now is co-authored with Jim Frazier, the Chair of the Assembly Transportation Committee. As amended, instead of directly changing the speed limit methodology, a statewide Vision Zero Task Force would be created to discuss statewide roadway safety issues, one of which would be the speed limit methodology (California State Legislature, 2018a). At the Transportation Committee hearing, Friedman stated that the goal of this task force would be "to reduce our vehicle-related collisions down to zero" (California State Legislature, 2018b). Others on the committee concurred with the goals and Frazier closed by stating, "We all know something has to be done, because this one-size-fits-all methodology that we have now doesn't work."

Given the change in direction, it is unclear what impact the proposed bill would have on the current methodology for setting speed limits. At the time of writing, the bill is awaiting referral to be heard in the Assembly Appropriations Committee. If the bill successfully passes the California Assembly, it would be sent to the Governor for approval and would be chaptered into the State Statutes and adopted into the *CVC*.

VI. Recommendations and Conclusion

This analysis of California's 85th percentile speed limit methodology finds that the current approach does not effectively prioritize safety. Further, the application of the law in Los Angeles illustrates the absence of an appropriate method to set speed limits in dense and highly complex urban areas. The best practices from domestic and international examples demonstrate that there are opportunities to improve the methodology for speed limits in California to better accommodate urban needs and produce safe outcomes.

Recommendations

Based on this analysis, I recommend that California end the practice of mandating the 85th percentile method as the only method for setting speed limits, particularly in urban areas. While the operating speed on a roadway is an important characteristic that should be surveyed and documented, it is not the only metric, or even the most important one, to consider when setting a speed limit to produce safe outcomes.

I recommend that California adopt a hybrid approach to setting speed limits that would shift speed-setting power from the state to local authorities and allow local jurisdictions to set speed limits for certain roadway types based on injury minimization principles. In addition, it is recommended that California adopt automated speed enforcement (ASE) to increase its capacity for enforcing speed limits. As discussed in the literature review, the National Transportation Safety Board (NTSB) (2017) found that ASE is "an effective countermeasure to reduce speeding-related crashes, fatalities and injuries" and recommended that more states, including California, adopt an ASE program.

This hybrid method would allow local jurisdictions to set speed limits that take into account local context and circumstances unique to urban areas like pedestrian and bicycle volumes and commercial activity, while also creating some consistency for drivers so that they would be able to associate certain types of roadways with certain speed limits. Local jurisdictions should pair this new methodology for speed limits with roadway design improvements (e.g., road diets, traffic calming measures like speed humps and curb extensions), education, and enforcement to further improve the safety outcomes.

Future Opportunities

On-going changes in transportation are likely to present additional challenges or opportunities for determining speed limits. Big data and autonomous vehicles are already changing the way cities manage transportation and will continue to impact roadways in the future.

Currently, speed surveys are conducted using radar or lidar during one short period of data collection. As discussed in the analysis section, this approach results in a small sample size that fails to capture a complete picture because traffic is dynamic and fluctuates depending on time, weather, special events, and other factors outside of the transportation system. However, new applications such as Google Maps, Waze, Uber, and Lyft collect large quantities of data from millions of vehicles on the road every day. Mining these data could provide a more accurate and complete picture of vehicle travel speeds on a given street. While this research paper challenges the practice of setting the speed limit based on the 85th percentile speed of vehicles in urban areas, operating speeds are valuable information for transportation departments.

For example, with the limited data collected through speed surveys today, a city traffic engineer may analyze data collected during a one-hour period on a given weekday and conclude that speeds on a certain street are significantly higher than the posted speed limit. Based on this finding, the traffic engineer may decide to raise the speed limit to match operating speeds. If the traffic engineer instead had access to big data for vehicle speeds on the street at all hours of the day, every day for an entire year, he/she may realize that speeding only occurs during the evening peak, perhaps because the street is used as a short-cut when a parallel thoroughfare is congested. In this circumstance, the traffic engineer might opt to restrict access to this street during the evening peak period, which may be a more appropriate countermeasure than raising the speed limit.

While big data has great potential, these data are currently proprietary and unavailable to the public. If these data become publicly available, they could be used to help traffic engineers better understand traffic behavior and make more informed decisions. In the case that the data do not become available, municipalities may want to invest in Bluetooth technology to collect their own data. The City of Newport Beach recently approved the installation of the BlueTOAD system, which would collect real-time traffic data using Bluetooth technology from devices such as cellphones and hands-free devices in vehicles (Casiano, 2017). This system cost $119,999 for 12 devices that would be placed at various intersections along major thoroughfares in areas such as the Balboa Peninsula, MacArthur Boulevard, Corona del Mar and Newport Coast Drive. The City of Los Angeles recently contracted with INRIX, a traffic data collection firm, to collect data on Venice Boulevard from GPS-enabled devices (LADOT, 2018a). INRIX collected travel times, speeds, collisions, and traffic volumes on Venice Boulevard. While currently only being used in select locations, this data has great potential to influence transportation engineering decisions in the future.

With the gradual introduction of autonomous vehicles into the transportation network, there are likely ultimately going to be associated safety improvements. NHTSA (2018) cites that 94 percent of serious motor vehicle collisions today occur as a result of human error, and most of this would be eliminated with the full automation of vehicles, calling these safety benefits “paramount.” Currently, the 85th percentile methodology is based on the assumption that the driver makes the decision on what a reasonable speed is for a given roadway. As autonomous vehicles take over driving responsibilities, the decision about the appropriate travel speed may also shift from the driver to a program within the vehicle. This may improve compliance with the speed limit if the vehicle is programmed to not exceed it. This may also have the opposite effect of increasing operating speeds on roadways as autonomous vehicles may operate at higher speeds than drivers if they do not require as much space between vehicles. The future effect of autonomous vehicles on operating speeds is currently unknown.

Conclusion

Roadway safety is a complex issue that requires a sophisticated combination of engineering, education, and enforcement. Managing speed is a critical component of achieving roadway safety and the first step is to set speed limits that are safe and enforceable for all users of the roadway. Los Angeles and other cities in California need an updated speed-setting methodology that will produce safe outcomes for urban streets. The hybrid approach for setting speed limits at the local level using injury minimization principles would update the existing speed setting methodology and would better serve the state's urban areas.

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Appendices

Appendix A. City of Los Angeles Resolution – Speed Limit Setting and Enforcement / Local Control

Appendix B. City of Los Angeles Resolution – AB 2363 (Friedman) / Speed Limits Established by Local Authority

Appendix C. Descriptions of Pertinent Sections of *CVC* and *CA MUTCD*

Appendix D. NCUTCD Survey

Appendix E. NACTO Survey

Appendix F. Speed Survey – Foothill Boulevard, Los Angeles

Appendix G. Speed Survey – Hubbard Street, Los Angeles

Appendix H. Assembly Bill 2363

Appendix A: City of Los Angeles Resolution – Speed Limit Setting and Enforcement / Local Control

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Appendix B: City of Los Angeles Resolution – AB 2363 (Friedman) / Speed Limits Established by Local Authority

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Appendix C: Descriptions of Pertinent Sections of *CVC* and *CA MUTCD*

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Appendix D: NCUTCD Survey

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Appendix E: NACTO Survey

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Appendix F: Speed Survey – Foothill Boulevard, Los Angeles

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Appendix G: Speed Survey – Hubbard Street, Los Angeles

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Appendix H: Assembly Bill 2363

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