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The Effects of Transportation Corridor Features on Driver and Pedestrian Behavior and on Community Economic Vitality: Final Study Report

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**THE EFFECTS OF TRANSPORTATION CORRIDOR FEATURES ON
DRIVER AND PEDESTRIAN BEHAVIOR AND ON COMMUNITY
VITALITY: FINAL STUDY REPORT**

**FEDERAL REPORT # CA12-1094
CALTRANS CONTRACT 65A0337 AND AMENDMENTS
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**PREPARED BY THE
UC BERKELEY SAFE TRANSPORTATION RESEARCH AND EDUCATION CENTER
FOR THE CALIFORNIA DEPARTMENT OF TRANSPORTATION, DIVISION OF RESEARCH AND
INNOVATION, OFFICE OF TECHNOLOGY APPLICATIONS AND DIVISION OF DESIGN,
LANDSCAPE ARCHITECTURE PROGRAM**



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<p>This report presents the results from a multiyear effort to develop and test performance measures for evaluating the impact of landscaping and roadside features on pedestrian and bicyclist safety and mobility and economic vitality for Caltrans' urban arterial network. The first phase of the study was a literature review, and the second phase focused on developing performance measures. The third and fourth phases focused on testing the proposed performance measures consisting of an infrastructure analysis, policy review, safety analysis and a pedestrian and bicyclist intercept survey on two urban corridors in California. The results of the fieldwork indicate that the majority of the proposed performance measures are valid and ready for adoption by Caltrans. The remainder of the measures require additional testing to produce conclusive results. The study also revealed that drivers, pedestrians, bicyclists, and transit users all request similar roadside design features to improve their perceptions of traffic safety, suggesting that transportation agencies may be able to target a few specific improvements for maximum benefit to all user groups. Finally, the study found that the cities with the most developed pedestrian and bicyclist policies and plans seemed to have commensurate pedestrian and bicycle infrastructure on the ground, suggesting that the policies and plans have a tangible impact on eventual development.</p>		14. SPONSORING AGENCY CODE	
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Traffic counts were gathered by Quality Counts in the San Francisco Bay Area and by Quality Traffic Data, LLC in Los Angeles.

Intercept surveys were performed by Ewald & Wasserman Research Consultants at all locations.

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Executive Summary

Over the past decade, the California Department of Transportation (Caltrans) has committed to increased integration of Complete Streets elements such as enhanced pedestrian crossings, context-sensitive design features that can attract pedestrians, and bicycle racks and facilities, especially through Deputy Directive DD-64-R1. In 2007, Caltrans teamed with the University of California Transportation Center and the Safe Transportation Research and Education Center (SafeTREC) at Berkeley to investigate the effects of transportation corridors' features on safety, mobility and economic vitality. Specifically to: 1) explore the relationship between landscape and roadside features and road user safety and behavior; 2) create a framework of performance measures for pedestrian and bicyclist safety and mobility, and environmental sustainability; 3) examine driver behavior and safety; and 4) understand how pedestrian and bicycle mobility can affect the economic vitality of an area. This research project has been conducted in three phases: a literature review, performance measure development, and field-testing of the performance measures.

For the literature review, the research team examined approximately 165 studies dealing with the effects of transportation corridor design features on user safety; walkability, bikability, and physical health; psychological well-being; community and economic vitality; and varying environmental concerns. The cumulative literature review research findings point to some key guidelines to make the design of urban arterials more accommodating to non-motorized travelers and environmental stewardship. The literature review was published in 2008 under the title "The Effects of Transportation Corridor Roadside Design Features on User Behavior and Safety, and Their Contributions to Health, Environmental Quality, and Community Economic Vitality: A Literature Review."

After completion of the literature review, the research team turned its attention to the development of performance measures within a framework that is directed toward conventional highways. Research and observation suggests these are the highways on which the greatest conflicts between motorized and non-motorized traffic occur, and where local quality of life is most impacted by design of the highway facility. The proposed performance measure framework is based on the research findings from the literature review, and modeled after Caltrans' current performance measurement system. The document "Performance Measures for Complete Green Streets: a Proposal for Urban Arterials in California" was published in 2010.

The final phases of the research project focused on field testing the proposed performance measures for validity and reliability. This entailed gathering data on multiple aspects of two key urban arterial conventional highway corridors: San Pablo Avenue in the East San Francisco Bay Area, and Santa Monica Boulevard in the Los Angeles area. The analyses looked at street design features; rates of pedestrian, bicyclist, and driver injuries and fatalities; jurisdictional policies pertaining to non-motorized transportation; and user perceptions of safety and mobility. Finally, baseline data, including street design features and intercept surveys, were collected along a portion of Highway 82 in San Jose in the South San Francisco Bay Area. Complete Street improvements are anticipated on Route 82 over the next few years.

Among the conclusions of this research efforts are:

- Several of the proposed performance measures concerning pedestrian and bicycle safety were

deemed valid and fitting within Caltrans' current practices for driver safety. These new measures will require the collection of pedestrian and bicyclist volumes and the calculation of pedestrian and bicycle crash rates. This data is not currently collected as part of Caltrans standard practices. Caltrans should begin to use the capabilities of their existing data collection processes, such as SWITRS, to collect pedestrian and bicyclist data. The Department should also develop and deploy new data collection processes as necessary to implement these performance measures.

- Urban arterials that include design features such as street trees, landscaping, street lighting, bicycle lanes, trash receptacles, public art and other beautification measures attract all user groups (drivers, pedestrians, bicyclists, and transit users) to the area more often, contributing to improved economic vitality along the corridor. Clean, well-maintained roadways and sidewalks were also found to attract all user groups to visit urban arterial corridors more often and further improve economic vitality.
- Intercept surveys, which were completed by people who had stopped at some point along the corridor, revealed that increased mobility and perceived safety along urban arterial corridors can be attained for all user groups (pedestrians, drivers, bicyclists, and transit users) through the installation of bicycle lanes, improved pedestrian crossings (e.g., flashing lights, longer crossing time, and reduced wait time to cross), slower traffic and improved driver behavior, more traffic signals, and increased street lighting.
- Cities, counties, and local agencies that have aggressively pursued pedestrian and bicycle improvements in transportation plans have a corresponding greater number of pedestrian and bicycle facilities than those places that have not, indicating that policies and plans do positively affect the design of highway corridors. This suggests that Caltrans should review and updated all of its highway planning and design guidance as necessary to address bicycle and pedestrian policies and improvements.
- While policies can lead to better facilities and landscape design features make environments more comfortable and enjoyable, multimodal urban corridors face additional challenges of increased vulnerable roadway users and persistent motor vehicle traffic. As with any complex environment, care should be exercised to maximize safety and comfort for all roadway users, particularly for areas known to be problematic, such as within the sight triangle.

The mix of factors that affect safety on an urban corridor is complex. Studies suggest that there are roadside design features that can encourage pedestrians and bicyclists to visit an area, but the effects of these features may be completely mitigated if the speed limit is beyond a certain level, or if automobile traffic volumes are so high that pedestrians and cyclists consistently feel at risk of being hit by a car. Research in this area could be furthered by: (1) developing and validating various composite measures that account for the effects of multiple elements; (2) improving measurements of pedestrian and bicycle exposure; (3) understanding how the needs of through traffic (which does not stop) and traffic that does stop along the corridor overlap and/or differ in their desire for corridor roadside design; and (4) observing pedestrian, driver, and bicycle behavior in the context of various design, facility, and countermeasure features.

This report will assist in furthering the implementation of transportation corridor design features that enhance the interrelated outcomes of mobility, perceived safety and traffic safety along urban arterials.

I. Introduction

Beginning in 2007, the California Department of Transportation (Caltrans) teamed with the University of California Transportation Center and the Safe Transportation Research and Education Center (SafeTREC) at Berkeley to explore the relationship between landscape and roadside features on road user safety and behavior and to create a framework of performance measures for pedestrian and bicyclist safety and mobility, and environmental sustainability. The project also examined driver behavior and safety, in particular how driver behavior can adversely affect pedestrian and bicyclist safety and mobility through speeding, turning without yielding, etc. In addition, the project examined how pedestrian and bicycle mobility can affect the economic vitality of an area.

As the project required field-testing the performance measures for validity and ease of application, the multijurisdictional corridor of San Pablo Avenue (SPA), traversing cities of Oakland, Emeryville, Berkeley, Albany, and El Cerrito in the eastern San Francisco Bay Area, was designated as the first test corridor. San Pablo Avenue was chosen because of the variety inherent in the street, in particular with regard to the presence of street trees and medians, the quality of the sidewalk and the land uses. In addition, several previous Caltrans research studies have examined the SPA Corridor for specific aspects of traveler safety not investigated in this project (e.g., pedestrian walking speed in relation to given crossing time at an intersection), and we felt the current research could build on that knowledge. The investigation included an analysis of the street design features along San Pablo Avenue; rates of pedestrian, bicyclist, and driver injuries and fatalities; local, regional, and state policies pertaining to non-motorized transportation; and pedestrian, driver, bicyclist, and transit user perceptions of safety and mobility.

The second and final test corridor selected was a portion of Santa Monica Boulevard (SMB) in West Hollywood and Los Angeles. Similarly to San Pablo Avenue, the analysis investigated street design features; rates of pedestrian, bicyclist, and driver injuries and fatalities; local, regional, and state policies pertaining to non-motorized transportation; and pedestrian, driver, bicyclist, and transit user perceptions of safety and mobility. Santa Monica Boulevard was selected as the second test corridor because of its abundance in street design features, the history of these street design features, and its variety in features throughout the corridor. A reconstruction project featuring many pedestrian and bicyclist design elements was completed in the West Hollywood portion of the corridor in 2001, providing the research team with ten years worth of collision history to analyze following the installation of the pedestrian and bicyclist elements. The corridor contains many elements that the San Pablo Avenue lacks, allowing the research team to further validate performance measures. The difference in design elements throughout the corridor provides the opportunity to conduct a cross-sectional analysis to evaluate how behavior, mobility, and safety vary in locations of the corridor with abundant features compare to locations in the corridor that lack these features. This chapter introduces the report and briefly describes the various phases, each contained within a single chapter.

Overview

California's transportation corridors must meet many needs. They serve multiple travel modes – motorized (cars, trucks, and transit vehicles) and non-motorized (pedestrians and bicyclists), and local, regional, and interregional traffic. They are a central feature in many urban and suburban neighborhoods and rural communities. Historically, transportation corridors have been designed primarily to maximize the throughput of motorized vehicle traffic. Recently, however, members of local communities and others have begun to question the wisdom of this approach, and have begun to push for transportation corridors that are designed to meet local needs as well as throughput needs, and that safely accommodate multiple travel modes. These efforts are supported by an increasing focus among city planners, designers, transportation engineers, and public health practitioners on enhancing the quality of life within communities. Local community quality of life is adversely affected by the presence of high volumes of motorized traffic moving much faster than pedestrians and bicyclists and thus diminishing roadway safety; increasing levels of obesity that may, in part, be related to community design characteristics that diminish walkability and bikability and hence contribute to reduced levels of physical activity; increases in air and water pollution levels due to automobile and truck throughput; and a growing population of aging adults who may lose their mobility if options other than driving alone are not provided.¹

The design of transportation corridors communicates many things to its users, and the message it sends can affect the travel mode a user decides to take, the speed at which a motorist decides to drive, whether a pedestrian will walk along or across a street, and whether a resident will bicycle to local shops. Design elements give visual cues to the users of transportation corridors that let them know what needs have been prioritized and what behavior is expected. The vehicle lane widths, presence or absence of sidewalks and bicycle lanes, and presence or absence of buffering elements such as street trees and parked cars all influence a user's perceptions and resulting behavior responses. Is it safe and pleasant to walk here? Can I safely cross the street? Can I drive fast here, or should I slow down? For these reasons, the Complete Streets movement aims to encourage street design that clearly welcomes all users: pedestrians, bicyclists, drivers, and transit and truck traffic where applicable.

Across the United States, departments of transportation are increasing their use of performance measures to assess the operation of transportation systems. However, assessment is generally limited to monitoring whether departmental goals are being achieved cost effectively or are generating net benefits, and how those benefits are being distributed. The impacts of particular transportation corridor design features on the local quality of life cannot be evaluated under these performance measurement systems. Although corridor design elements that support livable and sustainable communities have been identified through numerous research studies, their individual and cumulative quality of life impacts have been particularly difficult to quantify and measure, resulting in these elements being difficult to justify and prioritize, especially in times of limited funding. However, as public health and environmental needs, such as global climate change, obesity, and needed alternatives to fossil fuels, continue to motivate a new way of

¹ For this reason, in 2009 AARP endorsed the national Complete Streets Act and published a platform that urges Congress to include the Complete Streets Act in the authorization of the next federal surface transportation program. Retrieved June 25, 2009 from: http://www.aarp.org/makeadifference/advocacy/GovernmentWatch/StrongCommunities/articles/aarp_one_minute_guide_complete_streets_act.1.html#

planning for mobility, Complete Streets principles become more widely utilized and mandated, and the numbers of people who walk and bicycle grow, the importance of quantifying the quality of life impacts of specific corridor design elements and developing measures to assess performance toward quality of life goals will only increase (Bernstein, Bosch et al. 2007; National Complete Streets Coalition 2009).

Within the planning and transportation fields, some research on the broadly conceived safety impacts of corridor design elements on all roadway users, including the effects of narrower vehicle lane widths, parked cars, street trees, bicycle lanes, and wider sidewalks, has been conducted, and models of ideal “main streets” have been developed. However, few defensible performance measures exist for assessing the user safety, public health, economic vitality, multimodal mobility, and quality of life effects of various corridor design elements. Certainly, no comprehensive framework of such measures presently exists. Creating such a framework based on defensible research findings will assist transportation and planning professionals and policy makers in maximizing the potential public benefits associated with investments in highway right-of-way facilities and associated community networks, systems, and land use environments.

The adage justifying performance measures is “what gets measured gets done.” In order to ensure the design and development of Complete Streets, transportation agencies need a more robust system of performance measures including new measures for non-motorized safety and mobility. Recognizing this need, Caltrans initiated this project with a research team from UC Berkeley SafeTREC. The research team examined the effects of transportation corridor design features on user behavior and safety, the environment, public health, and community economic vitality, and the creation of defensible performance measures derived from the research that could be used by the Agency. The research effort was undertaken in three phases: a comprehensive literature review, the development of performance measures, and the field-testing of those measures. This report summarizes the literature review and performance measures development phases, and describes in detail the field-testing conducted for the proposed *Complete, Green Streets Performance Measure Framework for Urban Arterials*.

Focus of the Performance Measure Framework

As evidenced by its name, the performance measure framework has three key aspects:

- Applicability to Urban Arterials
- A focus on creating Complete Streets
- A focus on creating Green Streets

This emphasis derives from the findings of the Literature Review and also reflects and adopts the terminology of two important street design “movements” built in part on those findings.

Rationale for the Focus on Urban Arterials

The focus is on conventional highways, known hereafter in this report as “urban arterials”, rather than all Caltrans highway types, because research and observation suggest these are the highways where most conflicts occur between motorized and non-motorized traffic, and where

highway design has the biggest impact on local quality of life issues. As corridors that typically have a high concentration of commercial and retail attractions, often in addition to multi-family residential buildings, urban arterials act as a magnet to all types of traffic. However, this may create a situation wherein pedestrians and bicyclists feel and are less safe, due to high amounts of vehicular traffic. As a corollary effect, people may choose not to walk or bicycle in and through these areas, limiting mobility by these modes and thus reducing opportunities for physical activity. Vehicular traffic also negatively affects the immediate environmental quality, through releasing emissions during times of congestion and regular driving that pollute the air and exacerbate urban heat island effects caused by heat radiating from non-permeable surfaces.

Pedestrian and bicycle crashes also occur on rural highways; however, this report focuses on urban areas because of the greater population density and potential for walking and bicycling, and because performance measures for rural areas already exist in the Caltrans system.

The Complete Streets Concept

Adopting Complete Streets terminology throughout the performance measurement framework recognizes and incorporates recently approved state policies, enacted state legislation, and internal agency directives that either encourage or require Caltrans to move toward a highway system that reflects the Complete Streets concept. Although Caltrans currently focuses on meeting state and regional goals of moving motor vehicles at a high level of service (LOS), there is growing recognition that the existing roadway designs and standards often conflict with local, regional, and state needs and goals. Many of these goals are directed at encouraging pedestrian and bicycle travel and reducing air pollution from motor vehicles, and have come to be represented by the Complete Streets movement, which urges that transportation facilities be **“planned, designed, operated, and maintained to provide safe mobility for all users, including bicyclists, pedestrians, transit riders, and motorists appropriate to the function and context of the facility.”**

In California, *Assembly Bill 1358: The Complete Streets Act* was passed by the legislature in 2008, representing statewide recognition of the need to provide for all users of the transportation system (Leno 2007). In addition, Caltrans issued *Deputy Directive 64-R1: Complete Streets – Integrating the Transportation System*, which mandates the provision of bicycling and walking facilities along Caltrans’ roadways (except where prohibited, such as limited access expressways) (Caltrans 2008). DD-64-R1 evinces Caltrans’ commitment to a multimodal transportation system, and AB 1358 builds on a national movement for Complete Streets, as well as on local policies already in place throughout California. The Complete Streets concept and these two specific initiatives, which will be discussed in more detail later in this report, provide the basis on which the performance measure framework presented in this report was developed.

Complete Streets principles should benefit Californians in multiple ways. First, they should result in safer and more convenient roadways for Californians who walk, bicycle, or use transit. Second, the enhanced safety may encourage more people to choose active transportation, possibly resulting in greater health benefits from travel, as well as further increasing safety due to the principle of “safety in numbers” (Jacobsen 2003). Third, increases in active travel may lead to reductions in traffic congestion, auto-related air pollution, and the production of climate-

changing greenhouse gases. Although it is difficult to estimate how much environmental impact increased walking and bicycling could have, Assemblyman Mark Leno has anecdotally suggested that if every Californian substituted just one car trip per month with a bicycle trip, nearly 4,000 tons of carbon dioxide would be saved per year (Leno 2007).

An important final aspect of building Complete Streets is that it makes fiscal sense, particularly as world demand for resources grows and the future looks to be more constrained regarding energy, building materials, and other goods. When sidewalks, bicycle lanes, transit amenities, and safe crossings are integrated into the initial design of a project, costly retrofits are avoided. In addition, providing for multimodal transportation from the beginning will have immediate benefits to roadway infrastructure, as there are instant alternatives to driving for citizens within the community. In general, automobiles wear down roadways exponentially more quickly than bicyclists or pedestrians. Providing opportunities for travel via non-motorized modes may pay dividends in the form of reduced maintenance per user.

It should be noted that although Complete Streets terminology is used throughout the proposed performance measurement framework, transit related issues are not addressed. This is because the Literature Review did not cover these issues due to scope and budget limitations. It is hoped that in the future, additional research can be done directed at filling this gap.

The Green Streets Concept

A second concept that is gaining momentum within transportation agencies across the United States is that of Green Streets. Incorporating Green Streets terminology into the performance measurement framework is an attempt to encourage Caltrans to take a leadership role in this important environmental movement. Green Streets (City of Portland 2007) are defined as streets that maximize permeable surfaces, tree canopy and landscaping elements in order to:

- Divert stormwater from the sewer system and reduce basement flooding, sewer backups and combined sewer overflows;
- Reduce polluted stormwater entering rivers and streams;
- Improve pedestrian and bicycle safety;
- Reduce impervious surface so stormwater can infiltrate to recharge groundwater and surface water;
- Increase urban green space;
- Improve air quality and reduce air temperatures;
- Reduce demand on sewer collection system and the cost of constructing expensive pipe systems; and
- Address requirements of federal and state regulations to protect public health and restore and protect watershed health.

Although no states have adopted Green Streets policies, many agencies are conducting research to determine the feasibility of incorporating some Green Streets principles into their roadway design practices. At the federal level, staff at the Environmental Protection Agency (EPA) are currently working to develop street design performance metrics that are inclusive of green infrastructure practices. At the regional level, Oregon's Metro Portland has adopted design guidelines for Green Streets and the City of Portland is actively building city streets in accordance with them. During a recent EPA webinar on Green Streets, many DOTs stated that

their agency was beginning to address Green Streets principles through roadway design (Wilson 2009).

It should be noted that although Green Streets terminology is used in the proposed performance measurement framework, the only Green Streets ideas that are addressed with new measures involve the provision of more street trees and the reduction of non-permeable surfaces along urban arterials. These areas have been well-researched and provide a solid starting place for Caltrans to begin addressing environmental impacts of street design. It is hoped that future research efforts could lead to the creation of performance measures dealing with other green streets elements, particularly elements other than tree canopies that can simultaneously provide benefits like stormwater retention and beautify pedestrian space, such as bioswales or rain gardens.

Caltrans' Current Use of Performance Measures

Caltrans describes performance measures as “a necessary part of the California transportation plan...that can be used to determine whether the California Department of Transportation...is successfully meeting the state’s transportation goals...” (California DOT 2009). The agency currently uses performance measures to monitor the performance and progress of the transportation system throughout the State of California, and is working with local communities to encourage the use of performance measures in decision-making.

Caltrans' current performance measures framework is structured around a set of strategic agency goals. While Caltrans' stated mission is to “improve mobility across California,” it has developed a set of five goals that encompass a broader range of concerns (California DOT 2007). The goals are:

1. **Safety:** Provide the safest transportation system in the nation for users and workers.
2. **Mobility:** Maximize transportation system performance and accessibility.
3. **Delivery:** Efficiently deliver quality transportation projects and services.
4. **Stewardship:** Preserve and enhance California’s resources and assets.
5. **Service:** Promote quality service through and excellent workforce.

A series of objectives have been identified for each goal, and performance measures have been established that are intended to monitor the agency’s progress toward each objective. The objectives set specific timeframes and numerical targets that are coordinated with the Strategic Plan that Caltrans adopts every five years. The current performance measure framework contains 26 objectives supported by 57 performance measures, the full list of which can be found in Appendix A. Caltrans publishes quarterly Performance Measure Reports that track key indicators and annual reports on all of the adopted objectives and measures. At the end of each fiscal year, performance is measured against the targets set in the Strategic Plan and compared with the results of previous years. This annual review allows Caltrans to gauge overall progress toward objectives, and may be used to modify objectives if progress is made at a much different rate than expected.

The hierarchical structure of Caltrans' performance measurement system is based upon the following conceptual diagram and set of definitions:

Goal: The broad, long-term outcome or result the agency will work to realize.

Objective: A finite target the agency will aim to meet, with the year and quantity of change explicitly stated. May contain both short and long-term dates and quantities.

Performance Measure: The factor or trend that the agency will monitor, to track progress toward the objective and, ultimately, the goal.

Example (from Caltrans' existing Performance Measure Framework)

Goal: Provide the safest transportation system in the nation for users and workers.

Objective: By 2008, reduce the fatality rate on the California state highway system to 1.00 per 100 million vehicle miles traveled and continuously reduce annually thereafter toward a goal of the lowest rate in the nation.

Performance Measure: Fatalities per 100 million VMT on the California state highway system.

Evaluation of Caltrans' Current Performance Measurement Approach

Although this report is focused on proposing new performance measures to enhance Caltrans' current system, it should be noted that few state transportation agencies in the United States have performance measurement frameworks that are more sophisticated or progressive. Like Caltrans, most DOTs have for decades concentrated primarily on driver mobility and safety, in keeping with the focus of the highway engineering profession. As that profession continues to expand to include a focus on pedestrians and bicyclists, however, and as the mitigation of harm to the environment continues to grow in priority, all of these agencies will need to measure additional aspects of the transportation system. It is the authors' hope that the new measures proposed in this report will allow California to emerge as a "best practice" state in the area of performance measurement.

Caltrans supported this research to develop standards that could measure the progress toward aspects of its strategic goals related to the Complete Streets directives and Green Streets movement; e.g. measures concerned with the safety and mobility of non-motorized travelers and environmental quality. For example, the measure "The number of fatalities per 1,000,000 VMT" refers to pedestrian and bicycle fatalities, as well as driver fatalities, even though drivers routinely travel thousands more miles per year. Including all three modes in the same measure obscures the actual safety of pedestrian and bicycle travel, which is more accurately measured in the hundreds or low thousands of miles traveled per year. Caltrans has attempted to address the lack of focus on non-motorized transportation through its work on the Strategic Highway Safety Plan (SHSP), although the proposed SHSP goals tend to be programmatic and are still in the development process.

Because of these shortcomings, this research effort sought to develop new performance measures that would allow Caltrans to work towards state and national goals related to multimodal transportation, community quality and environmental stewardship.

Performance Measures: A Means, Not an End

It is important to remember that performance measures are not the end in themselves, but rather a

means to an end. The “end” in this case is a safer transportation system that improves mobility and traveler comfort while honoring the State of California through stewardship of environmental and fiscal resources, timely and quality delivery of projects, and service through its workforce.

Structure of the Report

This report contains five chapters, each with a number of sub-sections. This is the first chapter. Chapter II summarizes the research findings from the Literature Review and discusses their relevance and implications for urban arterials. Chapter III discusses the theoretical underpinnings of performance measurement and various approaches in the literature. It also presents the proposed *Complete, Green Streets Performance Measure Framework*, and includes discussion and recommendations related to setting targets and data collection. Chapter IV is the longest, as it elaborates on the third and fourth phases of the project. It contains several sections, each devoted to a separate type of analysis and field-work. The sections include a traffic injury analysis, a policy and plan analysis for related jurisdictions, an explication of the pedestrian and bicyclist intercept survey results, and analysis of the proposed performance measures based on the accumulated data. The final chapter provides conclusions. There are also several appendices containing data related to Phases III and IV.

This report provides Caltrans with tools to better serve an increasingly multimodal California. Although the research and proposals documented in this report are directed toward Caltrans, it is hoped that the information provided, particularly the rationale for the creation of the performance measures, will be useful for state highway departments across the United States and similar agencies elsewhere.

II. Phase I Literature Review

Background

The Literature Review conducted during the first phase of this research project forms the base of the proposed *Complete, Green Streets Performance Measure Framework* that is the focus of this research project. The Literature Review summarized the state of current knowledge regarding the effects of various corridor roadside design features on community quality of life issues. It addressed all transportation corridors under the jurisdiction of state highway departments, and so was concerned with controlled-access freeways, expressways, arterials, and “main street” highways. The focus was primarily on corridor roadsides, rather than vehicle roadbeds, because these are the interface zones between roadways and communities or the rural landscape. Because of their potential contributions to quality of life issues, attention was also paid to non-roadside design elements that contribute to traffic calming, walkability, and bikability, such as travel lane widths, crosswalks, and bicycle lanes. Funding and time constraints, and directives from Caltrans, necessarily limited the scope of the literature review and so transit-related roadside design elements, such as bus shelters or transit lanes, were not considered. As well, the quality of life effects of neighboring land uses were not addressed.

Rather than presuming to create a comprehensive review of every piece of applicable research, the researchers sought to include the most recent and relevant research. Approximately 165 studies, journal articles, and reports were reviewed for this phase.* In the summer of 2008, the Literature Review was circulated in draft form to a Technical Advisory Group composed of leading professionals and academics in the fields relevant to the literature. After incorporating their comments, the Review was published in late fall, 2008. It can be found on the University of California Transportation Center website at <http://www.uctc.net/papers/878.pdf>.

Findings from the Literature Review

The Literature Review was organized by broad category of subject matter related to user safety and behavior, health, community economic vitality, and the environment. Herein, only the findings applicable to *urban arterial streets* are presented because the focus of the performance measurement framework is on these streets, rather than all highway types, for the reasons explained in the Introduction to this report. In particular, findings from the Literature Review indicated that urban arterial streets were where most conflicts occur between motorized and non-motorized users because they typically offer direct movement routes and are usually lined with commercial establishments they attract pedestrians and bicyclists as well as drivers. As well, because of the higher number of pedestrians found there than on other highway types, the design of urban arterials has a greater cumulative effect on local quality of life than does how that of other highway types.

The research findings are summarized in seven sections focused on the following subject

** Additional research published or deemed relevant to this project since the publication of the Literature Review has also been included in this section.

matters: driver safety, pedestrian safety, bicyclist safety, physical health and active transportation, psychological well-being, community economic vitality, and environmental effects.

Driver Safety

Studies regarding driver safety and roadside design elements that are applicable to urban arterials have focused mainly on the relationship between speed and driver safety, and whether the presence of roadside trees contributes to or reduces driver safety. Following is a summary of the key findings:

- On urban arterials of all configurations (two-lane undivided, three-lane with center turn, four-lane undivided, four-lane divided), wider lane widths (12-13 feet) are more likely to be associated with higher driver speeds than narrow lane widths (10 feet) (Fitzpatrick, Carlson et al. 2000; Potts, Harwood et al. 2007). Of interest related to this finding is that research indicates that wider travel lanes only marginally increase traffic capacity. Access management or signal synchronization can be employed to offset the minor reduction in capacity caused by designing 11 or 10 foot lanes (Bochner and Daisa 2006).
- Higher highway driving speeds are more associated with vehicle crashes and fatalities than are slower speeds (Richter, Berman et al. 2006).
- Urban arterials with roadside trees, landscaping and pedestrian amenities—in other words, where expectations of lower driver speed is communicated through design—are associated with fewer vehicle collisions than are streets without these design elements, particularly far fewer pedestrian and bicyclist injuries and fatalities (Mok, Landphair et al. 2003; Dumbaugh 2005; Dumbaugh 2006). The reduction in accidents has been shown to hold true for arterials up to six lanes wide and with speeds up to 43 mph.
- Roadside trees that are planted close to the roadway have a greater effect on slowing driver speeds on multilane highways than do trees planted further away. In the study from which these findings come, the closer trees were 6.6 feet from the roadway edge and the further trees were 14.76 feet away (Van der Horst and de Ridder 2007).
- On urban highways, wide traffic lanes and wide shoulders are positively associated with more run-off-roadway accidents whereas the presence of trees is negatively associated (Lee and Mannering 1999).
- A national study of crash data found that roadside trees are involved in less than 1% of urban accidents and less than 0.001% of fatal urban accidents (Wolf and Bratton 2006). In addition, a review of numerous research studies concluded that roadside trees posed no significant safety risk (Dixon and Wolf 2007).
- Simulator studies indicate that drivers perceive urban streets with trees to be safer than urban streets without trees (Naderi, Kweon et al. 2008).
- Simulator studies indicate that closely spaced street trees (25 feet apart) that come up to the intersection—if properly selected, adequately spaced, and pruned for high branching—do not create a strong visibility problem for drivers, but parked cars near intersections do (Macdonald 2006).

The findings regarding driver speed are extremely important because driver speed affects not only driver safety but also that of pedestrians and bicyclists. If a driver is going too fast in an urban area, where a bicyclist could swerve to miss a pile of debris or a pedestrian could unexpectedly step off a curb, the driver will likely not have enough time to slow down and safely avoid hitting the unprotected pedestrian or cyclist (Ivan, Garder et al. 2001). Tragically,

pedestrians and cyclists can sustain serious injuries when hit by a car going just 25 mph, a slow speed along many urban arterials, and fatal injuries can occur at 35 mph, which is a common speed in many urban areas (Leaf and Preusser 1999).

Fast driver speeds are also associated with low perceptions of safety for pedestrians and cyclists, creating a hostile environment that tends to discourage walking and cycling (Parkin, Wardman et al. 2007). Therefore, the research suggests that as long as driver speeds on urban arterials remain high enough to endanger pedestrians and bicyclists, extra steps should be taken to both *protect* and *encourage* walking and bicycling.

The findings regarding roadside trees and driver safety are important because of the multiple quality of life benefits trees provide, as will be discussed in a later section.

Pedestrian Safety

Concern for pedestrian safety on urban arterials is well-founded because research shows that most pedestrian fatalities (85%) occur on non-local streets (Anderson, McLean et al. 1997). Fortunately, the research also suggests that achieving greater pedestrian safety along urban arterials can be accomplished through design. The key findings from the Literature Review are as follows:

- Urban arterials that have “main street” characteristics (sidewalks, crosswalks, on-street parking, stop signs, mixed land use, posted speeds of 30 mph or less, large amounts of pedestrian traffic) were found to have much lower numbers of pedestrian injuries than those with a commercial strip character (no sidewalks, no traffic controls, wide curb cuts or no curbs at all, no on-street parking, posted speeds above 30 mph) (Ossenbruggen, Pendharkar et al. 2001).
- In 2002, nearly 23% of motor vehicle/pedestrian crashes in the U.S. occurred while pedestrians were in a crosswalk, over 96% of these accidents occurred at intersections, and approximately one-third resulted in severe or fatal injury (Ragland and Mitman 2007).
- Higher driver speeds are associated with less yielding to pedestrians at crosswalks (Ivan, Garder et al. 2001).
- Although marked crosswalks alone may be effective on low-volume (10,000 ADT or less) urban arterials, research clearly demonstrates that arterials with higher traffic volumes need additional safety features to consistently achieve driver yielding (Fitzpatrick, Turner et al. 2006).
- The presence of a marked crosswalk at an urban arterial intersection is associated with less mid-block jay-walking by pedestrians and slightly decreased driver speed approaching the intersection, particularly where there are multiple traffic calming treatments, such as overhead warning lights, pedestrian refuge island, pedestrian activated in-roadway lighting, and advance yield signage (Huang and Cynecki 2001; Knoblauch, Nitzburg et al. 2001; Dulaski 2006).
- Marked crosswalks at unsignalized locations along multi-lane arterials (intersections or mid-block) have been found to be dangerous for pedestrians because drivers in far lanes often fail to stop. However, such crosswalks become much safer when they supplemented with flashing lights or red beacons (95% motorist compliance rates were observed),

especially on all multi-lane roadways and in areas with high volumes of fast-moving traffic (Zegeer, Stewart et al. 2005; Fitzpatrick, Turner et al. 2006; Ragland and Mitman 2007).

- At both signalized and unsignalized locations along urban arterials, crosswalks supplemented with in-pavement warning lights were found to be highly successful in encouraging driver yielding and somewhat successful at decreasing pedestrian jay-walking, particularly in areas of moderate to intense pedestrian traffic (Whitlock and Weinberger Transportation 1998; Godfrey and Mazzella 2000; Hakkert, Gitelman et al. 2002; Rousseau, Miller Tucker et al. 2004; Abdelghany 2005).
- Along urban arterials, pedestrian countdown signals at intersections were found to be associated with safer crossing behavior by pedestrians (Eccles, Tao et al. 2004).
- In a study of New York City intersections where right turns on red were allowed, the installation of leading pedestrian intervals was associated with significantly reduced crash rates (King 2000).
- In a given area, the likelihood of a pedestrian being injured or killed by a collision with a motorist decreases as the number of people walking increases. The principle of “safety in numbers” suggests that to increase pedestrian safety overall, greater rates of walking should be encouraged, as this leads to increased driver awareness and subsequently safer driving around pedestrians (Jacobsen 2003).

Bicyclist Safety

Research related to the design of urban arterials and bicycling safety is not as yet very robust. Most research studies concerning the safety of particular design elements have focused on bicycle sidepaths, long eschewed from U.S. transportation engineering practices. However, because many research studies are currently in progress it is likely that the field will evolve quickly to provide a greater understanding of how various treatments, such as painted bicycle lanes, bicycle boxes and separate bicycle signals, affect bicycle safety. Meanwhile, Jacobsen’s study on “safety in numbers,” cited above, applies equally to bicyclists, as can be seen in the statistics from Portland’s years of bicycle counts and crash data from bridge crossings (Portland Office of Transportation 2008).

Considerable literature does exist on bicyclists’ preferences regarding bicycle facilities, which are often linked to their perceptions of safety, as well as associations between the presence of bicycle facilities and increases in the number of bicycle trips. This literature is discussed below, in the Bikability section.

Physical Health and Active Transportation

Research suggests that good physical health leads to better quality of life and that community design that encourages active living can contribute to better physical health. A growing understanding of these cross effects combined with growing concerns about what seems to be an obesity epidemic in the United States, has led to increased linkages between the public health fields and the built environment fields. For instance, the American Academy of Pediatrics recently released a policy statement on the importance of designing communities that encourage children to use active transportation modes (Committee on Environmental Health - American

Academy of Pediatrics 2009). The authors emphasize that children and others need more opportunities for “incidental physical activity”, such as the ability to walk or bicycle to school or to the store for an unplanned trip. The importance of providing sidewalks and bicycling facilities for active travel and recreation is underscored. A recent report by Cycling England details all of the ways in which bicycling can help fight obesity and other chronic diseases (Cavill and Davis 2007), and numerous studies have found that walking and bicycling can significantly contribute to meeting nationally recommended goals for physical activity (Cooper, Page et al. 2003; Saelens, Sallis et al. 2003; Frank, Saelens et al. 2007; McDonald 2007).

The Literature Review focused on research related to walkability and bikability. Key findings are the following:

Walkability

- Numerous research studies suggest that urban form influences whether or not a community is walkable. Elements found to be positively associated with walkability that have applicability to the design of urban arterials include the connectivity of a community’s street system, the presence of sidewalks, and pedestrian pathways that are visually stimulating and scaled to pedestrians (Litman 2004; Handy 2005; Southworth 2005; Lee and Vernez Moudon 2006; Saelens and Handy 2008).
- People who live in walkable neighborhoods walk more than those who do not, even controlling for self-selection, and that they are generally less likely to be overweight or obese (Saelens, Sallis et al. 2003; Frank, Saelens et al. 2007).
- Related literature suggested that people are willing to walk farther than commonly assumed (one-half mile versus one-quarter mile) for utilitarian purposes (Schlossberg, Weinstein Agrawal et al. 2007).
- Research on pedestrian level of service (LOS) at signalized intersections indicates that conflicts with turning vehicles, as well as the volume and speed of perpendicular traffic, have the most negative effect on pedestrians’ perceptions of comfort (Petritsch, Landis et al. 2004).
- Along arterial streets, perceived pedestrian Level of Service (LOS) was found to decrease in correlation with the total width of driveway and intersection crossings, as well as the amount of traffic on the adjacent roadway (Petritsch, Landis et al. 2006).
- Pedestrian LOS for mid-block crossings was found to increase as the width of painted or raised medians increased, and when a crosswalk and/or pedestrian signals were present (Baltes and Chu 2002).
- Pedestrians were found to be more sensitive to delay than those driving or taking transit, perhaps due to climatic concerns (Rajamani, Bhat et al. 2002).
- The presence and number of street trees was found to positively influence the propensity to walk along a street (Lee and Vernez Moudon 2006; Lee and Vernez Moudon 2008).
- Streets with high volumes of traffic may act as barriers to pedestrians attempting to cross them, and thus may discourage walking (Schlossberg and Brown 2004; Litman 2008).

Bikability

Although not much research exists regarding bicyclists’ preferences for new types of bicycle facilities, solid research on the use of and preference for bicycle lanes and paths has been

conducted in the last few years. In particular, cities such as Portland, Oregon, and New York City, New York, continue to innovate and publish their findings regarding new bicycle facilities in the United States. The findings below represent the best of what is currently known and applicable to urban arterials.

- A national study found that in cities with populations over 250,000, each additional lane of Class II bicycle lanes per square mile was associated with approximately one point increase in the percentage of bicycle commuters (Dill and Carr 2003).
- Likewise, a study at the neighborhood scale found a positive association between the presence of bicycle lanes and paths in a neighborhood and the amount of bicycling in it (Lee and Vernez Moudon 2008).
- One survey found that perceptions of safety while cycling were associated with frequency of cycling, and that each additional mile of bicycle lane in a city was positively associated with a 5% increase in the likelihood of people to own a bicycle and to have ridden it in the week prior to the survey (Xing, Handy et al. 2008).
- An analysis of comprehensive investment in bicycling facilities in Portland, Oregon, found that a 215% increase in the bicycle network was matched by a doubling of the overall bicycle commute share, and a 210% increase in the number of bicycle trips in the surrounding areas (Birk and Geller 2005).
- A highly connected bicycle network leading to desirable destinations has been found to be positively associated with the number of bicyclists in a city (Birk and Geller 2005; Dill and Voros 2007; Douma and Cleaveland 2008).
- Bicyclists were found to be more sensitive to delay than those driving or taking transit, perhaps due to climatic concerns (Rajamani, Bhat et al. 2002).
- Streets with high volumes of traffic may act as barriers to bicyclists attempting to cross them, and thus may discourage bicycling (Schlossberg and Brown 2004; Litman 2008).
- A study using GPS data from Portland, Oregon, found that cyclists riding for utilitarian purposes rode mainly on facilities with bicycle infrastructure, and that nearly 30% of the travel occurred on streets with bicycle lanes. This study also found that bicyclists often go out of their way to use bicycle facilities, even when it lengthens trip time (Dill and Gliebe 2008).
- Several surveys have documented that bicyclists strongly desire more bicycle lanes and trails (Gonzales, Hanumara et al. 2004; Vernez Moudon, Lee et al. 2005; Dill and Voros 2007; Wardman, Tight et al. 2007).
- Other studies have evaluated stated preferences using dynamic modeling to determine the balance between commute time and facility quality. The results revealed a clear willingness to travel several minutes longer to get to and ride in a bicycle lane in order to avoid riding in mixed traffic (Hunt and Abraham 2007; Tilahun, Levinson et al. 2007).
- An analysis of perceived cycling risk and route acceptability found that high amounts of auto traffic were associated with increased perceptions of cycling risk, which can be helped, but not completely alleviated, by the presence of bicycle lanes (Parkin, Wardman et al. 2007).
- Research on bicycle LOS found that the presence or absence of a bicycle lane was the most commonly cited reason for giving a roadway a high or low score, respectively (Petritsch, Landis et al. 2006).
- Where motorists and bicyclists share lanes, “sharrows” have been found to encourage

safer driving and biking behavior (Alta Planning + Design 2004).

Other Aspects of Physical Health

Several studies have documented an increased risk of several health problems, including respiratory ailments, infant mortality, and cancers, in areas with high volumes of diesel truck and auto traffic (Wjst, Reitmeir et al. 1993; Pearson, Wachtel et al. 2000; Kim, Smorodinsky et al. 2004; Houston, Wu et al. 2006). In addition, the United States Global Change Research Program recently released a report detailing the risks to health global climate change, which include increased risk of extreme weather events and deaths related to extreme heat (such as heat stroke), reduced air quality, and increases in contagious diseases and pollen production (Karl, Melillo et al. 2009). It is therefore increasingly important to mitigate air pollution and the overall effects of global climate change, including rising urban temperatures, as much as possible. The findings described in the Environmental Effects section below demonstrate that the design of urban arterials can help.

Psychological Well-being

Psychological well-being is an important quality of life issue and evidence suggests that urban form can have a positive or negative impact. In particular, considerable literature links the presence of trees and greenery with psychological well-being. Although few studies have dealt directly with the psychological effects of greenery along urban arterials, the findings from studies of other spaces can be extrapolated to arterials. The main findings are as follows:

- Time spent viewing greenspace or being outside in a calm environment enhanced positive feelings both directly and indirectly by taming stress and frustration, and was associated with improved performance on subject tests (Ulrich 1986; Parsons, Tassinary et al. 1993; Kaplan 1995; Pretty 2004; Maller, Townsend et al. 2005).
- The presence of roadside landscaping has been tied to reduced traffic stress for both drivers and those who live along heavily traveled corridors (Parsons, Tassinary et al. 1993; Cackowski and Nasar 2003).
- Other research found that people generally prefer to live near greenery and mature trees, and that in a lower income area, greenery and mature trees near apartment buildings were associated with greater community interaction (Kuo 2003).

Community Economic Vitality

Whether or not a community is economically vital has an important impact on local quality of life. Unfortunately, little research has been done on the relationships between street design elements and community economic vitality. The research that has been done underscores that, as prime commercial areas, urban arterials should provide opportunities for pedestrian and bicycle access, as well as amenities such as street trees that enhance pedestrian comfort and therefore encourage foot traffic. The following are the key findings from the Literature Review:

- Several studies have found that pedestrians, transit users, and bicyclists routinely visit stores along commercial strips in urban areas more often and spend more money overall than do patrons who drive. In two of the studies, pedestrian intercept surveys found that patrons would prefer removing one lane of parking and installing bicycle lanes or widening the sidewalk by a ratio of 4:1 and nearly 5:1, respectively. Results from the third survey also suggested that widening the sidewalk could be very beneficial for the

businesses in the area (Schaller Consulting 2006; San Francisco County Transportation Authority 2009; Sztabinski 2009).

- Pedestrian improvements to a downtown business area were found to be associated with both increased pedestrian traffic and increased property values (Whitehead, Simmonds et al. 2006).
- Consumers were found to prefer business districts that have landscaping and trees, including those along main street arterials (Wolf 2004; Wolf 2004; Wolf 2005).

Environmental Effects

The theme throughout the environmental literature was that trees in urban areas tend to be overwhelmingly beneficial for communities. In particular, urban trees help mitigate air and water pollution, mitigate urban heat island effects, reduce emissions, retain stormwater, and reduce energy consumption through shading adjacent buildings (Heisler 1974; Simpson 1998; Scott, Simpson et al. 1999; Akbari, Pomerantz et al. 2001; McPherson and Simpson 2003; Streiling and Matzarakis 2003). The cumulative benefits of a community's entire urban forest can be substantial. A study of Sacramento County's urban forest concluded that it contributes to approximately \$20 million dollars in annual energy saving through shading and the reduction of wind speed and air temperature (Simpson 1998). Another study concluded that California's 177 million urban trees reduce energy used for cooling by 2.5%, for a total savings of almost 1.5 billion dollars annually (McPherson and Simpson 2003). Davis's public urban forest, consisting primarily of street trees, found an annual net benefit of \$66 per tree in terms of energy savings, air quality improvements, CO₂ and stormwater reductions, and aesthetic values for the city (Maco and McPherson 2003). A study of rainfall interception by trees in Santa Monica, California found that they intercepted 1.6% of total annual precipitation, annually saving the city over \$110,000 in avoided stormwater treatment and flood control costs associated with water runoff (Xiao and McPherson 2002). A model of urban forest effects on the urban heat island concluded that adding 5 million trees to the Los Angeles metropolitan area would result in an air temperature reduction of 5-7° F in the hottest areas (Akbari, Pomerantz et al. 2001).

How does all this relate to urban arterials? The environmental benefits of trees are incredibly important for urban arterials because the high amounts of traffic on these streets contribute to air and water pollution, while the high surface area of non-permeable asphalt contributes to the urban heat island and increased stormwater run-off. In addition, urban arterials tend to be lined with numerous energy-consuming buildings. At the same time, they are places where people live, work, shop, and relax and so it is important to design urban arterials in ways that contribute to people's physical comfort on them. As well, common sense suggests they should be designed to help mitigate the local harmful environmental effects they cause. Several complimentary strategies can be employed to accomplish this. One strategy is to design urban arterials with facilities for pedestrians and bicyclists, in order to encourage people to drive less and thereby decrease both vehicle energy use and air pollution. A second strategy is to reduce the amount of heat absorbing surfaces on urban arterials, particularly dark asphalt, to address the urban heat island effect. A third strategy is to reduce the amount of non-permeable surfaces on urban arterials, to mitigate stormwater run-off. A fourth strategy, which contributes to mitigating all the environmental problems, is to plant significant shade-giving trees along urban arterials.

Specific key findings about trees from the Literature Review that are applicable to urban

arterials are the following:

- Street trees in urban areas provide significant environmental benefits over their lifetimes that result in significant cost savings to communities. Large trees provide significantly greater heating and cooling energy savings, air pollution absorption, and stormwater runoff reduction than smaller trees. Quantification efforts from a Washington and Oregon study suggest that a large street tree (46 feet tall; 41-foot spread) provides a benefit of \$55/year; a medium tree (39 feet tall; 31-foot spread), approximately \$25/year; and a small tree (28 feet tall; 25-foot spread), approximately \$5/year (McPherson, Xiao et al. 2002).
- A study of a community tree-planting program in Iowa found that each newly tree planted annually sequestered 1.5 pounds of carbon per year and removed significant amounts of ozone and particulate matter (Thompson, Nowak et al. 2004).
- Trees with wider trunks remove significantly more pollution than those with small trunks. For example, a tree with a 2.5-foot diameter trunk removes 65% more than trees less than 3 inches in diameter (Thompson, Nowak et al. 2004).
- In the hot climate of Davis, California, shaded asphalt pavement was found to be 20 degrees cooler than unshaded pavement (Scott, Simpson et al. 1999).
- Asphalt parking areas with 50% tree coverage were found to be associated with 5% lower vehicle emissions than unshaded areas (Scott, Simpson et al. 1999).
- Depending on crown density, street trees allow only 2-40% of solar radiation to reach the ground surface (Heisler 1974).
- A study of the effects of tree shade on asphalt concrete pavement performance found that tree shading contributed to better pavement conditions and longer material life (McPherson and Muchnick 2005).

Implications for the Design of Urban Arterials

When viewed holistically, the cumulative research findings presented above seem to recommend some key guidelines for the design of urban arterials:

- Consider street designs that contribute to lower driver speeds, particularly narrower travel lanes, in order to contribute to driver, pedestrian, and bicyclist safety.
- Install sidewalks, crosswalks, and supportive pedestrian infrastructure in a systematic and correlated manner to give pedestrians the best chance of walking safely along any roadway and to increase their perceptions of safety. The more pedestrians there are on the road, the safer each pedestrian will be.
- At signalized intersections provide pedestrian countdown intervals and leading pedestrian intervals as well as crosswalks.
- Where pedestrian crosswalks occur at uncontrolled locations, particularly along multi-lane roadways, provide supplementary safety features such as in-pavement warning lights or overhead flashing beacons.
- Provide bicycle lanes, bicycle paths, or sharrows to build a network on which bicyclists feel comfortable and can interact safely with traffic. The more bicyclists there are on the road, the safer each bicyclist will be.
- Provide trees and greenery, particularly along stretches of

- highway where commercial uses attract people and where people live, in order to enhance psychological well-being and community economic vitality.
- Plant shade-giving sidewalk trees closely spaced together to create a continuous canopy along the street that will enhance the physical comfort of pedestrians and cyclists.
 - Provide large shade-giving deciduous trees to mitigate local air pollution, stormwater runoff, and the urban heat island effect, contribute to energy savings in surrounding buildings, and extend pavement life.

These guidelines should benefit pedestrian and bicycle traffic, including drivers and transit users when they choose to walk. They should also contribute to a more vibrant community by attracting people to walk and bicycle to local destinations. The guidelines form the basis for the performance measurement framework presented in the following section, and are in keeping with both Complete Streets and Green Streets principles, which will be discussed in Chapter III along with policies related to these concepts that effect Caltrans. First, however, we turn to a discussion of key issues concerning performance measures followed by examination of best practice examples of performance measures used by transportation agencies.

III. Phase II Performance Measures Development

The second phase of the research project focused on developing performance measures for pedestrian and bicyclist safety and mobility and environmental sustainability. The full report on performance measures was titled "Performance Measures for Complete Green Streets: a Proposal for Urban Arterials in California" and was published in 2010. While the content of the measures was based on the literature review conducted in Phase I, the format of the measures was based on a review of performance measures literature conducted as part of this phase. Fortunately, much literature exists regarding the formulation and use of performance measures in governmental agencies, business, and industry, including a host of literature directed at transportation agencies. In researching the foundational principles of performance measurement, several documents emerged as most useful because of their clear articulation of key concepts, important issues, and the variety of possible measurement approaches. These documents are summarized in the following sections, and include a national report on best practices in performance measurement, the proceedings from a major transportation conference focused on performance measures, a report on the development of multimodal performance-based planning from the National Cooperative Highway Research Project (NCHRP), and guidelines on creating performance measures for use within context sensitive solutions, among others.

Why Measure?

Performance measures are used to gauge progress for a simple reason: "what gets measured gets done" (United States Government 1997). More specifically, measuring performance provides an avenue for accountability for stakeholders and management, generally resulting in improved communication between the various groups; helps to gauge efficiency and effectiveness within an organization; provides clarity about the planning process and agency expenditures; and creates a direct feedback loop to foster improvement over time (Peyrebrune 2000). Peyrebrune quotes Osborne and Gaebler in *Reinventing Government*:

- If you don't measure results, you can't tell success from failure.
- If you can't see success, you can't reward it.
- If you can't see failure, you can't correct it.

Most performance measurement systems are based on the following hierarchy: broad goals, objectives that state the target year and desired change, and the performance measures that will be used to track progress toward objectives and goals.

It is critical that the objectives reflect the goals and are clear about the desired direction and magnitude of result. The performance measures must be identified in response to the objectives and goals to ensure that the desired results are obtained, rather than just what may be easier to gauge, and that the measures will in fact reflect progress toward the goals. A key part of performance measurement is its ability to provide accountability, which is generally achieved through monitoring and feedback to the process, in addition to communicating and reporting results to various stakeholders (Peyrebrune 2000).

Performance measures are often defined to give feedback about systems, and therefore influence the decision-making process. Although there was mention of concern about decision-makers

“chasing” performance measures to achieve high marks, the literature was clear that although these measures can influence the process, they do not replace it (Cambridge Systematics 1999; Peyrebrune 2000). Project selection is often highly political and may depend on the presence of constrained funding. Performance measures should therefore be used to help make the best decisions possible under the circumstances and within the directive of over-arching policies. Ideally, performance measures will clarify the trade-offs that occur between design alternatives, thus providing transportation professionals with an accepted “neutral” guidance system.

With that said, however, there was also recognition in the literature of the need for transportation agencies to create goals, objectives, and measures that resonate with society and values for quality of life. Several speakers at the *Conference on Performance Measures to Improve Transportation Systems and Agency Operations* suggested that measures that are easy do not necessarily completely reflect society’s greater goals, and that allowance must be made for struggling through incompatible measures such that quality of life is maximized (Peyrebrune 2000).

Creating Successful Performance Measures

In 1997, Vice President Al Gore commissioned the *National Performance Review* (NPR) to examine best practices in performance measurement in the United States. The authors defined performance measures as “quantitative or qualitative characterization(s) of performance” based on the progress made toward pre-determined goals after certain amounts of time (Cambridge Systematics 1999; Peyrebrune 2000). Although specific goals depend on the industry and context, it is common for goals to focus on efficiency, quality, outcomes, and effectiveness. The NPR lists several elements critical to the successful development of performance measures, including:

1. Leadership and alignment with a strategic direction,
2. A conceptual framework that includes target setting and benchmarking,
3. Effective communication about the process and the results both internally and externally,
4. Results that provide intelligence rather than just gather information,
5. Accountability for the results, and
6. A system of compensation and positive reinforcement.

The performance measurement framework developed in this research project incorporates a number of these elements, specifically alignment with Caltrans’ strategic directions, a conceptual framework for target setting and benchmarking, a means for both internal and external communication, and the gathering of real intelligence about the performance of urban arterials in relation to Complete Streets and Green Streets principles. Incorporation of the other critical elements would fall to Caltrans in their implementation process.

The NPR also provides guidance on how to develop individual performance measures. It suggests that performance information should be used to, among other things, inform resource allocation decisions, understand gaps between vision and reality, and influence reconsideration of current practice. Above all, performance measures should encourage taking appropriate action. The NPR recommends that in order to be successful, performance measures should be:

- Resonant with customer values,
- Able to show both a snapshot and a trend of progress toward goals,

- Simple,
- Easily understandable,
- Sensible,
- Repeatable,
- Timely,
- Sensitive, and
- Economical with regard to data collection.

These directives helped shape the proposed performance measures for urban arterials developed in this research project. In particular, efforts were made to develop measures that were based in policy and legislation reflective of customer values, influence a reconsideration of current practice, and capture both snapshots and trends. As well, recommendations for data collection focus on economical methods, drawing on existing data sources whenever possible. More is discussed about this below and in Chapter IV.

Many federal and state agencies have adopted performance measure frameworks to evaluate their operations. The Department of Health Services in Wisconsin (DHFS) is one such agency and its approach provides useful insight to how a performance measurement system is implemented (Strategic Planning Unit 2001). The DHFS suggests a five-stage approach to performance measurement:

1. Identify your desired accomplishments at the highest level reasonable,
2. Identify the performance measure(s) you will use to determine if you are reaching your desired accomplishment,
3. Obtain baseline or trend information on your performance measure(s),
4. Obtain comparison data and set a target or standard that you are trying to reach for each performance measure, and
5. Gather and report performance data.

This systematic approach contributed a conceptual underpinning to the process used by the researchers when brainstorming possible performance measures.

Context Sensitive Performance Measures

In 2004, the National Cooperative Highway Research Project (NCHRP) published a report to guide state Departments of Transportation about how to be more context sensitive in their development and usage of performance measures (TransTech Management, Oldham Historic Properties et al. 2004). Depending on the context and specific needs of the organization, they encourage a balance of performance measures that gauge progress at both the project and the organization level, and that evaluate both planning and design processes and post-occupancy outcomes.

NCHRP recommends that process-oriented performance measures should reflect open, early, and continuous communication with all stakeholders, contain multi-disciplinary input, and be tailored to involve the public with consensus-building. Outcome-oriented measures should reflect community values, and be sensitive to scenic, aesthetic, historic, and natural resources.

In order to mesh with Caltrans' existing performance measurement system, the proposed

performance measures for urban arterials developed in this report are outcome-level measures. However, Caltrans is currently moving in the direction of implementing context-sensitive design approaches recommended by NCHRP. As it does so, the agency can develop additional performance measures to address the process components of its corridor design undertakings.

What to Measure

Agencies can measure performance through examination of inputs, which examine the resources dedicated to a program (e.g., dollars per mile of sidewalk); outputs, which examine the products of the program (e.g., number of miles of sidewalk); or outcomes, which examine the impact of the products on the overall goals (e.g., improved sidewalk surface) (Peyrebrune 2000). Although it may be easier to measure inputs, the outcomes are what tell the transportation agencies how close they are to meeting their objectives, and what the stakeholders most often want to know. Therefore, agencies are encouraged to measure outcomes if possible, and to measure outputs when outcomes are too difficult to measure; inputs almost never provide the final desired information, although they help management understand how resources are being used.

It can be tempting to base performance measures on information that is readily available; however, this practice should be avoided, and measures should be defined to provide the information that is most helpful to the agency. In addition, although transportation agencies do not fully control all outcomes associated with implemented projects, particularly behavioral outcomes, (e.g., several factors other than the presence of a sidewalk go into the decision to walk to work), they should still be encouraged to use measures specific enough to provide concrete diagnostic information (Cambridge Systematics 1999).

Setting Targets and Determining Data Sources

The process of setting targets is a key part of creating a successful performance measurement system. The U.S. Department of Energy suggests that each target should be far enough off that the organization has to work to reach it, but close enough that there is a realistic chance of meeting it within a defined time period (Cambridge Systematics 1999). Cambridge Systematics recommends setting targets by defining the agency's current position in the various areas and then determining what a reasonable improvement would be. These should include evaluation criteria that can be measured in the near-term, but which are related to longer-term measures and goals. In this way, targets provide something to reach for while maintaining morale in the organization.

In addition, the literature recommends that targets should be set using currently available data whenever possible, as using existing data sources minimizes the time and resources needed to collect the data and evaluate progress (Peyrebrune 2000). In some cases, however, existing data cannot provide the information needed. While speaking at the aforementioned *Conference on Performance Measures*, Tarek Hatata, President of System Metrics Group, Inc., put it this way:

One of the guidelines, and one of my issues with performance measurement in general, is that even though relying on existing data makes it faster to implement, we are going through a revolution of information technology and information data sources...Maybe we need to change and put additional funds into it, as opposed to relying on the same data, just trying to manipulate it, and making it into something else. It may be why things haven't changed in 50 years—because there is a reluctance at every level, the regional, state, and federal levels, to think outside of the box and say, "Let's collect new data, brand new data that may

give us brand new answers.”

In order to get these “new answers”, new data sources will have to be created when there is no appropriate substitute and no other way to accurately gauge progress toward the desired goals.

The proposed *Complete, Green Streets Performance Measure Framework* was designed to make use of existing data sources whenever possible. The researchers recognize that the administrative cost of creating new data collection and analysis methods could serve as an obstacle to the adoption of these new measures. However, because incorporating non-motorized modes into all strategic goals is relatively new, it will not be possible to measure progress towards Complete, Green Streets without creating some new data collection/analysis processes. In some cases, an action already undertaken by the Agency will need to be expanded so that additional data can be collected (e.g. the annual pavement survey). For other proposed measures, entirely new data collection systems are required (e.g. counting bicycle and pedestrian trips).

When to Measure

When an organization using a performance measurement framework is involved in building projects and maintaining a built infrastructure, like Caltrans, the issue arises as to when the performance measures should be used: during the design phase or after projects are built (Weisbrod, Lynch et al. 2007).

Decision-making measures occur at the beginning of the decision-making process and can therefore influence the type of project implemented so that the organization’s goals are more likely to be met in the near term. These measures are commonly directed toward internal audiences, such as management and staff within the organization.

Post-occupancy measures, on the other hand, occur after project completion, and serve to “grade” the project on how well it meets pre-determined goals. These measures are often used for external audiences, such as citizen stakeholder groups who are affected by the outcomes of the projects. Also, post-occupancy measures can be applied to individual projects, to all projects completed during a specified time-period, or to the entire system.

Decision-making and post-occupancy measures can be used discretely or together as part of a comprehensive system of performance measurement. The *Complete, Green Streets Performance Measure Framework* includes measures that can be used during the decision-making stage of Caltrans’ work (i.e., when decisions are being made about which urban arterial projects to pursue, or which design elements to include in planned urban arterial projects), and for on-going monitoring of completed projects. Some proposed measures for completed projects evaluate only those projects completed during a specified time period (i.e., quarterly), while others measure the performance of Caltrans’ entire urban arterial system.

Assigning Value

One complex aspect of performance measurement is the assignment of value to certain goals or strategies. Perhaps the most common way of doing this is through the process of monetization, which incorporates direct and indirect costs to assign a dollar value to alternative proposals.

However, it is important to remember that not every impact can accurately be represented in monetary terms. Therefore, an alternative way is deciding a hierarchy of goals and choosing a design or implementation strategy that best fits that hierarchy. These two methods are discussed below.

Monetization

When an organization strives to meet several diverse goals with limited resources, it can be difficult to prioritize certain goals over others. Many organizations choose to monetize the expected benefits and costs in order to develop a hierarchy. A broad study of monetary valuation with regard to the effects of the transportation system, sponsored by the NCHRP, concluded that both direct and indirect effects should be monetized in order to create a holistic picture of a system (Weisbrod, Lynch et al. 2007). Direct effects include, but are not limited to:

- Accessibility (including Americans with disability),
- Mobility,
- Operations Efficiency (Average Travel Time and Distance),
- Customer satisfaction, and
- Safety.

Indirect effects measure the impact on people and the environment, and can include:

- Economic development,
- Environmental quality (air, water, land),
- Health,
- Quality of life, and
- Security.

The authors recommend that cost and benefit values may be determined by a variety of methods, including:

- Damage costs, which reflect the total estimated amount of economic losses produced by an impact;
- Control or prevention costs, which are estimated based on what it would cost to prevent, control, or mitigate an incidence after it occurred;
- Hedonic methods, which infer values for non-market goods from their effect on market prices, property values, and wages;
- Contingent valuation, which infers costs by surveying a representative sample of individuals about how much they value a particular non-market good;
- Compensation rates, which are legal judgments and other compensation rates for damages that can be used as a reference for assessing non-market costs; and
- Shadow prices, which reflect visitors' actual travel-related costs incurred (non-monetary expenses and time costs) as a way to measure the "consumer surplus" provided by making a trip. These prices may also be used to assign costs to emissions and resource loss.

While monetization may be convenient, it routinely faces the challenges of establishing a hierarchy of values and quantification of qualitative impacts. The challenge of the hierarchy of values refers to the reality that for different stakeholders, different aspects of a transportation system may be prioritized. For some, throughput and efficiency (direct effects) may be the most

important or valuable aspects, while for others environmental preservation and perceptions of comfort and safety (indirect effects) may be the most important. Although monetization may seem like a neutral way to value benefits and costs, this is often not the case due to the reality that many of the costs and benefits associated with transportation are not directly measured in dollars. This leads to the second challenge, which is that of quantification. Each stakeholder group may have a different opinion on the value of a life saved or the cost of treating or precluding air pollution. Because there are no universally-accepted values for many important impacts of transportation projects, subjectivity is almost always involved in the quantification of these impacts.

Even though the process is imperfect, however, it is important to quantify these effects as well as possible, to thwart the tendency of decision-makers to focus on “easy-to-measure impacts.” Table gives an example of some of NCHRP’s suggested valuations for direct and indirect effects.

Table . Assessment of Monetization Potential of Categories

Impact Class	Comments on How These Impacts or Benefits are Monetized
Accessibility	The monetary value for accessibility can be some form of the economic value of the activity that is occurring on the land enabled by transportation investment. Or the value of the travel time associated with accessing a particular activity might be a surrogate for the monetary benefit associated with such a trip (for example, such an approach is used for valuing recreational trips to major parks).
Mobility	The value of mobility improvements is commonly measured as the value of time and cost savings resulting from traffic congestion reduction or transit service improvement. For freight, there can be an economic measure of improved productivity for the freight sector.
Safety	Monetary measures can be developed for safety performance, based on the societal cost of vehicular crashes (from NHTSA) and the cost of injuries and death (by FHWA and other agencies).
Customer Satisfaction	It is not clear how to monetize customer satisfaction, except via a survey of stated preferences.
Energy & Resource Conservation	The value of reduced consumption of non-renewable resources is measurable as the cost savings to society and consumers.
Environmental Quality	The traditional approach is to assign monetary values to the reduction in health risks associated with transportation improvements.

The United States Office of Management and Budget recommends considering performance measure monetization from multiple perspectives (Office of Management and Budget 2003). For example, the benefits of the presence of positive effects should be quantified, as should the benefits of the absence of negative effects. In addition, active impacts are more easily quantifiable than passive impacts (such as a public park that one can see and use versus air pollution that may or may not be visible), but not necessarily more important, so they should be considered commensurate with their ultimate value.

Because of the complexity that would be involved in monetizing the impacts of transportation corridor design features, due to the need to debate and come to agreement on a whole host of values related to both direct and indirect impacts, monetization has not been included in the proposed performance measure framework developed in this research project.

Scoring System

An alternative to monetization is creating a scoring system that organizations can use to rank projects. This system tends to work when the organization is clear about its hierarchy of values and how each direct and indirect effect fit into the hierarchy, therefore precluding the need for monetization.

One example of such a system is the Eastman Kodak Safety Performance Index (Training Resources and Data Exchange 1995). The company develops a performance matrix with the goals and range of performance (on a scale of 1-10) for several metrics. The components are ordered in terms of importance and then weighted against one another. Each metric has a baseline, a goal the company expects to meet, and a “stretch goal” that could be attained with excellent performance. Values are determined for each baseline, goal, and stretch goal per metric (such as number of unplanned shutdowns). Actual values are then filled in and multiplied against the weight to find the “score” of each matrix. In this way, the company can monitor its progress, but the origins of the goals are based on an established hierarchy, which can include, but is not automatically linked to, monetization.

The researchers considered incorporating a scoring system into the proposed performance measurement framework developed for urban arterials. However, this approach was discarded in favor of developing an approach more consistent with the current system of performance measurement used by Caltrans.

Using the Information Generated by Performance Measurement

Performance information can be used in multiple ways. In its *Best Practices in Performance Measurement* report (United States Government 1997), the federal government suggests using the information to:

- Guide resource allocation decisions,
- Aid employee and management evaluations,
- Define gaps between goals and reality,
- Drive reengineering,
- Aid benchmarking,
- Improve organizational processes,
- Adjust goals, and
- Improve measures.

The researchers intend that Caltrans use the proposed *Complete, Green Streets Performance Measurement Framework* developed for this project in all these ways.

Best Performance Measurement Practices for Complete and Green Streets

In order to supplement Caltrans' current performance measures with measures that are both practical and progressive, the researchers reviewed various performance measurement frameworks used by other state DOTs. Of these, several performance measures stood out with regard to monitoring progress toward implementing Complete Streets principles. In particular, the states of Oregon, Vermont, and Washington, and Florida were identified as having performance measures most aligned with Caltrans goals, and were therefore used as a model for the newly proposed performance measures. An expanded discussion of these agencies' performance measures can be found in the report "Performance Measures for Complete, Green Streets: A Proposal for Urban Arterials in California."

In addition, current legislation, plans, and policies applicable to pedestrians and bicyclists in California were reviewed to ensure consistency with the proposed performance measures. These policies and plans are briefly described in Section B of Chapter III in this report.

Evaluation of Caltrans' Current Objectives and Performance Measures

Caltrans' traditional focus, as with all DOTs, has been on highway and motor vehicle engineering – which for a long time was the clear preference of most of the State. However, as people have grown more aware of the potential negatives of this singular focus, a different type of engineering and design – one that accounts for non-motorized travelers and the surrounding environment – has been and is being demanded. This new preference is prompting the Department to strengthen performance measures addressing non-motorized users and stewardship of natural resources. The following section examines the goals and objectives of the Strategic Plan (California DOT 2007) and analyzes how the objectives and performance measures could be modified to better fit with Complete Streets and Green Streets principles.

Goal: Safety

Caltrans' goal related to safety is to “**provide the safest transportation system in the nation for users and workers.**” However, only one of the three related objectives in Caltrans' 2007-2012 Strategic Plan aims to measure *users* of the transportation system (the other two measure Caltrans worker safety), and it measures *motorized* users:

Objective 1.1: By 2008, reduce the fatality rate on the California state highway system to 1.00/100mvmt and continuously reduce annually thereafter toward a goal of the lowest rate in the nation.

PM 1.1A: Fatalities per 100 million vehicle miles traveled (mvmt) on the California state highway system

Measuring fatalities per 100 million VMT obscures significant trends in pedestrian and bicyclist fatalities, as these modes travel only hundreds or in the low thousands of miles each year. Caltrans is attempting to address this lack of measurement through the Strategic Highway Safety

Plan (SHSP) as noted earlier. It is also important to remember that the term “state highway” refers both to limited access expressways and urban arterials. While the overall number of pedestrian and bicyclist deaths may be low on limited access highways due to low amounts of exposure, urban arterials remain important corridors for pedestrian and bicyclist movement and should be made measured separately to truly monitor and work toward safety.

Goal: Mobility

Caltrans’ goal related to mobility is to “**maximize transportation system performance and accessibility.**” This goal is subdivided into four objectives, two of which could feasibly affect non-motorized transportation: reducing delay and reducing single occupancy vehicle trips. However, unlike the performance measures from Oregon cited in Chapter II, Caltrans’ measure for delay looks at vehicle hours rather than person hours. This focus on vehicles suggests that pedestrian and bicycle delay is not measured.

Objective 2.1: By 2012, reduce daily vehicle hours or delay by 30,000 hours throughout the transportation system.

PM 2.1A: Average daily hours of delay

The second mobility objective aims to reduce single occupancy vehicle trips:

Objective 2.4: By 2012, reduce single occupancy vehicle commute trips by 5%.

PM 2.4A: Percent of single-occupant vehicles as compared to the total commute trips

This measure is one step Caltrans has taken to promote a more diverse transportation system. However, the objective could be reached through increased carpooling or transit use, and does not directly measure changes in non-motorized facilities or trips. Caltrans mentions non-motorized travel as a strategy for meeting this objective, suggesting an “increase (in) support for non-motorized and promotion/incentives for use of other alternate means of transportation.” This strategy is the only direct reference to non-motorized transportation in the entire mobility section. If bicycling and walking are to be encouraged in keeping with the policies and goals described earlier in this chapter, clearly additional objectives and measures dealing specifically with non-motorized transportation are needed.

Goal: Delivery

Caltrans goal for delivery is to “**efficiently deliver quality transportation projects and services.**” Because this goal applies to overall project efficiency and not to the delegation of resources, it does not favor one mode or user group over the other and has no direct relation to environmental quality. Therefore, within the proposed new framework presented in Chapter IV, no new objectives or performance measures are proposed for delivery.

Goal: Stewardship

The goal for stewardship is to “**preserve and enhance California’s resources and assets.**”

Most of the objectives for this goal focus on Caltrans' resources, such as pavement, infrastructure, and funding, instead of the natural resources in California. However, objective 4.4 pertains to the natural environment:

Objective 4.4: Each year, ensure environmental commitments are documented and implemented on 100% of projects.

PM 4.4A: Percent of projects that have updated environmental commitment records and a Certificate of Environmental Compliance at project closeout

PM 4.4B: Percentage of projects that have an Environmental Certification, including an updated Environmental Commitments Record, at the ready-to-list (RTL) milestone

“Environmental commitments” are the actions Caltrans must take to ensure that the *California Environmental Quality Act* (CEQA) is observed during construction. However, CEQA only deals with mitigating possible harm caused by a new project, and does not push Caltrans to improve the existing environment of the transportation corridor, such as mitigating the amount of pollution already present due to travel along the corridor. While this has been the accepted practice for years, the urgency of global climate change and its effects on California's natural environment prompt a reconsideration of this practice to include more mitigating aspects.

One of the proposed performance measures in Chapter IV concerns increasing permeable surface area through landscaping to aid in stormwater retention and reduce the urban heat island effect. Both of these effects should enhance the longevity of the infrastructure, in keeping with goal #6 of the California Transportation Plan, and the quality of the environment for users, in addition to the benefits they provide through water and energy savings. A second proposed measure concerns planting trees along the corridor to increase air pollution interception, provide shade for users and buildings, thereby decreasing energy usage and reducing the urban heat island effect, and provide additional stormwater retention. Enhancing the quality of the corridor through these measures has the complimentary benefit of creating a more pleasant environment for pedestrians and bicyclists, which may encourage more non-motorized trips and possibly lead to fewer motorized trips.

Goal: Service

The final goal for Caltrans pertains to service, and is to “**promote quality service through an excellent workforce.**” This goal is accompanied by several objectives, none of which deal specifically with training for any particular user group. Given the strong history of highway engineering in Caltrans, however, it seems appropriate and may be necessary to encourage training regarding other user groups in order to adequately plan and design Complete Streets. Two of the current objectives are related to this idea, and should provide momentum for complete streets training:

Objective 5.3: By 2012, increase by 15% the number of Caltrans employees who agree or strongly agree that employees are encouraged to try new ideas and new ways of doing things to improve Caltrans.

PM 5.3A: Percent of Caltrans employees that agree or strongly agree that employees are encouraged to try new ideas and new ways of doing things to improve Caltrans.

Objective 5.5: By 2012, increase by 5% the number of Caltrans employees who agree or strongly agree that the training they have received at Caltrans has adequately prepared them for the work they do.

PM 5.5A: Percent of Caltrans employees who agree or strongly agree that the training they have received at Caltrans has adequately prepared them for the work they do.

Looking Forward

The numerous policy goals and mandates described in this chapter speak to a vision of a completely multi-modal transportation system, which is inherently more sustainable than the current system and its primary focus on motorized single-occupancy vehicles. However, as can be seen from the above analysis of the objectives and measures in current Caltrans' Strategic Plan, work is needed to create roadways that embrace all users and enhances community quality of life. The next chapter describes in detail the *Complete, Green Streets Performance Measures Framework for Urban Arterials* proposed to encourage progress toward this more sustainable vision. California has shown national leadership at several key times in its transportation-related history, such as requiring unleaded gasoline in the 1970's and higher fuel standards in the 2000's. The proposed new performance measures represent yet another pivotal opportunity for the State of California to take the lead in transportation policy and practice.

Proposed Performance Measures for Complete, Green Streets

The following proposed performance measurement framework will aid Caltrans in meeting its own internal Directive to improve mobility for non-motorized users and build a Complete Streets network. Recognizing the numerous community and environmental quality benefits that trees and permeable surfaces bring to transportation facilities and the communities they serve, the performance measure framework incorporates elements of the Green Streets concept. Recognizing as well that improvements to urban arterials will result in the greatest local quality of life benefits, the framework is directed toward them. Specifically, this *Complete, Green Streets Performance Measures Framework for Urban Arterials* it is designed to result in more:

- bicycle and pedestrian facilities and safety features
- people who safely bicycle and walk
- permeable surfaces,
- trees, and
- Caltrans staff trained in the design and maintenance of bicycle and pedestrian facilities.

By combining the proposed measures with Caltrans' existing measures, the agency would take a major step toward creating a meaningful and comprehensive system to measure their progress toward a complete, multimodal and community-serving transportation system.

To enable Caltrans' incorporation of these new measures into their current performance measure document, the proposed framework is presented using Caltrans' existing format and structure. Each section begins with the Agency's adopted goals regarding Safety, Mobility, Delivery, Stewardship and Service. Following each goal are proposed objectives, labeled "CGS

objectives” (for Complete, Green Streets), and performance measures, labeled using the abbreviation “PM”. For reference, Caltrans’ existing objectives and performance measures for each goal (already adopted and monitored by Caltrans) are included in the Appendix A of this document. The numbering of the new (proposed) objectives (i.e., 1.1, 1.2, etc.) and measures will need to be adjusted when they are incorporated with the existing framework.

The following paragraphs detail the proposed objectives and performance measures, including a discussion of how Caltrans can collect the data and set the targets for each measure. In several places, an “X” is used as a placeholder for a year or target where more work is needed before a finite target year (i.e., 2017) or target level (reduce injury rate to 1 per 1 million vehicle miles traveled) could be set. It is recommended that Caltrans apply the same target setting methodology for these new measures that it uses for its existing performance measures, incorporating stakeholder involvement when necessary.

SAFETY

Goal: Provide the safest transportation system in the nation for users and workers.

CGS Objective 1.1	By 20XX, reduce the annual pedestrian and bicycle injury and fatality rates to the following levels, and continuously reduce annually thereafter with the goal of having the lowest rates in the nation. Pedestrian fatality rate target: X per X walking trips. Pedestrian injury rate target: X per X walking trips. Bicyclist fatality rate target: X per X bicycling trips. Bicyclist injury rate target: X per X bicycling trips.
PM 1.1a	Number of pedestrian fatalities per x walking trips.
PM 1.1b	Number of pedestrian injuries per x walking trips.
PM 1.1c	Number of bicyclist fatalities per x bicycling trips.
PM 1.1d	Number of bicyclist injuries per x bicycling trips.

Discussion

In existing performance measures, Caltrans tracks the safety of drivers and workers, but not of non-motorized users. This omission is incompatible with the Agency’s goal to provide a safe system for all users. In many communities, urban arterials serve as central corridors that provide essential mobility and accessibility for pedestrians and cyclists. While traveling on urban arterials, however, pedestrians’ and bicyclists’ exposure to injury and death is severe compared to automobile drivers’. Because they are not surrounded by the metal buffer of a vehicle, non-motorized users can be severely injured or killed by even low-speed crashes. Furthermore, research indicates that the likelihood of a pedestrian surviving a crash with a vehicle decreases significantly between the vehicles speeds of 30 and 40 MPH (Leaf and Preusser 1999). This fact is especially significant to this research effort, since vehicles on urban arterials tend to travel at speeds in this range.

Furthermore, there is a growing body of research that quantifies the economic costs to a

community of traffic-related injuries and fatalities. According to the National Highway Traffic Safety Administration, the total cost in 2000 to the United States of all crashes, including vehicle, pedestrian and bicyclist crashes, was \$230.6 billion (in 2000 dollars) (NHTSA 2007). Similarly, a review of national studies commissioned by the California Department of Motor Vehicles found that the cost of traffic accidents in California ranges annually from \$13 to 49 billion (in 1994 dollars) (Peck and Healey 1996). These costs include losses to property damage and productivity, medical expenses, and other societal costs. As a state agency that is responsible for a major transportation system and community asset, Caltrans should work to reduce these costs to the greatest extent practicable.

Caltrans should adopt a broad, system-wide approach to improving pedestrian and bicyclist safety along urban arterials. Since only some of the transportation facilities in an urban area are state-owned and operated, this safety objective will require Caltrans' continuing coordination with other jurisdictions and stakeholders who are involved in planning, operating and using the local transportation system. A comprehensive approach that incorporates facility improvements, safety programs and educational campaigns may be recommended.

Data Collection

Summary: Existing data sources need to be expanded and new data needs to be collected.

For all four of these proposed performance measures, injury and fatality data will come from the existing Statewide Integrated Traffic Records System (SWITRS) data set. The agency will need to adjust its current data entry and reporting technique to isolate pedestrian and bicycle injuries and fatalities. Caltrans may also need to work with local police and the California Highway Patrol to ensure that local accident data for all urban arterials is captured.

For walking and bicycle trips, Caltrans should work toward conducting targeted counts of non-motorized trips on urban arterials. To collect this essential data, Caltrans could partner with university research centers and consulting agencies. This goal is also included as a part of a new objective, or "action" in the SHSP. Until this new data is collected, Caltrans could estimate pedestrian and bicycle trips using existing regional sources, like the Bay Area Transportation Survey (BATS), or from statewide census data, although these data sources are limited in scope and should not be considered long-term replacements for the more targeted exposure data.

Some challenges to measuring the rate of pedestrian and bicyclist injury and fatality should be noted. First, there is limited data on the number of pedestrian and bicyclist trips occurring on state urban arterials. While Caltrans works to generate better data on the number of non-motorized trips, statewide modeshare data from the Census can be used as a proxy for walking and biking trips on urban arterials. While this is a functional short-term solution, there are several issues that need to be addressed long-term. First, the Census counts commute trips, which only account for approximately 20% of present-day travel. In addition, it is taken in April, when it is still too cold to walk and bicycle in many parts of the country, thus incorrectly approximating the amount of non-motorized travel at other times of year. It also only counts the mode used for the longest part of the trip, so a trip that is part walking and part bus would be counted as bus if that segment were longer.

Second, this method of measuring the rate of injury and fatality does not specifically account for exposure on Caltrans urban arterials as opposed to other Caltrans facilities. Third, injury and fatality rates can be misleading in cases where there are no deaths or injuries because no one is walking or biking in a certain location. For this reason, overall trips (which are measured in proposed Mobility Objective 2.1) must also be measured and considered in relation to injury and fatality rates. A final challenge with this objective is that pedestrian and bicyclist injuries and fatality records often under-represent the actual number of incidents. Police records do not always accurately record the type of collision and anecdotal evidence suggests that many crashes go unreported. Furthermore, injury and death data from hospitals is rarely gathered and compiled with police report data. For these reasons, the rates calculated for this measure should be used primarily to monitor trends and Caltrans should work with partner agencies to improve the collection of injury and fatality data for pedestrians and bicyclists.

Setting Targets

The proposed target year 2014 was selected with input from Caltrans headquarters in order to provide enough time to feasibly begin to reach the goal. The rate targets (pedestrian injuries per walking trip, etc.) could be set using projections of the decreasing injury and fatality rate over the past several years.

CGS Objective 1.2	By 20XX, establish a baseline of the percentage of Californians who feel safe using non-motorized modes on urban arterials. Annually increase this percentage, with the goal of having the highest reported percentage in the nation.
PM 1.2	Percentage of Californians who feel safe using non-motorized modes on urban arterials.

Discussion

Safety of non-motorized users must be measured in a variety of ways. Measuring safety by counting injuries and fatalities, however, is only one way to look at safety. People’s perception of safety plays an important role in their decision to walk or ride a bicycle. Monitoring user attitudes will help to gauge perceived safety amongst all system users, not just those who currently choose to walk or bike. This measure will help the Agency direct projects or programs to areas that might yield to the greatest improvements in perceived safety and use.

Caltrans could begin measuring perceived safety through their annual External Customer Survey, which includes a user survey. Such a survey could be administered to all state residents by mail, as is done by the Oregon DOT. Caltrans could use this opportunity to ask other questions of its users to help measure improvement in other areas. According to the timeline proposed here, Caltrans should administer the first user survey in 2012 in order to set a baseline for the number of system users who feel safe walking and biking on Caltrans urban arterials. As long as Caltrans receives enough responses, the rate can be determined using number of positive responses over the number of survey respondents, which will serve as a statistically significant proxy for population.

Data Collection

Summary: An existing data source must be adapted for this measure.

Caltrans currently conducts an External Customer Survey. This measure would require the addition of one or two new questions to that survey.

Setting Targets

The proposed target year of 2017 is the next time that Caltrans will update its Strategic Plan after 2012. By syncing target dates with Strategic Plan updates, Caltrans will have the opportunity to change Strategic Planning priorities to improve upon any areas where targets are not met. This is the approach Caltrans currently uses in setting existing performance measure targets. The 2017 target gives Caltrans ample time after the performance measures are adopted to gather the necessary data and be prepared to monitor it annually thereafter.

CGS Objective 1.3	By 20XX, all Caltrans urban arterial projects (new expenditures) are designed to increase safety for non-motorized users in accordance with Complete Streets principles. Ensure that each new and retrofit urban arterial project incorporates Complete Streets principles annually thereafter, with the goal of thorough Complete Streets influence over time.
PM 1.3a	Percent of signalized intersections along urban arterials with marked crosswalks and one or more of the following: countdown signals, leading pedestrian intervals, bulb-outs, or pedestrian refuge islands.
PM 1.3b	Percent of unsignalized 4-way (multilane) intersections along urban arterials with marked crosswalks and one or more of the following: HAWK signal*, yield to pedestrian signage, user-activated overhead warning lights.
PM 1.3c	Percent of urban arterial intersections with one or more of the following improvements geared toward bicyclists: bike box*, painted bicycle lane through the intersection*, bicycle signal, functioning bicycle loop detectors, bicycle left turn lane.
PM 1.3d	Percent of urban arterials that do not have a posted speed greater than 25 mph.

Discussion

Incorporating pedestrian and bicycle safety treatments into urban arterial projects will be an important part of building Complete Streets. These performance measures are meant to compliment the previous proposed safety measures (1.1 & 1.2) by measuring physical improvements geared toward pedestrian and bicyclist safety on Caltrans urban arterials. Urban arterials are located in central areas, which typically have a high vehicle throughput. For this reason, Caltrans must target these facilities with special safety features that have been shown to

* It should be noted that the HAWK signals have not yet been approved for use in California, although it is expected to be so in the future. Bike boxes and painted bicycle lanes have been approved for provisional use.

*

reduce pedestrian and bicyclist collisions and improve perceived safety.

Performance measures 1.3 a, b, and c measure the percent of urban arterial intersections in the Caltrans system where a specified list of treatments (countdown signals, HAWK signals*, bike boxes, etc.) are provided. These treatments were selected because there is substantial literature indicating their effectiveness at improving pedestrian or bicyclist safety. Measures 1.3a and b are designed to improve pedestrian safety at two of the most dangerous places along urban arterials: signalized and unsignalized intersections along multilane arterials. Performance measure 1.3c will help Caltrans build Complete Streets by measuring progress toward broadly incorporating bicycle safety into the design of urban arterials, particularly at intersections.

It is important to note that these measures are not meant to prescribe design treatments for urban arterial intersections or to result in all treatments being used at all locations. Instead, Performance Measures 1.3 a, b, and c provide designers with a list of approved treatments that have a demonstrated effect on motorist, pedestrian or bicycle behavior and safety, with the goal of a system-wide increase in the application of these treatments. The list of safety treatments in Performance Measures 1.3a, b, and c will encourage Caltrans designers to use their professional judgment to design context-sensitive solutions that suit each intersection. As with all traffic facilities, careful design will be essential. Especially for treatments that have not been widely applied in California, such as bike boxes and bicycle left turn lanes, close consultation with design guidelines (*like the AASHTO Greenbook or the AASHTO Design Manual*²) and/or with pedestrian and bicycle design professionals may be necessary.

While Performance Measures 1.3 a, b and c focus specifically on intersections, urban arterials must also be designed to promote safety of users traveling along a road section. Performance Measure 1.3d gauges the “percent of urban arterials that do not have a posted speed greater than 25 mph” and is intended to address design speed. While the mission of Caltrans is to improve mobility in California, historically in the transportation field, improving mobility has meant increasing driver speeds. Increasing vehicle speeds, however, can be highly detrimental to driver, pedestrian and bicyclist safety. In order to build Complete Streets, Caltrans must apply a balanced approach that provides multimodal mobility without sacrificing the safety of any users.

Research has shown that the relationship between risk of injury or death and vehicle speed is non-linear (Leaf and Preusser 1999). For example, a pedestrian hit by a car traveling 20 mph has an approximately 80% chance of surviving with a non-incapacitating injury, while that chance drops to less than 60% when hit by a car traveling at 30 mph. As speeds rise, the risk continues to increase non-linearly. Because of this reality, it is important to consider pedestrian and bicyclist safety when designing a corridor for a certain speed—particularly when drivers may exceed the speed limit and further increase the risk.

In the State of California, the de facto speed limit for business or residential districts is set by the Vehicle Code at 25 MPH. However, localities can petition to have their speed changed if they demonstrate that 85% of drivers are driving a certain speed. In other words, the 85th percentile

² See also Zegeer, C. V., C. Seiderman, P. Lagerwey, M. Cynecki, M. Ronkin, and R. Schnieder. 2002a. *Pedestrian facilities users guide—Providing safety and mobility*. Report No. FHWA-RD-102-01. Washington, DC: Federal Highway Administration.

rule adjusts the law (speed limit) to fit the behavior (actual speed). According to the Vehicle Code, “a reasonable speed limit is one that conforms to the actual behavior of the majority of motorists, and by measuring motorists’ speeds, one will be able to select a speed limit that is both reasonable and effective.” While this system may be appropriate on freeways and major highways, it is not suited to urban environments where roads are shared by a variety of users.

This measure approximates the 85th percentile speed by measuring the percent of urban arterials on which the speed limit has been raised above the de facto 25 mph. By monitoring this quantity, Caltrans will be able to know which streets should perhaps be modified to encourage lower speeds in order to ensure maximum safety and comfort for all users. There is a range of design treatments that can help accomplish desired vehicle speeds and increase user safety while maintaining system throughput. In some circumstances, speed-calming measures such as center islands or raised intersection crosswalks may be appropriate. Lane narrowing may also be a desirable approach, especially on urban arterials and in places with limited right-of-way. Narrowing lane widths has been associated with slower driving speeds and accident rates that were either reduced or unchanged (Fitzpatrick, Carlson et al. 2000; Harwood 2000). According to the AASHTO *Green Book*, urban arterials lane widths may vary from 10 to 12 feet. The *Green Book* states that 12-foot lanes may be most appropriate on higher speed, free flowing, principal arterials. However, on signalized arterials operating at less than 45 MPH (all urban arterials), “narrower lane widths are normally quite adequate and have some advantages.” Furthermore, it has been demonstrated that vehicle capacity is minimally or not at all affected by a reduction of lane widths from 12 to 10 feet (Zegeer 2007).

Data Collection

Summary: A new process for collecting and analyzing data is required for these measures.

For all of these performance measures, data for measuring new projects/expenditures should be collected from the final design documents for individual projects. A new form may be needed to collect this data. For measuring system-wide facilities, data must be compiled from each of the Caltrans regional districts. A new database or GIS file could be created to ease in the evaluation of this measure.

Setting Targets

Caltrans’ Complete Streets Deputy Directive (DD-64-R1) was issued in October of 2008, but the proposed performance measures project did not conclude until 2011. Therefore, the Agency believes it is reasonable that it could be designing all new projects as Complete Streets by 2014 (after the next Strategic Plan update). The three-year interim gives the Agency time to adjust their design procedures and train staff as needed. Caltrans may choose to conduct a facility safety audit to determine the timeline and cost of meeting this target. The target for each of the first three performance measures, which work toward all facilities designed for safety according to Complete Streets principles, will be 100%.

CGS Objective	By 20XX, annually reduce the number of pedestrian and bicycle hotspots (high concentration of collisions) on urban arterials.
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1.4

PM 1.4a	Overall number of pedestrian collision hotspots on urban arterials.
PM 1.4b	Overall number of bicycle collision hotspots on urban arterials.

Discussion

Even as Caltrans succeeds in reducing the overall system rate of pedestrian and bicyclist injury and fatality, the Agency must work to address its most unsafe locations. Caltrans already has a process for mapping and responding to vehicle collision hot spots, functionally defined in the Agency as any cluster of collisions. This performance measure simply extends that process to bicycle and pedestrian collision clusters as well. Since this performance measure applies only to urban arterials, hot spots should be analyzed for collisions occurring on similar road types, as is currently done for automobiles. Also, since pedestrian, bicyclist, and driver safety each depend on a different set of roadway characteristics, it is essential that each mode is analyzed individually.

Data Collection

Summary: Existing data sources will have to be altered for these measures.

For both of these measures, injuries and fatalities could be mapped using data from the California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS), though the Agency will need to change their data entry and reporting technique to isolate pedestrian and bicycle injuries and fatalities. A goal of the SHSP is to update TASAS with pedestrian and bicycle injuries. In analysis, however, it will be important to recognize that pedestrian and bicycle crashes are underreported. Therefore, data from state databases likely do not reflect the extent of pedestrian and bicycle traffic-related injuries.

Setting Targets

If Caltrans is continually working to address areas of concentrated injury and fatality, the agency's goal should ultimately be to have zero hotspots. This performance measure must be addressed in coordination with an effort to reduce the overall rate of pedestrian and bicycle injury (as captured in proposed performance measure 1.1).

MOBILITY

Goal: Maximize transportation system performance and accessibility.

CGS Objective 2.1	By 20XX, all Caltrans urban arterial projects (new expenditures) are designed to increase mobility for non-motorized users in accordance with Complete Streets principles, aiming to link up to a larger community bicycle and pedestrian network where possible. Ensure that each new and retrofit urban arterial project incorporates Complete Streets principles annually thereafter, with the goal of thorough Complete Streets influence
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over time.	
PM 2.1a	On urban arterials, ratio of sidewalk mileage to roadway mileage, bi-directionally.
PM 2.1b	On urban arterials, ratio of Class II bicycle facility mileage to roadway mileage, bi-directionally.
PM 2.1c	On urban arterials, percentage of intersections that are ADA compliant.
PM 2.1d	Percentage of urban arterial projects designed as Complete Streets.
PM 2.1e	Number of pedestrian trips on urban arterials.
PM 2.1f	Number of bicycle trips on urban arterials.

Discussion

To accomplish its Complete Streets directive, Caltrans must begin measuring the mobility provided to system *users*, not to automobiles. Mobility is the ability and efficiency, usually measured in time, with which one can move between places. Measuring mobility for pedestrians and bicyclists is very different than doing so for automobiles. For bicyclists and pedestrians, the first measure of mobility is whether a reasonable travelway exists for them to walk or bike on. For this reason, the Complete Streets mobility performance measures begin with 2.1a and b, which measure the system-wide presence of sidewalk and Class II bicycle facilities, respectively, in comparison to roadway miles. It is important to note that broader system connectivity will be important in providing pedestrian and bicyclist mobility. To accomplish this, Caltrans should work with local jurisdictions and consider how bicycle and pedestrian facilities on urban arterials connect to surrounding streets. Furthermore, Caltrans should incorporate local bicycle and pedestrian plans into the design of urban arterial facilities.

In addition to measuring the presence of a facility for non-motorized users, the Agency must continue to measure the accessibility of that facility to people with disabilities. The Americans with Disabilities Act (ADA) requires that governments provide accessibility for people with disabilities to all public services and facilities. With regards to new projects in the public realm, ADA has led to a near-universal application of ramps and curb warning systems at intersections, wheelchair-accessible push buttons at crossing signals, and many other features. Since ADA was passed in 1990, however, most jurisdictions have not been able to retrofit all of their pre-existing facilities to ADA compliance, due to financial limitations. Central to the Complete Streets concept, however, is the idea that the streets are public spaces that can be used by everyone. California's progress toward ADA compliance on all facilities is an important measure of their progress toward Complete Streets. For this reason, performance measure 2.1c measures the percentage of intersections that are ADA compliant. Intersections, rather than entire sections of roadway, are measured for reasons of feasibility – but Caltrans should work toward accessibility on all of its facilities.

Performance measure 2.1d directly tracks the Agency's progress toward designing transportation projects, specifically urban arterials, as Complete Streets. One might find this measure duplicative with other measures proposed here, but this is the measure that considers all modes and travelers simultaneously. If Caltrans is making improvements on each of the other new measures proposed here, this measure will also steadily improve. To determine if the facility

qualifies as a Complete Street, Caltrans should adopt a scorecard that can be used in the final design phase of project development.

While the existence and design of a facility is important, people's decision to walk or bike depends on a wide range of factors. Performance measures 2.1e & f count the actual number of trips made by pedestrians and bicyclists on urban arterials. This measure incorporates the outcomes of the facility-oriented work addressed by the previous proposed measures and thus, allows the agency to measure multimodal mobility in a comprehensive way.

Data Collection

Summary: New data methods will need to be generated for these measures.

For measures 2.1 a, b, and c, Caltrans will need to compile facility data from each of the regional District offices. A unified database or GIS file might ease in reporting for this measure.

For measure 2.1d, Caltrans will need to develop or adopt a scorecard/checklist for determining whether a facility qualifies as a Complete Street.

For measures 2.1 e and f, Caltrans should work toward conducting targeted counts of non-motorized trips on urban arterials. This data is also required for proposed CGS Objective 1.1.

Setting Targets

- 2.1a: Along urban arterials, the target ratio of sidewalk mileage to roadway mileage should be 1 (all urban arterials have sidewalks on both sides).
- 2.1b: Recognizing that there are some streets where bicycle facilities are not possible or necessary due to space constraints, lower traffic volumes, lower vehicle speeds or other factors, the target for the ratio of Class II bicycle facility mileage to roadway mileage should steadily increase from year to year. A finite target may not be necessary.
- 2.1c: Since federal law requires that all public facilities are ADA accessible, the target for percent of intersections that are ADA compliant should be 100%.
- 2.1d: In 2014 and thereafter, the percent of urban arterial projects (new expenditures) designed as Complete Streets should be 100%.
- 2.1e, f: The target for the number of pedestrian and bicycle trips on urban arterials should be a steadily increasing number each year. If the Agency wants to set a finite target, it can measure trips for several years, determine an annual rate of change, and propose a steady increase to that rate of change.

DELIVERY

Goal: Effectively deliver quality transportation projects and services.

(No proposed measures)

STEWARDSHIP

Goal: Preserve and enhance California’s resources and assets.

CGS Objective 4.1	By 2017, all new and retrofit Caltrans urban arterial projects (new expenditures) are designed to minimize negative environmental impacts in accordance with Green Streets principles. Ensure that each new and retrofit urban arterial project incorporates Green Streets principles annually thereafter, with the goal of thorough Green Streets influence on all urban arterials over time.
PM 4.1a	Ratio of pervious to impervious surfaces on Caltrans urban arterial projects, including medians, buffer strips, and tree wells.
PM 4.1b	Percent of urban arterial lane mileage with tree canopy coverage.

Discussion

Existing Caltrans performance measures address Stewardship primarily by measuring pavement and bridge conditions, equipment availability and the obligation of some types of funding. Maintaining facilities is important, but stewardship should be viewed more broadly as the agency’s responsibility to the users and communities where Caltrans facilities are located. Proposed performance measures 4.1a and b will allow the Agency to work towards its Stewardship Goal to “Preserve and Enhance California’s Resources and Assets” more holistically.

To become a successful steward of the State’s resources, Caltrans should incorporate Green Streets principles into the design of urban arterials. Green streets are designed with the maximum canopy coverage and permeable surfaces practicable. These principles are incorporated into this proposed performance measure framework because of the role that greenery can play at improving the traveler experience on urban arterials. Trees in particular can improve the thermal equivalent index by creating shade and can attract people to travel through a business district. The shade can also help reduce the urban heat island effect, which is the increase in ambient air temperature created by the reflective properties of pavement. Beyond traveler experience, landscaping and trees can filter and reduce storm water runoff, sequester carbon, and mitigate other air pollution caused by vehicle traffic. Trees also bring about energy savings through building shading, and can promote social equity by improving air quality and providing an amenity to neighborhoods with high amounts of auto traffic.

Proposed performance measure 4.1a measures the ratio of pervious to impervious surfaces on Caltrans urban arterials. This ratio will improve with each newly planted median strip, buffer and tree that Caltrans incorporates into its projects. Performance measure 4.1b measures the urban arterial land mileage with tree canopy coverage. Canopy coverage is an important part of the pedestrian experience and is also a measure of the potential environmental benefits a tree-lined street provides.

Data Collection

Summary: New data sets will have to be created for these measures.

For performance measure 4.1a, an annual survey of a random sample set of urban arterial segments will be required. It is possible that this could be done in tandem with the annual pavement survey.

For performance measure 4.1b, Caltrans will first need to set a baseline, which could be done by estimating canopy coverage from aerial images. This baseline should be re-evaluated every five years. In the interim years, the Agency should estimate canopy coverage from the final design documents of new projects. Canopy measurements should estimate the expected size at maturity, and trees that are unhealthy or dying should not be included (see Appendix B for a demonstration of estimating pervious surfaces and canopy coverage).

Setting Targets

No additional target setting is required.

CGS Objective 4.2	By 20XX, all Caltrans urban arterials meet a baseline for non-motorized facility quality.
PM 4.2a	Percent of urban arterial sidewalk mileage in fair or better condition.
PM 4.2b	Percent of urban arterial bicycle lane mileage in fair or better condition.

Discussion

As part of their existing Performance Measure framework, Caltrans monitors distressed pavement through an annual pavement survey. The Agency also monitors the maintenance of road striping, guardrails and the overall roadway. There is no measure, however, specifically for the upkeep of bicycle and pedestrian facilities. Broadening the Stewardship objectives to include maintenance of all facilities, including sidewalks and bike lanes would help to meet Complete Streets objectives.

For pedestrians, cracks or gaps in the sidewalk can be a tripping hazard and can create a barrier for people with disabilities and other users. Poor sidewalk conditions also create an unappealing environment for walking and can discourage pedestrians from using a facility. For bicyclists, the condition of the pavement and maintenance of the facility can play an important role in a person's decision whether to ride. Failing pavement conditions in a bicycle lane can create uncomfortable and unsafe conditions. Litter and debris from the roadway often collect in bicycle lanes, further reducing the appeal and performance of a facility. Also, when pavement markings for bicycle lanes are not maintained, cyclists' safety may be threatened when drivers become

unaware of the presence of the facility. As with all transportation facilities, maintenance and upkeep are essential to the function of bicycle and pedestrian travelways.

Data Collection

Summary: Existing data collection process will have to be adapted for this measure.

For both of these measures, data should be collected through an annual survey done in coordination with the existing pavement condition survey.

Setting Targets

Caltrans may need to develop a uniform method for grading sidewalk and bicycle facility conditions. The Agency should use a similar method to that presently used in the existing pavement survey.

SERVICE

Goal: Promote quality service through an excellent workforce.

CGS Objective 5.1	Annually increase the number of Caltrans management, design, and maintenance personnel trained regarding Complete Streets principles and Green Streets principles.
PM 5.1a	Number of personnel trained in Complete Streets principles.
PM 5.1b	Number of personnel trained in Green Streets principles.

Discussion

Since the design and maintenance of bicycle and pedestrian facilities has not always been central to the departments of transportation, many Agency employees will need special training in order to implement projects that work toward Complete Streets. As stated, the design and maintenance of a bicycle and pedestrian facility will play an important role in a users’ choice of mode. Especially since the selection and design of the most appropriate bicycle or pedestrian treatment will vary from site to site, designers must have expansive and current knowledge of best practices in facility design and function. The same is true for maintenance of facilities and collection of data related to bicycle and pedestrian travel. For this reason, it is essential that Caltrans work to expand the capacity and knowledge of the design, maintenance and management staff on a variety of issues that relate to facilities for non-motorized users.

Some of the required trainings may be developed and offered by Caltrans. For example, Caltrans may want to establish a new training for design staff on how to determine whether a certain design qualifies as a Complete Street. Other training opportunities may be offered by outside

providers like the Institute of Transportation Engineers or by a bicycle and pedestrian design firm.

Caltrans staff will also need to be trained on designing, building and maintaining Green Streets. Specific elements related to the placement, species and spacing of trees, the size of buffers and tree wells, and the design of medians can determine extent of the safety and quality of life benefits these investments will bring to surrounding communities. Informed design and maintenance will ensure that this public investment in infrastructure and landscaping will yield meaningful and long-term results. The Green Streets movement is still evolving and may not offer a variety of specific training programs, but there are a range of landscape programs that would allow Agency staff to work towards meeting the new Objectives that relate to tree canopy coverage and permeability.

Data Collection

Summary: New data will need to be generated for this measure.

For both of these measures, Caltrans can add a category to the Learning Management System that currently tracks all personnel training.

Setting Targets

No target setting required.

Next Steps

The next steps for the proposed performance measures include testing the measures for validity and reliability through field-work. This has been the focus of Phase III of the research project, and is described in detail in the following chapter.

IV. Phase III and Phase IV Analysis

The third and fourth phases of the research project focused on testing the proposed performance measures for validity and reliability. This entailed gathering data on multiple aspects of two key transportation corridors: San Pablo Avenue in the East San Francisco Bay Area, and Santa Monica Boulevard in the Los Angeles area. The data included aspects of the street design, such as sidewalk presence and width, the presence and amount of street trees and landscaping, the numbers of driveways and different types of businesses, the presence and width of center medians, and posted speed limit, among other things. Data on motorist, pedestrian, and bicyclist volumes and collisions was also gathered. This data was then analyzed for its relationship to pedestrian, bicyclist, and motorist safety, as described in Section A of this chapter. This was accompanied by a policy and plan analysis of the cities and counties through which San Pablo Avenue and Santa Monica Boulevard run, in order to provide a basis for understanding how policies and plans are translated into action. The policy analysis is described in Sections B and C of this chapter. A pedestrian and bicyclist intercept survey was then conducted to explore perceptions of safety and preferences for design features along the two corridors. This information is elaborated upon in Section D. Finally, Section E shows how the proposed performance measures rank in terms of their reliability and validity.

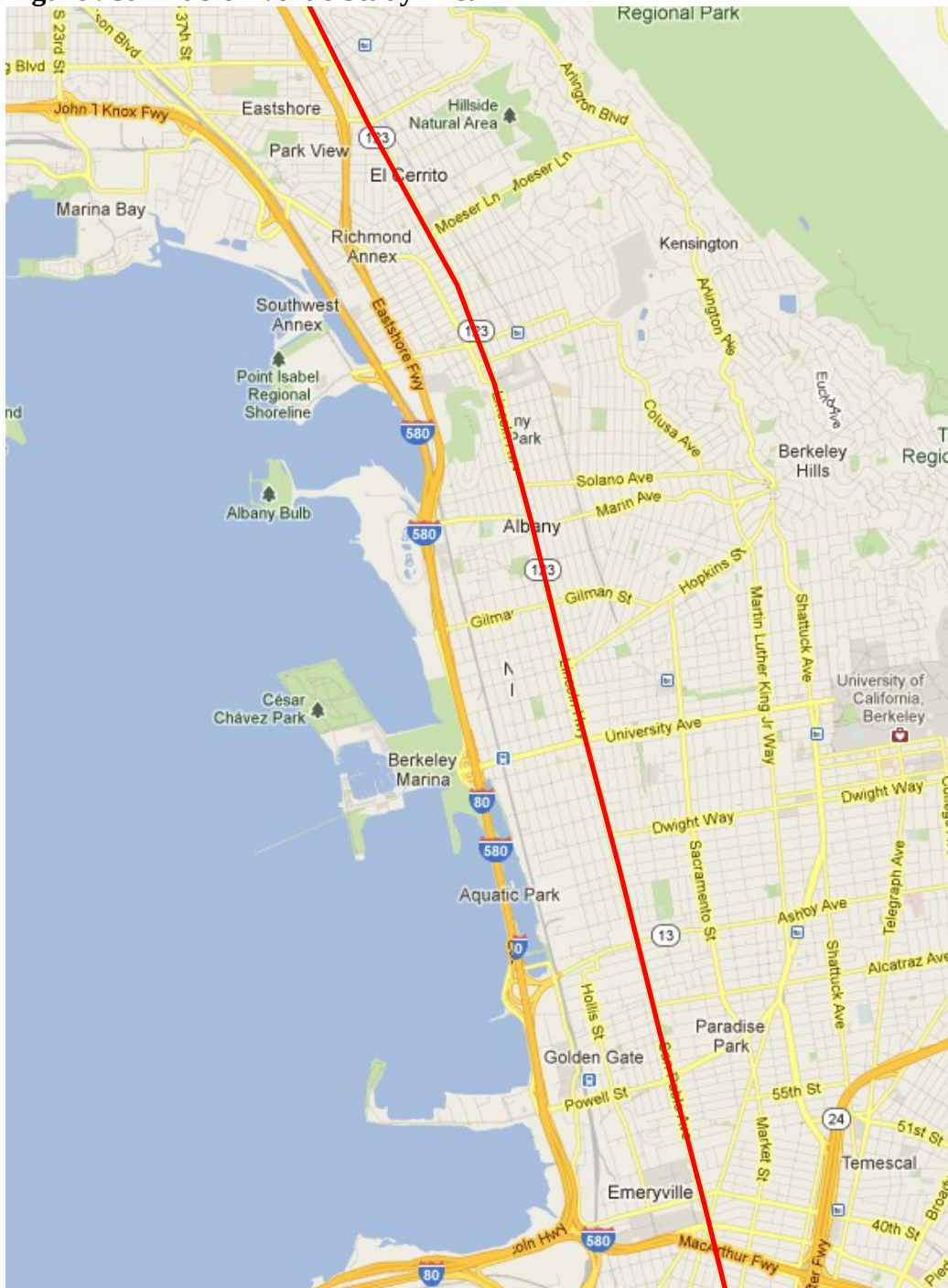
A. Pedestrian, Bicyclist, and Driver Safety Analysis

The third and fourth phases of the project focused on gathering data to field-test the proposed *Complete, Green Streets Performance Measures* for safety and mobility. This section describes the field study area and the data gathering process for the facility analysis, in addition to results for the pedestrian, bicyclist, and driver safety analysis.

Study Areas

The research team selected two test corridors for this project: San Pablo Avenue in the East San Francisco Bay area and Santa Monica Boulevard in the Los Angeles area. San Pablo Avenue (represented by the red line in Figure), a 9.5-mile, multi-jurisdictional corridor in the East San Francisco Bay of California, was selected as the first test corridor for the project. San Pablo Avenue is a historic State Route (123) that acts as an urban arterial, so while it is under the jurisdiction of Caltrans, its design is influenced by the cities through which it runs. This guaranteed that there would be some consistency in the street layout and operation, but also a variety of design conditions that may affect pedestrians and bicyclists, such as landscaping, decorative paving, public seating, etc.

Figure . San Pablo Avenue Study Area



As seen in Table , some aspects of the street had little to no variety and essentially acted as control variables within the analysis. Other variables showed quite a bit of variety. The signs in parentheses indicate the expected influence of each element on pedestrian safety and mobility

(e.g., a (-) indicates an expected negative effect, while a (?) indicates that the literature is unclear on whether the effect should be positive or negative).

Table . Description of Street and Intersection Conditions along San Pablo Avenue

“Control” Variables (90-100% present)	<ul style="list-style-type: none"> • Speed limit of 30 mph (-) • 85th percentile speed of 34-38 mph (-) • At least four lanes of traffic (-) • Sidewalks ≥ 5 feet in width, in good condition, and ADA accessible (+) • Bidirectional traffic (+)
“Control” Variables (≤10% present)	<ul style="list-style-type: none"> • Decorative or textured paving for sidewalks or crosswalks (+) • Mid-block crossings (?) • Signs prohibiting right turns on red (+) • Traffic calming* other than a median (+)
Walkability (intersections):	<ul style="list-style-type: none"> • 75% of intersection corners were ADA accessible (+) • 24% of intersections had a marked crosswalk on each leg (+) • 22% of intersections had marked crosswalks and additional pedestrian features (e.g., user-activated lighting, pedestrian countdowns, refuge islands, or yield-to-pedestrian signage) (+)
Walkability (street segments):	<ul style="list-style-type: none"> • 85% of segments had no abandoned buildings (+) • 80% of segments had pedestrian (street) lighting (+) • 60% of segments had ≥ 1 trash receptacle on either side (+) • 60% of segments had no noticeable litter (+) • 25% of segments had public seating on at least one side (+) • 23% of street segments had ≥ 3 retail locations on either side (+) • 20% of segments had school zones (+) • 11% of the corridor had > 5 driveways on at least one side (-)
Landscaping	<ul style="list-style-type: none"> • 81% of segments had a raised median (+) • 69% of medians had landscaping (+) • 62% of segments had gardens or planters on at least one side (+) • 57% of medians were ≥ 10 feet wide (+) • 50% of segments had regularly spaced street trees on both sides (+) • 56% of landscaped medians had trees (?)
Traffic Operations	<ul style="list-style-type: none"> • 85% of segments had parallel parking (?) • 69% of intersections had a crossing speed of ≤ 3.5 feet/second (+) • 63% of intersections had at least one dedicated left turn lane (-) • 60% of segments had on-street parking at the intersection on at least one side (-) • 37% of intersections were signalized (?) • 12% of signalized intersections had pedestrian signals with countdowns (+)

*Traffic calming was defined as one of the following features: curb extensions or bulbouts, pavement treatments or lighting, speed tables, bicycle lane at intersection, mini-circles, semi-diverters, speed humps, partial closures, or roundabouts.

The second test corridor selected was a segment of Santa Monica Boulevard in the Los Angeles area. The segment is approximately five miles long, running from the western border of West

Hollywood to its intersection with Highway 101 in Los Angeles, as shown in Figure . Santa Monica Boulevard is a State Route (2) that acts as an urban arterial in Los Angeles. The West Hollywood section is also an urban arterial. However, this section was relinquished from Caltrans to the City of West Hollywood in 1999 prior to the 2001 reconstruction project that included the design of many landscape, pedestrian, and bicyclist features. This allows for the test of innovative design features that have been implemented in West Hollywood and proposed in the Performance Measures based on recent studies but are still being tested for implementation within Caltrans. The Santa Monica Boulevard segment contains several features that were not present and able to be tested along the San Pablo Avenue corridor. These include bike lanes, bike boxes, bulb-outs, and a greater variety in medians along the corridor. Table shows the percentage of intersections and segments with various features along Santa Monica Boulevard.

Figure . Santa Monica Boulevard Study Area

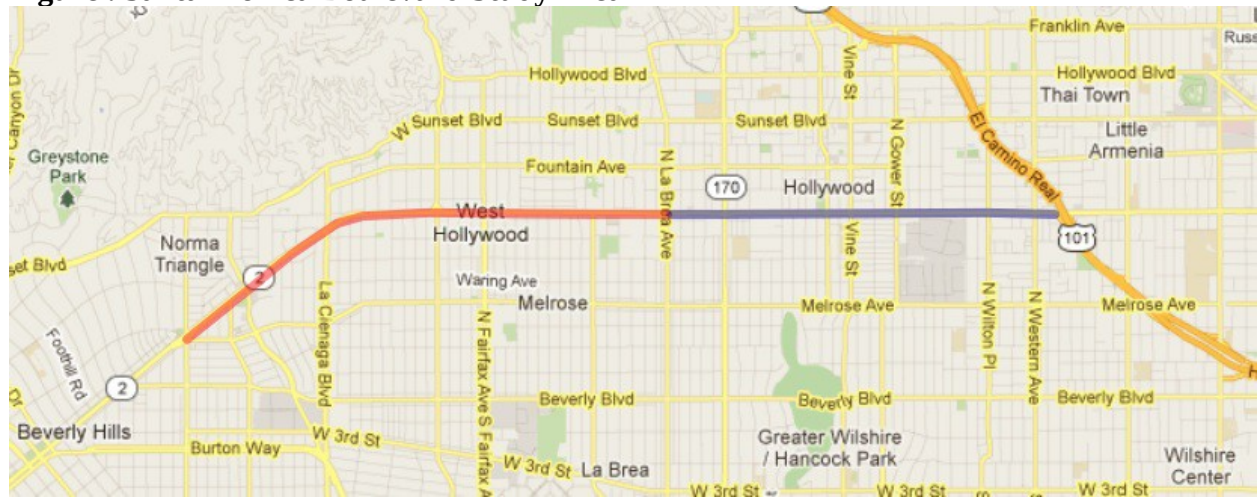


Table . Description of Street and Intersection Conditions along Santa Monica Boulevard

<p>“Control” Variables (90-100% present)</p>	<ul style="list-style-type: none"> • Speed limit of 30 or 35 mph (-) • 85th percentile speed of 31-35 mph (-) • At least four lanes of traffic (-) • Sidewalks ≥ 5 feet in width, in good condition, and ADA accessible (+) • Bidirectional traffic (+)
<p>“Control” Variables (≤10% present)</p>	<ul style="list-style-type: none"> • Decorative or textured paving for sidewalks or crosswalks (+) • Mid-block crossings (?) • Signs prohibiting right turns on red (+)
<p>Walkability (intersections):</p>	<ul style="list-style-type: none"> • 72% of intersection corners were ADA accessible (+) • 30% of intersections had a marked crosswalk on each leg (+) • 49% of intersections had marked crosswalks and additional pedestrian features (e.g., user-activated lighting, pedestrian countdowns, refuge islands, or yield-to-pedestrian signage) (+) • 50% Traffic calming* other than a median (+)
<p>Walkability (street segments):</p>	<ul style="list-style-type: none"> • 30% of segments had no abandoned buildings (+) • 74% of segments had pedestrian (street) lighting (+) • 80% of segments had ≥ 1 trash receptacle on either side (+)

	<ul style="list-style-type: none"> • 83% of segments had no noticeable litter (+) • 85% of segments had public seating on at least one side (+) • 71% of street segments had ≥ 3 retail locations on either side (+)
Landscaping	<ul style="list-style-type: none"> • 10% of segments had a raised median (+) • 25% of medians had landscaping (+) • 25% of segments had gardens or planters on at least one side (+) • 25% of medians were ≥ 10 feet wide (+) • 53% of segments had regularly spaced street trees on both sides (+) •
Traffic Operations	<ul style="list-style-type: none"> • 92% of segments had parallel parking (?) • 64% of intersections had at least one dedicated left turn lane (-) • 40% of intersections were signalized (?) • 25% of signalized intersections had pedestrian signals with countdowns (+)

Methodology

The research team compiled an inventory of landscape and design features along with other characteristics of the corridors including speed, demographic information, and vehicle, pedestrian, and bicycle volume. Crash history for the corridors was compiled for a ten year period, and crash models were developed to test the relationship between the corridor features and crash rates of different locations throughout the corridors. Vehicle, pedestrian, and bicycle volume was used as a measure of exposure to account for varying volumes throughout the corridors. Models were built for San Pablo Avenue during Phase III of the study, and the procedure was modified slightly based on the experience with San Pablo Avenue to include several additional features in Phase IV of the study which included modeling for Santa Monica Boulevard.

The research team developed a checklist to facilitate gathering the data needed to test the proposed performance measures. The checklist included elements needed to perform the National Cooperative Highway Research Program's Multimodal Level of Service Analysis for Urban Streets, which assesses how well various roadway users' needs are met on an urban street. This was done in order to double-check any conclusions the research team could draw about the framework with an accepted LOS method. The San Francisco Pedestrian Environmental Quality Index was also used for the facility analysis, as it measures some of the necessary information to test the proposed performance measures.

In addition, the research team reviewed the pedestrian and bicycle plans of each city and county with jurisdiction over San Pablo Avenue and Santa Monica Boulevard, and added the most common elements of the plans to the facility checklist as a way to evaluate the impact of policies on the design of the corridor. The checklist can be found in Appendix C. Finally, economic data from the 2010 US Census was used to predict pedestrian volumes for the corridors.

Data Collection: San Pablo Avenue

Data was gathered along San Pablo Avenue between October, 2009 – June, 2010, at various

times in good weather. The lead author and two undergraduate researchers collected the data on paper forms, using standard engineering measuring wheels and stopwatches to enable measurement of distance and time. There are approximately 180 intersections along the test corridor, and the data was gathered for each intersection and its corresponding southern roadway section (both sides of the street segment were measured separately). In this way, data for each intersection and roadway section were attached to a unique ID in the analysis. The researchers spent about 15-20 minutes gathering the data for each intersection and roadway segment. After the data was gathered manually, it was input into a Microsoft Excel™ spreadsheet and checked for accuracy through a combination of Google Maps Street View™ and Google Earth™. When the data could not be corroborated through online tools, a second site trip was made.

The original data set contained 181 intersections along San Pablo Avenue as determined by each city's GIS files, and researchers at SafeTREC coded each intersection with the total number of pedestrian, bicyclist, and driver injuries and fatalities from the years 1997-2007. The crashes were determined from the California Highway Patrol Statewide Integrated Traffic Records System (SWITRS), and were coded to the nearest intersection along the corridor. It should be noted that underreporting of pedestrian and bicyclist crashes has been found in previous research, so it is possible that the crashes modeled in this research do not necessarily account for all pedestrian and bicyclist crashes during this time period. However, SWITRS data represents the best data available for analysis at this time. In addition, when gathering the physical data for analysis, a few of the intersections in the GIS files were unable to be located on the ground, suggesting that changes to the street pattern that may not have been recorded in the GIS database. This resulted in the deletion of 11 intersections from the data set; 170 intersections remained.

Data Collection: Santa Monica Boulevard

Data for Santa Monica Boulevard was first collected in a similar manner using a combination of Google Maps Street View and Google Earth to record design features and measurements on paper forms as well as to verify that features were present along the corridor for the entire ten year study period. Data was collected between October 2011 and March 2012. Not all measurements were able to be recorded using Google Earth because of lack of visibility. The measurements and observations were then field verified and completed during a site visit with good weather between Tuesday, March 27, 2012 and Thursday, March 29, 2012. Standard engineering measuring wheels and stop watches were used to measure distance and time.

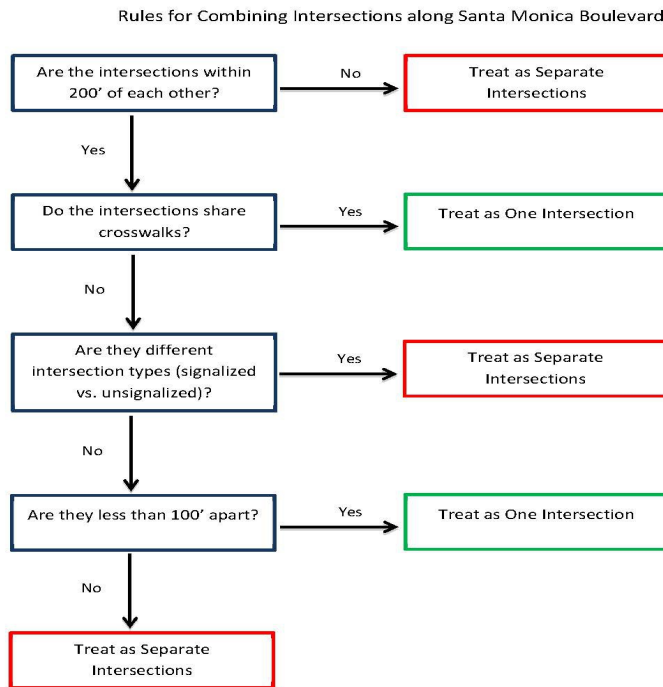
The research team developed a methodology for defining intersections in order to collect the data in a way to complete an informative analysis. There are 94 intersections along the corridor, but many of these intersections are close together or effectively act as one offset intersection as shown in Figure . This issue was not present at the same extent along San Pablo Avenue; and therefore, this methodology was not warranted or applied to the intersections on San Pablo Avenue. Intersections could not all be treated as separate intersections because the unit of analysis for the regression modeling was determined to be an intersection and its two surrounding blocks. Some block lengths were short enough that there would have been no recorded measurements of features for that block. Therefore, a methodology was developed to determine how intersections would be combined in order to condense intersections into units that were small enough to be accurate and informative for collision analysis but spaced far enough

apart to provide informative collision analysis results. The methodology developed is shown in Figure .

Figure Example of Offset Intersection



Figure . Methodology for Combining Intersections



After applying the methodology outlined in Figure , the original 94 intersections were condensed into 80 intersections. The resulting 80 intersections used for analysis are listed in Appendix I with their corresponding postmile. The intersections that were combined and treated as one intersection were categorized as “offset” in the database to indicate the difference in intersection design. Data was gathered for each of the 82 intersections and both sides of its corresponding western roadway section. In this way, data for each intersection and roadway section were attached to a unique ID in the analysis. After the data was gathered manually, it was input into a Microsoft Excel™ spreadsheet.

Data: Safety Analyses

Data were obtained from the California Statewide Integrated Traffic Record System (SWITRS). SWITRS is an electronic database of police-reported traffic collisions maintained by the California Highway Patrol (CHP). CHP and all local law enforcement agencies in the state are required by law to submit data on all police-reported collisions.

The SWITRS database is comprised of three data files: (1) collision; (2) party; and (3) victim. The collision table contains one record per collision, and each record is associated with one or more parties in the party table. A party is any participant involved in the collision and may be categorized as driver, pedestrian, parked vehicle, bicyclist, or other. The party table contains one record per party, and each record is associated with one or more victims in the victim table. The associated records are linked with numeric identifiers. Injury in the victim table is coded as “fatal,” “severe,” “other visible injury,” “complaint of pain,” or “none.” Fatal includes a death within 30 days of the collision. Severe includes any injury which prevents one from performing normal activities that one was able to perform prior to the collision. Other visible includes an injury other than fatal or severe which is evident at the time of the collision scene. Complaint of pain includes injuries claimed but not evident (including limping). Collision characteristics were also used to determine what percentage of collisions at each intersection involved alcohol.

SWITRS data for the Santa Monica Boulevard corridor for a recent 10 year period (2001-2010) were geocoded. Collisions that caused some degree of injury and that occurred within 200 feet of the study intersection were included. Some studies have been more conservative with the distance criteria for pedestrian crashes, however, research using SWITRS indicates that a majority of pedestrian, bicycle, and motor vehicle crashes are captured within 200 feet (Zhang, Pande, & Grembek, 2012). Collisions within 200 feet of more than one intersection were assigned to the closer intersection. The following endpoints were used:

- 1) Number of pedestrian injuries (includes those in or operating a pedestrian conveyance such as baby carriage, skateboard, wheelchair);
- 2) Number of bicycle (including passengers on bicycle) injuries; and
- 3) Number of motor vehicle (driver and passenger in electric powered devices not on rails, including mopeds) injury collisions.

Measures of Exposure

Developing a crash model requires data explaining the exposure of the corresponding mode. Locations with higher numbers of vehicles are inherently expected to experience higher numbers of vehicle crashes. The relationship between the increase in vehicle volume and the increase in number of vehicle crashes may not be linear. In order to build pedestrian, bicycle, and motor vehicle crash models, volumes were obtained for each of the three modes as explained below.

Vehicle Volume

Vehicle volume was calculated based on the sum of the average annual daily traffic (AADT) for a location over a ten year period. For the San Pablo Avenue corridor, the AADT was obtained from the cities through which the corridor runs. For Santa Monica Boulevard, the AADT was obtained from the tube counts conducted in 2012.

Because consistent data for the vehicle volume of side streets along the corridors was not

available, a proxy variable was used to indicate whether the side streets carried high or low vehicle volumes in comparison to the remainder of the corridor.

Bicycle Volume

Bicycle volume for both corridors was obtained from professional counting firms who conducted four-hour counts between 2 pm and 6 pm during weekdays in the summer of 2012. Because there is no 24-hour bicycle volume available for the corridors to show how volumes varied throughout the week and year, a full bicycle volume model could not be built as was done with the pedestrian volume. Therefore, bicycle volumes were extrapolated throughout the corridor based on the 4-hour counts in a similar fashion as was applied to the vehicle AADT. Rather than extrapolating the 4-hour bicycle counts to annual volumes, the exposure data for the bicycle crash model is based on the 4-hour counts in order to reflect relative differences in bicycle volume by location.

Pedestrian Volume – San Pablo Avenue

In order to account for exposure along San Pablo Avenue, pedestrian volumes were estimated according to a model based on the work of Schneider, Arnold, et al. (2009), which was derived using data from a variety of intersections in the Bay Area, including several along San Pablo Avenue.

Pedestrian Volume – Santa Monica Boulevard

In order to account for exposure along Santa Monica Boulevard, a model was built to predict pedestrian volumes along the corridor. Rather than using the same pedestrian volume model utilized for the San Pablo Avenue corridor, researchers felt a separate model was necessary to account for the differences in behavior between two distinct regions: the San Francisco Bay Area and the Los Angeles Area. A similar procedure was followed to develop the pedestrian volume model for Santa Monica Boulevard as was used in the development of the Bay Area pedestrian volume model.

A professional traffic counting firm collected pedestrian crossing counts at eleven different locations throughout the Santa Monica Boulevard corridor between the hours of 2 pm and 6 pm on a weekday between Tuesday and Thursday. Counts were conducted during the summer months of June and July 2012. Pedestrians were counted for each leg of the intersection they crossed in order to provide an accurate representation of exposure to potential crashes. Therefore, pedestrians who crossed multiple legs of the intersection were counted multiple times.

In addition, Eco-Counters were utilized to collect 24-hour counts for multiple weeks at three different locations throughout the corridor. These counts provided insight into pedestrian volume trends by time of day and day of week at various locations throughout the corridor. One site selected for the 24-hour counts was located next to a school to illustrate how pedestrian patterns vary when school is in and out of session.

The first step in creating a pedestrian volume model for the corridor involved extrapolating the

4-hour counts at eleven different locations to weekly volumes. In order to do this, an adjustment factor was created for each hour of each day based on the percentage that the hourly volume made up of the entire weekly pedestrian volume. Adjustment factors were created for each of the three Eco-Counter locations separately and then averaged together to create a corridor average. Figure shows the percentage of weekly volume corresponding to each hour of the week based on the overall corridor average. The adjustment factors created for each hour between 2 and 6 pm were then applied to the corresponding counts to calculate a weekly volume for the eleven count locations. Because the adjustment factors produced four weekly volume estimates at each location, an average of the estimates was utilized for the final weekly volume. No adjustments were made to account for weather because there is no significant variation in weather throughout the corridor.

Figure . Percentage of Weekly Volume by Time of Day

When creating this adjustment factor, only the weekly volumes and trends corresponding to time periods when school was out of session were used at Van Ness Avenue. The volume trends when school is in session would not accurately reflect travel patterns throughout the corridor. During a future step in the modeling process, weekly volumes were extrapolated to annual volumes. At this point, the school volumes were utilized to create accurate volumes at the school locations only based on the number of weeks per year that school is in session.

Using the weekly volume projections at eleven locations, a pedestrian model was built to associate different land use and design feature elements with pedestrian volume in an effort to predict volume exposure. Following the methodology used in the Bay Area pedestrian model, a log linear model was used. Variables that were expected to have an association with pedestrian volume based on literature or researchers’ hypotheses were tested. These variables included a mixture of demographic variables obtained from Census data, design and landscape features, and land use characteristics. The final pedestrian volume model configuration is shown in Table below. The final model included variables indicating the total number of retail on both blocks surrounding an intersection, the presence of public art on both blocks, the presence of tree grates on both blocks, and the signalization of the intersection. The research team believed all of these associations to be reasonable because retail and high quality locations are likely to attract pedestrians. Pedestrian intersection crossing volumes are likely to be higher at locations with a signal providing pedestrians with a form of protection.

Table . Final Pedestrian Volume Model: (Adj. R2 = 0.91)

Variable	Coefficient	Std. Error	P-Value
Number of retail both sides of intersection	0.031	0.005	0.001
Indicates public art both sides (yes vs. no)	0.850	0.139	0.001
Number of treegrates on both blocks	0.284	0.108	0.038
Traffic signal (yes vs. no)	0.683	0.156	0.005
constant	8.451	0.185	0.000

Using the model configuration presented above, weekly pedestrian volumes were calculated for each intersection within the corridor. The weekly volumes were then multiplied by 52 weeks per year and then again by 10 years to project exposure for the ten year period during which crashes are evaluated. Variables selected for this final model were excluded from the crash models.

Although the model is the most accurate attempt to produce pedestrian exposure data for the Santa Monica Boulevard corridor, it should be noted that the model was developed based on counts from only eleven locations and 24-hour counts from only three locations. Additional counts would produce an even more reliable model. In addition, the counts were conducted in 2012 and are serving as a measure of exposure for crashes that occurred between 2001 and 2010. Therefore, the model relies on the assumption that pedestrian volumes have not significantly changed during the past twelve years.

Data Analysis

All data were entered into Excel 2007 (Microsoft, Redmond, WA). All analyses were conducted using STATA (Stata Corp, College Station, TX) and SAS 9.2 (SAS Institute, Cary, NC). Analysis was first completed for San Pablo Avenue in Phase III of the project. A separate analysis was completed for Santa Monica Boulevard.

Traffic fatalities are relatively infrequent events and, therefore, all levels of injuries were combined. For all endpoints or dependent variables, bivariate and multivariable negative binomial regressions were conducted. Negative binomial is an appropriate approach for count outcomes and relaxes the variance assumptions required for Poisson regression.

All safety analyses statistical models completed during Phase IV of the study were developed in a stepwise fashion:

- (1) Relationship between potential independent variable and outcome were evaluated;
- (2) All variables that had a $p < 0.20$ were considered; and
- (3) Variables with the least significance were removed one at a time.

In addition, the relationship between the potential independent variables was evaluated using the Pearson correlation coefficient which measures the degree to which variables are related or move together. Cohen's guide for small, medium, and large effect sizes was used.

Unweighted Complete Streets Index

During Phase III of the project, the research team hypothesized that sections of the San Pablo Avenue corridor with a greater number of "pedestrian-friendly" features (as identified in the literature review) would be safer for pedestrians after controlling for exposure. To examine this hypothesis, they created an index of the various features along the corridor with a reasonable expectation of either contributing to or detracting from pedestrian safety. Values were entered as averages of measurements from the street segments flanking the intersection to which the crash was assigned. Variables contributing to pedestrian safety (e.g., in-street medians, marked

crosswalks) were added, while those presumed to detract from pedestrian safety (e.g., driveways) were subtracted. The total number was the unweighted CSI (complete streets index) score. *The unweighted index was used solely for exploratory purposes.* Results of the index and its relationship to pedestrian safety are discussed in the following section.

Findings

The pedestrian and driver safety models were created in part to test the validity of some of the proposed performance measures. The Santa Monica Boulevard corridor was added to the project in an attempt to test the treatments that did not occur frequently on San Pablo Avenue. Further testing on additional corridors would provide even more data. Findings regarding pedestrian, bicyclist, and driver safety are reported. This section elaborates on the findings for the pedestrian, bicyclist, and driver crash models created in Phase III and IV of the project.

Regression Analysis for San Pablo Avenue

Appendix D describes the range and distribution of the original street treatment variables tested in the pedestrian and driver crash models. Those variables were used to create combinatory variables, for a final data set containing over 350 variables for testing. This section discusses the findings from the modeling. No final versions of the pedestrian and driver crash models are presented for the San Pablo Avenue corridor, due to limitations in the dataset that suggest a need for continued testing using additional data. After obtaining bicycle volume for the San Pablo Avenue corridor in 2012, a bicycle crash model was developed. The final model is presented in this section, although the results should be interpreted with caution due to limitations in extrapolating bicycle volume.

Regression Analysis for Pedestrian Safety for San Pablo Avenue

The negative binomial regression model for pedestrian crashes was created by testing hundreds of variables and variable combinations for their significant relationship to pedestrian injuries and fatalities. Some variables that have been previously found to be related to pedestrian safety were also found to be significant in this model (e.g., pedestrian exposure volume). In addition, there is some evidence that street design features such as public seating and the percent of ADA accessible corners at each intersection may also be significantly related to pedestrian safety.

However, results from the crash model also suggest that many of the variables found in past analyses are not highly significant for understanding crash rates on San Pablo Avenue. For example, among the pedestrian features identified earlier in this report as contributing to or detracting from pedestrian safety, only vehicular traffic shows any significance in the final version of the model. The authors are cautious about interpreting the results from tests of other previously established significant variables, such as marked crosswalks combined with ancillary traffic calming features, pedestrian countdown signals, medians, right-turn only lanes, and driveways, as contradicting previous study findings. San Pablo Avenue is a single corridor for which the effects of speed and its interaction with these various features cannot be examined given the constant and relatively high speed of vehicles in the roadway. In addition, some features were not present in high enough values to be able to have a statistically significant effect

on such a model. Finally, while pedestrian exposure was approximated through a model, validation via observation was not able to be done, and this may create some disturbance in the model. These results urge a deeper exploration both of features expected to be significant, and those, such as the presence of public seating, that have been less explored in previous studies.

In an attempt to do such exploration, multiple variables examining the effects of various types of landscaping and pedestrian amenities such as public seating, textured paving, trash receptacles, and public art were analyzed for their relationship to pedestrian crashes. Combinations of these variables were also examined. In the latest version of the model, only the presence of public seating was found to be positively associated with the number of crashes. While this needs to be explored further, it is possible that this variable is related to other factors of pedestrian exposure. With one exception, combinations of variables are, at this time, not significant. The one exception is that the presence of three of a list of variables (street trees, the percent of the sidewalk with context sensitive paving, trash receptacles, lighting, context sensitive crosswalks, street landscaping, median landscaping, and public seating) was found to be significant in the model. However, permutations of that variable, such as 2 or 4 of that same list, were not found to be significant, suggesting that further study is needed. In addition, while these variables may not show up as significantly related to pedestrian crashes, the survey portion of this research project found that many of these elements are related to perceptions of safety and comfort.

Variables attempting to understand “corridor effects”, rather than just “intersection effects”, were also created. These included variables that could account for the fact that a corridor with timed lights might encourage a single-minded focus on “catching” lights, and may distract a driver from paying attention to pedestrians attempting to cross at unsignalized intersections in between signalized intersections. At this time, none of these variables show significance in the pedestrian crash model. Further exploration using additional data is necessary to validate these findings.

Finally, a series of economic and demographic variables was also entered into the pedestrian crash model. Data measuring the presence of retail stores near the intersection and Census data accounting for age, gender, income, and poverty status of the population of the Census Tract in which the intersection is located were entered into the model. However, none of those variables showed any significant relation to pedestrian crashes.

Regression Analysis for Driver Safety for San Pablo Avenue

The negative binomial regression model for driver crashes suggests that some variables not previously researched as applicable to driver safety may, in fact, have some impact (including percent of ADA-accessible corners and the number of trash receptacles on each block). However, the authors are cautious about interpreting these results without further testing on additional corridors, given the limitations explained for the pedestrian safety model above. For example, the relationship between driver safety and the percent of ADA-accessible corners at each intersection is not immediately clear, nor is the relationship between driver safety and trash receptacles on the blocks flanking the intersection; for example, both of these measures may reflect higher pedestrian volumes which encourage drivers to drive more cautiously. The variables representing vehicle exposure and street lighting were found to have a significant relationship to driver crashes, as expected from past studies.

As with the pedestrian crash model, variables combining multiple street treatments were also tested for their relationship to driver crashes. Only one of these combinatory variables was found to be significantly related to driver crashes: a variable that combined the presence of a traffic signal, marked crosswalks, a median, and pedestrian countdown signals. The authors urge caution in interpreting this finding until it can further corroborated using additional data from separate corridors.

While variables testing “corridor effects” and economic and demographic characteristics of the surrounding area were tested, none of these variables shows significance in the current driver crash model. Further exploration is necessary to understand these findings.

Regression Analysis for Bicyclist Safety for San Pablo Avenue

Bicyclist volumes for San Pablo Avenue were obtained during Phase IV of the project and extrapolated throughout the corridor. These volumes enabled the development of a bicyclist crash model, based on the number of bicyclist injuries at each intersection. A step-wise procedure was used in an attempt to fit an explanatory model while controlling for correlation. The results of the bivariate analysis are shown in Appendix L. The significant variables from the bivariate analysis were then checked for correlation and compiled into a model to begin the step-wise approach. The configuration of the final model is shown in Table .

The presence of graffiti revealed a negative association with bike injuries, likely due to a decrease in bicyclist volume in location with high occurrences of graffiti. This may be related to perceptions of public safety rather than traffic safety. The presence of bus stops, ladder crosswalks, and percent of intersection corners that are ADA compliant were positively associated with bike injuries. The research team believed these relationships could be due to higher numbers of pedestrians, which increase potential conflicts for bicyclists and can cause increased distractions for both drivers and bicyclists.

Although the bicyclist volume was not significantly correlated with bicyclist injuries, the positive relationship reveals an expected relationship. In addition, the positive association between vehicle speed and bicyclist injuries also supports findings from previous studies that speed increases risk for bicyclists.

Table . Multivariate negative binomial regression of bicyclist injuries and fatalities*, SWITRS SPA 1997-2007

Parameter	Coefficient	Standard Error	95% Confidence Interval		P-Value
Grffiti (yes vs. no)	-0.479	0.241	-0.951	-0.007	0.047
Number of bus stops	0.327	0.107	0.118	0.536	0.002
Speed 85 th percentile	0.192	0.086	0.025	0.361	0.025
Log bike	0.199	0.167	-0.129	0.527	0.235

volume					
Percent of corners that are ADA	0.021	0.005	0.011	0.031	0.000
Number of ladder crosswalks	0.273	0.077	0.123	0.422	0.000
_cons	-10.572	3.210	-16.863	-4.281	0.001

Regression Analysis for Santa Monica Boulevard

Similarly to the methodology used for San Pablo Avenue, negative binomial regression was used for the regression analysis for all three Santa Monica Boulevard crash models. When building the Santa Monica Boulevard crash models, a step-wise approach was applied. The first step in the modeling process involved testing the bivariate relationship between the number of crashes and each of the numerous independent variables. Based on bivariate analyses, variables with p-values less than 0.2 were kept and then checked for correlation with one another. When two variables were correlated, the least significant variable was removed. The remaining variables were then used to build the crash model in a backward step-wise method, removing the least significant variable after each iteration until every variable was significant at the 90% confidence level. This confidence level was more appropriate for this sample size and in some cases relationships with a lower significance level that were close were kept. While parsimonious (i.e. less complex, fewer parameters) models are generally favored, the sample size and relative importance of type 2 vs. type 1 error were considered in this decision.

The dependent variable is the log of the number of crashes or injuries with exposure as an independent variable. This modification is a common procedure in crash modeling and provided insight into how the frequency of crashes or injuries varied with the exposure. The functional form for each outcome and the respective exposure was evaluated. The exposure variable was never removed in the modeling process even if it was the least significant variable. This was done to ensure that exposure as controlled for in the model, but it allowed associations with other variables to be illustrated even if there was no relationship between exposure and number of crashes.

Additional data was collected for the Santa Monica Boulevard corridor based on the experience with the San Pablo Avenue models, and the best models for those corridors are therefore presented in this section. However, the research team cautions that these models still reflect limitations, and further studies are needed to validate any findings presented here.

Regression Analysis for Pedestrian Safety for Santa Monica Boulevard

The regression coefficients in Table 6 indicate the relative change in pedestrian injuries and fatalities in relation to the presence of the corresponding features. In the bivariate model, pedestrian volume was positively associated with pedestrian injury and fatality. However, when

newspaper racks, trash receptacles, intersection pedestrian features, and bike parking were considered, this relationship did not reach statistical significance. A positive relationship was observed for alcohol involvement and there is research to suggest that pedestrian crash rates tend to be positively associated with proximity to alcohol sales establishments (Schneider, Diogenes, Arnold, Attaset, Griswold, and Ragland, 2010). Traffic volume on the cross streets was associated with an increase in pedestrian injuries and fatalities.

Newspaper racks, trash receptacles, and bike parking are often found in areas with higher pedestrian and bicyclist volumes, and may therefore be acting as a proxy for volume in the model. They may also have been placed in the sight triangle³ at the intersection in such a way that visibility was reduced. Sight distance was not evaluated in this study; future research should differentiate between design features inside and outside of the sight triangle. The increased expected pedestrian injuries where there are pedestrian countermeasures is somewhat counterintuitive; however, it is possible that these countermeasures are installed where there is a crash history or particularly high volumes and remain particularly problematic. It is also possible that roadway users behave differently where there are pedestrian countermeasures (e.g. more violations due to increased sense of safety or additional restrictions).

Table . Multivariate negative binomial regression of pedestrian injuries and fatalities*, SWITRS SMB 2001-2010

Parameter	Coeff	SE	95% CI		P-value
Alcohol: Percent of intersection crashes that involved alcohol	0.023	0.009	0.005	0.040	<0.01
Newspaper racks: Number of 4 surrounding blocks that have at least 1	0.224	0.128	-0.026	0.475	0.08
Trash receptacles: Average number of trash receptacles per segment for the 4 surrounding blocks	0.381	0.129	0.128	0.633	<0.01
Bike parking: Number of bike parking spaces on the 4 surrounding blocks	0.036	0.022	-0.006	0.079	0.09
Intersection ped features**	0.702	0.184	0.342	1.062	<0.001
Traffic volume: cross street volume classification	0.445	0.218	0.019	0.872	<0.05
Log pedestrian crossing volume	-0.001	0.154	-0.302	0.300	0.99

³As defined in the AASHTO Green Book, the sight triangle is an area of the intersection corner that should be kept clear to maximize visibility for roadway users, if possible. AASHTO recommends that designers exercise care in placement of any design features in the sight triangle, including trees, bus shelters, power poles, and control cabinets. If possible, these should be placed well in advance of the intersection approach or around the corner, on the egress. In addition, as the eye of the driver typically sits 3.5 feet above the pavement ² any objects around this height should be outside of the sight triangle if possible, including curbside parked cars, trash cans, low shrubs, newsracks, and transit benches. References: [A Policy on Geometric Design of Highways and Streets 2011 6th Edition](#); AASHTO; <http://www.ctre.iastate.edu/pubs/traffichandbook/4SightDistance.pdf> [Handbook of Simplified Practice for Traffic Studies, Chapter 4 - Sight Distance](#), Center for Transportation Research and Education, Iowa State University, 2002

*Number of pedestrian injuries and fatalities within 200 feet of study intersection.

**Is signalized intersection with marked crosswalks and one or more of the following: ped countdown signal, leading pedestrian intervals, bulb-outs, or pedestrian refuge island; or an unsignalized intersection with marked crosswalks and one or more of the following: yield to ped signage, user-activated overhead or in-ground warning lights.

Regression Analysis for Driver Safety for Santa Monica Boulevard

The regression coefficients in Table 7 indicate the relative change in driver injuries and fatalities in relation to the presence of the corresponding features. In the multivariate model, traffic volume on Santa Monica Boulevard was negatively associated with motor vehicle injury crashes. It may be with higher traffic volume, traffic slows enough to reduce harmful conflict. However, cross street volume was positively associated with motor vehicle injury crashes. Landscaped bulb-outs were associated with fewer crashes. It should be noted that this feature was only associated with 2 study intersections and was marginally significant. Bike parking (number of bicycle parking spaces on the two blocks surrounding the study intersection) and percentage of the intersection with curb ramps and/or truncated domes were positively associated with crashes. These features may be indicators of volumes and land use.

Table . Multivariate negative binomial regression of motor vehicle occupant injury crashes*, SWITRS SMB 2001-2010

Parameter	Coeff	SE	95% CI		P-value
Number of industries	0.117	0.071	-0.022	0.255	0.10
Landscaped bulb-outs	-0.887	0.552	-1.967	0.194	0.11
Number of bike parking spots	0.045	0.019	0.007	0.082	<0.05
Percent of corners that are ADA	0.017	0.003	0.011	0.023	<0.0001
Offset intersection	-0.328	0.218	-0.755	0.099	0.13
Log 10 year AADT	-1.760	0.748	-3.23	-0.294	<0.05
Cross street classification	0.854	0.214	0.435	1.273	<0.0001

*Number of motor vehicle occupant injury crashes within 200 feet of study intersection.

Regression Analysis for Bicyclist Safety for Santa Monica Boulevard

The final configuration of the bicyclist injury model, using the methodology outlined above, is shown in Table . The coefficients on the variables indicate the direction and strength of association between the variable and the natural log of bike volume.

Table . Multivariate negative binomial regression of bicyclist injuries and fatalities, SWITRS SMB 2001-2010

Variable	Coefficient	Standard Error	95% Confidence Interval		P-value
Number of industries	0.199	0.059	0.083	0.315	0.001
Number of bike parking spots	0.049	0.017	0.015	0.083	0.005
Log bike volume	-0.707	0.578	-1.839	0.426	0.221
Percent of corners that are ADA	0.007	0.004	-0.001	0.014	0.076
Ped countdown signal	0.552	0.197	0.165	0.940	0.005
Speed 85 th percentile	0.157	0.065	0.029	0.284	0.016
constant	-1.961	3.282	-8.393	4.471	0.550

The positive coefficient on number of industrial enterprises within the two blocks indicates that the number of bike injuries increases with the presence of industrial use buildings. The industrial category was applied to buildings on the corridor that were used for purposes such as storage, warehouses, studios, and transportation operation companies. The presence of these facilities likely indicates locations in which automobile use and speed is higher and places in which bicycle use is lower. Qualitative exploration of the data reveals that the industrial uses are all located within the Los Angeles section of the corridor. There are no bike facilities on the road at these locations.

The next significant variable in the model is the number of bicycle parking spaces on the two blocks surrounding the study intersection. The positive coefficient indicates that as the number of bicycle parking spaces increases, the number of bicycle injuries also increases. Bicycle parking spaces are likely more common in locations with higher numbers of bicyclists. Therefore, it is possible that the association revealed here is due to the relationship between bicycle parking and bicycle volume.

The percentage of the intersection with curb ramps and/or truncated domes was associated with a positive coefficient and indicates an increase in the number of bike injuries associated with a higher percentage of curb ramps at the intersection. This relationship is not clear without further research. The percent of corners with ramps may be an indication of higher pedestrian volumes, creating the potential for more conflicts between bicyclists and pedestrians. Further research is

needed to determine if this relationship holds true in larger corridors with a greater variety in the percent of corners with curb ramps.

The positive coefficient on pedestrian countdown signals indicates that with the presence of this feature the number of bicycle injuries increases. This may indicate that pedestrians at these locations are not actively looking for bicyclists when they are crossing because of the comfort of having a countdown signal. The relationship could also be attributed to potential higher volumes of pedestrians at locations with pedestrian countdown signals, and the higher pedestrian volume could be associated with more bicycle injuries because of the bicycle-pedestrian conflicts as well as the increased distraction that pedestrians may cause bicyclists. However, it also may be an example of the difference in bicycle injury rates between West Hollywood and Los Angeles because the majority of the pedestrian countdown signals were located in Los Angeles.

The final significant variable in the model other than the exposure data is the 85th percentile speed. The 85th percentile speed was obtained by measuring speeds during free flow traffic conditions. Therefore, this speed does not account for the times that the corridor is congested. The positive coefficient on the 85th percentile speed variable indicates that bicycle crashes are more common in locations with higher speeds. This relationship aligns with expectations that bicyclists are at higher risk of injury or fatality when vehicles are traveling at higher speeds. The relationship between speed and bicycle injuries raises the question of whether the landscape and design features are related to the corridor travel speed. Further studies with more robust speed data are needed to test this relationship.

Finally, the model shows an inverse relationship between bike injuries and bike volume throughout the corridor. However, the variable is not significant in the model at the 90% confidence level. The reason for this association is not directly clear because the number of crashes typically increases with the number of bicyclists on the road, although the rate of increase in crashes may be lower than the rate of increase of bicyclists due to safety in numbers. The negative coefficient indicates that the number of crashes increase as the number of bicyclists on the road decrease. This may be due to the fact that bicyclists are avoiding areas perceived to be dangerous. If this is the case, it represents a situation in which perceived safety is important in encouraging bicycling.

Although the final model produced results indicating a relationship between some pedestrian design elements, speed, land use, and bicycle injuries, further studies should be conducted with larger corridor lengths and larger numbers of intersections. In addition, more accurate bicycle volume data is needed. The bicycle volume data should account for trends throughout the day, week, and year to provide accurate exposure data. Historical counts would be useful to provide true exposure data for the past ten years. The volume used in this model was compiled in 2012. Therefore, the model rests on the assumption that bicycle volumes have not fluctuated significantly since 2001.

Because speed appeared to be significantly related to bicycle injuries, additional work is needed to analyze the relationship between speed and different landscape and design elements to determine if there is an indirect relationship between these landscape and design features and bicyclist safety.

Combined Corridors Regression Analysis

Combined regression models were built using a dataset made of the data from both San Pablo Avenue and Santa Monica Boulevard corridors. By combining the datasets from the two corridors, the sample size used for regression modeling increases to 249 intersections, which can provide for more reliable model results. However, it is important to remember that the two corridors are very different corridors in both location and characteristics.

Regression Analysis for Pedestrian Safety for Both Corridors

The final model configuration for the pedestrian crash model for both corridors combined is shown in Table . In the combined model for pedestrian safety on both corridors, pedestrian volume was not significant. However, it was kept in the model in order to control for pedestrian exposure. The average number of trash receptacles per block, the presences of pedestrian scale lighting, the presence of newspaper racks, and intersection pedestrian features were all significant and positively correlated with a higher number of increased crashes. The research team believes this may be because the features are correlated with a true increase in pedestrian volume that was not detected by the pedestrian volume model. In addition, the number of legs at the intersection was also significant and positively correlated with pedestrian crashes at intersections. This finding supports the expectation that pedestrians are at higher risk at locations with more locations at which pedestrians, vehicles, and bicycles may all conflict, such as intersections with four legs rather than three.

**Table . Multivariate negative binomial regression of pedestrian injuries and fatalities
SWITRS: SMB 2001-2010 & SPA 1997-2007**

Variable	Coefficient	Standard Error	95% Confidence Interval		P-Value
Log weekly ped volume	0.009	0.128	-0.243	0.261	0.944
Average number of trash receptacles per block	0.182	0.109	-0.032	0.396	0.096
Ped scale lighting	0.585	0.095	0.399	0.771	0.000
Number of intersection legs	0.660	0.140	0.385	0.936	0.000
Number of newspaper racks	0.322	0.093	0.139	0.505	0.001
Ped features (yes vs. no)	0.580	0.153	0.279	0.880	0.000
_cons	-2.567	1.136	-4.793	-0.340	0.024

Regression Analysis for Driver Safety for Both Corridors

The final model configuration for the motor vehicle crash model is shown in Table . Again, the vehicle volume was not significant but was kept in the model to control for vehicle exposure data. The cross street classification was significant and positively associated with an increase in vehicle crashes. Higher vehicle volumes on cross streets would present an increased risk for vehicle collision. Similarly, the number of driveways is positively associated with number of vehicle crashes, likely due to the increase in potential conflicts.

Some features that may indicate areas with higher pedestrian and bicyclist volumes (percent of corners that are ADA, pedestrian scale lighting, number of newspaper racks, pedestrian features, high numbers of retail locations, and bike volume) are associated with higher vehicle crash rates. This may be due to the increase in vehicle-pedestrian and vehicle-bicycle conflicts as well as in distractions for drivers.

Additional pedestrian signs and ladder crosswalks are significant and negatively associated with motor vehicle crashes, indicating that these facilities may be beneficial to users other than pedestrians. These pedestrian warning features may cause drivers to be more alert to their surroundings or to reduce vehicle speeds.

Table . Multivariate negative binomial regression of motor vehicle occupant injury crashes SWITRS: SMB 2001-2010 & SPA 1997-2007

Variable	Coefficient	Standard Error	P-Value	95% Confidence Interval	
Log vehicle volume	-0.412	0.573	0.472	-1.534	0.710
Cross street classification	0.562	0.133	0.000	0.301	0.823
Percent of corners that are ADA	0.016	0.003	0.000	0.011	0.022
Number of ladder crosswalks	-0.096	0.056	0.087	-0.207	0.014
Additional signs for peds	-0.311	0.141	0.027	-0.586	-0.035
Does the block have an average sidewalk width greater than 8'	0.344	0.130	0.008	0.089	0.598
Ped scale lighting	0.382	0.079	0.000	0.228	0.536
Number of newspaper racks	0.349	0.072	0.000	0.207	0.490
Number of driveways	0.025	0.010	0.011	0.006	0.044
Ped features (yes vs. no)	0.242	0.141	0.086	-0.034	0.518
Blocks with at least 6 retail locations	0.239	0.124	0.054	-0.004	0.482
Log bike volume	0.212	0.096	0.027	0.024	0.401
_cons	3.215	5.901	0.586	-8.351	14.781

Regression Analysis for Bicyclist Safety for Both Corridors

The combined bike model showed a significant and positive relationship between bike volume and bike crashes, indicating that the number of bicycle crashes increases as bicycle volume increases, as expected. The percent of the street that is a complete street is also positively associated with higher numbers of bicycle crashes. This again may be due to more bicyclists in locations that are complete streets because these locations have bicycle facilities.

Pedestrian volume was negatively correlated with bicycle crashes, indicating that bicycle crashes may be less common in locations with high numbers of pedestrians. However, other variables that may indicate locations with high numbers of pedestrians (retail locations, pedestrian countdown signals, and newspaper racks) were associated with higher numbers of bicycle crashes.

Higher numbers of bicyclist crashes were also associated with higher numbers of driveways and higher numbers of legs at the intersection. Both of these are related to increased chance of conflict with vehicles.

Graffiti and street trees were negatively associated with higher numbers of bicyclist crashes. The association with graffiti could be due to a lower number of bicyclists in locations that may be deemed unsafe or undesirable to ride a bicycle. The relationship with street trees should be further explored to determine whether street trees provide a safety benefit to bicyclists.

**Table Multivariate negative binomial regression of bicyclist injuries and fatalities
SWITRS: SMB 2001-2010 & SPA 1997-2007**

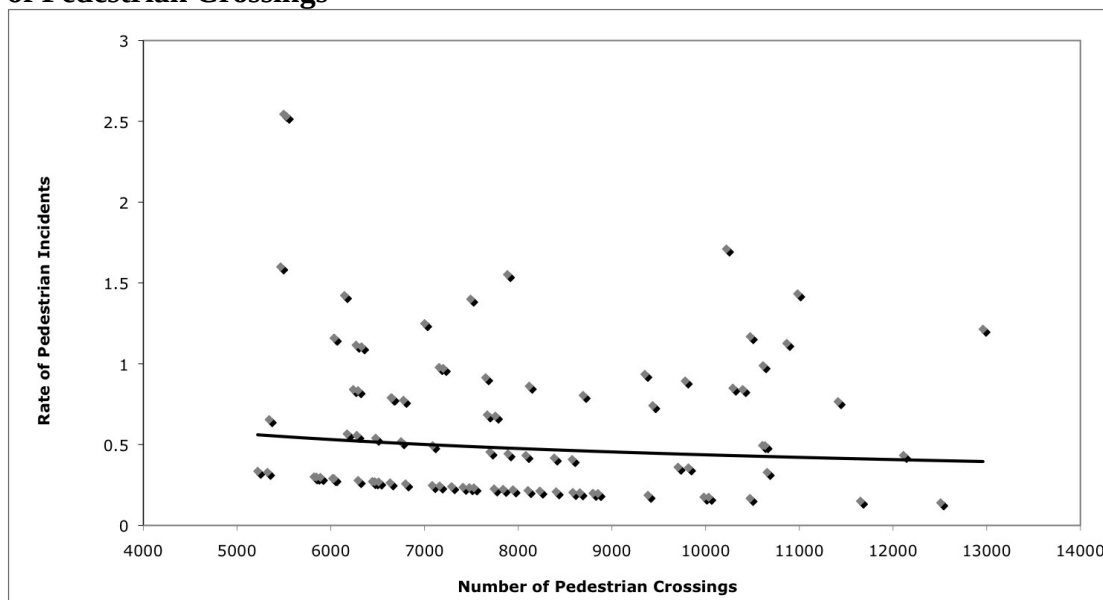
Variable	Coefficient	Standard Error	P-value	95% Confidence Interval	
Log bike volume	0.300	0.151	0.047	0.004	0.595
Log weekly ped volume	-0.231	0.131	0.077	-0.488	0.025
Ped countdown signal	0.610	0.162	0.000	0.293	0.928
Graffiti (yes vs. no)	-0.468	0.201	0.020	-0.863	-..0074
Number of intersection legs	0.633	0.137	0.000	0.366	0.901
Number of driveways	0.031	0.011	0.005	0.009	0.054
Percent of the block that is a complete street	0.009	0.002	0.000	0.005	0.014
Blocks with at least 6 retail locations	0.460	0.146	0.002	0.175	0.746
Does the block have regularly spaced trees on both sides	-0.458	0.148	0.002	-0.747	-0.169
Number of newspaper racks r	0.163	0.085	0.056	-0.004	0.330

_cons	-1.437	1.283	0.263	-3.953	1.078
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Safety in Numbers

Although many past research studies have found a “safety in numbers” effect for pedestrians and bicyclists (Jacobsen 2003; Raford and Ragland 2005), Figure shows that this effect was quite small for the data in this study (outliers removed). The project is still exploring the reason why the data is distributed in this fashion, but it may be connected to the relationship between vehicle speed and pedestrian safety – which could not be analyzed in this study due to near uniform posted speed limit and 85th percentile speed values for vehicles.

Figure . The Relationship between Rate of Pedestrian Incidents and the Estimated Number of Pedestrian Crossings



Unweighted Complete Streets Index

The scores for the unweighted CSI that was developed for San Pablo Avenue ranged from 1.5 to 15 for the various intersections, with a mean value of 7 and a standard deviation of 2.34. Figure and Figure show photos of the intersections at the high and low ends of the scale, respectively.

Figure . Cross-section Photo of 43rd Street – a High CSI Score

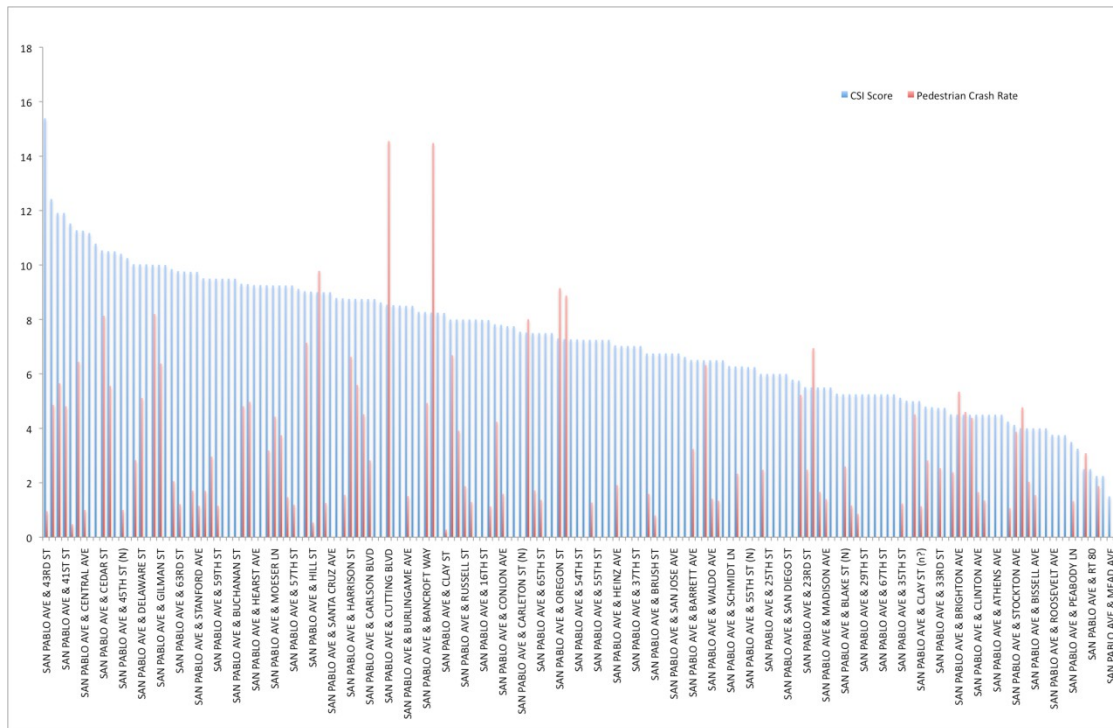


Figure . Cross-section Photo of Mead Avenue – a Low CSI Score



Although the intersections look different, this does not guarantee an effect on pedestrian crashes. If the CSI had any relation to pedestrian safety, one would expect to see the crash rate either positively or negatively associated with the CSI score. However, as Figure depicts, there seems to be no relationship between the two, and a variable for the CSI score was highly insignificant in the regression model. This may be arbitrary, given the unweighted nature of the index. Nevertheless, it is interesting to begin to examine how combinations of design elements do or do not affect pedestrian safety. On this test corridor, strong relationships between combinations of elements and pedestrian safety have remained difficult to decipher.

Figure . Pedestrian Crash Rates per Unweighted Complete Streets Index Scores
 Unweighted CSI Score Pedestrian Crash Rate



Limitations

There are several limitations to the research presented in this section. First, as this research was conducted on only two corridors on which several variables were present with little variation (e.g., posted speed limit, number of vehicle lanes), care should be used in extending conclusions reached in this paper to other situations. Second, it should be noted that, although the test corridors have almost 300 intersections and a variety of conditions, the intersections cannot be assumed to be entirely independent due to the likelihood of carrying the same traffic for at least parts of the corridor. Third, further research is needed to explore why some variables previously found to affect pedestrian safety were not found to be significant in these models or found to have unintended effects. Finally, it is possible that unreported pedestrian crashes are related to different elements than reported pedestrian crashes. This paper analyzed only reported pedestrian, bicycle, and vehicle crash data.

Conclusions and Next Steps

This section presented the findings from the pedestrian, bicyclist, and driver crash models created to help test safety components of the *Complete, Green Streets Performance Measures Framework*. This is one of the first attempts to test multimodal safety along a corridor using crash models and innovative pedestrian volume modeling. The findings of the Phase III and IV field tests suggest that pedestrian safety along San Pablo Avenue and Santa Monica Boulevard may not follow previously established findings, but that this is not certain given limitations to the data.

The driver crash model for Santa Monica Boulevard revealed that driver safety is closely related

to vehicle volume as would be expected. In addition, whether or not the intersection was offset appeared to be significant in the final model. The offset characteristics indicated that drivers are less likely to be in a crash at these intersections, which is likely due to the reduction in conflict points associated with an offset intersection. The positive association between ADA compliant intersection corners and bike parking with driver safety could be attributed to the increased pedestrian and bicyclist volumes associated with these features.

The pedestrian crash model for Santa Monica Boulevard supported the common perception that vehicle conflicts are a significant concern for pedestrians. Based on the final pedestrian crash model, vehicle traffic volumes of both Santa Monica Boulevard and side streets were significantly associated with an increase in pedestrian injuries and fatalities. However, pedestrian volume was not significantly associated with pedestrian injuries and fatalities.

The positive association between intersection pedestrian features, trash receptacles, and newspaper racks is unexpected. Intersection pedestrian features are thought to improve safety for pedestrians. However, these results reveal that intersection pedestrian features are not necessarily associated with increased safety. There are many reasons for this potential association. Pedestrians may be less alert due to an increase in perceptions of safety. The association may also be due to an increase in pedestrian volume at these locations that was not accurately picked up by the pedestrian volume model. Regardless, the results from the pedestrian volume model indicate that vehicle conflicts continue to be the most significant concern for pedestrians.

In addition, the positive association between the percent of collisions involving alcohol and the number of crashes at an intersection revealed that the involvement of alcohol in pedestrian crashes is significant.

The bicycle crash models for both Santa Monica Boulevard and San Pablo Avenue both revealed correlation between vehicle speed and the percent of corners that are ADA compliant. It is worth noting that the percent of corners that are ADA compliant was highly correlated with the number of crosswalks at an intersection. Both of these models indicate that bicyclists are at higher risk when vehicles are traveling at higher speeds. The increase bicycle injuries at intersections with curb ramps, which may serve as a proxy for number of crosswalks or number of legs of the intersection, indicates that bicyclists are at higher risk when there are higher pedestrian volumes or potential conflicts with vehicles turning. The bicyclist features did not appear to be more significant than the vehicle issues. However, bicycle features should be further tested on a corridor with more abundant features before any conclusions can be drawn about their safety effectiveness.

The Santa Monica Boulevard bicyclist crash model also revealed a positive relationship between industrial land use and bicycle injury and fatality occurrences. The researchers noted an association between a lack of all pedestrian and bicycle enhancements at many locations that were deemed to be industrial land use. Therefore, they felt that the industrial land use variable may serve as an indication of a lack of all features. This lack of features is correlated with a higher bicyclist injury rate.

Overall, these models reveal that further research is still needed to explain the associations that

are being discovered. Because it appears that driver behavior (speed, awareness of pedestrians and bicyclists) may be an important component in pedestrian and bicyclist safety, the results found here may not accurately depict the full effect of the design elements. Many vehicles pass through West Hollywood and Los Angeles on Santa Monica Boulevard, and their behavior at different intersections may therefore be correlated.

The results also reinforce the need for continued collection of volume data for pedestrians and bicyclists. Although additional volume data was collected for Phase IV in an effort to improve crash models, the relationship between exposure data and crash data is not always as strong as would be expected. Further research needs to be conducted on pedestrian and bicyclist volume models.

Finally, all three crash models revealed high correlations among features. Further work should be conducted on additional corridors to develop weighted indexes of multiple variables to better understand this relationship.

All of the results presented in this section should be considered preliminary and be interpreted with caution. The projections of volume using models and extrapolation, while considered a standard approach, presents some error. The models developed here were not able to account for all the association among variables. Additional research should be undertaken to help understand this relationship.

As an alternative way to observe the impact of these features, the Highway 82 longitudinal, or before and after, study presents a unique opportunity. The counting firm utilized video technology to record the pedestrian and bicyclist counts along this corridor. Video footage from these counts, which will be provided to the research team, could be reviewed after the improvements to complete an observational study.

The following sections elaborate on other key findings from the project. Section C presents the results of the pedestrian and bicyclist intercept survey, while Section D presents an analysis of each performance measure's validity and ease of application. Issues that have been identified are being addressed so that the performance measures can be fully recommended for use by Caltrans. In doing so, the researchers plan to deliver a valid and relatively easy to implement set of measures for Caltrans' *Complete, Green Streets Performance Measures Framework for Urban Arterials*. It will then be Caltrans's role to begin to set targets and gather the data necessary to measure the performance of its network with regard to pedestrian and bicyclist safety and mobility. The result of implementing the proposed *Complete, Green Streets Performance Measures Framework for Urban Arterials* should be a Caltrans roadway system that better accommodates pedestrians and bicyclists and contributes to environmental sustainability and community vitality through increased multimodal mobility, and ultimately, more holistic street design.

B. San Pablo Avenue Pedestrian and Bicycle Policy and Plan Analysis

Introduction & Background

San Pablo Avenue (SPA) is a historic state route that acts as an urban arterial on the eastern side of the San Francisco Bay. As a state route, the roadway is under the jurisdiction of Caltrans, but influenced by the six cities and two counties through which it runs. This variety in governance has naturally resulted in a variety of local priorities – many of which were written into the design of the street itself. This can be seen, for example, at the transition of two cities. Whereas one city built medians into the street and planted them with trees that would create a large canopy, another banned medians to facilitate access to businesses. As can be seen in Figure 10 & Figure 11 below, these two design decisions have resulted in dramatically different streetscapes.

Figure 10 & Figure 11. San Pablo Avenue, City of Berkeley (left) and City of Albany (right) Cross-sections at Shared Border



While these decisions may have made the most sense at the time, priorities have begun to change with regard to the many purposes roadways serve. A decline in physical activity, along with alarming growth in the rate of obesity and diabetes in the United States, has spurred the CDC to recommend building bicycle and pedestrian facilities as a key strategy to increase public health (CDC 2009). Evidence of global climate change has also convinced the United States government to target reducing vehicle miles traveled (VMT) as an important objective (EPA 2010).

In addition, roadway funding is in short supply: the highway trust fund, which has traditionally paid for the maintenance of highways in the United States, is functionally bankrupt (AASHTO 2010), and communities across California continue to struggle to keep up with maintenance needs. Thus, fiscally it is not clear that continuing to focus on the most expensive and least efficient form of transportation – the private automobile – is in the State's best interest. Caltrans' current Strategic Plan acknowledges these challenges, in addition to the burden of a rapidly growing population on the aging transportation system (California DOT 2007).

Many of the jurisdictions with authority over San Pablo Avenue have recognized the importance

of prioritizing alternative transportation in their policies. While several of these policies are new, and have therefore not had time to affect design, they still serve as important harbingers of the future of walking and bicycling along San Pablo Avenue. *In addition, in the places where policies have been in place for several years, clear results can be seen in the built form, offering encouraging evidence of the importance of policy and political will with regard to defining priorities.* Specific examples of this can be seen in the following sections of this Chapter. This section examines the city and county policies that affect pedestrian and bicycle safety and mobility along San Pablo Avenue, and compares the current policies and their potential to create a more walkable, bikable San Pablo Avenue.

Overview

This section briefly describes each agency's roles and responsibilities regarding transportation planning, and details the policies applicable to pedestrian and bicyclist safety and mobility, and community vitality along San Pablo Avenue. Policies from the following agencies/jurisdictions are included in the analysis:

- California Department of Transportation (Caltrans)
- Alameda County
- Contra Costa County
- Metropolitan Transportation Commission (MTC)
- City of Albany
- City of Berkeley
- City of El Cerrito
- City of Emeryville
- City of Oakland
- City of Richmond

We looked at 43 different strategies and physical elements that could encourage pedestrian and bicyclist safety, and compared to one another using a checklist developed from the summary review of all plans. The aim of this effort is to understand how design and policies interact in each jurisdiction to produce the observed outcomes.

Format

Each plan that influences the design of San Pablo Avenue was examined, along with its specific goals and objectives for increasing walking and bicycling along San Pablo Avenue. The exact text from the plans discussed here can be found in Appendix F. In the concluding section, a checklist will summarize and compare the aspects of pedestrian and bicyclist safety and mobility covered by a combination of each city's or county's plans. A summary comparison of the contents of all policies reviewed herein is located in Appendix E.

Local Agency Roles and Policies for San Pablo Avenue

The various plans from each city through which San Pablo Avenue runs as State Route 123 are detailed in this section. Only plans that specifically mention San Pablo Avenue are discussed. For each city, any plan that is specifically geared toward San Pablo Avenue is discussed first, followed by the general plan of the city, and then by pedestrian and bicycle plans. Other policies that are not specific to any plan, but that would be generally applicable to San Pablo Avenue

(e.g., a street tree ordinance), are mentioned at the end of the city's section. The California Streets and Highways Code requires that sidewalks be maintained by the adjoining private property owner ([Section 5610](#)) in all cities, so sidewalks are not mentioned except where cities have added an addendum to this section.

City of Albany

History and authority: The City of Albany was incorporated in 1908 (City of Albany 2008). The city partially maintains the route for the State. The most recent maintenance deal was signed in 1981 (Caltrans 1981).

Roles and responsibilities: In agreement with Caltrans, the City of Albany is responsible for maintaining the roadside (including sidewalks), street tree and median maintenance and care, litter cleanup, and operational aspects such as signal timing and speed limits. Due to possible impacts on air quality and traffic congestion, decisions about operations are influenced by regional authorities such as the congestion management agency (CMA) and the Metropolitan Transportation Commission. Decisions about modifying the route, such as by adding a signal or a crosswalk, must be approved by the State.

San Pablo Avenue Streetscape Master Plan (2001)

This is Albany's only San Pablo Avenue-specific plan. The plan aims to create a consistent streetscape for San Pablo Avenue in Albany. It focuses on amenities, such as street lights, benches, trash receptacles, and street trees. There is little attention given to pedestrians or bicyclists, other than design features such as pedestrian-scaled lighting and bicycle rack placement (pp. 2-3). However, it can be assumed that the amenities would benefit both pedestrians and bicyclists by creating a more pleasant place to walk and bicycle. There are no stated goals or policies in this document.

Albany General Plan (1994)

Albany's current General Plan focuses on pedestrian improvements along pathways, rather than on the sidewalks of major streets. While the plan mentions the various types of bikeways that could be developed, as well as a need to develop a network, it also states that it has not developed a network. It should be noted that the current General Plan was approved over 10 years before the current Albany Bicycle Plan. The plan has only one goal specific to pedestrians and bicyclists, and four supporting policies, which are summarized below.

Goal: Support alternative modes of transportation to the private automobile.

Policies:

1. Create incentives for walking and bicycling.
2. Connect pathways to major uses and amenities to encourage walking.
3. Increase compliance with the ADA to enable disabled pedestrian access.
4. Assure that pedestrian pathways (including sidewalks) are safe and accessible.

Albany Bicycle Plan (~2005)

The Albany Bicycle Plan defines several goals and supporting policies to increase bicycling in the city. Many of the goals and policies are operational and involve programming, so are difficult to measure with a physical analysis. The goals that are physical in nature can be measured, but are not targeted for implementation along San Pablo Avenue. In general, the plan acknowledges that bicycling may take place along San Pablo Avenue, and so argues for increased

bicycle parking, but does not recommend facilities along the street. The goals that are applicable to San Pablo Avenue are summarized below.

Goals:

1. Develop a comprehensive bicycle transportation system that links neighborhoods to regional destinations.
2. Attempt to fund bicycle transportation system with state and federal monies.
3. Aim to accommodate both recreational and commuter bicyclists.
4. Provide connections to transit.
5. Improve safety for bicyclists.
6. Encourage bicycling through city events and efforts (e.g., a bicycle map).

City of Albany Traffic Management Plan (2000)

Vision: The Traffic Management Plan is presented as a set of defined goals, objectives, and implementation actions designed to enhance the City's quality of life by creating more livable streets, which promote safer automotive travel, and safer and more convenient facilities and programs that increase and encourage bicycle, pedestrian, and transit travel (adapted, p. 1).

This plan identifies the goals and strategies for managing traffic in Albany. Several of the overall goals relate to improving pedestrian and bicycle access in Albany. These include the following:

1. Provide equal rights of access for non-automobile modes.
2. Reduce automobile trips in the City by encouraging use of non-automobile modes.
3. Create conditions throughout the City for safer and more convenient walking and bicycling, especially for children going to and from school.

The traffic plan focuses on travel safety and traffic calming on key streets (including San Pablo Avenue). It recommends that a future Pedestrian Preferential Plan be developed to more fully deal with pedestrian issues.

How does Albany Compare?

The plans mentioned here reflect efforts to increase pedestrian and bicycle safety and access in Albany. **Table** in the concluding section shows that Albany's plans cover 12 of the 43 topics, many fewer than the other cities profiled in this report. In addition, even though there are specific safety and landscape design projects mentioned in the plans, some of these improvements have yet to be implemented. **Figure** and **Figure 13** show major intersections in Albany as currently designed.

Figure & Figure . San Pablo Avenue in Albany: Cross-section with and without a median



City of Berkeley

History and authority: The City of Berkeley was incorporated in 1878 (City of Berkeley 1878). The city maintains the route for the State. The most recent maintenance contract with Caltrans was signed in 1988 (California DOT 1988).

Roles and responsibilities: In agreement with Caltrans, the City of Berkeley has assumed responsibility for the maintenance of San Pablo Avenue, and is thus responsible for ensuring the quality of the roadway and sidewalks (where not private). This includes roadway and sidewalk paving and construction, where needed; street tree and median maintenance and care; litter cleanup; providing and refurbishing pavement markings and signs; and operational aspects such as signal timing and speed limits. Due to possible impacts on air quality and traffic congestion, decisions about operations are influenced by regional authorities such as the congestion management agency (CMA) and the Metropolitan Transportation Commission. Decisions about modifying the route, such as by adding a signal or a crosswalk, must be approved by the State.

City of Berkeley San Pablo Avenue Public Improvements Plan (2003)

Vision: The City of Berkeley is committed to improving the San Pablo Avenue streetscape to balance the needs of pedestrians, bicyclists, local and regional drivers, public transit users, business owners, and local residents (p. 2).

Through this plan, the city aims to create a more walkable and accessible San Pablo Avenue that is economically vibrant and connected to the local Berkeley neighborhoods. The plan identified the following actions to accomplish this vision:

- Upgrade existing crosswalks and install pedestrian-scaled light fixtures.
- Upgrade curb ramps to current ADA standards.
- Designate key intersections through special features or markings.
- Further define Berkeley's character through maintenance and enhancement of street and median trees.
- Use landscaping and bulb-outs to enhance sidewalk connections from residential and commercial areas to San Pablo Avenue.
- Consider adding differential gateway features to mark north and south entries.

The plan also looks at medians, special paving, special pedestrian signals, crosswalks, trash

receptacles, benches, news racks, public art, bicycle parking, and new traffic signals where San Pablo Avenue intersects with bicycle boulevards.

Berkeley General Plan (2001)

The Berkeley General Plan contains several policies to address various aspects of walking and bicycling. These policies are summarized below.

Policies:

1. Consider separate traffic signals to increase pedestrian and bicycle access.
2. Coordinate with other departments to improve bicycle and pedestrian access when possible.
3. Provide a comfortable bicycling network for all types of bicyclists.
4. Emphasize education and enforcement to encourage safe driving and bicycling.
5. Promote benefits of bicycling to the public.
6. Improve pedestrian access for the disabled community.
7. Maintain sidewalks to facilitate pedestrian access.
8. Prioritize pedestrians when there is competition for sidewalk space.
9. Increase pedestrian safety at crossings.
10. Address intersections with high pedestrian and bicycle collision rates.
11. Ensure that bicyclists and pedestrians are provided for in neighborhoods.
12. Create pedestrian-friendly commercial areas.

Berkeley Pedestrian Master Plan (2008)

The Berkeley PMP is modeled from and consistent with the City's General Plan. Many of the goals are linked to the policies in the Berkeley General Plan.

Goals

1. Plan, Build and Maintain Pedestrian Supportive Infrastructure

This Goal includes policies, actions and implementation measures related to design standards, engineering, maintenance, funding priorities, and development review.

2. Provide Universally Safe and Equal Access

This Goal includes policies, actions and implementation measures related to the ADA, safe crossings, access to destinations, and reducing conflicts and collisions.

As part of the PMP, the City developed a GIS-based sidewalk centerline network model that includes sidewalk centerlines, sidewalk widths, pathway and stair centerlines, the location of audible pedestrian signals, pedestrian actuated signals and pedestrian count-downs, and the location and types of crosswalks, traffic calming devices, curb ramps, and signage. This data enables the city to keep track of how well they are meeting plan goals.

3. Develop Pedestrian Supportive Encouragement and Enforcement Programs

This Goal includes policies, actions and implementation measures related to education, encouragement, enforcement, and coordination with other institutions. The plan is quite thorough, and also includes detailed information about pedestrian safety and risk.

Berkeley Bicycle Plan (1998; updated in 2005)

Mission: To create a model bicycle-friendly city where bicycling is a safe, attractive, easy, and

convenient form of transportation and recreation for people of all ages and bicycling abilities. Following are the goals of the plan that directly affect the San Pablo area.

Goals

1. Planning

Integrate the consideration of bicycle travel into City planning activities and capital improvement projects, and coordinate with other agencies to improve bicycle facilities and access within and connecting to Berkeley.

2. Network and Facilities

Develop a safe, convenient, and continuous network of bikeways that serves the needs of all types of bicyclists, and provide bicycle parking facilities to promote cycling.

3. Education/Safety

Improve the safety of bicyclists through education and enforcement.

4. Promotion

Increase bicycle mode share by increasing public awareness of the benefits of bicycling and of the available bike facilities and programs.

5. Implementation

Secure sufficient resources from all available sources to fund ongoing bike improvements and education.

Additional policies:

Street Tree Planting

Street trees positively affect pedestrians by providing shade, serving as a buffer between the sidewalk and the roadway, visually enclosing a space, and providing a sense of street continuity. Over 800 new and replacement street trees are planted in the parkway strip (area between the sidewalk and curb) each year by the Parks Recreation & Waterfront Department (City of Berkeley 2010).

How does Berkeley compare?

The particulars of Berkeley's plans show more detailed planning for pedestrian and bicycle issues in comparison with other communities. Table in the concluding section shows that Berkeley's plans cover 31 of the 43 topics. In addition, many of the specific actions in Berkeley's San Pablo Avenue Improvement Plans have been implemented, such as street trees, public seating or amenities, high visibility crosswalks, audible pedestrian signals, and pedestrian-scaled lighting. Figure and Figure 15 show the effect of street trees and medians. However, there is still work to be done to meet the remainder of the various plans' goals.

Figure & Figure . San Pablo Avenue in Berkeley: London Plane and Mixed Trees



City of El Cerrito

History and authority: The City of El Cerrito was formally established in 1917 (City of El Cerrito 2010). The city partially maintains the route for the State. The most recent maintenance contract with Caltrans was signed in 1992 (California DOT 1992).

Roles and responsibilities: In agreement with Caltrans, the City of El Cerrito is responsible for the landscaping, drainage, litter cleanup and electrical maintenance of lights along San Pablo Avenue. However, in contrast to Berkeley, El Cerrito is not responsible for the physical quality or operations of the roadway. El Cerrito is responsible for the quality of the public sidewalks; however, private sidewalks are required by state law to be the responsibility of the abutting property owner.

Cities of El Cerrito and Richmond Draft San Pablo Avenue Specific Plan (2009)

Vision: The heart of El Cerrito and an important artery for Richmond, San Pablo Avenue is a vibrant, cohesive and community-strengthening corridor that serves existing and new residents, businesses, commuters and visitors. Its new residential, commercial and civic uses and activities are linked by easy and safe cross-avenue connections, increasing the corridor's activity, vitality and prosperity. The character of this East Bay "gem" is cohesive while allowing for variations and unique elements (p. 37).

The vision continues that the street

is oriented to provide an improved environment that encourages walking, biking, and transit use. San Pablo is a safe, attractive street, with wide sidewalks, trees, lighting and other amenities supporting a healthy pedestrian environment. Sustainable street design elements are incorporated into the infrastructure, supporting the environmental and ecological commitment of the community. While San Pablo Avenue is a bustling, pedestrian-oriented place, the Ohlone Greenway runs parallel to the street, providing a safe and more natural environment for bicyclists and pedestrians. Key east-west connections are designed to better balance the demands of autos, bicyclists and pedestrians. Intersection improvements improve cross-avenue connectivity, and new streets, pedestrian connections, and alleys break up large blocks, enhancing walkability of the plan area (p. 37).

The following key principles and goals affect pedestrian and bicyclist safety and mobility:

Circulation Principles

1. Balanced transportation modes provide options for mobility.
2. Improvements to circulation routes increase safety for pedestrians and bicyclists.
3. Universal accessibility ensures a safe and efficient circulation experience for everyone.

Transportation Goals

T-1 Make the plan area a walkable and bikeable corridor at the seam of the El Cerrito and Richmond communities.

T-3 Strengthen multi-modal connections in and around the plan area.

This plan is a special case of city partnership, as the City of Richmond maintains the west side of the roadway, and the City of El Cerrito maintains the east side. Differences in quality between the two sides are noticeable in some places currently; however, the plan clearly creates a unified vision for the quality of the street. The plan aims for a high-quality streetscape, and thoroughly identifies areas of improvement along the corridor. It is not possible to measure the effects of this plan on the built environment at this time, as it was just recently released as a draft. However, it has the potential to significantly improve San Pablo Avenue in El Cerrito and Richmond.

For its part, the City of El Cerrito intends that San Pablo Avenue become an environment that supports walking, bicycling, and transit use. The City sponsored the San Pablo Avenue Streetscape Improvement Project from 2007-2010, fitting with the development of the larger San Pablo Avenues Specific Plan. El Cerrito desires San Pablo Avenue to be a safe roadway, complete with sidewalks, trees, and lighting and other amenities that encourage walkability. It should also become a sustainable streetscape that supports the “ecological commitment of the community.” The Ohlone Greenway will be the more natural parallel to SPA, while important east-west routes will help balance multimodal travel demands. The city also aims to improve intersections and break up large blocks to increase walkability.

El Cerrito General Plan (1999)

El Cerrito aims to create an atmosphere of pedestrian friendliness and economic vitality. The General Plan envisions El Cerrito as a “pedestrian friendly place” with a pedestrian-friendly network of streets, pathways, and open spaces that conveys safety and mobility for city residents. The city aims to emphasize pedestrians, cyclists, and public transit users through slowing automobile traffic and creating an attractive place to be. The city also aims to accommodate pedestrians through land use patterns that can support alternative transportation.

San Pablo Avenue is specifically targeted to be more transit and pedestrian friendly. The city’s policies promote greater mixed uses along SPA that can connect various parts of the avenue, as well as connect the avenue to the Ohlone Greenway. Businesses are to have adequate pedestrian and bicycle facilities, such as curb ramps and bicycle parking, and connections to transit where possible. San Pablo Avenue should have a coherent identity reinforced through landscaping and street improvements.

El Cerrito Circulation Plan for Bicyclists and Pedestrians (2007)

The Circulation Plan is consistent with the General Plan. With the development and implementation of this Circulation Plan, the City of El Cerrito hopes to attain the following goals:

Goals

1. Create a comprehensive citywide network of bicycle and ADA accessible pedestrian routes that connect travelers to both local and regional destinations.
2. Promote bicycling and walking as alternative modes of transportation through design, designation, programs, policies, and education.
3. Foster a sustainable community by addressing the social, economic, and environmental impacts of transportation infrastructure and services.
4. Provide safe and accessible routes to schools, transit stops and stations, and City facilities.
5. Create bicycle and pedestrian facilities that fulfill the needs of both utilitarian and recreational users.
6. Accommodate bicycle and pedestrian access in the design and development of new buildings and facilities.
- ...
8. Work with City departments, neighboring jurisdictions, and regional organizations to coordinate efforts during the planning and implementation phases of bicycle and pedestrian improvement projects.
9. Establish priorities and identify funding sources for implementing bicycle and pedestrian improvements.

The Circulation Plan has designated San Pablo as a proposed pedestrian route in the city, and has identified seven intersections along San Pablo for improvement. It also urges consideration of allowing previously prohibited pedestrian crossings, installing pedestrian countdown signals, reconfiguring lanes, lowering the speed limit to 30 mph (which is consistent with the speed limit in Berkeley and Albany)⁴, and prohibiting vehicular right turn on red movements at select intersections. The plan suggests developing streetscape improvements in coordination with redevelopment along the San Pablo Avenue corridor, and exploring potential for Caltrans' relinquishment of control of sidewalks to the City of El Cerrito.

How does El Cerrito compare?

The plans mentioned here reflect efforts to increase pedestrian and bicycle safety and access in El Cerrito. Table in the concluding section shows that El Cerrito plans cover 33 of the 43 topics, the most of any city profiled in this report. Anecdotal evidence from the facility analysis suggests that El Cerrito has followed through with some of its plans to improve the streetscape and plant trees for pedestrians, as demonstrated by

Figure & Figure . San Pablo Avenue in El Cerrito: Regular (left) and Sporadic (right) Street Trees



However, these plans have not yet been universally implemented, as demonstrated in Figure 17. In addition, other actions, such as the intention to increase bicycle parking, have not been as evidently accomplished. The recently released San Pablo Avenue Specific Plan contains specific recommendations which, when implemented, should greatly improve the walkability of the corridor. None of the plans advocate for bicycle facilities along San Pablo Avenue, though, which brings into question how bikable the corridor will eventually become (this is the case for all cities evaluated in this document, not just El Cerrito). It will take a few years before the newest recommendations come to fruition. Evaluation of the plans' effectiveness will be more appropriate at that time.

City of Emeryville

History and authority: The City of Emeryville was incorporated in 1896 (City of Emeryville 2010). The City partially maintains the route for the State. The most recent maintenance contract with Caltrans was signed in 1989 (California DOT 1989).

Roles and responsibilities: In agreement with Caltrans, the City of Emeryville is responsible for the landscaping, drainage, litter cleanup and electrical maintenance of lights along San Pablo Avenue. Similar to the City of El Cerrito, Emeryville is not responsible for the physical quality or operations of the roadway.

Emeryville Draft General Plan (2009)

The fourth Guiding Principle of Emeryville's GP states that the City is "a walkable, fine-grained city, emphasizing pedestrians."

The General Plan establishes that all of Emeryville will be easily traversed on foot. A fine-grained pattern of blocks and streets is a fundamental prerequisite of a walkable and accessible city; the General Plan promotes walkability through encouragement of active uses, creation of smaller parcels/blocks and inter-connections as large sites are redeveloped, and improved sidewalks, pathways, and streetscapes. Where larger buildings may be appropriate, these shall be constructed with smaller footprints to preserve views and ensure pedestrian access. Where appropriate, in people-intensive places—such as retail, office, and residential districts—pedestrians will have priority over automobiles, and buildings shall be articulated and designed to visually engage and offer comfort to pedestrians (p. I-3).

San Pablo Avenue is classified as a "transit street" in Emeryville, which accommodates pedestrians through large sidewalks. Part of SPA is also designated a "Pedestrian Priority Zone" -- an area designed to accommodate and encourage high volumes of pedestrian traffic along the sidewalk. The designation includes:

- Building wide sidewalks with plentiful pedestrian amenities;
- Encouraging interesting building frontages;
- Giving high priority to pedestrian crossings at intersections; and
- Providing well-protected mid-block crosswalks where appropriate.

The City also plans to replace its Level of Service analyses (LOS) with a Quality of Service analysis that will give more weight to pedestrian and bicyclist concerns than traditional LOS.

Emeryville Bicycle and Pedestrian Plan

This plan does not deal with San Pablo Avenue specifically, except in its claim that a majority of residents are able to walk around Emeryville via its sidewalks.

How does Emeryville compare?

The plans mentioned here signify progress toward increasing pedestrian and bicycle safety and access in Emeryville. Table in the concluding section shows that Emeryville's plans cover 20 of the 43 topics. Figure and Figure 19 show that some of the policies have already been implemented. For example, San Pablo Avenue is fairly consistently lined with street trees and many medians have landscaping.

Figure & Figure . San Pablo Avenue in Emeryville: Medians with Plants and Trees



City of Oakland

History and authority: The City of Oakland was incorporated in 1852 (Oakland Convention & Visitors Bureau 2008). The most recent maintenance contract with Caltrans was signed in 1991 (California DOT 1991).

Roles and responsibilities: In agreement with Caltrans, the City of Oakland has assumed responsibility for the maintenance of San Pablo Avenue, and is thus responsible for ensuring the quality of the roadway and bridges (where applicable). This includes roadway and sidewalk paving and construction, where needed; street tree and median maintenance and care; litter cleanup; providing and refurbishing pavement markings and signs; and operational aspects such as signal timing and speed limits. Due to possible impacts on air quality and traffic congestion, decisions about operations are influenced by regional authorities such as the congestion management agency (CMA) and the Metropolitan Transportation Commission. Decisions about modifying the route, such as by adding a signal or a crosswalk, must be approved by the State.

Oakland General Plan (1998)

The General Plan has a few transportation goals broadly related to pedestrian and bicycle transportation.

These are:

- T2 – Provide mixed use, transit-oriented development that encourages public transit use and increases pedestrian and bicycle trips at major transportation nodes.
- T4 – Increase use of alternative modes of transportation.
- T6 – Make streets safe, pedestrian accessible, and attractive.

These goals form the basis for many of the goals, policies, and actions developed for the Oakland Pedestrian and Bicycle Master Plans. There are not many specific actions in the General Plan; however, this may be appropriate given the scope of the plan. For example, San Pablo Avenue is designated in the plan as a regional transit street and an arterial, typically having speeds between 30-45 mph. However, there are no other specifics about San Pablo -- the plan mentions only a desire to generally “improve” the arterial. The plan references the Oakland Bicycle and Pedestrian Master Plan for more information.

Oakland Pedestrian Master Plan (2002)

The vision of the Oakland Pedestrian Master Plan is to:

...promote a pedestrian-friendly environment; where public spaces, including streets and off-street paths, will offer a level of convenience, safety and attractiveness to the pedestrian that will encourage and reward the choice to walk (p. 6).

To foster pedestrian safety, the City established a Pedestrian Route Network that connects every public school, park, recreational center, and library in the City of Oakland. The network was integrated with existing school safety programs that have targeted sidewalk and crossing improvements. It also identifies key routes that serve AC Transit bus lines and BART stations. These routes include the “transit streets” designated by the Land Use and Transportation Element (of which San Pablo Avenue is one).

The plan has the following goals for enhancing pedestrian safety. These include:

1. Pedestrian Safety. Create a street environment that strives to ensure pedestrian safety.
2. Pedestrian Access. Develop an environment throughout the City – prioritizing routes to school and transit – that enables pedestrians to travel safely and freely.
3. Streetscaping and Land Use. Provide pedestrian amenities and promote land uses that enhance public spaces and neighborhood commercial districts.
4. Education. Educate citizens, community groups, business associations, and developers on the safety, health, and civic benefits of walkable communities.
5. Implementation. Integrate pedestrian considerations based on federal guidelines into projects, policies, and the City’s planning process.

Oakland Bicycle Master Plan (2007)

Vision Statement: *Oakland will be a city where bicycling is fully integrated into daily life, providing transportation and recreation that are both safe and convenient (p. 15).*

The plan establishes the following goals to encourage bicycling in Oakland:

1. Infrastructure: Develop the physical accommodations, including a network of bikeways and support facilities, to provide for safe and convenient access by bicycle.
2. Education: Improve the safety of bicyclists and promote bicycling skills through education, encouragement, and community outreach.
3. Coordination: Provide a policy framework and implementation plan for the routine

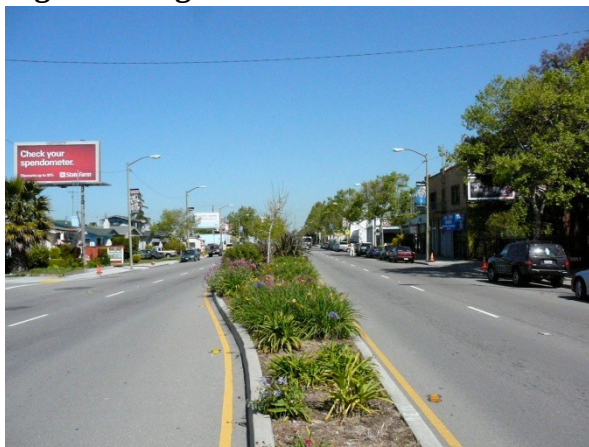
accommodation of bicyclists in Oakland’s projects and programs.

The Bicycle Master Plan aims to help the City achieve “Bicycle Friendly Community” status, as awarded by the League of American Bicyclists, by the year 2012.

How does Oakland compare?

The plans mentioned here demonstrated concerted effort toward increasing pedestrian and bicycle safety and access in Oakland. Table in the concluding section shows that Oakland’s plans and policies cover 21 of the 43 topics. Many of these topics have been addressed along parts of San Pablo Avenue. Figure represents an area of San Pablo Avenue in Oakland with great attention to landscaping, full sidewalks, and pedestrian-scaled lighting. In contrast, Figure 21 depicts a part of the avenue where the policies do not seem to have had much effect.

Figure & Figure . San Pablo Avenue in Oakland: Planted and Concrete Medians



History and authority: The City of Richmond was chartered in 1909 (City of Richmond 1909). The most recent maintenance contract with Caltrans was signed in 1973 (California DOT 1973).

Roles and responsibilities: Caltrans still has responsibility for most of the maintenance of San Pablo Avenue, including the restoration and repair of the surface and base within the roadbed area; cleaning of the culverts, ditches, natural water channels and gutter; restoring side slopes, removal of drifted material, drift prevention, erosion control, and maintenance of walls, cribs or bank protection, sidewalks and curbs, and other roadside facilities. The state also controls the vegetation and performs routine tree maintenance for safety only. The City is responsible for street sweeping and cleaning, roadway marking maintenance, and maintenance of select curb paint. The state pays for all signs used for warning or regulating traffic and for lighting at intersections, when required for the safety of persons crossing the streets.

Richmond General Plan (2009)

As part of its General Plan, Richmond developed a vision of what the community will look like in 2030. This vision describes

Richmond as a place that “ensures mobility and access for all residents, workers and visitors through a safe, interconnected, multimodal transportation system.” The vision continues with a specific focus on non-motorized transportation:

Richmond’s grid-based network of streets balances modes of travel, supports pedestrian and bicycle connectivity, transit accessibility and a smooth flow of vehicular traffic. The City is easily navigable with clear directional signage and barrier-free links connecting all neighborhoods. Many residents rely on walking, bicycling and transit. These modes of travel are well supported by attractive streetscapes, pedestrian amenities, connected hubs and reliable bus service that provides connections to local destinations. Crosswalks, sidewalks, traffic calming features, multimodal trails and designated bike routes further provide safe and comfortable conditions for pedestrians and cyclists (p. 2, Circulation Element).

The pedestrian and bicycle goals relevant to San Pablo Avenue in Richmond’s General Plan include:

Circulation

- CR1. Expand the Multimodal Circulation System
- CR2. Promote Walkable Neighborhoods and Livable Streets
- CR3. Create a Safe and Well-Maintained Circulation System

Land Use

- LU6. Promote High-Quality and Sustainable Development

Richmond has also focused on San Pablo Avenue as a “community connector street”, a transit street, and a “key corridor.” In this way, it serves as a link to neighborhoods in other parts of the City, with a particular emphasis on accommodating public transit and being multimodal.

How does Richmond compare?

Richmond’s General Plan and the Richmond/El Cerrito San Pablo Avenue Specific Plan demonstrate concerted effort toward increasing pedestrian and bicycle safety and access in Richmond. In addition, the City is currently in the process to develop a pedestrian plan. Table in the concluding section shows that Richmond’s plans and policies cover 23 of the 43 topics. Figure and Figure 23 depict typical street and landscaping conditions in Richmond. The policies show effort to improve the environment for pedestrians and cyclists in ways that may dramatically alter the current streetscape.

Figure & Figure . San Pablo Avenue in Richmond: Street Trees and a Typical Cross-section



Regional Agency Roles and Policies for San Pablo Avenue

Regional agencies produce broad plans that aim to work with the local plans and policies addressing San Pablo Avenue and the region. The counties of Alameda and Contra Costa have both produced pedestrian and bicycle plans, and the Bay Area's Metropolitan Transportation Commission has produced its own regional bicycle plan. These plans are discussed briefly below.

Alameda County

In 1986, voters in Alameda County elected to pay a ½ cent sales tax in order to support discretionary transportation funding. The Alameda County Transportation Improvement Authority (ACTIA) was formed to manage this money, known as “Measure B” funds, on behalf of county residents. When the measure went to the ballot again in 2002, voters again supported it – this time with a guarantee of 5% of the funding (estimated to be about \$150 million) going to pedestrian and bicycle projects (Alameda County Transportation Improvement Authority 2010). The county's pedestrian and bicycle plans were developed in part to guide the allocation of Measure B funds.

Alameda Countywide Strategic Pedestrian Plan (2006)

According to the Pedestrian Plan, its main purpose is to improve the status of pedestrians in Alameda County. The plan will be used to guide funding decisions in a strategic fashion to encourage walking in Alameda County.

Vision: Alameda County will be a community that inspires people to walk for everyday trips, recreation and health where development patterns, connections to transit, and interconnected pedestrian networks offer safe, attractive, and widely accessible walking routes and districts (p. iv).

The goals of the plan target a range of areas, from connectivity to safety. The following goals are complimented by actions over which Caltrans may have some influence:

1. Number and Percentage of Walk Trips: Increase the number and percentage of walking trips with the intention of reducing motor vehicle use.
2. Safety: Improve actual and perceived pedestrian safety and security.
3. Infrastructure and Design: Improve Alameda County's pedestrian environment through additional infrastructure, better design and maintenance.
4. Connectivity: Ensure that essential pedestrian destinations throughout Alameda County—particularly public transit—have direct, safe and convenient pedestrian access
6. Staffing and Training: Ensure that public agency staff and elected and appointed officials are well-informed and well-trained in the pedestrian realm.

Alameda Countywide Bicycle Plan (2006)

Similar to the pedestrian plan, the Countywide Bicycle Plan aims to encourage bicycling throughout the county, and to provide guidance on priority projects to help accomplish this overall goal.

Vision: To establish and maintain bicycling as a viable mode of transportation and integrate it with other modes of transportation; to assure that bicycling is safe for bicyclists of all abilities; and to encourage multi-jurisdictional coordination to plan, fund, design and construct bicycle

projects (p. ES-2).

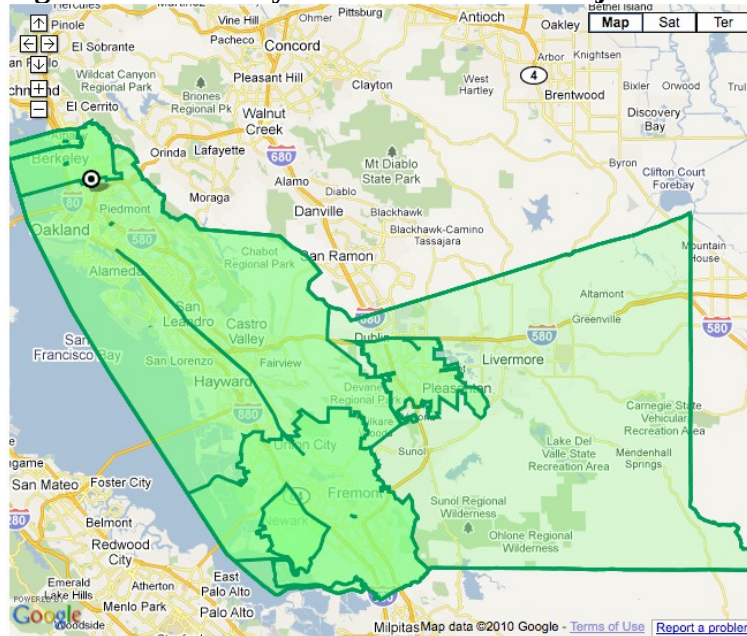
The goals of the bicycle plan include:

- Create and maintain an inter-county and intra-county bicycle network that is safe, convenient and continuous.
- Integrate bicycle travel in transportation planning activities and in transportation improvement projects.
- Encourage policies and actions that foster bicycling as a mode of travel.
- Improve bicycle safety through facilities, education and enforcement.
- Maximize the use of public and private resources in establishing the bikeway network.

How does Alameda County compare?

The plans mentioned here demonstrate concerted effort toward increasing pedestrian and bicycle safety and access in Alameda County. Figure shows the ACTIA project area; the lines and blocks of color represent nearly 20 programs and projects.

Figure . ACTIA Bicycle and Pedestrian Project Area



Source: Alameda County
Transportation Authority

However, because Alameda County includes several cities that each have their own bicycle and pedestrian plans (at least the cities covered in this report), it may be difficult to differentiate the effects of the county plans from the effects of the city plans. In addition, because much of the County's efforts go into programs to encourage bicycling or walking, rather than actual expenditure on infrastructure, it is difficult to know how much effect they have on San Pablo Avenue. The low number of 'x' marks in Table , which compares the regional and state plans, reflects this reality. Alameda County's plans cover 9 of the 43 of the topics on the list.

Contra Costa County

In 2004, voters in Contra Costa County overwhelmingly supported Measure J, which continued a ½ cent sales tax (previously passed as Measure C in 1988) to provide funds for transportation projects. The Measure is estimated to provide about \$30 million for pedestrian and bicycle projects over a 30-year period. The funds are managed by the Contra Costa County Transportation Authority (CCCTA) (Contra Costa Transportation Authority 2010). The county's pedestrian and bicycle plans were developed in part to guide the allocation of Measure J funds.

Draft Contra Costa County Bicycle and Pedestrian Plan (2009)

The County Bicycle and Pedestrian Plan aims to encourage walking and bicycling through supporting cities in their efforts to accommodate pedestrians and bicyclists, guiding regional allocation of funds designated for bicycle and pedestrian projects, and influencing other regional funding to routinely consider pedestrians and cyclists.

Vision: More people who live, work, shop and go to school in Contra Costa will walk and bicycle, thereby improving health, reducing emissions of greenhouse gases and making our transportation system more sustainable. To support walking and bicycling, Contra Costa will have an integrated system of safe, convenient and comfortable pedestrian and bicycle facilities that provide access to schools, jobs, shopping, neighborhoods, community facilities, parks and regional trails. Agencies within Contra Costa will collaborate on creating interjurisdictional facilities and accommodate the needs of pedestrians and bicyclists when planning, designing and approving all development and transportation projects (p. 29).

The goals of the Bicycle and Pedestrian Plan applicable to San Pablo Avenue include:

1. Expand, Improve and Maintain Facilities for Walking and Bicycling
2. Improve Safety for Pedestrians and Bicyclists
3. Encourage More People to Walk and Bicycle
5. Consider and Plan for the Needs of Pedestrians and Bicyclists

Contra Costa Countywide Transportation Plan (2009)

Vision: Strive to preserve and enhance the quality of life of local communities by promoting a healthy environment and a strong economy to benefit the people and areas of Contra Costa, sustained by 1) a balanced, safe and efficient transportation network; 2) cooperative planning; and 3) growth management. The transportation network should integrate all modes of transportation to meet the diverse needs of Contra Costa. (p. v)

To direct the actions of the CTP, the Authority established the following goals:

1. Enhance the movement of people and goods on highways and arterial roads,
2. Manage the impacts of growth to sustain Contra Costa's economy and preserve its environment,
3. Provide and expand safe, convenient and affordable alternatives to the single-occupant vehicle, and
4. Maintain the transportation system.

In general, the plan focuses on moving traffic, but does state a few multimodal transportation service objectives, including:

- Improving bicycle and pedestrian access to transit to make it more competitive with driving.
- Increase bicycle and pedestrian mode splits in West Contra Costa County to 3 percent for

commute trips by 2012.

The plan also identifies specific actions for San Pablo Avenue and other key routes. However, most of the bicycle and pedestrian projects are not intended for San Pablo Avenue.

How does Contra Costa County compare?

The plans mentioned here demonstrate intention to encourage pedestrian and bicycle safety and access in Contra Costa County. In comparison with Alameda County, Contra Costa has allocated less money to pedestrian and bicycle projects, and may be disadvantaged because of development patterns (Contra Costa County lacks dense areas like downtown Berkeley or Oakland which naturally encourage non-motorized modes). However, anecdotal evidence indicates that strong policies and plans to encourage bicycling and walking can influence rates of walking and bicycling, and the plans profiled here are a good start. Table shows that the County's plans cover 6 of the 43 topics among the plans affecting San Pablo Avenue.

San Francisco Bay Area

The main influence on San Pablo Avenue at the regional level, other than county agencies, is the Metropolitan Transportation Commission (MTC), which is the conduit through which most federal money flows for bicycle and pedestrian projects in the Bay Area. The MTC has a vested interest in regional transportation flows, and has been active in trying to encourage more sustainable transportation in the Bay Area. In this vein, MTC produced a regional bicycle plan to encourage inter-regional bicycling as a way to potentially reduce congestion and air pollution, and increase physical activity.

MTC Regional Bicycle Plan (2009)

Overall goal: *To ensure that bicycling is a safe, convenient, and practical means of transportation and healthy recreation throughout the Bay Area, including in Priority Development Areas (PDAs); to reduce traffic congestion and risk of climate change; and to increase opportunities for physical activity to improve public health (p. 5).*

The Regional Bicycle Plan states the following goals for encouraging bicycling in the Bay Area:

1. Routine accommodation - Guarantee that accommodations for bicyclists and pedestrians are routinely considered in the planning and design of all roadway, transit and other transportation facilities funded by MTC.
2. The Regional Bikeway Network (RBN) - Define a comprehensive RBN that connects every Bay Area community; provides connections to regional transit, major activity centers and central business districts; and includes the San Francisco Bay Trail.
3. Bicycle safety - Encourage local and statewide policies that improve bicycle safety.
4. Bicycle education and promotion - Develop training sessions and educational materials that emphasize bicycle safety and the positive benefits of cycling.
5. Multimodal integration - Work toward developing seamless transfers between bicycling and public transportation.
6. Comprehensive support facilities & mechanisms - Encourage the development of facilities and institutions that contribute to a bicycle-friendly environment.
8. Planning - Continue to support ongoing regional bicycle planning.

What does the MTC contribute?

We used the same table that we've used throughout this paper to profile the efforts covered in the MTC plan. However, we asked a different question, because there is no appropriate entity with which we could compare MTC's efforts in the Bay Area. Thus, the focus is on the additional aspects of bicycle and pedestrian safety and mobility that MTC contributes. Table shows that MTC's plan covers 6 of 43 topics on the list. Figure and Figure show the proposed regional bicycle network links in Alameda and Contra Costa County, respectively.

Figure . Regional Bike Network Links in Alameda County

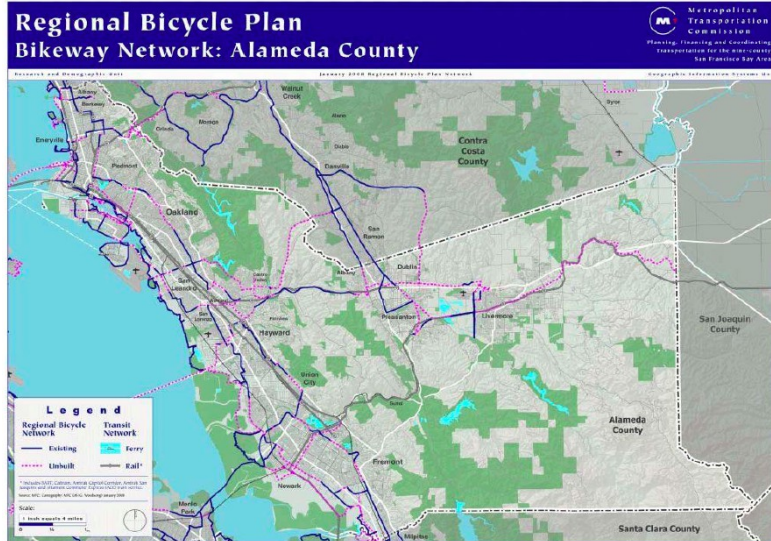
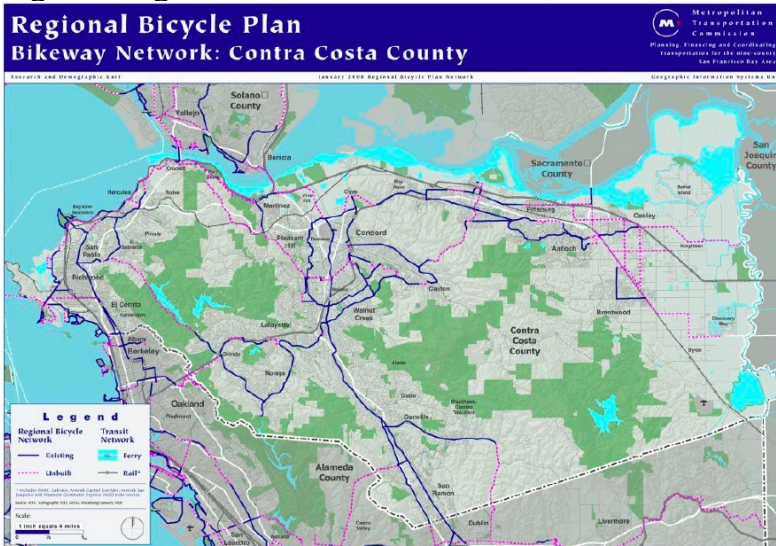


Figure . Regional Bike Network Links in Contra Costa County



State Agency Roles and Policies Affecting San Pablo Avenue

State influences come mainly from Caltrans, which is the roadway authority in the State. However, additional influences may come from legislation passed by the State. Policies and plans that may have an effect on pedestrian and bicyclist safety and mobility on San Pablo Avenue are covered in this section.

California Department of Transportation

Although Caltrans is most often associated with the major interstate highways, its policies and plans affect local roadways most directly when state highways run through cities as local arterial roadways. In many of its statements and policies, Caltrans presents a holistic vision. Its five high-level goals cover a broad range of topics (*safety, mobility, stewardship, delivery, and service*) important to Californians. Following are Caltrans' plans and policies that most directly affect pedestrians and bicyclists on San Pablo Avenue.

California Blueprint for Cycling and Walking (2002)

The Blueprint was Caltrans' response to the Budget Act's requirement to address "measurable goals for increasing bicycling and walking within the state, funding of facilities, and a reduction in pedestrian and bicycling injuries and fatalities" (Davis, Contreras-Sweet et al. 2002). The report stated ambitious goals:

- **A 50 percent increase in the number of bicycling and walking trips by the year 2010** (compared to base year 2000 levels as measured by the US Census)
- **A 50 percent decrease in the bicycle and pedestrian fatality rates by the year 2010** (compared to base year 2000 levels as measured by the NHTSA)
- Increased funding for bicycle and pedestrian programs as necessary to meet these goals

As the California-specific data from the 2010 Census had not yet been released by the time of this report, how close California has come to doubling the number of number of trips from the baseline of 0.83% bicycle and 2.85% pedestrian commute trips cannot be exactly determined (U.S. Census Bureau 2000). However, data from the American Community Survey from 2009, also administered by the U.S. Census Bureau, may be used as a proxy. The ACS data indicates that California's rate of bicycle commuting as of 2009 had increased to 0.89%, and walking to work had decreased slightly, to 2.75% (U.S. Census Bureau 2011). Although the slight uptick in bicycle commuting is encouraging, the lack of major movement in non-motorized commute trends in California suggests that the trip goals of the Blueprint will be almost impossible to meet.

Data for safety is measured more frequently, and trends are therefore more easily determined. Figure and Figure illustrate the slightly negative overall trend in traffic fatalities in California from 2000 to 2009 – clearly not yet to the goal of halving the rates of fatalities (National Highway Traffic Safety Administration 2000-2009). These trends suggest that the goal for safety, like the goal for increasing trips, will go unmet. However, it is difficult to tell from this data the true picture of bicycle and pedestrian safety, as the available data does not control for exposure (i.e., if bicycle trips are increasing, a commensurate increase in bicycle crashes could

be expected). Thus, it is possible that the presence of these goals has had a positive effect on pedestrian and bicycle activity in California.

Figure . Rate of Pedestrian and Bicyclist Fatalities in California per 100,000 Population (2000-2009)

Data Source: National Highway Traffic Safety Administration

Figure . Pedestrian and Bicyclist Fatalities as Percent of Total California Traffic Fatalities (2000-2009)

California Transportation Plans 2025 (2006) and 2030 (2007)

The California Transportation Plan 2030 (CTP) is an update to California's long-range transportation plan, CTP 2025. Both were developed in conjunction with Caltrans by the Office of State Planning, and seek to "influence transportation decisions and investments to create a world-class transportation system" (Smith, Korte et al. 2006). As the basis for Governor Schwarzenegger's *GoCalifornia* plan, which aims to spur a reduction in congestion and improvements in mobility, the CTP documents outline a broad-level approach to the future of transportation in California, summed in its sweeping vision:

California has a safe, sustainable, world-class transportation system that provides for the mobility and accessibility of people, goods, services, and information through an integrated, multimodal network that is developed through collaboration and achieves a Prosperous Economy, a Quality Environment, and Social Equity (cover page).

The CTP speaks candidly about the need to improve non-motorized mobility and preserve the natural environment in order to achieve a more sustainable transportation system:

Mobility is not mode-specific: rather it encompasses **all modes**. We need to choose **and efficient use of the entire system**. ... A sustainable transportation system is one that **meets people's needs equitably**, fosters a **healthy environment**, provides a broad, balanced system in which the private vehicle, **public transportation, bicycling, and walking are all viable options** and can be maintained and operated efficiently and effectively over time.

In recent years, the number of non-work trips has overtaken the number of commute

trips...the increase...can be partially attributed to the need to drive to most destinations, due to changes in urban and street design, and **lack of safe, convenient travel choices**.

A major focus of SAFETEA-LU and of the CTP 2030 Addendum is the **linking of transportation planning with natural resource and environmental planning** to promote early consultation. ... **The goal of this early consultation is transportation plans, and ultimately projects, that preserve and enhance California's valuable natural and environmental resources** (emphasis added).

These statements seem to indicate a need to increase investment in pedestrian and bicycling facilities and public transportation. The CTP developed several goals and strategies for achieving a sustainable transportation system. The goals applicable to pedestrian and bicyclist safety and mobility follow below.

Goals

1. Improve Mobility and Accessibility
4. Enhance Public Safety and Security
5. Reflect Community Values

Caltrans Strategic Plan (2007)

Caltrans' Strategic Plan, which is updated every five years, is the key governing document for the agency, and the agency's performance measurement system is linked to it. The current Strategic Plan states that it "...focuses on strategies which are seen as key for organizational process improvement over the next five years...(and) addresses the key external and internal driving forces that are affecting or have the potential to affect Caltrans mandates" (p. 5). The Strategic Plan elaborates upon how the agency plans to work toward its goals during the years 2007-2012.

The overall goals of the Strategic Plan reflect Caltrans' organizational goals. The two that are most applicable to pedestrian and bicyclist safety and mobility on San Pablo are:

1. Safety: Provide the safest transportation system in the nation for users and workers.
2. Mobility: Maximize transportation system performance and accessibility

Regarding the goal of *safety*, the Strategic Plan describes two efforts pertaining to non-motorized users: the Safe Routes to Schools program and the Strategic Highway Safety Plan (covered below). The goal of *mobility* is described as, among other things, "improving multi-modal connectivity, (and) addressing bicyclist and pedestrian needs..." (p. 26).

Strategic Highway Safety Plan (2006)

The Strategic Highway Safety Plan (SHSP) aims to improve traffic safety in California in 12 specific areas, based on analysis of California's crash trends and demographics. Through a statewide process involving over 200 agencies to develop strategic goal for the SHSP, three "Challenge Areas" were developed that are particularly applicable for pedestrian and bicyclist

safety and mobility along San Pablo Avenue.

Challenge Areas

7: Improve Intersection and Interchange Safety for Roadway Users

8: Make Walking and Street Crossing Safer

13: Improve Bicycling Safety

Deputy Directive 64-R1: Complete Streets – Integrating the Transportation System (2008)

The internal Caltrans mandate known as DD-64-R1 is a key policy for pedestrian and bicyclist safety and mobility within Caltrans. It mandates a new Complete Streets attitude for the agency. Key parts of the directive are as follows (Caltrans 2008):

The California Department of Transportation (Department) provides for the needs of travelers of all ages and abilities in all planning, programming, design, construction, operations, and maintenance activities and products on the State highway system. **The Department views all transportation improvements as opportunities to improve safety, access, and mobility for all travelers in California and recognizes bicycle, pedestrian, and transit modes as integral elements of the transportation system.**

The Department develops integrated multimodal projects in balance with community goals, plans, and values. Addressing the safety and mobility needs of bicyclists, pedestrians, and transit users in all projects, regardless of funding, is implicit in these objectives. **Bicycle, pedestrian, and transit travel is facilitated by creating “complete streets” beginning early in system planning and continuing through project delivery and maintenance and operations.** Developing a network of “complete streets” requires collaboration among all Department functional units and stakeholders to establish effective partnerships.

Although there are no fixed goals associated with this directive, it is important to mention because of its potential to influence how the Department works to achieve all of the other goals mentioned in this section.

State Legislation

The State Legislature has passed several pieces of legislation pertaining to various aspects of transportation in California. Each of these bills mandates or encourages provision for non-motorized users on California’s streets, and should positively affect pedestrian and bicyclist safety and mobility along San Pablo Avenue.

AB 1358 Complete Streets (2008)

The Complete Streets Act of California was signed into law in September of 2008, following the lead of several other states with established Complete Streets policies (California Bicycle Coalition 2008). The Act went into effect on January 1, 2009, and

...requires the legislative body of a city or county, upon revision of the circulation element of their general plan, to **identify how the jurisdiction will provide for the**

routine accommodation of all users of the roadway including motorists, pedestrians, bicyclists, individuals with disabilities, seniors, and users of public transportation (Leno 2007).

AB 32: The Global Warming Solutions Act (2006)

Assembly Bill 32 is known as the “Global Warming Solutions Act” because it aims to curb the amount of greenhouse gases emitted into the atmosphere in California. The bill set an ambitious target for reducing the amount of greenhouse gases: by 2020, the emissions should be at 1990 levels. The long-term goal is an 80% reduction of 1990 levels by 2050. According to the California Air Resources Board, which is the lead agency for implementing the legislation, this amounts to an approximately 15% reduction from current levels of emissions, or about 4 fewer tons of carbon dioxide emitted per person in the state (approximately 147,000,000 tons of CO₂) (California Air Resources Board 2008). Understandably, broad actions are focused on making the state’s heavy and light duty vehicles and power plants cleaner. However, making non-motorized transportation a viable option for short trips throughout the state’s urbanized areas can help achieve these goals in two important ways. First, because automobiles release the majority of their emissions while the engine is warming up (a “cold start”), short automobile trips disproportionately pollute the air in comparison with longer trips (Ludykar, Westerholm et al. 1999); second, short trips in urban areas contribute to the urban heat island effect, necessitating greater energy usage by power plants to keep buildings cool. Substituting transit, bicycling, or walking for short trips in urban areas can therefore actually make a considerable contribution to reducing emissions.

SB 375 Regional Planning for Greenhouse Gas Reduction (2008)

Passed in 2008, Senate Bill 375 is meant to complement AB 32 by seeking to reduce the amount of vehicle miles traveled through a combination of land use and planning incentives (California Bicycle Coalition 2009). The bill requires regional transportation planning agencies to develop more sophisticated transportation planning models for the purpose of creating "sustainable community strategies (SCS)" that limit greenhouse gas emissions in their regional plans. The bill also provides incentives for local governments to incorporate these SCSs into the transportation elements of their general land use plans. Ultimately, it is likely that the SCSs will promote moderate to dense urban development, which tend to provide more opportunities to walk and bicycle and will therefore require adequate pedestrian and bicycle facilities to support the travel.

AB 57 Safe Routes to School (2007)

Begun in 1999, the Safe Routes to School (SR2S) legislation in California requires federal safety funds to be allocated equally between state highways, local roads, and the SR2S construction program (Safe Routes to School National Partnership 2007). The funding for SR2S supports bicycle and pedestrian safety, infrastructure, and traffic calming projects such as sidewalks, bicycle lanes, trails, and intersection improvements. AB 57 served to make the previous funding allocation permanent and created a state framework for federally funded safe routes program

which was in effect from 2005-2009.

What does the State contribute?

We used the same table that we've used throughout this paper to profile the efforts covered in Caltrans' various plans and State legislation. However, we asked a different question, because there is no appropriate entity with which we could compare State efforts in the Bay Area. Thus, the focus is on the additional aspects of bicycle and pedestrian safety and mobility to which the State plans and legislation contribute. Table shows that the State plans and legislation either directly or indirectly cover 21 of 43 topics.

Conclusions

This policy review included local, regional, and state-level plans and policies that could affect pedestrian and bicyclist safety and mobility along San Pablo Avenue, in the East San Francisco Bay Area of California. The plans were examined for strategies and physical elements that could encourage pedestrian and bicyclist safety, and compared to one another using a checklist developed from the summative review of all plans. Table shows how the cities and counties rank in comparison to one another on the content of their plans, while Table compares regional and state policies. It should be noted that the size and purview of the organization that developed the plan affects how many of the elements the plan covers. For example, it is understandable that a county plan may be much less specific than a city plan.

Table . Comparison of Local Plans with Regard to Elements and Strategies to Encourage Non-Motorized Safety and Mobility

Characteristics	Albany	Berkeley	El Cerrito	Emeryville	Oakland	Richmond
ADA accessible sidewalks		X	X	X	X	X
Street trees	X	X	X	X	X	X
Public seating or amenities	X	X	X	X	X	X
Pedestrian-scaled lighting	X	X	X	X	X	X
Minimum sidewalk passage of 10 ft.		X	X	X	X	X
Curb ramps	X	X	X	X	X	X
Continuous sidewalks			X		X	X
Pedestrian signals (countdowns/leading pedestrian intervals/separate signals altogether)		X	X	X		X
Median refuges	X	X	X	X		X
Signals timed at 3.5 ft/sec or lower		X	X		X	X
Marketing campaigns to promote walking or cycling		X	X	X	X	
Marked crosswalks		X	X	X		X
Fair or better pavement quality		X	X	X		
Wayfinding signage	X	X	X	X	X	X
High visibility crosswalks		X	X			X

Unobstructed sidewalks	X	X	X	X		X
Audible pedestrian signals		X	X	X	X	
Bulb-outs			X	X		X
Public art	X	X			X	X
Crosswalk lighting			X			X
Prohibited parking near intersection		X				X
Complete Streets aims		X	X	X		X
Pedestrian safety signage		X	X	X		
On-street parking as buffer					X	X
Short distance between crossings		X				
Pedestrian pushbuttons			X	X		
Mid-block crosswalks		X				
Truncated domes at curb ramps			X			X
Blocked visibility at intersection			X		X	
Police enforcement with regard to pedestrians or bicyclists	X	X	X		X	
Speed limit			X		X	
Bus stops on far side of intersection		X				
Bicycle lanes well-maintained, clean		X	X		X	
Bicycle facilities	X	X	X	X	X	X
Bicycle parking or storage	X	X	X	X	X	X
Bicycle signals or detectors	X	X			X	
Pedestrian/bicycle over/underpasses			X		X	
Physical deterrents to bicycling		X				
Recessed stop line			X			
Prohibited right turn on red			X			
Pedestrian crossings prohibited			X			
Accessible Transit stops		X				
New signal warrant		X				
TOTAL	12	31	33	20	21	23

Table . Comparison of Regional and State-Level Plans with Regard to Elements and Strategies to Encourage Non-Motorized Safety and Mobility

Characteristics	Alameda County	Contra Costa County	MTC	State
ADA accessible sidewalks	X			X
Street trees				
Public seating or amenities				
Pedestrian-scaled lighting				
Minimum sidewalk passage of 10 ft.				

Curb ramps				X
Continuous sidewalks	X	X		X
Pedestrian signals (countdowns/leading pedestrian intervals/separate signals altogether)				
Median refuges				
Signals timed at 3.5 ft/sec or lower				
Marketing campaigns to promote walking or cycling	X	X	X	X
Marked crosswalks				X
Fair or better pavement quality				
Wayfinding signage		X	X	
High visibility crosswalks				X
Unobstructed sidewalks				X
Audible pedestrian signals				X
Bulb-outs				
Public art				
Crosswalk lighting				
Prohibited parking near intersection				
Complete Streets aims		X		X
Pedestrian safety signage				X
On-street parking as buffer				
Short distance between crossings				X
Pedestrian pushbuttons				X
Mid-block crosswalks				X
Truncated domes at curb ramps				X
Blocked visibility at intersection				
Police enforcement with regard to pedestrians or bicyclists	X	X	X	X
Speed limit				
Bus stops on far side of intersection				
Bicycle lanes well-maintained, clean	X			X
Bicycle facilities	X	X	X	X
Bicycle parking or storage	X		X	
Bicycle signals or detectors	X		X	X
Pedestrian/bicycle over/underpasses				X
Physical deterrents to bicycling	X			X
Recessed stop line				
Prohibited right turn on red				
Pedestrian crossings prohibited				
Accessible Transit stops				X

New signal warrant				
TOTAL	9	6	6	21

Comparison of Jurisdictions along San Pablo Avenue

This policy review included local, regional, and state-level plans and policies that could affect pedestrian and bicyclist safety and mobility along San Pablo Avenue. Pedestrian and bicyclist safety and mobility along San Pablo Avenue is clearly addressed through multiple plans and policies at various levels of government. Out of 43 topics we identified which represent a range of pedestrian and bicycle safety and mobility improvements, the City of Albany has implemented 12, the City of Berkeley has implemented 31, the City of El Cerrito has implemented 33, the City of Emeryville has implemented 20, the City of Oakland has implemented 21 and the City of Richmond has implemented 23. However, the checklists do not tell a complete story, given that many of the elements and strategies are present in new plans that have only recently been adopted. The impact of these plans will likely become clearer in the future, and anecdotal evidence suggests that the cities that have had policies for several years demonstrate noticeable results in the built form. The following sections explore the extent to which there is empirical evidence that policies are related to features of the built environment. The data analysis explores how these policies are related to actual and perceived safety and mobility of the San Pablo Avenue corridor.

C. Santa Monica Boulevard Pedestrian and Bicycle Policy and Plan Analysis

Introduction & Background

Santa Monica Boulevard, California, also known as State Route 2, is a historic route (“FAQ - SMB Reconstruction Project,” 2012) that serves as an urban arterial running from the city of Santa Monica in the west through Beverly Hills, West Hollywood, and into Los Angeles. This study will focus on the five mile segment of Santa Monica Boulevard that begins at the intersection with North Doheny Drive, at the west entrance to West Hollywood, and ends at the intersection with Highway 101, in the City of Los Angeles. The route is under two different jurisdictions along this five mile corridor. Santa Monica Boulevard falls under the City of West Hollywood’s jurisdiction throughout the West Hollywood segment, due to a relinquishment of the road from the California Department of Transportation (Caltrans) in 1999 (“FAQ - SMB Reconstruction Project,” 2012). The route transfers to the jurisdiction of Caltrans between La Brea Avenue and Highway 101 in Los Angeles.

The difference in priorities across the two jurisdictions is evident in the street’s design, as shown in Figure and Figure 30. Figure shows a typical pedestrian crossing along Santa Monica Boulevard in West Hollywood, while Figure 30 shows a typical crossing in Los Angeles. West Hollywood prides itself on being a multimodal city that encourages walking and bicycling as forms of transportation. The City completed a major redevelopment of Santa Monica Boulevard in 2001 that added landscaped medians, street trees, bulb-outs, high visibility crosswalks, bus-bulbs, and bike lanes in some locations (“FAQ - SMB Reconstruction Project,” 2012). In contrast, the City of Los Angeles has adopted plans and policies prioritizing non-motorized modes of transportation more recently, and, thus, the full implementation of these policies has yet to be observed. This document describes the city and county policies that affect pedestrian and bicycle safety and mobility along this five-mile segment of Santa Monica Boulevard and explores their potential to create a more walkable, bikeable Santa Monica Boulevard.

Figure . Ped. crossing in West Hollywood



Figure . Ped. crossing in LA



Overview

This section briefly describes each agency’s roles and responsibilities regarding transportation planning, and details the policies applicable to pedestrian and bicyclist safety and mobility, and community vitality along Santa Monica Boulevard. Policies from the following jurisdictions are

included in the analysis:

- City of West Hollywood
- City of Los Angeles
- Los Angeles County
- California Department of Transportation (Caltrans)

Each plan with legal influence over Santa Monica Boulevard was examined, along with its specific goals and objectives for increasing walking and bicycling along Santa Monica Boulevard. The exact text from plans discussed in the body of the report can be found in the Appendix. At the end of each section, a checklist will summarize the aspects of pedestrian and bicyclist safety and mobility covered by a combination of the city's or county's plans.

Local Agency Roles and Policies for Santa Monica Boulevard

The various plans for West Hollywood and Los Angeles are discussed in this chapter. Only plans that are directly applicable to Santa Monica Boulevard are included. For each city, the general plan is reviewed first and then followed by bicycle and pedestrian plans. The California Streets and Highways Code requires that sidewalks be maintained by the adjoining property owner (Section 5610) in all cities, so sidewalks are not included in this section.

City of West Hollywood

History and authority

The City of West Hollywood was incorporated in 1984 (“City of West Hollywood General Plan 2035,” 2011). Santa Monica Boulevard, State Route 2, was relinquished by Caltrans to the City of West Hollywood in 1999. The City now owns and maintains Santa Monica Boulevard, allowing the City to implement designs that make Santa Monica Boulevard West Hollywood’s “Main Street” (“FAQ - SMB Reconstruction Project,” 2012).

Roles and responsibilities

As a result of the 1999 relinquishment of Santa Monica Boulevard in West Hollywood, the City now assumes all liability and maintenance responsibilities for that portion of the corridor (“Relinquishment of State Highways by Legislative Enactment,” 2005).

West Hollywood General Plan 2035 (2011)

West Hollywood’s General Plan focuses on creating an efficient multi-modal transportation system throughout the city to alleviate the traffic it experiences due to its central location. The Mobility Section of the General Plan expresses the City’s desire to maintain and improve its pedestrian friendly environment. Although the General Plan lists specific improvements that should be considered for various facility types, including pedestrian, bicycle, and automobile facilities, it refers to the 2003 Bicycle and Pedestrian Mobility Plan for location-specific improvements to the bicycle and pedestrian network and suggests that the Bicycle and Pedestrian Mobility Plan be implemented. The Mobility section of the General Plan specifies the nine goals listed below, all of which have the potential to improve non-motorized transportation within the City, and two of which focus specifically on such improvement.

- M-1: Develop a world-class transit system in West Hollywood
- M-2: Collaborate on regional transportation solutions that improve mobility, quality of life, and environmental outcomes.
- M-3: Maintain and enhance a pedestrian-oriented City.
- M-4: Create a comprehensive bicycle network throughout the City.
- M-5: Create an environmentally and financially sustainable transportation network that provides for the mobility and livability needs of West Hollywood residents, businesses, and visitors.
- M-6: Utilize Transportation Demand Management strategies to reduce auto travel.
- M-7: Protect and preserve residential neighborhoods from intrusion of non-residential traffic.

- M-8: Manage parking supply to serve residents, businesses and visitors.
- M-9: Facilitate sustainable, effective, and safe movement of goods and commercial vehicles.

West Hollywood Bicycle and Pedestrian Mobility Plan (2003)

The West Hollywood Bicycle and Pedestrian Mobility Plan explicitly recommends locations where pedestrian and bicycle facilities should be improved. The Plan states that walking and bicycling already occur heavily within the City due to its dynamic nature. Santa Monica Boulevard is designated as a Retail-Commercial Street, which should have the “widest sidewalks, the widest crosswalks, the brightest street lighting, the most furnishings, and other features that will enhance the pedestrian environment.” The Plan also emphasizes the risks of allowing bicycling on sidewalks, which is permitted in locations without bike facilities in West Hollywood, and expresses the need to extend the existing bike lanes on Santa Monica Boulevard further to remove bikes from the sidewalks. The physical characteristics suggested by the Plan are recorded in Table . Due to Santa Monica Boulevard’s significant presence in the small City of West Hollywood, all of the six goals outlined in the City’s Bicycle and Pedestrian Mobility Plan, listed below, are applicable to Santa Monica Boulevard.

1. Promote Bicycle Transportation
2. Develop an Enhanced Bikeway Network
3. Enhance Bicycle Transportation Safety
4. Enhance Pedestrian Mobility
5. Enhance Pedestrian Safety
6. Encourage More People to Walk

West Hollywood Vision 2020 Strategic Plan (2003)

Mission Statement: As a premiere city, West Hollywood is proactive in responding to the unique needs of its diverse community, creative in finding solutions to managing its urban environment, and dedicated to preserving and enhancing its well being. West Hollywood strives for quality in all its actions, setting the highest goals and standards. (Adapted for context.)

The West Hollywood Vision 2020 Strategic Plan, finalized in 2003, identifies the City’s Core Values as follows:

- Respect and Support for People
- Responsiveness to the Public
- Idealism, Creativity and Innovation
- Quality of Residential Life
- Promote Economic Development
- Public Safety
- Responsibility for the Environment

In addition, the Strategic Plan presents the City’s Five Primary Goals, based on the most important issues facing the City, as identified through meetings with the community. The first Primary Goal reflects the City’s desire to promote pedestrian and bicycle mobility: *Maintain the City’s Unique Urban Balance with Emphasis on Residential Neighborhood Livability.*

A list of Ongoing Strategic Programs, programs previously established as important for maintaining the nature of the community, is also identified. The Strategic Programs that pertain to pedestrian and bicyclist mobility within the City are listed below.

- Promote Economic Development while Maintaining Business Vitality & Diversity

- Transportation System Improvement
- Enhance Technology and Access for the City and its Citizens
- Enhance and Expand Disability Access throughout the City

The full text of the Mission Statement is located in Appendix F.

How does West Hollywood compare?

The plans in this section reflect the City of West Hollywood’s efforts to create and maintain streets welcoming to pedestrians and bicyclists. Table contains a checklist of the elements affecting Santa Monica Boulevard. An ‘X’ represents elements covered in West Hollywood’s plans and policies. West Hollywood’s plans cover 30 of the 48 topics.

Table . Elements Covered in West Hollywood’s Plans

Elements	West Hollywood	Elements	West Hollywood
ADA accessible sidewalks	X	On-street parking as buffer	
Street trees	X	Short distance between crossings	
Public seating or amenities	X	Pedestrian pushbuttons	X
Pedestrian-scaled lighting	X	Mid-block crosswalks	
Minimum sidewalk passage of 10 ft.	X	Blocked visibility at intersections & driveways	X
Curb ramps	X	Vehicle speed	X
Continuous sidewalks	X	Bus stops on far side of intersection	
Pedestrian signals	X	Signals timed at 3.5 ft/sec or lower	X
Median refuges	X	Bicycle lanes well-maintained, clean	X
Truncated domes at curb ramps	X	Bicycle facilities	X
Marketing campaigns to promote walking or cycling	X	Reflective striping alternatives to reduce slippery conditions for wet bike lanes	
Marked crosswalks	X	Bicycle parking or storage	X
Bicycle scale/path street lighting		Bicycle signals or detectors	X
Pedestrian wayfinding signage	X	Pedestrian/bicycle over/underpasses	
High visibility crosswalks	X	Physical deterrents to bicycling	
Unobstructed sidewalks	X	Recessed stop line	
Audible pedestrian signals	X	Prohibited right turn on red	
Bulb-outs	X	Accessible Transit stops	
Public art	X	New signal warrant	X
Crosswalk lighting		Bicycle facilities at transit stops	X
Prohibited parking near intersection		Fair or better pavement quality	
Complete Streets aims	X	Bicycle safety signage	
Pedestrian safety signage		Bicycle wayfinding signage	X
Police enforcement with regard to pedestrians or bicyclists		Removal of on-street parking to accommodate bike lanes	
Total Elements Covered			30

City of Los Angeles

History and authority

Los Angeles was incorporated as a city on April 4, 1850 (“Headline History, Los Angeles County 1848 to 1865,” 2012). The City partially maintains Santa Monica Boulevard between La Brea Avenue and Route 101. The most recent maintenance agreement between Caltrans and the City of Los Angeles was signed in 2005 (“Agreement for Maintenance of State Highways in the City of Los Angeles,” 2005).

Roles and responsibilities

In agreement with Caltrans, the City of Los Angeles has assumed responsibility for the maintenance of Santa Monica Boulevard and is thus responsible for ensuring the quality of the roadway and sidewalks (where not private). This includes roadway and sidewalk paving and construction, where needed; all maintenance and care of landscaped areas on the Boulevard, within the freeway interchange and landscaped traffic medians; and the maintenance of all state highway related signing located outside of State Right-of-Way. From the city limits 0.04 mile east of La Brea Avenue to the off-Ramp southbound Hollywood Freeway, Route 101 the city assumes the following responsibilities: cleaning, maintaining, and repairing culverts, ditches, and drains related to sidewalk drainage on an emergency basis; providing for the removal of litter and debris from the roadway and roadside; and maintaining electrical facilities including traffic signals, traffic signal systems, safety lighting and sign lighting.

Los Angeles City General Plan: Transportation Element (Adopted 1999)

The Purpose of the Transportation Element of the City of Los Angeles’ General Plan is to guide the development of a citywide transportation system to efficiently move people and goods. The Transportation Element states three overarching Goals, which are supported by specific Objectives and Policies. Of these three Goals shown below, one directly calls for a pedestrian and bicycle network. Although the supporting policies do provide several design requirements for pedestrian and bicycle facilities, the policies within Goal C call for implementation of the Bicycle Plan, which provides more specific guidelines for facility design requirements.

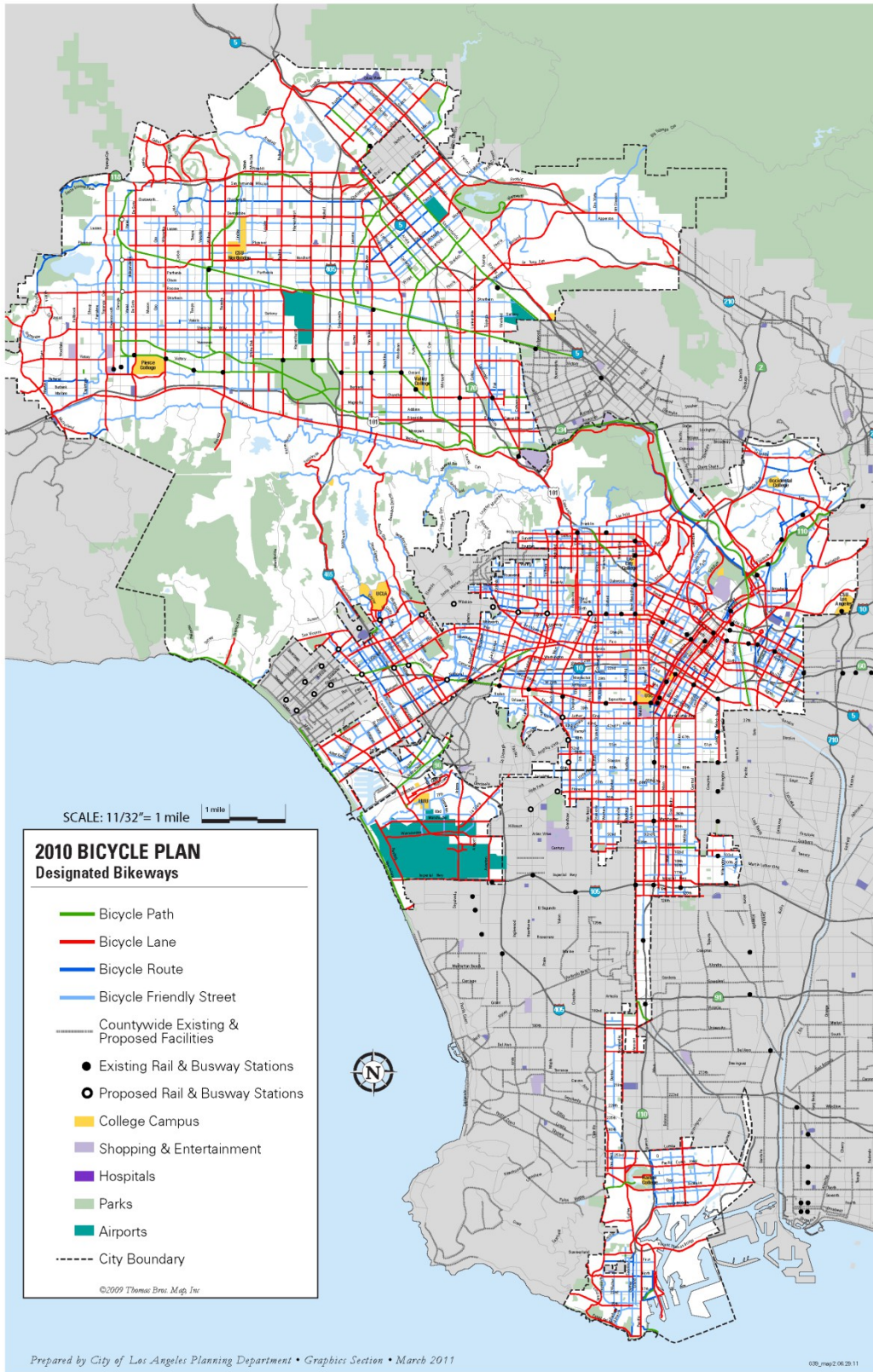
- *Goal A: Adequate accessibility to work opportunities and essential services, and acceptable levels of mobility for all those who live, work, travel, or move goods in Los Angeles.*
- *Goal B: A street system maintained in a good to excellent condition adequate to facilitate the movement of those reliant on the system.*
- *Goal C: An integrated system of pedestrian priority street segments, bikeways, and scenic highways which strengthens the City’s image while also providing access to employment opportunities, essential services, and open space.*

City of Los Angeles 2010 Bicycle Plan (Adopted 2011)

In its attempt to make Los Angeles a more bicycle-friendly city, the 2010 Los Angeles City Bicycle Plan presents three new bikeway networks for the City: the Backbone, the Neighborhood Network, and the Green Network. The 2010 Plan calls for a bikeway network of 1,684 miles, significantly larger than the existing network of 334 miles in 2010. The network, shown in Figure , shows planned Class II bicycle lanes on Santa Monica Boulevard extending east from the intersection with La Brea Avenue past the end of the study segment, U.S. 101. Although

Santa Monica Boulevard is not classified as such, the Plan also introduces the concept of Bicycle Friendly Streets, which are neighborhood streets that will be designed to be more “inviting” to bicyclists and pedestrians through design features such as signage, pavement markings, bulb-outs, and traffic diversions, among others. A toolbox for potential design elements for these types of streets is located in Section Four of the Technical Design Handbook, substituting for a relative lack of physical design elements within the Objectives, Goals, and Policies of the Bicycle Plan. The Technical Design Handbook compiles standards and current best practices from agencies and municipalities throughout the United States. The relevant design elements that are covered in the Technical Design Handbook are listed in Appendix F.

Figure . Map of Los Angeles City Bicycle Plan



How does Los Angeles compare?

The plans in this section reflect the City of Los Angeles' efforts to create and maintain streets welcoming to pedestrians and bicyclists. Table contains a checklist of the elements; an 'X' represents elements covered in Los Angeles' plans and policies. Only 15 topics are covered.

Table . Elements Covered in Los Angeles' Plans

Elements	Los Angeles	Elements	Los Angeles
ADA accessible sidewalks		On-street parking as buffer	
Street trees	X	Short distance between crossings	
Public seating or amenities		Pedestrian pushbuttons	
Pedestrian-scaled lighting		Mid-block crosswalks	
Minimum sidewalk passage of 10 ft.	X	Blocked visibility at intersections & driveways	
Curb ramps		Vehicle speed	X
Continuous sidewalks		Bus stops on far side of intersection	
Pedestrian signals		Signals timed at 3.5 ft/sec or lower	
Median refuges		Bicycle lanes well-maintained, clean	X
Truncated domes at curb ramps		Bicycle facilities	X
Marketing campaigns to promote walking or cycling	X	Reflective striping alternatives to reduce slippery conditions for wet bike lanes	
Marked crosswalks		Bicycle parking or storage	X
Bicycle scale/path street lighting	X	Bicycle signals or detectors	X
Pedestrian wayfinding signage		Pedestrian/bicycle over/underpasses	
High visibility crosswalks		Physical deterrents to bicycling	
Unobstructed sidewalks		Recessed stop line	
Audible pedestrian signals		Prohibited right turn on red	
Bulb-outs		Accessible Transit stops	
Public art		New signal warrant	
Crosswalk lighting		Bicycle facilities at transit stops	X
Prohibited parking near intersection		Fair or better pavement quality	
Complete Streets aims	X	Bicycle safety signage	X
Pedestrian safety signage		Bicycle wayfinding signage	X
Police enforcement with regard to pedestrians or bicyclists	X	Removal of on-street parking to accommodate bike lanes	X
Total Elements Covered			15

Comparison of West Hollywood and Los Angeles

The City of West Hollywood’s General Plan, Pedestrian and Bicycle Plan, and Strategic Plan together cover 30 of the 48 topics related to pedestrian and bicyclist safety and mobility, most of which have been implemented along Santa Monica Boulevard in the City and make the corridor rich with pedestrian and bicyclist amenities. Figure shows an example of a segment of Santa Monica Boulevard in West Hollywood. In addition to stating goals of having a pedestrian and bicyclist friendly city, West Hollywood has successfully included policies to further guide the design of such streets.

In contrast, the City of Los Angeles’ General Plan and Bicycle Plan only cover a total of 15 of the 48 topics related to pedestrian and bicyclist safety and mobility. This lack of topics is likely due to the age of the City’s current Transportation Element of the General Plan, which was adopted 13 years ago. The recent Bicycle Plan also lacks specific policies pertaining to physical design because it defers those issues to a Technical Design Handbook. Of the 15 topics that were covered in the plans, very few were observed on Santa Monica Boulevard during a field visit. The City has begun placing additional bicycle parking, but the remainder of the topics covered in the new bicycle plan have yet to be built along the corridor. Figure shows an example of a typical segment of Santa Monica Boulevard in Los Angeles and the noticeable difference in features between West Hollywood.

Figure . SMB in West Hollywood



Figure . SMB in Los Angeles



Regional Agency Roles and Policies Affecting Santa Monica Boulevard

Regional agencies produce broad plans that aim to work with the local plans and policies to address region-wide transportation issues and circulation. These plans include county-wide plans as well as regional plans extending across numerous counties. This section will focus on the Los Angeles County Bicycle Master Plan. The Southern California Association of Governments (SCAG) is in the process of developing a Regional Bicycle and Pedestrian Plan. Because this Plan is not currently complete, it is not discussed in this section (“Non-Motorized,” n.d.).

Los Angeles County

Santa Monica Boulevard, between North Doheny Drive and Highway 101, is located entirely within Los Angeles County. In addition to the cities’ bicycle and pedestrian plans previously discussed, the County of Los Angeles also recently created a regional bicycle plan that is discussed briefly below.

County of Los Angeles Bicycle Master Plan (2012)

The County of Los Angeles Bicycle Master Plan incorporates bicycle networks proposed by local cities and creates a region-wide network by facilitating connections of routes between different cities. The County’s plan has several Goals which are supported by specific policies.

- *Goal 1: Expanded, improved, and interconnected system of county bikeways and bikeway support facilities to provide a viable transportation alternative for all levels of bicycling abilities, particularly for trips of less than five miles.*
- *Goal 2: Increased safety of roadways for all users.*
- *Goal 3: Develop education programs that promote safe bicycling.*
- *Goal 4: County residents that are encouraged to walk or ride a bike for transportation and recreation.*
- *Goal 5: Community supported bicycle network.*
- *Goal 6: Funded Bikeway Plan.*

The plan shows bicycle facilities connecting to the cities’ proposed bike lanes on Santa Monica Boulevard, creating a region-wide network for bicyclists.

Evaluation of Los Angeles County Plans

The County’s Bicycle Master Plan only directly covers five of the pedestrian and bicyclist topics as shown in Table . This lack of specific policies and guidelines may be due to the fact that the County’s plan is meant to serve in conjunction with local plans and policies. The County plan is meant to guide bicycle infrastructure development in unincorporated locations which have differing needs from urban environments.

Table . Topics Covered in Los Angeles County’s Plans

Elements	LA County	Elements	LA County
ADA accessible sidewalks		On-street parking as buffer	
Street trees		Short distance between crossings	
Public seating or amenities		Pedestrian pushbuttons	
Pedestrian-scaled lighting		Mid-block crosswalks	
Minimum sidewalk passage of 10 ft.		Blocked visibility at intersections & driveways	
Curb ramps		Vehicle speed	
Continuous sidewalks		Bus stops on far side of intersection	
Pedestrian signals		Signals timed at 3.5 ft/sec or lower	
Median refuges		Bicycle lanes well-maintained, clean	
Truncated domes at curb ramps		Bicycle facilities	X
Marketing campaigns to promote walking or cycling	X	Reflective striping alternatives to reduce slippery conditions for wet bike lanes	X
Marked crosswalks		Bicycle parking or storage	X
Bicycle scale/path street lighting		Bicycle signals or detectors	
Pedestrian wayfinding signage		Pedestrian/bicycle over/underpasses	
High visibility crosswalks		Physical deterrents to bicycling	
Unobstructed sidewalks		Recessed stop line	
Audible pedestrian signals		Prohibited right turn on red	
Bulb-outs		Accessible Transit stops	
Public art		New signal warrant	
Crosswalk lighting		Bicycle facilities at transit stops	
Prohibited parking near intersection		Fair or better pavement quality	
Complete Streets aims		Bicycle safety signage	
Pedestrian safety signage		Bicycle wayfinding signage	
Police enforcement with regard to pedestrians or bicyclists	X	Removal of on-street parking to accommodate bike lanes	
Total Elements Covered			5

Conclusions from the San Pablo Avenue and Santa Monica Boulevard Avenue Policy Analyses

These analyses assisted in informing whether policies were associated with the presence of pedestrian and bicycle safety and mobility features. Policies – from general plans to pedestrian or bicycle plans – help guide jurisdictional expenditure in safety and mobility improvements. An improvement must generally be included in some plan before it is funded and scheduled. Cities for the San Pablo Avenue study site had 12-33 of the 43 policies examined. West Hollywood had 30 and Los Angeles had 15 of the 48 pedestrian and bicyclist safety and mobility policies examined included in their plans. West Hollywood had a majority of the features of interest while Los Angeles had much fewer.

The specific performance measures evaluated were:

- percent of signalized intersections along urban arterials with marked crosswalks and one or more of the following: countdown signals, leading pedestrian intervals, bulb-outs, or pedestrian refuge islands; and percent of unsignalized 4-way (multilane) intersections along urban arterials with marked crosswalks and one or more of the following: HAWK signal*, yield to pedestrian signage, user-activated overhead warning lights;
- percent of urban arterial intersections with one or more of the following improvements geared toward bicyclists: bike box, painted bicycle lane through the intersection, bicycle signal, functioning bicycle loop detectors, bicycle left turn lane; and
- percent of urban arterials that do not have a posted speed greater than 25 mph.

A greater proportion of intersections had features from #1 on Santa Monica Boulevard in West Hollywood compared to Los Angeles and the Bay Area. Features for #2 were present in West Hollywood. Neither study corridor had feature #3. In general, cities that have aggressively pursued including pedestrian and bicycle improvements in plans had greater levels of implemented improvements.

D. Pedestrian and Bicyclist Intercept Survey

Introduction

This section explains the results of the San Pablo Avenue and Santa Monica Boulevard pedestrian and bicyclist intercept surveys. The purpose of the surveys was to understand: 1) general attractions to or detractors from San Pablo Avenue and Santa Monica Boulevard (for example shopping attracts people and crime may deter visitors), 2) perceptions of traffic safety in the area for pedestrians, bicyclists, and motor vehicle drivers and passengers, and 3) how landscaping and street design features currently or could potentially affect perceived traffic safety risk, economic vitality, and general satisfaction with the area. Respondents' perceptions and preferences will be revealed through this survey. These perceptions will be used to evaluate the proposed performance measures that can only be evaluated by asking roadway users about their preferences. Further discussion of performance measure evaluation is presented in Section E of this report.

Many of the questions in the survey focus on user's perceptions of safety and the landscape or design elements that would encourage users to visit the area more often or increase perceptions of safety. These questions are asked to determine how landscape and design elements can potentially increase economic vitality and quality of life of the corridor. When people perceive an area as safe and attractive to visit, they are more likely to visit the area for many purposes including recreation, shopping, and residential purposes.

Methodology

Survey development & site choice

The survey was developed in conjunction with a professional survey firm in order to ensure the highest possible validity and reliability of the questions. The survey included questions about trip purpose, frequency of visits to the area, perceived traffic risk under various conditions, preferences for various design amenities, and likelihood of walking or bicycling more under certain conditions. The San Pablo Avenue survey was conducted in 2010, allowing time for analysis and review of the results before the Santa Monica Boulevard survey in 2012. The research team took advantage of this opportunity to slightly alter the survey by replacing two of the original questions to learn different things about the Santa Monica Boulevard respondents. Where possible, this chapter compares the results from the two surveys.

The research team chose eight survey locations along San Pablo Avenue and nine survey locations along Santa Monica Boulevard, attempting to include a variety of street design amenities and land uses in the analysis. Surveys were generally conducted within a two block area including both of the blocks surrounding the intersection. A map displaying these survey locations is presented in Appendix M. These locations with differing features were selected to show how preferences varied in locations with different features to determine if the features do indeed influence user perceptions. Respondents were intercepted on foot and bicycle, regardless of how they arrived to the site. Table and Table display the traffic and collision information for each of the survey areas.

Table . Pedestrian, Driver, and Bicyclist *Injury, Volume, and Speed Information for San Pablo Avenue Survey Areas

	Fresno	Brighton	Solano	Cedar	Haskell	57 th	45 th	Alcatraz
Study area length	0.08 mi	0.29 mi	0.28 mi	0.38 mi	0.12 mi	0.35 mi	0.26 mi	0.08 mi
Total Ped Injuries ¹ (Low-high number of injuries at intersections)	3 (0-3)	7 (0-5)	16 (0-10)	12 (0-5)	13 (0-8)	2 (0-1)	18 (0-6)	3 (0-1)
Total Ped Fatalities ¹ (Low-High)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0-1)	0 (0)	0 (0)
Total Bike Injuries ¹ (Low-High)	1 (0-1)	2 (0-2)	7 (0-3)	19 (1-10)	10 (0-4)	3 (0-1)	7 (0-3)	1 (0-1)
Total Motor Vehicle Injuries ¹ (Low-High)	7 (0-5)	44 (0-26)	56 (0-33)	136 (13-46)	119 (0-89)	37 (1-11)	90 (4-25)	24 (0-10)
Total MV Fatalities ¹ (Low-High)	0 (0)	0 (0)	1 (0-1)	0 (0)	2 (0-2)	2 (0-1)	0 (0)	0 (0)
Modeled pedestrian crossings ² (Low/High)	7,483/ 7,756	8,527/ 10,710	9,385/ 11,413	5,889/ 6,393	5,524/ 6,291	8,342/ 8,658	10,033/ 10,613	7,289/ 7,839
AADT ³ (Low/High)	28,733/ 28,795	26,917/ 29,000	28,250/ 29,000	27,398/ 28,452	26,218/ 27,250	21,333/ 28,924	29,908/ 30,973	24,183/ 24,753
**Speed: Range mph	17-39	15-41	16-36	20-41	20-40	16-39	15-40	17-36
**Speed: 85 th % mph	33	32	31	34	32	32	29	36

* Injuries and fatalities from 1997-2007; there were no bicycle fatalities along San Pablo Avenue during these years.

**The posted speed limit is 25 mph along the corridor

¹California Statewide Integrated Traffic Records System (SWITRS), 1997-2007

² Modeled pedestrian data (using Schneider, et al., 2009 model)

³Caltrans Traffic Accident Surveillance and Analysis (TASAS) data

Table . Pedestrian, Driver, and Bicyclist *Injury, Volume, and Speed Information for Santa Monica Boulevard Survey Areas

	Cole	Fairfax	Gardner	Gower	Harper	La Brea	San Vicente	Western	Van Ness
Number of intersections in study area	5	5	5	6	5	5	5	5	5
Total Ped Injuries ¹ (Low-high number of intersection injuries)	29 (2-10)	51 (2-15)	7 (0-3)	19 (0-6)	15 (0-9)	29 (2-13)	50 (3-22)	55 (0-20)	25 (2-7)
Total Ped Fatalities ¹ (Low-High)	0	1 (0-1)	0	1 (0-1)	0	0	0	0	1 (0-1)
Total Bike Injuries ¹ (Low-High)	14 (1-5)	8 (0-3)	4 (0-2)	21 (1-7)	14 (0-10)	13 (0-5)	10 (1-4)	22 (2-7)	15 (0-7)
Total Motor Vehicle Injuries ¹ (Low-High)	171 (7-90)	119 (3-84)	47 (2-19)	178 (11-70)	59 (2-25)	145 (9-55)	91 (7-28)	334 (22-118)	151 (9-62)
Total MV Fatalities ¹ (Low-High)	0	1 (0-1)	0	0	0	0	0	0	0
Modeled pedestrian crossings ² (Low/High)	5,291/ 11,485	7,187/ 44,969	8,124/ 30,375	5,456/ 20,533	17,787/ 56,533	12,007/ 44,248	10,066/ 51,126	11,035/ 56,470	5,456/ 20,553
AADT ³ (Low/High)	31,789/ 31,976	32,007/ 32,805	31,977/ 32,200	25,260/ 28,618	33,326/ 34,059	31,487/ 31,583	35,786/ 36,069	25,260/ 25,654	25,260/ 28,618
**Speed: 85 th % mph	33	31	31	34	32	34	34	35	35

* Injuries and fatalities from 2001-2010; there were no bicycle fatalities along Santa Monica Boulevard during these years.

**The posted speed limit is 30 and 35 mph along the corridor

¹California Statewide Integrated Traffic Records System (SWITRS), 2001-2010

² Weekly modeled pedestrian data

³Based on tube counts

Weather and conditions

For the San Pablo Avenue surveys, the survey team visited the sites from 9 am – 6 pm over five weekdays and three weekend days in September 2010. There was no rain during the survey period, and temperatures were slightly above average for the Bay Area, but not unpleasant.

For Santa Monica Boulevard, the survey team visited the area from 8 am – 8 pm over 13 weekdays and 6 weekend days in June 2012. Again, there was no rain during the survey period, and temperatures were close to average temperatures for West Hollywood during the time period.

Data modifications post-survey

For San Pablo Avenue, the survey results from two different sites were combined and analyzed together. This occurred because one of the sites proved too dangerous from a personal security standpoint for the survey team, so a site similar in design was found and used as a substitute. The results from the two sites were then combined and analyzed as one.

No changes were made to the Santa Monica Boulevard data after the survey closed.

Responses

The surveys along San Pablo Avenue were conducted only in English. Twenty-four percent of those approached refused to take the survey, for a total of 537 respondents. The surveys along Santa Monica Boulevard were conducted in English and Spanish. Thirty-eight percent of those approached refused to take the survey, for a total of 567 respondents. All survey respondents had to be at least 18 years old to take the survey.

The results were entered into a Microsoft Excel spreadsheet, and then analyzed using the statistical software package STATA. The results presented in this chapter represent both descriptive statistics and statistically significant relationships between variables in the analysis. Statistical analysis was determined through Analysis of Variance and Chi-square tests. Only statistically significant relationships where the p value was ≤ 0.10 (indicating significance at the 90% level) are presented here.

Results

Survey Population Characteristics

This section describes the respondent population. It is important to understand the characteristics of the population being surveyed in order to be sure the survey is representative of the larger population.

San Pablo Avenue

The age range for the San Pablo Avenue respondents was broad and fairly well distributed. Table shows that 23% of respondents were aged 25-34, while 22% were aged 55-70. Census data from the survey areas suggest that the respondent population was slightly younger than the surrounding areas. The gender split for the survey was 57% male to 43% female, underrepresenting females for the areas. The racial composition of the sample, at 51% white, 29% African American, and less than 10% each of Asian, Hispanic, or “other” races, suggests that it overrepresents African American and underrepresents Asian and Hispanic respondents.

The survey population was also slightly more educated than the survey area might suggest.

Table . San Pablo Ave Survey Area Characteristics at the Census-Tract Level

	Survey Sample Population (N=537)	Survey Area Population (N=17,546)*	Survey Region Population (N=1,903,577)*
Age¹	%	%	%
18-24	14	10	12
25-34	23	24	18
35-44	17	18	20
45-54	17	18	20
55-70	22	19	19
70+	5	10	11
Sex²			
Male	57	49	49
Female	43	51	51
Race/Ethnicity²			
Caucasian or White	51	49	53
**Hispanic	6	13	23
African American or Black	29	21	11
Asian	9	22	21
Native American or Alaska Native	0	0	0
Other	5	3	10
Education³			
Less than high school	3	10	13
High school graduate	16	17	21
Some college	24	25	30
College degree or higher	55	49	36
Commute Mode⁴			
Car, truck, or van	-	63	79
Public transportation	-	20	10
Bicycle	-	4	1
Walked	-	6	3
Motorcycle, taxi, other	-	1	1
Arrival Mode to Survey Area			
Car, truck, or van	39	-	-
Public transportation	16	-	-
Bicycle	9	-	-
Walked	35	-	-
Motorcycle, taxi, other	0	-	-

1 American Community Survey 2006-2010 5-year Estimates, S0101 Age and Sex

2 ACS 2006-2010 5-year Estimates, DP05 ACS Demographic and Housing

3 ACS 2006-2010 5-year Estimates, S1501 Educational Attainment

4 ACS 2006-2010 5-year Estimates, B08006 Sex of Workers by Means of Transportation to Work

* Population aged 18 and over

**Hispanic counted separately from other races in Census, so totals add up to more than 100%.

Age was significantly related to how the respondent arrived to the area, but not to the likelihood of walking more than 1 block, whether or not additional design improvements were installed. The respondent's sex was significantly related to likelihood of walking or bicycling more if there were more sidewalk lights ($p \leq 0.10$) and street medians ($p \leq 0.05$) but not to general likelihood to walk or bicycle more than one block, visit frequency, or arrival mode. Race was significantly related to arrival mode ($p \leq 0.000$) in the case of white and black respondents, and to visit frequency ($p \leq 0.10$) in the case of Asian and black respondents. The likelihood of walking or bicycling more if there were more street improvements was significantly related to some races and not others for each element.

Santa Monica Boulevard

The data describing the demographics of the respondent population for Santa Monica Boulevard are shown in Table .

Table . Santa Monica Blvd Survey Area Characteristics at the Census-Tract Level

	Survey Sample Population (N=567)	Survey Area Population (N=60,593)	Survey Region Population (N=9,758,256)
Age¹	%	%	%
18-24	16	12	14
25-34	27	26	21
35-44	21	19	20
45-54	19	14	18
55-70	10	15	17
70+	4	13	10
Sex²			
Male	62	53	49
Female	38	47	51
Race/Ethnicity²			
Caucasian or White	51	50	35
*Hispanic	25	24	32
African American or Black	14	3	6
Asian	6	5	9
Native American or Alaska Native	0	0	0
Other	5	18	18
Education³			
Less than high school	6	17	24
High school graduate	17	16	22
Some college	25	26	28
College degree or higher	44	41	26
Commute Mode⁴			
Car, truck, or van	-	76	87
Public transportation	-	14	7
Bicycle	-	2	1
Walked	-	7	3
Motorcycle, taxi, other	-	1	3
Arrival Mode to Survey Area			
Car, truck, or van	28	-	-
Public transportation	34	-	-
Bicycle	3	-	-
Walked	35	-	-
Motorcycle, taxi, other	1	-	-
Usual Mode around City			
Car, truck, or van	37	-	-
Public transportation	48	-	-
Bicycle	4	-	-
Walked	10	-	-
Motorcycle, taxi, other	2	-	-

1 American Community Survey 2006-2010 5-year Estimates, S0101 Age and Sex

2 ACS 2006-2010 5-year Estimates, DP05 ACS Demographic and Housing

3 ACS 2006-2010 5-year Estimates, S1501 Educational Attainment

4 ACS 2006-2010 5-year Estimates, B08006 Sex of Workers by Means of Transportation to Work

*Hispanic counted separately from other races in Census, so totals add up to more than 100%.

For Santa Monica Boulevard, age was significantly related ($p \leq 0.10$) to how respondents over age 45 arrived to the area, as well as to their usual travel mode. Age was not significantly

correlated with visit frequency, nor with the likelihood of walking or bicycling more than 1 block, regardless of additional design improvements. The respondent's sex was significantly related to arrival mode ($p \leq 0.01$), but not to usual travel mode, visit frequency, or general likelihood of walking or bicycling more than one block. Sex was related to the likelihood of walking or bicycling more if there were more shade trees ($p \leq 0.01$), bike parking ($p \leq 0.10$), and public art or decorative trash receptacles ($p \leq 0.05$). Race was significantly related to arrival mode in the case of white and Hispanic respondents ($p \leq 0.001$), and in the case of black respondents ($p \leq 0.01$). Race was also significantly related ($p \leq 0.001$) to usual travel mode for these groups, as well as for "other" races ($p \leq 0.05$). Race was not significantly related to visit frequency or general likelihood of walking or bicycling more than one block, except in the case of "other" races ($p \leq 0.05$). The likelihood of walking or bicycling more if there were more street improvements was significantly related to some races and not others for each element.

Table compares the respondent demographics from San Pablo Avenue and Santa Monica Boulevard. The survey population for San Pablo Avenue is slightly older, more gender-balanced, more highly educated, less Hispanic, and more African American than the population from Santa Monica Boulevard. In addition, there were more drivers and bicyclists, but fewer public transit users among the San Pablo Avenue group.

Table . Comparison of San Pablo Avenue and Santa Monica Boulevard Respondent

Demographics

	San Pablo Avenue Survey Sample Population (N=537)	Santa Monica Boulevard Survey Sample Population (N=567)
Age	%	%
18-24	14	16
25-34	23	27
35-44	17	21
45-54	17	19
55-70	22	10
70+	5	4
Sex		
Male	57	62
Female	43	38
Race/Ethnicity		
Caucasian or White	51	51
*Hispanic	6	25
African American or Black	29	14
Asian	9	6
Native American or Alaska Native	0	0
Other	5	5
Education		
Less than high school	3	6
High school graduate	16	17
Some college	24	25
College degree or higher	55	44
Arrival Mode to Survey Area		
Car, truck, or van	39	28
Public transportation	16	34
Bicycle	9	3
Walked	35	35
Motorcycle, taxi, other	0	1

Trip Characteristics

This section describes the characteristics of trips made to San Pablo Avenue and Santa Monica Boulevard. Understanding the trip characteristics is important for understanding the impact of these users on the corridor's vitality. For example, if the majority of pedestrian trips are made by people who are shopping, dining, or working in the area, this would imply that improving the pedestrian travel experience on the corridor would be economically beneficial.

Trip Purpose

The main reasons people visited San Pablo Avenue on the survey day can be categorized into eight categories.⁵ Shopping was the most popular reason, with just over one-quarter of respondents citing that as their main purpose for their visit. Living in the area was the second most-cited reason, at 18%. How the respondent arrived to San Pablo Avenue was significantly related ($p \leq 0.0001$) to the main purpose of the trip. Figure depicts how the categories compare for the survey date.

⁵ Santa Monica Boulevard respondents were not asked this question.

Figure . Main Purpose of San Pablo Ave Trip by Mode of Arrival (N=537)

Figure compares the “typical” activities of survey respondents along San Pablo Avenue to those along Santa Monica Boulevard. Note that while shopping is a popular activity for both corridors, a much higher percentage of San Pablo Avenue respondents (46% vs. 20%) reported it as a typical activity.

Figure . Typical Activities* on San Pablo Avenue and Santa Monica Boulevard

*Respondents could name more than one activity; “other” and “don’t know” excluded from figure.

Figure shows the breakdown of arrival mode for each of the typical activities along San Pablo Avenue. Note that while drivers make a large portion of the trips, they make less than half of almost every category.

Figure . Typical Activities along San Pablo Avenue, by Arrival Mode (N=537)

Figure shows the same breakdown for Santa Monica Boulevard. Note that the percentage of public transit users is much greater for each activity than it was on San Pablo Avenue. Similar to the San Pablo Avenue results, drivers made up less than half of almost every category.

Figure . Typical Activities along Santa Monica Blvd, by Arrival Mode (N=567)

Travel Mode

Understanding the travel mode of respondents is important to understand how survey responses vary among different users. It would be expected that pedestrians prefer pedestrian improvements, bicyclists request bicycle improvements, and vehicles request vehicle improvements. Finding convergence among respondents’ preferences reveals methods and improvements with which Caltrans can focus its resources to have the greatest affect among all users.

Thirty-five percent of respondents for both surveys arrived to the survey area by foot. Another 39% arrived to San Pablo Avenue by car, whereas only 24% arrived to Santa Monica Boulevard by car. Figure compares the reasons for driving to San Pablo Avenue versus to Santa Monica Boulevard. “Convenience” was the most commonly-cited reason for driving for both groups. Another 38% of San Pablo Avenue respondents also cited distance as a main reason for driving (compared to 23% of Santa Monica Boulevard respondents).

Figure . Reasons for Driving to San Pablo Ave versus Santa Monica Boulevard

Frequency of Visits

The frequency of visits to the area is important to understand how improvements can increase frequency of visits to the area. More visits to the area would lead to higher economic vitality of the area.

Table and Table show the frequency with which the survey respondents typically visit the San Pablo and Santa Monica Boulevard areas, respectively. Fifty-six percent of respondents visit San Pablo Avenue “all the time”, while another 18% visit “fairly often.” For Santa Monica Boulevard, 46% visit “all the time”, while 26% visit “fairly often”. These numbers suggest that the survey responses have a high validity due to familiarity with the area.

There was a significant correlation ($p \leq 0.0001$) between how the respondent arrived and how often they typically visit the survey areas. Seventy-two percent of San Pablo Avenue pedestrians and 63% of Santa Monica Boulevard pedestrians—the most of all mode groups—reported that they visit “all the time.”

Table . Frequency of Visits to San Pablo Avenue, by Arrival Mode

	Everyone (N=537) %	Drivers (n=208) %	Pedestrians (n=190) %	Transit Users (n=84) %	Bicyclists (n=49) %	Other (n=6) %
All the time	56	42	72	57	49	67
Fairly often	18	17	14	19	33	17
Occasionally	16	24	9	13	16	17
Rarely	8	13	4	7	2	0
First time today	3	5	1	4	0	0

Table . Frequency of Visits to Santa Monica Boulevard, by Arrival Mode

	Everyone (N=567) %	Drivers (n=154) %	Pedestrians (n=195) %	Transit Users (n=270) %	Bicyclists (n=15) %	Other (n=6) %
All the time	46	29	63	45	33	33

Fairly often	26	25	27	25	47	17
Occasionally	20	38	8	18	13	17
Rarely	6	6	3	7	7	33
First time today	3	3	1	5	0	0

Figure depicts the information presented in the above tables. Note that, for both corridors, more pedestrians visit “all the time” than any other user group. In addition, San Pablo Avenue has a higher general percentage of drivers and bicyclists and a lower general percentage of public transit users than Santa Monica Boulevard.

Figure . Visit Frequency to San Pablo Ave (N=537) and Santa Monica Blvd (N=567), by Arrival Mode

Likelihoods of Walking or Bicycling

Likelihood of Walking or Bicycling More Given Various Improvements

Information revealing how various improvements could improve the likelihood of walking or bicycling reveals specific features that Caltrans should consider focusing its resources to achieve higher percentages of people walking or bicycling.

The analysis found that there is no significant difference between areas regarding the general likelihood to walk more than one block along San Pablo Avenue. Overall, nearly 65% of people are “very” or “somewhat” likely to walk more than one block. However, there is a significant connection ($p \leq 0.0001$) between how often respondents visit the area and their likelihood of walking or bicycling more than one block. For example, those who visit “all the time” are much more likely to walk or bicycle more than one block than those who visit occasionally or rarely. There is also a significant relationship ($p \leq 0.0001$) between how someone arrived to the area

and the likelihood of walking or bicycling more than one block. Those who arrived on foot or by public transportation are much more likely to walk more than one block than those who drove or even those who bicycled. Figures representing these associations can be found in Appendix G.

For Santa Monica Boulevard, 73% of people are “very likely” or “likely” to walk or bicycle more than one block while visiting. As was the case for San Pablo Avenue, the likelihood of walking or bicycling more than one block along Santa Monica Boulevard is significantly positively correlated ($p \leq 0.0001$) with how often the respondent visits the area. For example, those who visit “all the time” are much more likely to walk more than one block than those who visit occasionally or rarely. There is also a significant relationship ($p \leq 0.0001$) between how someone arrived to the area and the likelihood of walking or bicycling more than one block. Those who arrived on foot, by bicycle, or by public transportation are much more likely to walk or bicycle more than one block than those who drove. Figures representing these associations can be found in Appendix H.

The survey also asked about the likelihood of walking or bicycling more given certain street improvements. Table shows that around 50-60% of San Pablo Avenue respondents said that they would be at least “somewhat likely” to walk or bicycle more given an increase in most of the proposed street improvements. The lowest-scoring elements were medians, curb extensions, and decorative pavement, all of which had an approximately 40% likelihood. Note that the “unlikely” number does not indicate that people do not want these treatments, just that they are unlikely to walk or bike more if these treatments are installed.

Table . Likelihood of Walking or Bicycling More along San Pablo Avenue if More Design Amenities (N=537)

	Likely %	Neutral %	Unlikely %	N/A %	Total
Outdoor seating areas	65	8	23	-	100
Sidewalk lighting	63	7	25	2	100
Landscaping	55	9	35	-	100
Bicycle lanes	53	4	17	25	100
Shade Trees	50	8	38	1	100
Bicycle parking	48	6	19	26	100
Public art/decorative trash receptacles	47	11	40	1	100
Curb extensions	43	8	40	1	100
Medians	37	9	44	4	100
Decorative pavement	36	10	49	1	100

Table shows the results to these same questions for the Santa Monica Boulevard respondents. The results indicate that the Santa Monica Boulevard respondents were uniformly more likely to walk or bicycle more given these improvements than the San Pablo Avenue respondents. The “likelihood” order of the improvements was nearly the same between the two groups, with outdoor seating areas and sidewalk lighting being the two categories with the most positive

responses for both groups. One key difference for Santa Monica Boulevard was the greater positive response toward street trees, which may reflect several things, including respondents’ comments about needing more shade on hot days and the fact that many parts of San Pablo Avenue already have a lot of shade trees. These types of explanations will be discussed further in the case study section at the end of the chapter.

Table . Likelihood of Walking or Bicycling More along Santa Monica Boulevard if More Design Amenities (N=567)

	Likely %	Neutral %	Unlikely %	N/A %	Total
Outdoor seating areas	77	13	7	3	100
Sidewalk lighting	70	17	9	4	100
Shade Trees	69	20	8	2	100
Landscaping	60	23	16	2	100
Bicycle lanes	60	16	13	11	100
Bicycle parking	57	17	15	10	100
Curb extensions	56	25	15	4	100
Decorative pavement	50	21	26	3	100
Landscaped medians	49	25	18	8	100
Public art/decorative trash receptacles	48	22	27	3	100

Each “likelihood” question was further examined for its connection to arrival mode and visit frequency, as shown in Table . Figures representing significant associations are located in Appendix G for San Pablo Avenue and Appendix H for Santa Monica Boulevard.

Table . Significant Correlations between Likelihood of Walking or Bicycling More Given Certain Design Features and Travel Mode and Visit Frequency

	San Pablo Avenue		Santa Monica Boulevard		
	Arrival mode	Visit frequency	Arrival mode	Usual mode	Visit frequency
Outdoor seating areas	*	*			**
Sidewalk lighting				#	*
Shade Trees	**	*		**	#
Landscaping ⁶	*			*	#
Bicycle lanes			***	***	
Bicycle parking			***	***	

⁶ The San Pablo Avenue survey asked about “landscaping or other plants”; the Santa Monica Boulevard survey asked about “plants on the sidewalk.”

Curb extensions	#			**	
Decorative pavement	*		#	**	
Landscaped medians ⁷	#				
Public art/decorative trash receptacles			***	***	

Significant correlations at the following levels: # $p \leq 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

There was a significant difference between groups for likelihood of walking or bicycling more given more of certain improvements. In the section below, the significant correlations are explained for each improvement.

Shade Trees

Overall, just over 50% of San Pablo Avenue respondents and nearly 70% of Santa Monica Boulevard respondents would be at least “somewhat likely” to walk or bicycle more if there were more shade trees. The significant correlation to arrival mode for San Pablo Avenue respondents reflects that more pedestrians and bicyclists than drivers were more likely to walk or bicycle more than one block if more shade trees were present. The significant correlation to usual mode for Santa Monica Boulevard respondents reflects that more public transit users than any of the other modes were more likely to walk or bicycle more than one block if more shade trees were present. The significant correlation to visit frequency for both areas reflects that those who visit the most frequently are also more likely to walk or bicycle more than one block if more shade trees are planted. This likelihood was significantly related to the survey area along San Pablo Avenue and Santa Monica Boulevard. This may reflect the difference between survey locations in terms of the presence of shade trees.

Landscaping

Overall, 55% of San Pablo Avenue respondents and 60% of Santa Monica Boulevard respondents said they would be more likely to walk or bicycle more if there were more landscaping. As with shade trees, significant correlations to arrival mode for San Pablo Avenue respondents and usual mode for Santa Monica Boulevard respondents reflects that more pedestrians and bicyclists (in the case of San Pablo Avenue) and more transit users (in the case of Santa Monica Boulevard) than the other groups were more likely to walk or bicycle more than one block if more landscaping were present. The slightly significant correlation to visit frequency for Santa Monica Boulevard reflects that those who visit more frequently are also more likely to walk or bicycle more than one block if more landscaping is present. This likelihood was significantly related to the survey area along San Pablo Avenue and Santa Monica Boulevard, again perhaps reflecting the difference in landscaping between survey areas.

Street/Landscaped Medians

Thirty-seven percent of San Pablo Avenue respondents and 49% of Santa Monica Boulevard respondents stated that they would be at least “somewhat likely” to walk or bike more if there were more street/landscaped medians. This likelihood was not significantly correlated to visit frequency for either area, and was only slightly significantly correlated to arrival mode along San Pablo Avenue. This slight correlation reflects pedestrian, transit user, and bicyclist willingness to

⁷ The San Pablo Avenue survey asked about “medians in the middle of the street”; the Santa Monica Boulevard survey asked about “landscaped medians.”

walk or bicycle more than drivers if medians are present. This likelihood was not significantly related to the survey areas for either corridor.

Sidewalk Lighting

Approximately 63% of San Pablo Avenue respondents and 70% of Santa Monica Boulevard respondents would be at least “somewhat likely” to walk or bike more if there were more sidewalk lighting along their respective corridors. This likelihood was not significantly correlated to visit frequency or arrival mode for San Pablo Avenue, suggesting that neither of those attributes made any certain user group more or less likely to walk or bike more if there were more sidewalk lighting. Santa Monica Boulevard respondents who visited less often were significantly less likely to walk or bicycle more if more sidewalk lighting were installed. Public transit users and bicyclists were more likely than drivers or pedestrians to walk or bicycle more given more sidewalk lighting. This likelihood was significantly related to the survey area along Santa Monica Boulevard, but not San Pablo Avenue.

Curb Extensions

Just over 43% of San Pablo Avenue respondents and 56% of Santa Monica Boulevard respondents reported being more likely to walk or bike more if there were more curb extensions. This likelihood was not significantly related to survey area for San Pablo Avenue, but was for Santa Monica Boulevard. This may reflect the general lack of curb extensions along San Pablo Avenue and the fact that Santa Monica Boulevard has them in some places but not others. There is a significant association between this likelihood and arrival mode for San Pablo Avenue, as well as with usual travel mode for Santa Monica Boulevard, reflecting a greater preference among non-drivers for this feature. This likelihood was not associated with visit frequency for either corridor.

Colored or Decorative Paving

Overall, just over 36% of San Pablo Avenue respondents and 50% of Santa Monica Boulevard respondents were at least “somewhat likely” to walk or bike more if there were more colored or decorative pavement. This was significantly related to area for San Pablo Avenue, though in an unexpected direction. For example, nearly 50% of respondents from the Castro/Solano area, which already has a large amount of context-sensitive and pedestrian-friendly features, would likely walk more given these conditions. In contrast, only 26% of respondents from the Kains/Castro area, with few context-sensitive and pedestrian-friendly features, would likely do so. This likelihood was not significantly related to area along Santa Monica Boulevard.

There was also a significant association between this likelihood and arrival mode for all respondents, as well as with usual travel mode among Santa Monica Boulevard respondents. This is likely explained by the responses of those who took public transit, as they seem to be the most likely to walk (or bicycle) more given more colored/ decorative paving. While pedestrians along Santa Monica Boulevard seemed likely to walk more given this treatment, this was less clear along San Pablo Avenue. Finally, there was no significant correlation between this likelihood and visit frequency.

Bicycle Parking

Approximately 48% of San Pablo Avenue respondents and 57% of Santa Monica Boulevard

respondents were at least “somewhat likely” to (walk or) bike more if there were more bicycle parking. Approximately 26% of San Pablo Avenue respondents and 11% of Santa Monica Boulevard respondents answered “not applicable” to this question. This was not significantly related to area for San Pablo Avenue, although it was for Santa Monica Boulevard. It was not related to visit frequency for either area. There was a significant relation to arrival mode and usual travel mode among Santa Monica Boulevard respondents, mostly explained by bicyclists’ preferences.

Bicycle Lanes

Approximately 53% of San Pablo Avenue respondents and 60% of Santa Monica Boulevard respondents reported being at least “somewhat likely” to walk or bike more if there were more bicycle lanes, with 25% of San Pablo Avenue respondents and 10% of Santa Monica Boulevard respondents again answering “not applicable”. This was not significantly related to area for either corridor, perhaps because there are no bicycle lanes along San Pablo Avenue and they exist only on a short section of Santa Monica Boulevard. This was significantly related to how arrival mode and usual mode for Santa Monica Boulevard respondents, again likely due to bicyclists’ preferences. It was not related to visit frequency for either corridor.

Public Art or Decorative Trash Receptacles

Nearly 47% of San Pablo Avenue respondents and 48% of Santa Monica Boulevard respondents are “likely” or “somewhat likely” to walk or bike more if there were more public art or decorative trash receptacles. This likelihood was not significantly related to area or visit frequency for either corridor. There was a significant association between the likelihood and arrival mode and usual mode for Santa Monica Boulevard respondents, likely due to a higher preference among transit users, pedestrians, and bicyclists, in comparison to drivers.

Outdoor Seating

Just over 65% of San Pablo Avenue respondents and 77% of Santa Monica Boulevard respondents are “likely” or “somewhat likely” to walk or bike more if there were more outdoor seating areas. This was significantly related to area for both corridors. A significant connection to how San Pablo Avenue survey respondents arrived is likely explained by a high preference among public transit users for more outdoor seating. Visit frequency for both corridors is significantly related to this likelihood, perhaps reflecting that those who visit more often were more likely to walk or bike more if more outdoor seating were available.

Activities and Attributes of San Pablo Avenue and Santa Monica Boulevard

This section reveals the characteristics the users like most about San Pablo Avenue and Santa Monica Boulevard. Understanding these preferences can help reveal how improvements can increase trips to the area. It is important to understand what users feel is the primary characteristic of the corridor that attracts them to understand whether it is the landscape and design elements, land use, or another attribute that draws people to the area.

The data showed that the survey respondents tended to enjoy similar things about the areas. Dining and shopping were far and away the most popular activities for each survey area, although some areas seemed to have more diverse offerings than others. The attributes people liked most and least about San Pablo Avenue and Santa Monica Boulevard also seemed fairly

similar between user groups. These findings are elaborated upon below.

Attributes Respondents Liked Best about San Pablo Avenue and Santa Monica Boulevard

The survey asked respondents to name the attributes of San Pablo Avenue and Santa Monica Boulevard they liked most and least. Because these were open-response questions, respondents could answer more than one answer. The data indicated that the attributes and characteristics that respondents liked best about San Pablo Avenue and Santa Monica Boulevard were related to their typical activities. Figure shows a comparison of the two corridors in terms of what respondents liked best. Both corridors were considered to have “good shopping/restaurants” and had a high percentage of respondents who liked that they were close to home and/or work.

Figure . Attributes Respondents Liked Best about San Pablo Avenue (N=537) and Santa Monica Boulevard (N=567)

*Other includes answers chosen by less than 2% of respondents.

Note that a higher percentage of Santa Monica Boulevard respondents like every other option than San Pablo Avenue respondents. This could be due to a difference in survey populations or overall survey area, but it may also reflect the extensive upgrades Santa Monica Boulevard has undergone in the past ten years.

Note that many of these attributes—such as shopping/restaurants and proximity to work or home—are not directly related to street design. However, other attributes, such as attractiveness and access to public transit, have the potential to be affected by street design. For San Pablo Avenue respondents, these preferences were slightly significantly related to frequency of visit, but not to the respondents’ arrival mode. For Santa Monica Boulevard, preferences were significantly related to arrival mode and visit frequency.

Attributes Respondents Liked Least about San Pablo Avenue and Santa Monica Boulevard

Figure compares San Pablo Avenue and Santa Monica Boulevard in terms of aspects that respondents liked least overall. In contrast to the things that people liked best about the two corridors, those that they liked least were not significantly related to arrival mode or visit frequency. Note that the complaints are similar for both corridors—particularly, traffic congestion, appearance, and safety. However, in every single category a higher percentage of Santa Monica Boulevard than San Pablo Avenue respondents named these as issues.

Figure . Attributes Respondents Liked Least about San Pablo Avenue (N=537) and Santa Monica Boulevard (N=567)

*Other includes answers chosen by less than 3% of respondents.

Clearly there are some aspects that are beyond the control of street design, such as a lack of shops. However, many of these aspects could be improved by additional elements to calm traffic and provide pedestrian and bicyclist amenities.

Street Improvements that Would Encourage More Visits

Respondents were asked to name the various types of street improvements that could encourage them to visit the area more often. Identifying these improvements can help Caltrans determine where to focus its resources. The breadth of responses for each corridor are shown in Figure and Figure . Note that these figures do not contain responses suggested by less than 2% of the survey populations; there were dozens of answers to this question. In spite of this, some responses were clearly preferred by more people, as seen in Table and Table .

These improvements were significantly related to arrival mode but not to survey area or frequency of visit. The figures in this section include responses that are not street improvements under Caltrans’ purview, such as increasing shops and restaurants and reducing vagrancy. These responses were left in to allow comparability between users’ overall priorities, and to show the complexity of creating attractive environments.

Figure . Suggestions to Encourage More San Pablo Avenue Visits (N=537)

Figure . Suggestions to Encourage More Santa Monica Boulevard Visits (N=567)

Table and Table show the most commonly suggested street improvements to encourage visits to San Pablo Avenue and Santa Monica Boulevard, respectively. These tables illustrate an alignment in preferences among the various respondent groups.

Note the high number of “nothing” responses for both groups, suggesting that these people will not visit the corridor more, regardless of added features. For Santa Monica Boulevard, this percentage (including “missing” responses) is fairly even across groups. For San Pablo Avenue, however, a majority of transit users, bicyclists, and drivers have suggestions for improvements that could encourage more visits.

Table . San Pablo Avenue Respondents’ Top Five Street Improvements to Encourage More Frequent Visits, by Arrival Mode

	All Users (N=531)	Driver (n=208)	Pedestrian (n=190)	Transit User (n=84)	Bicyclist (n=49)
Improvement	% of	%	%	%	%

	Responses				
1. Trees & landscaping	15	11	22	11	12
2. Retail, food, entertainment	13	11	15	8	20
3. Clean area/more trash cans	8	6	8	14	8
4. Street lighting	8	6	11	8	4
5. Bike lane*	7	8	4	2	20
5. Art/beautification*	7	6	8	4	10
- Nothing	43	37	61	27	24

*Tied for fifth most-requested improvement.

Table . Santa Monica Boulevard Respondents’ Top Five Street Improvements to Encourage More Frequent Visits, by Arrival Mode

	All Users (N=567)	Driver (n=159)	Pedestrian (n=195)	Transit User (n=192)	Bicyclist (n=15)
Improvement	% of Responses	%	%	%	%
1. Clean streets/sidewalk/area	12	12	14	11	13
2. Road/sidewalk maintenance/repair	7	8	5	6	13
3. More plants/landscaping/parks	6	5	8	6	-
4. Bicycle lanes/parking	4	3	3	4	27
4. More entertainment options	4	4	5	2	-
4. Police/security/cameras	4	4	6	3	-
- Nothing/missing	51	48	48	59	47

*Tied for fourth most-requested improvement.

Perceived Traffic Safety on San Pablo Avenue and Santa Monica Boulevard

This section describes how safe users felt along San Pablo Avenue and Santa Monica Boulevard. People are unlikely to travel through a corridor if they feel unsafe doing so. The survey participants were questioned about how safe they feel from traffic while doing certain things on San Pablo Avenue. It is clear from the responses shown in Table that people in general feel much safer walking along San Pablo Avenue than they do bicycling. In addition, over 50% of respondents answered “not applicable” to questions about bicycling safety. While this half likely includes many respondents with no desire to ride a bicycle, it may also include people who would like to bicycle but do not consider it because of perceived danger. Perceived safety while

walking or bicycling was not significantly related to survey area, arrival mode, or frequency of visit (other than in one instance explained below).

Table . Perceptions of Traffic Safety while Walking and Bicycling on San Pablo Avenue (N=537)

	Very safe	Somewhat safe	Neutral	Somewhat unsafe	Very unsafe	N/A or Don't know
When walking on the sidewalk	57%	25%	10%	4%	2%	2%
When walking across the street	28%	20%	25%	15%	10%	2%
When bicycling across the street	7%	8%	12%	10%	8%	52%
When bicycling on the roadway	4%	5%	9%	12%	15%	53%

Table shows how safety the Santa Monica Boulevard respondents feel when walking and bicycling along and across the corridor. The percentages are actually quite similar to those for San Pablo Avenue, except that a higher percentage of San Pablo Avenue respondents feel “very safe” walking along and across the street.

Table . Perceptions of Traffic Safety while Walking and Bicycling on Santa Monica Boulevard (N=567)

	Very safe	Somewhat safe	Neutral	Somewhat unsafe	Very unsafe	N/A or Don't know
When walking on the sidewalk	46%	37%	11%	2%	1%	3%
When walking across the street	21%	29%	27%	14%	6%	3%

When bicycling across the street	7%	7%	22%	16%	10%	38%
When bicycling on the roadway	4%	5%	16%	19%	17%	39%

Perceived Safety from Traffic When Walking

The questions about perceived safety while walking revealed a fairly safe experience. Only 25% and 6% of respondents reported feeling unsafe while walking across and along San Pablo Avenue, respectively. The difference between perceived traffic safety when crossing the street and the frequency of one’s visits to San Pablo Avenue reached marginal significance (Figure), although it may be in an unexpected direction. It seems that the more someone visits, the less safe they feel, which may reflect a familiarity with certain dangers, or just the fact that more visits means more exposure to whatever dangers exist.

Figure . Perceived Traffic Safety When Walking Across San Pablo Ave, by Visit Frequency (N=525)

For Santa Monica Boulevard, only 20% and 3% of respondents reported feeling unsafe walking across and along the corridor, respectively. There was no significant association between perceived traffic safety and visit frequency.

Perceived Safety from Traffic When Bicycling

The questions about bicycling safety revealed a much greater disparity in perceived safety. While only 18% and 27% of respondents reported feeling unsafe while bicycling across or along San Pablo Avenue, respectively, over 50% of respondents for both questions responded “not applicable.” This not applicable suggests that these respondents do not bicycle at all, which previous research has linked to fear of bicycling risk (Dill and Voros, 2007).

For Santa Monica Boulevard, 26% and 36% of respondents reported feeling unsafe bicycling across and along the street, respectively. In this case, an additional nearly 40% of respondents chose “not applicable” as their response. There was a significant association ($p \leq 0.01$) between visit frequency and perceived traffic safety bicycling across the street, as well as bicycling along the street ($p \leq 0.10$). Figure shows that the general trend that the more someone visits, the less safe they report feeling bicycling. This may reflect dangers on Santa Monica Boulevard, but that causation cannot be established without further study. This trend is somewhat less apparent, although still present, in Figure .

Figure . Perceived Traffic Safety When Bicycling Across Santa Monica Boulevard

Figure . Perceived Traffic Safety When Bicycling Along Santa Monica Boulevard

Encounters with Cars

The survey also asked about respondents' encounters with cars. The following percentages give a picture of the traffic risk survey respondents have encountered walking and bicycling along San Pablo Avenue and Santa Monica Boulevard.

- Percentage of respondents who have almost been hit by a vehicle while walking or biking in their area:
 - o Nearly 38% of San Pablo Avenue respondents
 - o Approximately 31% of Santa Monica Boulevard respondents
- Percentage of respondents who have had a motor vehicle come too close to them while walking or bicycling along the corridor :
 - o Over 50% of San Pablo Avenue respondents
 - o Nearly 44% of Santa Monica Boulevard respondents
- Percentage of respondents who have almost been hit by a car door while walking or biking along the corridor:
 - o Nearly 17% of San Pablo Avenue respondents
 - 15% of those hit were injured
 - o Over 13% of Santa Monica Boulevard
 - 34% of those hit were injured

Street Improvements that Would Increase Perceived Traffic Safety

Respondents were asked to name the various types of street improvements they thought would improve safety from traffic. Respondents could name as many things as they wanted, and many named more than one street improvement. Response trends are discussed in this section.

San Pablo Avenue

As seen in Figure and Table , a bicycle lane was the most requested traffic safety improvement along San Pablo Avenue, both overall and among each user group except for public transit users

(who ranked it fifth). The second most-requested addition was improved pedestrian crossings, such as adding lighted crosswalks and increasing crossing times. This category was requested second-most by each group except bicyclists (who ranked it third).

Figure . Requested Street Improvements to Increase Perceived Traffic Safety along San Pablo Ave, by Arrival Mode (N=533)

* “Other” includes 14 requested improvements, each of which was requested by less than 2% of the sample.

Table . Respondents’ Top Five Street Improvements to Increase Perceived Traffic Safety along San Pablo Avenue, by Mode

	All Users (N=531)	Driver (n=208)	Pedestrian (n=190)	Transit User (n=84)	Bicyclist (n=49)
Improvement	% of respondents	%	%	%	%
1. Bicycle lane	18	14	16	6	63
2. Improved crosswalks	14	13	15	13	8
3. Slow traffic/ Improve driver behavior	11	10	12	18	6
4. Street lighting	9	13	5	10	10
5. More traffic lights and stop signs	5	4	8	11	4
- Nothing	28	31	27	25	14

There are several interesting trends found in this table. The first is that all users requested the same top 5 street improvements, although in different order. This may reflect the fact that many users are multimodal—that is, drivers, transit users, and bicyclists are all pedestrians at some point in their trip, while pedestrians likely use other modes at different times. The same could be said for the permeability of other modes.

The second trend to notice is that pedestrians, drivers, and bicyclists all ranked a bicycle lane as the top request to improve perceived traffic safety, even though bicyclists requested it the most. This may reflect the point raised above, that some pedestrians and drivers may bicycle at other times, but it may also reflect benefits to the pedestrians and drivers from having a bicycle lane for bicycle traffic. For example, this may increase predictability for drivers in terms of bicyclists’ actions, and it may encourage more bicyclists to ride on the roadway instead of the sidewalk, thus improving pedestrian comfort and safety on the sidewalk.

There was also a high percentage of respondents (28%) who answered that “nothing” could improve traffic safety along San Pablo Avenue. Because of the response, it is difficult to know if that “nothing” is because the situation is already quite safe, or because the respondents feel that it

is so unsafe that “nothing” could improve it. A look at respondents’ perceptions of safety from elsewhere in the survey may offer some clarity: 59% of respondents who answered “nothing” also reported feeling “very safe” walking along and across San Pablo Avenue. This correlation provides some evidence that the “nothing” from these respondents could be viewed positively. On the other side of the scale, no one who answered “nothing” also reported feeling “very unsafe” walking, but 13% reported feeling “very unsafe” bicycling (including 8% who feel “very safe” walking). This may be evidence that those responses should be viewed as a negative. It is unclear how the remaining 36% of “nothing” responses should be interpreted. However, it is clear that 72% of respondents overall—including 86% of bicyclists—believed that there was room for improvement.

Table shows how the most-requested traffic safety improvements were ranked by visit frequency. Those who visit frequently were more likely to request traffic safety improvements.

Table . Respondents’ Most Requested Traffic Safety Improvements along San Pablo Avenue, by Frequency of Visit (N=536)

	All the Time (n=299)	Frequently (n=94)	Occasionally (n=87)	Rarely (n=41)	First Time (n=15)
Improvement	% of Responses	%	%	%	%
Bike Lane	18	22	20	13	13
Improved pedestrian crossings	14	14	7	17	33
Slow traffic/Improve driver behavior	12	12	9	5	-
Street lighting	10	9	7	5	7
Nothing	34	36	46	49	40

Traffic safety improvements were also significantly related to survey area, which will be discussed in a later section.

Santa Monica Boulevard

Figure presents the results from the open-ended traffic safety improvement question along Santa Monica Boulevard. Similar to the responses from San Pablo Avenue, there was alignment among user groups about traffic safety elements, with improved crosswalks and bike lanes/improvements as the two most-requested categories.

Figure . Requested Street Improvements to Increase Perceived Traffic Safety along Santa Monica Boulevard, by Arrival Mode (N=567)

* “Other” includes over 20 requested improvements, each requested by no more than 2% of the sample.

This alignment between user preferences continued through the five most-requested traffic safety improvements, as presented in Table 33. One exception to this alignment is that the fifth most-requested improvement, reduced driver speed, was not requested by any bicyclists.

Table . Respondents’ Top Five Street Improvements to Increase Perceived Traffic Safety along Santa Monica Boulevard, by Arrival Mode

	All Users (N=567)	Driver (n=159)	Pedestrian (n=195)	Transit User (n=192)	Bicyclist (n=15)
Improvement	% of responses	%	%	%	%
1. Improved crosswalks	13	14	14	13	7
2. Bicycle lanes/improvements	11	8	9	10	67
3. Road maintenance/clean streets	6	8	5	6	13
4. More/wider traffic lanes	7	6	4	8	20
5. Decreased speeding	5	4	5	6	-
- Nothing	19	22	24	10	13
- Skipped question	26	19	19	39	7

There are several things to note from this table. As in the case of San Pablo Avenue, all user groups prioritized traffic safety improvements traditionally thought to benefit just one group. Improved pedestrian crossings were not only the most-requested addition overall, they were also the most-requested among those who drove, walked, and took transit to the site (ranked fifth by bicyclists). Bicycle lanes or improvements were ranked second overall and second by all groups except bicyclists, who ranked them first. While these preferences may reflect the multimodality of these respondents, they also potentially reflect benefits to other modes. For example, when requesting a bicycle lane, one respondent said, “...walking feels dangerous with bikes on the sidewalks.”

There is also a fairly high percentage of people who either requested “nothing” to improve traffic safety (19%), or skipped the question (26%). As with the data from San Pablo Avenue, it is difficult to decipher if this is a positive or negative non-response. Further analysis shows that 41% of those respondents already feel “very safe” walking or bicycling along Santa Monica Boulevard, so a good portion of the responses do seem to be positive. However, the remaining 59% of responses cannot be categorized one way or the other. Regardless of the meaning of the non-response, it is clear that a majority of corridor users (55%) would like to see traffic safety improvements, including 80% of bicyclists and nearly 60% of drivers and pedestrians.

Table shows how the most-requested traffic safety improvements were ranked by frequency of visit. Note that the enthusiasm for pedestrian and bicycle improvements remains fairly consistent regardless of visit frequency.

Table . Respondents' Most Requested Traffic Safety Improvements along Santa Monica Boulevard, by Frequency of Visit (N=563)

	All the Time (n=259)	Fairly Often (n=146)	Occasionally (n=111)	Rarely (n=31)	First Time (n=16)
Improvement	% of Responses	%	%	%	%

1. Improved crosswalks	13	18	11	3	13
2. Bicycle lanes/ improvements	20	15	15	29	25
3. Road maintenance /clean streets	5	8	7	10	-
4. More/wider traffic lanes	3	8	10	3	6
5. Decreased speeding	5	2	10	-	-
- Nothing	20	15	15	29	25

Limitations

For all of the findings about preferences, a few important limitations apply. First, all survey respondents were intercepted on foot or bicycle, regardless of their mode of arrival to the corridor. Thus, it is possible that their answers reflected their preferences as a pedestrian more than their preferences as a driver or transit user. Likewise, pedestrians may have different preferences for street design when traveling via other modes. There is no way to fully measure those possible differences from this data, although it is worth noting that the answers of the other roadway user groups do not exactly mirror (and in some cases diverge from) those of the pedestrian group, suggesting that they did not think solely as a pedestrian when answering the questions.

One way the research team attempted to address this limitation was by asking respondents along Santa Monica how they “usually” traveled around the city. These answers were then compared with requested traffic safety improvements to detect any influence of the arrival mode on one’s choices. Figure and

display these results. Note that it does appear that one’s arrival mode influenced one’s answers to the question. For example, a smaller percentage of people who usually walk requested pedestrian crossings than the percentage of those who walked to the site that day. However, the percentages were relatively close for all modes, particularly for drivers and public transit users, suggesting that the answers based on arrival mode are reliable.

Figure . Requested Street Improvements to Increase Perceived Traffic Safety along Santa Monica Boulevard, by Usual Mode (N=567)

Table . Respondents’ Top Five Street Improvements to Increase Perceived Traffic Safety along Santa Monica Boulevard, by Usual Travel Mode

	All Users (N=565)	Driver (n=208)	Pedestrian (n=54)	Transit User (n=270)	Bicyclist (n=23)
Improvement	% of responses	%	%	%	%
1. Improved crosswalks	13	16	6	14	0
2. Bicycle lanes/improvements	11	8	6	11	48
3. Road maintenance/clean streets	7	4	4	8	9
4. More/wider traffic lanes	6	7	2	7	4
5. Decreased speeding	5	3	6	6	-
- Nothing	19	25	30	11	9

A second, but related, limitation is that this survey explores roadway design preferences of traffic that has stopped at some point along this corridor. Thus, it cannot be said to represent the preferences of traffic that uses this corridor solely for traveling through these locations. However, this concern is somewhat less relevant, as data about walking and bicycling trip characteristics indicate that it is highly unlikely that very many, if any, pedestrians and bicyclists would traverse the lengths of these two corridors without stopping.

Finally, open-response questions such as the one about traffic safety improvements did not give users a choice set from which to select responses. While this has the benefit of not leading the respondent to a certain answer, it has two main disadvantages. First, all users may not have the same knowledge or ideas about what street improvements are possible. Second, and relatedly, without a choice set, respondents may not know what is possible beyond their general familiarity. For example, roadways with high amounts of fast-moving traffic like San Pablo Avenue and Santa Monica Boulevard would be designed with physically-separated bicycle lanes (i.e., cycle-tracks) in cities like Copenhagen or Paris. However, these treatments are rarely used in the United States and therefore likely unfamiliar to most of the respondents to this survey.

Case Study Approach

Another way to examine the data from the San Pablo Avenue and Santa Monica Boulevard surveys is using a case study approach. This section explores and compares the survey findings from each area to try to understand how various outcomes are influenced by design features.

San Pablo Avenue

Table and Table display information about the San Pablo Avenue survey areas (which are shown on a map in Appendix M), which are the blocks surrounding the identified intersection. A few things are clear from the percentages and preferences listed in these two tables. First, areas

where a higher percentage of respondents arrived by bicycle ranked a bicycle lane as the most-requested traffic safety improvement. However, all areas except the area around the intersection of Solano Avenue and San Pablo Avenue rank a bicycle lane either first or second, suggesting that it is seen as a need throughout the corridor. This high ranking is due to the fact that drivers, pedestrians, and transit users also requested a bicycle lane, as was shown in Table . Table and Table also show that the areas with a higher percentage of respondents arriving by bicycle are not necessarily considered safer in terms of bicycling. While there is a significant correlation ($p \leq 0.05$) between perceptions of safety while bicycling and whether a traffic safety improvement is requested in the area, there is no significant correlation between perceptions of safety while bicycling and requesting a bicycle lane.

These same trends are less clear for pedestrians. There is no correlation between the percentage of people arriving by foot and whether improved pedestrian crossings were requested. Although there is a significant correlation ($p \leq 0.0001$) between perceptions of safety while walking and whether a traffic safety improvement is requested, it seems that those who report feeling safer are actually more likely to request an improvement than those who feel less safe. In addition, there is no significant correlation between perceptions of safety while walking and requesting improved pedestrian crossings. Overall, there is no significant difference between areas for whether people feel safe walking or bicycling along or across the street, or whether they requested design elements to improve traffic safety.

There is also no significant difference between areas regarding the likelihood of walking or bicycling more when one visits. However, there were significant differences between the areas when respondents were queried about their likelihoods of walking or bicycling more given more of certain design elements. The following elements were significantly related to area, suggesting that some areas might see a greater effect from the addition of these elements:

- Shade trees
- Sidewalk lighting
- Bicycle parking
- Bicycle lanes
- Outdoor seating areas

The findings about design improvements that could encourage more visits are somewhat less clear-cut. There is no significant correlation between requesting a design improvement to encourage more visits and how often someone visits. There is a marginally significant correlation ($p \leq 0.10$) between requesting design improvements to encourage more visits and arrival mode, in that drivers were the least likely and transit users and bicyclists were the most likely to request an improvement. There was also a marginally significant correlation ($p \leq 0.10$) between areas for whether a design improvement was requested.

Table . Traffic Safety & Visit Frequency Comparison - San Pablo Avenue Areas 1-4

	Fresno n=76	Brighton n=61	Solano n=63	Cedar n=66
Arrival Mode				
% Arrive on foot	33	39	37	26
% Arrive by bike	7	3	3	6
% Arrive by transit	5	18	22	14
Traffic Safety Components				
% somewhat or very safe walking across street	44	37	27	27
% somewhat or very safe biking across street	9	11	3	12
% somewhat or very safe walking along street	65	51	51	52
% somewhat or very safe biking along street	2	3	2	6
Top-ranked traffic safety improvement	Bicycle lane	Slow drivers/ improve behavior	Improve ped crossings	Bicycle lane
Second-ranked traffic safety improvement	Improve ped crossings	Bicycle lane	Slow drivers/ improve behavior	Sidewalk lighting
% not requesting traffic safety improvement	42	46	41	35
Average ped injuries	1	1	3	2
Average bike injuries	0	0	1	4

Visit Frequency Components				
% Visit usually or all the time	75	66	75	61
Top-ranked visit more improvement	Trees & plants	Ped amenities	Trees & plants	Trees & plants
Second-ranked visit more improvement	Better ped design	(tie) Cleaner area; Trees & plants	(tie) Shopping/dining options; beautification/art; sidewalk lighting; cleaner area	Bike lane
% not requesting visit more improvement	48	57	52	36
Street tree coverage	Sporadic	Regular	Regular	Regular
Bike lane present	No	No	No	No
Average number of crosswalks/intersection	2	2	3	4
Average median presence	All blocks	No blocks	No blocks	All blocks
Comparison with Policy Analysis				
Total number of elements covered by City's plans	23	12	12	31

Table . Traffic Safety & Visit Frequency Comparison - San Pablo Avenue Areas 5-8

	Haskell n=91	57th n=45	45th n=58	Alcatraz n=64
Arrival Mode				
% Arrive on foot	33	53	26	44
% Arrive by bike	8	13	19	19
% Arrive by transit	25	11	14	11
Traffic Safety Components				
% somewhat or very safe walking across street	42	21	26	34
% somewhat or very safe biking across street	15	4	15	13
% somewhat or very safe walking along street	70	41	49	60
% somewhat or very safe biking along street	8	4	11	15
Top-ranked traffic safety improvement	Bicycle lane	Improve ped crossings	Bicycle lane	Bicycle lane
Second-ranked traffic safety improvement	Slow drivers/improve behavior	Bicycle lane	Improve ped crossings	Improve ped crossings
% not requesting traffic safety improvement	33	28	38	42

Average ped injuries	3	0	3	1
Average bike injuries	2	0	1	0
Visit Frequency Components				
% Visit usually or all the time	74	89	78	78
Top-ranked visit more improvement	More ped amenities	Shopping/ dining options	More ped amenities	Shopping/ dining options
Second-ranked visit more improvement	More sidewalk lighting	Art/ beautification	Shopping /dining	More trees & plants
% not requesting visit more improvement	38	29	33	41
Street tree coverage	Regular	Regular	Regular	Regular
Bike lane present	No	No	No	No
Average number of crosswalks/intersection	3	3	3	3
Average median presence	Half the blocks	All blocks	All blocks	All blocks
Comparison with Policy Analysis				
Total number of elements covered by City's plans	31	20	21	20

Santa Monica Boulevard

Table and Table display information about the Santa Monica Boulevard survey areas. There was a significant difference ($p \leq 0.01$) between areas regarding requesting improved pedestrian crossings for traffic safety. Seven of the nine survey areas ranked improved pedestrian crossings as one of the top two requested traffic safety improvements. This is likely related to the significant difference ($p \leq 0.01$) between areas in terms of safety walking along and across the street, as whether respondents requested improved pedestrian crossings was significantly related ($p \leq 0.05$) to how safe they felt walking along and across the street.. Requesting improved pedestrian crossings was not related to arrival mode, but was slightly significantly related ($p \leq 0.10$) to usual travel mode.

A bicycle lane to improve traffic safety was one of the top two requests for six of the nine survey areas. In this case, however, there was no significant difference between areas—even though perceptions of safety while bicycling did significantly differ ($p \leq 0.01$) between survey areas. Requests for bicycle lanes were significantly related ($p \leq 0.0001$) to arrival mode, usual mode, and perceptions of safety while bicycling along and across Santa Monica Boulevard.

For Santa Monica Boulevard, there was a significant difference ($p \leq 0.05$) between areas regarding the likelihood of walking or bicycling more when one visits. There were also significant differences between the areas when respondents were queried about their likelihoods of walking or bicycling more given more of certain design elements. The following elements were significantly related to area, suggesting that some areas might see a greater effect from the addition of these elements:

- Shade trees
- Sidewalk lighting

- Sidewalk landscaping
- Widened curb extensions
- Bicycle parking
- Outdoor seating areas

Regarding design improvements that could encourage more visits, there is a significant correlation ($p \leq 0.01$) to how often someone visits, which represents the fact that those who visit occasionally or fairly often have the most suggestions for increasing visit frequency. There is a slight significant correlation ($p \leq 0.05$) between requesting design improvements to encourage more visits and arrival mode, which seems to reflect that a greater percentage of public transit users requested an improvement than those of other groups.

Table . Traffic Safety & Visit Frequency Comparison – Santa Monica Boulevard Areas 1-4

	Cole n=72	Fairfax n=43	Gardner n=63	Gower n=63
Arrival Mode				
% Arrive on foot	35	16	32	35
% Arrive by bike	4	-	5	2
% Arrive by transit	22	72	29	24
Traffic Safety Components				
% somewhat or very safe walking across street	59	40	76	29
% somewhat or very safe biking across street	9	9	15	16
% somewhat or very safe walking along street	86	93	94	71
% somewhat or very safe biking along street	3	7	7	14
Top-ranked traffic safety improvement	(tie) Improve ped crossings	(tie) Improve ped crossings	Improve ped crossings	Road maintenance
Second-ranked traffic safety improvement	(tie) Slow drivers	(tie) Bike lane	Bike lane	Bike lane
% not requesting traffic safety improvement	46	42	33	49
Average ped injuries	8	14	1	1
Average bike injuries	4	1	0	3
Visit Frequency Components				

% Visit usually or all the time	68	81	68	71
Top-ranked visit more improvement	(tie) Bike lane	Cleaner street/area	Cleaner street/area	Road/sidewalk maintenance
Second-ranked visit more improvement	(tie) Landscaping & parks	(tie) Increase/improve parking; landscaping & parks	Landscaping & parks	Cleaner street/area
% not requesting visit more improvement	38	29	33	41
Street tree coverage	Sporadic	Regular	Regular	Sporadic
Bike lane present	No	No	No	No
Average number of crosswalks/intersection	4	3	2	1
Average median presence	No blocks	All blocks	Half the blocks	Half the blocks
Comparison with Policy Analysis				
Total number of elements covered by City's plans	15	30	30	15

Table . Traffic Safety & Visit Frequency Comparison – Santa Monica Boulevard Areas 5-9

	Harper n=89	La Brea n=74	San Vicente n=63	Van Ness n=55	Western n=45
Arrival Mode					
% Arrive on foot	58	26	29	35	29
% Arrive by bike	1	3	6	2	-
% Arrive by transit	11	31	40	55	53
Traffic Safety Components					
% somewhat or very safe walking across street	40	38	71	40	56
% somewhat or very safe biking across street	16	13	13	19	16
% somewhat or very safe walking along street	81	82	98	69	80
% somewhat or very safe biking along street	9	8	8	11	9
Top-ranked traffic safety improvement	Improve ped crossings	(tie) Bike lane	Bike lane	Improve ped crossings	Police/security
Second-ranked traffic safety improvement	Bike lane	(tie) More/wider lanes	Improve ped crossings	Road maintenance	(tie) Improve ped crossings; road maintenance
% not requesting traffic safety improvement	37	38	57	46	56
Average ped injuries	2	6	7	5	12
Average bike injuries	1	2	2	3	4
Visit Frequency Components					

% Visit usually or all the time	80	58	74	80	81
Top-ranked visit more improvement	Landscaping & parks	Cleaner street/area	(tie) Bike lanes/parking	Cleaner street/area	Cleaner street/area
Second-ranked visit more improvement	Entertainment options	More/better sidewalk lighting	(tie) Landscaping & parks	Public art/beautification/advertising	Police/security
% not requesting visit more improvement	51	43	79	42	49
Street tree coverage	Regular	Regular	Regular	Sporadic	Sporadic
Bike lane present	No	No	Yes	No	No
Average number of crosswalks/intersection	2	2	2	2	2
Average median presence	No blocks	No blocks	All blocks	Half the blocks	No blocks
Comparison with Policy Analysis					
Total number of elements covered by City's plans	30	30	30	15	15

Limitations

Some limitations of the survey methodology should be noted. First, drivers and transit users were intercepted on foot instead of in their mode of arrival. This means that they may have been reflecting their preferences as a pedestrian more than their preferences as a driver or transit user. Likewise, pedestrians and bicyclists may have different preferences as drivers and transit users than were reflected in their answers. There is no way to measure those possible differences from this data. In addition, respondents were all users who had stopped along the corridor for one reason or another. Transit users and drivers passing through the corridor without stopping were not intercepted and may have different preferences from those intercepted.

A second limitation to the survey is that the open-response questions did not give users a choice set from which to select responses. While this has the benefit of not leading the respondent to a certain answer, the disadvantage is that all users may not have the same knowledge or ideas about what street improvements are possible. A third limitation is that some items that could have been named to improve perceived traffic safety or encourage more visits, such as landscaping, may not have been named in other locations because they already existed along the area of San Pablo Avenue or Santa Monica Boulevard where the survey response was captured; in a different circumstance, different answers may have arisen. A comparison of the number of pedestrian and bicyclist elements covered by the City's plans and the percentage of percentage of respondents who felt safe or somewhat safe walking along the corridors appears to be positively related, indicating that policies pertaining to pedestrian and bicyclist facilities did influence the corridor design and thus the users responses.

Finally, several questions resulted in a percentage of respondents answering "nothing"—for example, that "nothing" could improve perceived traffic safety. This "nothing" is difficult to interpret, as it could mean that nothing could make it better because it is already great—or that nothing could possibly help such a terrible situation. Regardless of the possible interpretation, however, it is notable that only 14% of bicyclists along San Pablo Avenue and 20% of bicyclists

along Santa Monica Boulevard did not request any improvements for traffic safety, suggesting that there is a lot that could improve perceived bicycling traffic safety along the roadway. In fact, only one-third of all San Pablo Avenue respondents and 45% of Santa Monica Boulevard respondents had no suggestions for improving traffic safety, suggesting that this is an important subject area to be addressed in the future.

Discussion

The original intent of the survey was to provide a basis for testing the pedestrian and bicyclist mobility performance measures proposed in Chapter III of this report. The findings accomplish this goal, as explained in Section E. However, the survey has also informed the research about how the potential impacts of various design features varies by how one travels to and how often one visits the area by revealing how preferences vary among users of different modes.

The various analyses also revealed notable findings about strategies for corridor design. The most salient findings from the survey analysis included an alignment between all user groups (pedestrians, drivers, bicyclists, and transit users) about what would increase their perceptions of traffic safety along San Pablo Avenue and Santa Monica Boulevard. For San Pablo Avenue, all user groups listed the same top five suggestions, which included the installation of a bicycle lane (#1 for all groups except transit users), improved pedestrian crossings (e.g., flashing lights, longer crossing time, and reduced wait time to cross), slowed traffic and improved driver behavior, more traffic lights, and increased street lighting. There was also alignment for the Santa Monica Boulevard respondents, with pedestrians, drivers, and public transit users all requesting improved pedestrian crossings and bicycle lanes or improvements as the top two responses. Santa Monica Boulevard bicyclists requested bicycle lanes or improvements first, and improved pedestrian crossings sixth.

The alignment of these preferences suggests that all user groups may benefit from treatments traditionally considered mode-specific, such as bicycle lanes and improved pedestrian crossings. These design elements not only benefit drivers and transit users if and when they choose to bicycle and walk, but may also provide increased predictability while driving. While slowing traffic is often seen as detrimental to vehicular throughput, if the speed is kept constant such that drivers have less stopping and starting at lights, the throughput may not be adversely affected. In addition, slowed traffic clearly benefits all users by improving perceived and actual traffic safety when they walk—even if that walking is just to cross the street after having parked one’s car or alighting from a bus. These findings indicate that Caltrans may have the opportunity to focus its investment in a few key areas and potentially reap large dividends in terms of increased mobility and perceived safety for all users.

There was also alignment among all users regarding the types of design elements that would encourage them to visit the area more often. All San Pablo Avenue user groups ranked trees and landscaping in their top five choices, and three of the four user groups requested more street lighting, public art/beautification, and a cleaner area/more trash receptacles in their top five. For Santa Monica Boulevard, there was similar alignment, with all groups requesting a cleaner and better-maintained roadway and sidewalk. Three of the four groups also requested more landscaping and park areas along the corridor. While this category had a bit more diversity among group preferences for both corridors, for example, bicyclists specifically requested a bicycle lane and transit users specifically requested increased seating, the alignment of many of

the preferences present yet another opportunity to create a more desirable street setting by focusing efforts on a few design elements.

The survey analysis also suggested that economic vitality is created by the complex interaction of many elements. It was clear from the survey responses that shopping and dining were the activities that respondents did the most and liked the best about San Pablo Avenue and Santa Monica Boulevard. Conversely, perceptions of crime, dirtiness, and high amounts of auto traffic were the things that respondents liked the least about the two areas. Thus, the role of street design in encouraging vitality is nuanced: street design seems to be the mortar that can hold crucial elements of economic vitality together, rather than the building blocks for economic vitality themselves. For example, design elements such as landscaping and street trees can encourage users to visit an area more often, but without the shops and restaurants to attract the users, these street design elements will be limited in their attraction. Similarly, street and sidewalk lighting can increase perceptions of personal security, but without thriving businesses to produce “eyes on the street” and accessible police services, street and sidewalk lights will be limited in their efficacy.

Future research could survey people who could use the corridor but do not (e.g. residents in the surrounding neighborhoods) to identify the leading improvements that could be made to encourage visits to the corridor.

Conclusions & Recommendations

The goal of developing and testing performance measure 1.2 (the percentage of Californians who feel safe using non-motorized modes on urban arterials) was accomplished by assessing perceptions of safety by: (1) demonstrating there is variation in perceptions of safety by intercept location; and (2) providing a baseline measure that can be used for a benchmark with the deterioration or improvement of features. The findings also indicate that at these study sites many pedestrians do not feel safe crossing the street and of those that bike, many do not feel safe crossing the street. The research also confirmed that visitors to these corridors want features and facilities supportive of active transportation. This finding was consistent in both study areas. Specifically, all users requested:

- bicycle lanes;
- improved pedestrian crossings;
- improved driver behavior; and
- street lighting.

In addition, elements associated with pleasure and comfort can encourage more frequent visits to the corridor. Specific requests included:

- trees,
- landscaping,

- street lighting,
- public art and beautification, and
- cleanliness.

Caltrans may focus its efforts on improving design elements that benefit all users by increasing perceptions of traffic safety on the corridor and encouraging users to visit the corridor more often, thus improving economic vitality. The results presented can serve as a baseline for continued monitoring of efforts focused on traffic safety, mobility, and economic vitality. Future research should also consider objective measures of economic vitality and the perceptions and preferences of those who live in the neighborhoods surrounding the corridor and roadway users who travel through but do not visit the corridor.

E. Performance Measures Analysis

This section describes the analysis and corresponding results of testing the proposed performance measures for validity and ease of application. Validity was determined differently for the various performance measures. For measures that examine relationships between design elements and safety (e.g., measures 1.3a-d), validity was assessed by whether or not the measurement proved significantly related to pedestrian or driver safety in the crash models. For measures that examine quantities of incidents (e.g., measures 1.1a-b and 1.4a-b) and concepts, validity was determined by whether or not that quantity made sense as the selected measurement of the subject area. Statistically significant results from the pedestrian and bicyclist intercept survey were also used to validate some of the proposed measures. Ease of application was determined after evaluating the amount of time and effort the task took the research team to complete.

It should be noted that one cannot compare the validity of the various measures without the context of the data that needs to be measured. For example, multivariate regression models tend to look at the impact of various independent, or predictor, variables on a dependent variable. This type of data testing works well when there is enough information (usually, a sample of at least 100 observations) about all of the independent variables to be able to test their effects on the dependent variable without a high risk of bias. In this case, a regression model was used to test pedestrian, bicyclist and driver safety, as there was a lot of information about the independent variables and there were several hundred observations of pedestrian, bicyclist, and driver crashes assigned to the 250 intersections of the two corridors.

A regression model could not be constructed to test relationships between some of the other variables, such as that between perceived safety and roadside design features, because surveys were conducted in only eight locations along the San Pablo Avenue corridor and nine locations along the Santa Monica Boulevard corridor. This small sample size (17 locations) means that there is not enough variability in the roadside design features to ensure that the results would not be biased in some serious way. In this case, statistical significance was examined through a test known as the Kruskal-Wallis test, which compares how various groups (e.g., bicyclists, pedestrians, drivers, transit users) ranked or chose different variables. If there was a notable difference in the way these groups chose or ranked the variables, the test was deemed significant; else, it was not.

Findings

This section elaborates on the findings regarding the validity and ease of application of the pedestrian safety-related performance measures proposed in Phase II of the project.

CGS Performance Measures 1.1a - 1.1d: Rates of Injury and Fatality

The guiding objective for performance measures 1.1a and 1.1b was modeled after Caltrans' objective for vehicular safety:

By 20XX, reduce the annual pedestrian and bicycle injury and fatality *rates to the following levels, and continuously reduce annually thereafter with the goal of having the lowest rates in the nation.

- **Pedestrian fatality rate target: X per X walking trips.**
- **Pedestrian injury rate target: X per X walking trips.**
- **Bicyclist fatality rate target: X per X bicycling trips.**

– Bicyclist injury rate target: X per X bicycling trips.

*Rates not set due to the need to establish a baseline number.

It is well-established that accounting for exposure is the most accurate way to assess pedestrian risk (Jacobsen 2003; Raford and Ragland 2005). Measuring the number of crashes without accounting for exposure could give the impression that a reduction in crashes is due to safer behavior on the roadway, when in reality, the number of pedestrians could be declining. Similarly, measuring only overall numbers may give the impression that an intersection with zero crashes is very safe, when in reality it could be so unsafe that no one dare cross it. Both of these scenarios reinforce the need to measure incidence rate, rather than a cumulative incident number, to accurately gauge pedestrian risk. However, gathering pedestrian volumes is a task that has not been historically performed by State transportation agencies, so pedestrian safety may or may not be measured through other ways. For example, Caltrans currently measures combined traveler safety: pedestrian and bicycle fatalities are combined with vehicle fatalities, and then divided by 100 million VMT in order to gauge the rate of collisions on state highways (including those that run through cities as urban arterials) (California DOT 2007). Whether there were 10 or 1,000 pedestrian fatalities, the actual picture of pedestrian safety would be unclear due to having been combined with other modes.

Proposed CGS performance measures 1.1a (*number of pedestrian fatalities per x walking trips*) and 1.1b (*number of pedestrian injuries per x walking trips*) have the potential to provide a much more specific and accurate picture of the risk pedestrians face on the roadway. To “test” these measures, the overall number of pedestrian injuries and fatalities were compared to the rate of injuries and fatalities per intersection crossings (a proxy for pedestrian trips). As shown in Figure and Figure , intersections with the same number of pedestrian incidents can have dramatically different crash rates. In this case, a person crossing the intersection with the highest rate has almost five times as much risk of being hit as a person crossing the intersection with the lowest rate. This demonstrates that a reliance on total numbers could wrongly suggest that certain intersections are safer or more dangerous than they actually are. For this dataset, fatalities and injuries were combined due to a low number of fatalities. Likewise, if Caltrans were to measure individual corridors in the future, performance measure 1.1a may be modified to measure both fatalities and injuries. However, in the case of a system-wide evaluation, it is recommended that separate performance measures be evaluated for pedestrian injuries and fatalities, in order to fully understand the level of each type of risk to pedestrians.

Figure . Rate of Pedestrian Fatalities & Injuries (per weekly pedestrian crossing) at San

Pablo Avenue Intersections With Identical Fatality and Injury Counts, 1997-2007

Figure . Rate of Pedestrian Fatalities & Injuries (per weekly crossings) at Santa Monica Boulevard Intersections with Identical Fatality and Injury Counts, 2001- 2010

Proposed CGS performance measures 1.1c (*number of bicyclist fatalities per x bicycling trips*) and 1.1d (*number of bicyclist injuries per x bicycle trips*) have the potential to provide a much more specific and accurate picture of the risk bicyclists face on the roadway. Similar to the pedestrian injury and fatality rates, to “test” these measures, the overall number of bicyclist injuries and fatalities were compared to the rate of injuries and fatalities per number of bicycle intersection crossings (a proxy for bicycle trips). Figure shows the bicyclist injury and fatality rate per bike intersection crossing for several intersections with the same fatality and injury counts for bicyclists along Santa Monica Boulevard. As Figure shows, intersections with the same number of bicyclist injuries and fatalities can have different rates. The intersection with the highest rate of bicyclist injuries and fatalities per bicyclist volume had a rate almost two times that of the lowest rate for intersections with a total of three bicyclist injuries or fatalities during the ten year period.

Figure . Rate of Bicyclist Injuries & Fatalities at Santa Monica Boulevard Intersections with Identical Fatality and Injury Counts, 2001- 2010

PM 1.1a, 1.1b, 1.1c, & 1.1d Conclusions

Validity: The proposed performance measures evaluate the intended quantity, and are the most accurate measures for the subject area.

Ease of Application: The research team concluded that the ease of application for this performance measure is reasonably high. The data needed for these performance measures includes: 1) the number of incidents in the system, and 2) the corresponding number of pedestrian trips (or a proxy, such as the number of pedestrian crossings per intersection). The challenges to obtaining this data are explained below.

- 1) The number of incidents on Caltrans’ roadways can be obtained through the CHP SWITRS database. The data must be filtered for pedestrian crashes and road type, and then separated by year and injury type before it can be summed; however, all of these functions can be done using readily available desktop software.
- 2) Pedestrian and bicyclist exposure data is difficult and expensive to gather, and is not currently routinely gathered by the State. However, Caltrans may work with local jurisdictions to use their counts (and influence future count locations). Additional efforts by other organizations may also help Caltrans gather this data. For example, UC Berkeley SafeTREC (Schneider) has developed a method to collect pedestrian and bicycle counts in a standardized way across the state. Also, ITE and Alta Planning + Design have been working since 2007 on a joint effort to encourage consistent, annual pedestrian and bicycle counts throughout California, which may be usable for these measures. Finally, the SHSP has identified a new objective to “develop a plan to collect pedestrian infrastructure and pedestrian volume data to be incorporated in the future into

the Caltrans Traffic Surveillance and Analysis System – Transportation Systems Network (TASAS-TSN).”

- 3) Pedestrian and bicyclist volume data can be generated from models. This project is currently testing the validity of using pedestrian count models in the place of on-the-ground pedestrian counts. Count models use geographic information and data from the U.S. Census to give estimates of pedestrian volumes that can be used as a proxy for actual exposure, facilitating the application of this performance measure. Additional bicycle counts are needed to validate a bicyclist model.

CGS Performance Measure 1.2: Perceptions of Safety

The guiding objective for performance measure 1.2 is:

By 20XX, establish a baseline of the percentage of Californians who feel safe using non-motorized modes on urban arterials. Annually increase this percentage with the goal of having the highest reported percentage in the nation.

The associated performance measure gauges the *Percentage of Californians who feel safe using non-motorized modes on urban arterials*. Table and Table use data from this project to demonstrate the value of this measure. There is a marked difference in the percent of people who report feeling safe walking as compared to bicycling on San Pablo Avenue and Santa Monica Boulevard. Without measuring this percentage, Caltrans will have no way of knowing whether these perceptions of safety are improving or deteriorating, and will not be able to fully estimate the benefits of its investments in pedestrian and bicycle infrastructure.

Table . Survey Respondents’ Perceptions of Safety Walking and Bicycling along San Pablo Avenue

	Very safe	Somewhat safe	Neutral	Somewhat unsafe	Very unsafe	N/A or Don’t know
When walking on the sidewalk	57%	25%	10%	4%	2%	2%
When walking across the street	28%	20%	25%	15%	10%	2%
When bicycling on the roadway	4%	5%	9%	12%	15%	53%
When bicycling across the street	7%	8%	12%	10%	8%	52%

Table . Survey Respondents’ Perceptions of Safety Walking and Bicycling along Santa Monica Boulevard

	Very safe	Somewhat safe	Neutral	Somewhat unsafe	Very unsafe	N/A or Don’t know

When walking on the sidewalk	46%	37%	11%	2%	1%	3%
When walking across the street	21%	29%	27%	14%	6%	3%
When bicycling on the roadway	4%	5%	16%	19%	17%	39%
When bicycling across the street	7%	7%	22%	16%	10%	38%

PM 1.2 Conclusions

Validity: The proposed performance measure evaluates the intended quantity, and is the most accurate measure for the subject area.

Ease of Application: The research team concluded that the ease of application for this performance measure is reasonably high. Although this subject area is not something Caltrans has monitored in the past, it is something that can be asked on the annual External Customer Survey without adding substantial analysis or data gathering burden.

CGS Performance Measures 1.3a - 1.3d: Complete Streets

The guiding objective for performance measures 1.3a – 1.3d is:

By 20XX, all Caltrans urban arterial projects (new expenditures) are designed to increase safety for non-motorized users in accordance with Complete Streets principles. Ensure that each new and retrofit urban arterial project incorporates Complete Streets principles annually thereafter, with the goal of thorough Complete Streets influence over time.

The core of this objective, “accordance with Complete Streets principles,” refers to the Complete Streets goal of providing “safe mobility for all users” (Caltrans 2008). While “safe mobility” may be simple enough to imagine, developing a succinct, practical performance measure for the concept has proven more difficult. Based on research showing the effect of vehicle speed and various street design treatments on pedestrian safety, the research team developed four performance measures to capture the essence of the objective (Godfrey and Mazzella 2000; King 2000; Huang and Cynecki 2001; Knoblauch, Nitzburg et al. 2001; Eccles, Tao et al. 2004; Rousseau, Miller Tucker et al. 2004; Abdelghany 2005; Dumbaugh 2005; Zegeer, Stewart et al. 2005; Fitzpatrick, Turner et al. 2006; Ragland and Mitman 2007).

Measures, 1.3a and b, pertains to the *percent of signalized intersections along urban arterials with marked crosswalks and one or more of the following: countdown signals, leading pedestrian intervals, bulb-outs, or pedestrian refuge islands; and percent of unsignalized 4-way (multilane) intersections along urban arterials with marked crosswalks and one or more of the following: HAWK signal*, yield to pedestrian signage, user-activated overhead warning lights.* HAWK signals are not currently allowed in California, so the effectiveness of this part of the

measure could not be tested. In addition, there are no user-activated overhead warning lights or leading pedestrian intervals along either of the study corridors. San Pablo Avenue did not have any bulb-outs, however, Santa Monica Boulevard had several. Only 10% of San Pablo Avenue intersections have a pedestrian countdown signal or yield to pedestrian signage. Forty-nine percent of Santa Monica Boulevard intersections have one or more pedestrian feature (15% of all intersections are unsignalized with pedestrian features and 34% of all intersections are signalized with pedestrian features). Counter to expectation, this measure demonstrated a positive association with pedestrian injury and fatality when tested on Santa Monica Boulevard. It is possible that these countermeasures are installed where there is a crash history or particularly high volumes that remain problematic. Perhaps at these locations with additional pedestrian features, roadway users behave differently (e.g. more violations due to increased sense of safety or additional restrictions).

*HAWK signal stands for a High-intensity Activated crossWalk signal that allows pedestrians to trigger a modified signal head to turn from no light to yellow to red in order to get drivers to legally stop.

PM 1.3a and b Conclusions

Validity: This performance measure needs further validation before it can be recommended.

Ease of Application: Given that the measure may be modified significantly from its current state, a formal evaluation of the ease of application is not possible at this time. It is likely that the measure will require a large amount of data collection to isolate the effect of specific pedestrian features, which will then be able to be maintained with minimal effort. However, given the high resolution and widespread availability of aerial images from sources like Google Streetview™, the data collection will not necessarily be too taxing to obtain.

The third measure for this objective pertains to *the percent of urban arterial intersections with one or more of the following improvements geared toward bicyclists: bike box, painted bicycle lane through the intersection, bicycle signal, functioning bicycle loop detectors, bicycle left turn lane*. Because San Pablo Avenue had none of these features, the performance measure was unable to be tested on San Pablo Avenue. The performance measure was tested on Santa Monica Boulevard but was not found to have a significant association with the bike injury and fatality rate in either the bivariate analysis or the final model. However, bike features were only present on a small portion of the Santa Monica Boulevard corridor. The performance measure should be further tested on a corridor with more abundant features.

PM 1.3c Conclusions

Validity: This performance measure needs further testing before it can be recommended for implementation.

Ease of Application: Given that the measure may be modified significantly from its current state, a formal evaluation of the ease of application is not possible at this time. It is likely that the measure will require a large amount of data collection in the beginning, which will then be able to be maintained with minimal effort. However, given the high resolution and widespread availability of aerial images from sources like Google Streetview™, the data collection will not necessarily be too taxing to obtain.

The fourth measure, *percent of urban arterials that do not have a posted speed greater than 25 mph*, is based on research showing the non-linear relationship between risk of injury or death and vehicle speed (Leaf and Preusser 1999). This research indicates that pedestrians have a less than 60% chance of surviving with a non-incapacitating injury when hit by a car traveling at 30 mph, and the risk increases non-linearly as speeds rise. Unfortunately for both the research and pedestrians along San Pablo Avenue and Santa Monica Boulevard, no sections of the corridor were applicable for this performance measure, so it was unable to be tested. This is due to a posted speed limit of between 30 and 35 mph throughout the corridor, which influenced the average speed and the 85th percentile speed on both corridors. While it may seem that a measure seeking speeds around 25 mph does not fit a corridor with a 30 mph speed limit, it is precisely the danger to pedestrians from the average and 85th percentile speeds that necessitates some kind of acknowledgement of the risk inherent in the corridor's design speed.

PM 1.3d Conclusions

Validity: This performance measure must be evaluated on a separate corridor before it can be recommended.

Ease of Application: The data needed for this performance measure is available through engineering documents justifying changes to Caltrans corridors, thus enabling implementation of the measure.

CGS Performance Measures 1.4a - b: Hotspots

The final performance measure for pedestrian and bicyclist safety is guided by the objective:

By 20XX, annually reduce the number of pedestrian and bicycle hotspots (high collision concentrations) on urban arterials.

PM 1.4a gauges the *overall number of pedestrian collision hotspots on urban arterials* as a way to ensure that high collision locations are specifically examined even when the location may have a lower rate of pedestrian collisions due to exposure. The same is true for PM 1.4b and bicyclists. This mirrors Caltrans' practice with motorized vehicles. This concept was "tested" for pedestrians through evaluation of incidence rate versus overall number of incidents, similar to PM 1.1a and 1.1b. In the San Pablo Avenue dataset, for example, the intersection with the 9th highest rate had the 3rd highest number of collisions. While the rate suggests that it should be a lower priority, it still merits attention given the total number of crashes.

PM 1.4a & 1.4 b Conclusions

Validity: The proposed performance measure evaluates the intended quantity and is the most appropriate measure for the subject area.

Ease of Application: The data needed for this performance measure is the SWITRS crash data – the same data needed for proposed performance measures 1.1a-b. The research team thus concludes that the ease of application for this performance measure is reasonably high.

CGS Performance Measures 2.1a - 2.1f: Pedestrian and Bicyclist Mobility

The guiding objective for these performance measures is:

By 20XX, all Caltrans urban arterial projects (new expenditures) are designed to increase mobility for non-motorized users in accordance with Complete Streets principles, aiming to link up to a larger community bicycle and pedestrian network where possible. Ensure that each new and retrofit urban arterial project incorporates Complete Streets principles annually thereafter, with the goal of thorough Complete Streets influence over time.

The first measure under this objective is PM 2.1a, *on urban arterials, ratio of sidewalk mileage to roadway mileage, bi-directionally*. Data from the pedestrian and bicyclist intercept surveys (Table and Table) show that over 90% of respondents felt at least “neutral” or “somewhat safe” while walking on the sidewalk along San Pablo Avenue and Santa Monica Boulevard. These findings suggest that this measure is on the right track for gauging the mobility of pedestrians along a corridor. However, since San Pablo Avenue and Santa Monica Boulevard have nearly 100% sidewalk coverage, this measure would be strengthened through further evaluation on a corridor that is lacking sidewalk coverage in places. Ideally, this comparison would come through a prospective design where data can be gathered before and after before sidewalks are installed.

PM 2.1a Conclusions

Validity: This performance measure seems valid, but should be further tested on a comparison corridor before it can be fully recommended.

Ease of Application: Given the strong research on which this measure was based, it is unlikely that it will change significantly from its current state. Therefore, a tentative evaluation of the ease of application may be appropriate. The data needed for this performance measure will have to be manually gathered through audits of the facilities themselves or the latest pertinent design plans. We estimate that this measure will be data-intensive in the beginning, as a database is set up to catalogue the presence of sidewalks on appropriate state facilities. However, ease of maintenance should be relatively high once the database has been set up, and analysis should follow easily from that point.

The second measure under this objective is PM 2.1b, *on urban arterials, ratio of Class II bicycle facility mileage to roadway mileage, bi-directionally*. This performance measure was tested on the Santa Monica Boulevard portion of the corridor that had bike lanes. As stated in the modeling section, the presence of a bicycle facility was not significant in the crash model, although this should be interpreted with caution since the bike lane along Santa Monica Boulevard was only a few blocks long, and therefore could not affect the majority of the corridor. Only one survey location (San Vicente) was located in an area with a bike lane, but the responses at this location were not significantly different from other locations: respondents all along the corridor requested bicycle lanes.

Data from the pedestrian and bicyclist intercept survey shows that people feel unsafe bicycling along San Pablo Avenue and Santa Monica Boulevard under current conditions (Table and Table). In addition, 63% of San Pablo Avenue survey respondents and 67% of Santa Monica Boulevard respondents who bicycled on the day of the survey named a bicycle lane as their top suggested traffic safety improvement, as shown in Table and Table . Thus, while this measure could be strengthened through a comparative evaluation with more data from a corridor with

bicycle lanes, the available data suggest that this measure is valid.

Table . San Pablo Avenue Bicyclists’ Top Suggested Traffic Safety Improvements

Improvement	Rank (#)	% of Responses
Bike Lane	1	63%
Street lights	2	10%
Improve Pedestrian Crossings	3	8%
Slow traffic/Improve Driver Behavior	4	6%
Traffic signals	5	4%
Landscaping	5	4%
Nothing		14%

Table . Santa Monica Boulevard Bicyclists’ Top Suggested Traffic Safety Improvements

Improvement	Rank (#)	% of Responses
Bike lane/improvements	1	67%
More/wider lanes	2	20%
Maintain/clean streets	3	13%
Public transit improvements	3	13%
Nothing		13%

PM 2.1b Conclusions

Validity: This performance measure seems valid, but would be strengthened through further testing on a comparison corridor before being fully recommended.

Ease of Application: Given the strong research on which this measure was based, it is unlikely that it will change significantly from its current state. Therefore, a tentative evaluation of the ease of application may be appropriate. The data needed for this performance measure will have to be manually gathered through audits of the facilities themselves or the latest pertinent design plans. We estimate that this measure will be data-intensive in the beginning, as a database is set up to catalogue the presence of Class II bicycle lanes on appropriate state facilities. However, ease of maintenance should be relatively high once the database has been set up, and analysis should follow easily from that point.

The third measure under this objective is PM 2.1c, *on urban arterials, percentage of intersections that are ADA compliant*. Caltrans is required by the Americans with Disabilities Act to retrofit its roadways to be ADA-compliant, so the appropriateness of this measure is not in question. In addition, we were able to measure this through the facility analysis, in which we found that the amount of compliance was relatively high overall, but much higher in some places along the corridor than others.

PM 2.1c Conclusions

Validity: This performance measure is valid and appropriate for the subject area.

Ease of Application: The data needed for this performance measure will have to be manually gathered through audits of the facilities themselves or the latest pertinent design plans. We estimate that this will be data-intensive at first, as a database is set up to catalogue the presence of various ADA intersection treatments on appropriate state facilities. However, ease of

maintenance should be relatively high once the database has been set up, and analysis should follow easily from that point.

The fourth measure under this objective is PM 2.1d, *percentage of urban arterial projects designed as Complete Streets*. This measure exists to ensure accountability for the continued design of relevant California roadways as complete streets. There was no aspect of this measure that could be tested for validity in the traditional sense, although the validity of creating a policy and enacting measures of accountability for the policy has long been recognized as a way to ensure that the policy is actually followed. Thus, we deem this measure to be valid and appropriate for the intended purpose.

PM 2.1d Conclusions

Validity: This performance measure is valid and appropriate for the subject area at this time.

Ease of Application: The data needed for this performance measure will have to be manually gathered through audits of new design plans. We estimate that this will create some extra work in the beginning, as an initial database is established, but that, given the overall number of applicable plans, it is not likely to be too data-intensive. The ease of maintenance should be high once the database has been set up, and analysis should follow easily from that point.

The fifth and sixth measures under this objective are PM 2.1e, *number of pedestrian trips on urban arterials*, and 2.1f, *number of bicycle trips on urban arterials*. The aim of these measures is to compliment PM 1.2, perceptions of safety, to ensure that perceptions of safety are not increasing along State arterials simply because fewer people are walking and bicycling (creating a potentially biased sample).

PM 2.1e & 2.1f Conclusions

Validity: The proposed performance measures evaluate the intended quantity, and are the most accurate measure for the subject area.

Ease of Application: The research team concluded that the ease of application for this performance measure is medium, as this is the same data needed for performance measures 1.1 a-d. The same challenges and opportunities explained in PM 1.1a-d exist for these measures.

CGS Performance Measures 4.1a - 4.1b: Environmental Stewardship

The guiding objective for these performance measures is:

By 20XX, all new and retrofit Caltrans urban arterial projects (new expenditures) are designed to minimize negative environmental impacts in accordance with Green Streets principles. Ensure that each new and retrofit urban arterial project incorporates Green Streets principles annually thereafter, with the goal of thorough Green Streets influence on all urban arterials over time.

This objective aims to expand Caltrans' current definition of environmental stewardship to be more inclusive of the environmental impacts of road design and vehicular travel. Thus, the measures under this objective focus on "green street" principles of stormwater infiltration and air pollution interception as ways to reduce the negative impacts of roadway design and travel.

The first measure under this objective is PM 4.1a, *ratio of pervious to impervious surfaces on*

Caltrans urban arterials, including medians, buffer strips, and tree wells. This measure aims to understand the water infiltration potential of State roadways, and to encourage design with greater infiltration potential over time. The second measure under this objective is PM 4.1b, *percent of urban arterial lane mileage with tree canopy coverage.* While street trees have numerous walkability benefits, this measure aims to understand the air pollution interception potential of State roadways, and to encourage design with greater air pollution interception potential in the future.

PM 4.1a & 4.1b Conclusions

Validity: These performance measures are valid and appropriate for the subject area, although more research should be conducted to set the appropriate target.

Ease of Application: The data needed for this performance measure will have to be manually gathered through audits of the facilities themselves or the latest pertinent design plans. It is possible that this process could be eased through choosing a random sample of street segments to represent the system. We estimate that this measure will be data-intensive in the beginning, as a database is set up to catalogue the ratio of pervious to impervious surfaces and the presence of street trees on appropriate state facilities (although this would be significantly eased if the sample method is used). Ease of maintenance should be medium high once the database has been set up, although updating of street trees may need a bit more effort. Analysis should follow easily once the database has been populated.

CGS Performance Measures 4.2a – 4.2b: Non-Motorized Facility Quality

The guiding objective for these performance measures is:

By 20XX, all Caltrans urban arterials meet a baseline for non-motorized facility quality.

This objective also aims to expand the definition of environmental stewardship, this time to ensure that non-motorized modes have equal opportunity to travel along State arterials with motorized vehicles. The measures under this objective are PM 4.2a, *percent of urban arterial sidewalk mileage in fair or better condition,* and PM 4.2b, *percent of urban arterial bicycle lane mileage in fair or better condition.* There were no specific tests for these measures, as they simply measure the presence of facilities (and corresponding opportunities for non-motorized travel).

PM 4.2a & 4.2b Conclusions

Validity: These performance measures are valid and appropriate for the subject area.

Ease of Application: The data needed for this performance measure will have to be manually gathered through audits of the facilities themselves or the latest pertinent design plans. We estimate that this measure will be data-intensive in the beginning, as a database is set up to catalogue the ratio of sidewalks and bicycle lanes in “fair or better condition” to roadway mileage. One of the more difficult parts will be judging “fair or better condition”, although the guidelines given by the Oregon DOT (outlined in the Phase II Performance Measures report) seem to work fairly well, and require a simple formula (easily set up in a spreadsheet) to work. Ease of maintenance should be medium high once the database has been set up, although updating the conditions of sidewalks and bicycle lanes may need a bit more effort. One way to ease the data burden is to select sample segments to represent the street population as a whole.

Analysis should follow easily once the database has been populated.

CGS Performance Measures 5.1a - 5.1b: Advanced Training for Personnel

The guiding objective for these performance measures is:

Annually increase the number of Caltrans management, design, and maintenance personnel trained regarding Complete Streets principles and Green Streets principles.

Both of the performance measures for this objective pertain to employee training opportunities. The first is PM 5.1a, *number of personnel trained in Complete Streets principles*, and the second is PM 5.1b, *number of personnel trained in Green Streets principles*. These measures will not be able to be tested until they are implemented, but seem intuitively valid. Providing employees the opportunities to learn more about the various types of design they will be expected to create seems a natural way to simultaneously increase employees’ skill sets and reinforce the other measures described in this chapter.

PM 5.1a & 5.1b Conclusions

Validity: These performance measures seem valid and appropriate for the subject area.

Ease of Application: The data needed for this performance measure will have to be manually gathered through employee reviews or an employee survey. This may be somewhat data intensive in the beginning, as a database cataloguing training is set up, but the data should be relatively easy to maintain and analyze once the initial work has been done.

Conclusions

This chapter elaborated on the findings from the field-tests for the *Complete, Green Streets Performance Measures Framework* proposed to provide Caltrans with the measures needed to monitor pedestrian and bicyclist safety and the environmental health of its urban arterials. The findings of the Phase III and IV field tests, summarized in Table , suggest that several of the performance measures developed after Phase I and II of the project adequately measure the intended qualities, and should be retained for future use. However, there are a few measures that should be further tested and potentially revised before being recommended for use by Caltrans.

Table . Relative Validity and Ease of Application of Proposed Performance Measures

	Ease of Application
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		Low (Requires adjustment before Caltrans can implement)	Moderate (Moderately easy for Caltrans to implement. Potentially data intensive)	High (Relatively easy for Caltrans to implement)
Validity	High (Determined to be valid based on field testing)		<ul style="list-style-type: none"> • PM 1.1a-b: Rate of pedestrian injuries & fatalities • PM 1.1c-d: Rate of bicyclist injuries & fatalities • PM 2.1a-b: Ratio of sidewalk and bicycle lane mileage to arterial centerline mileage • PM 2.1c: Percent of ADA-compliant intersections • PM 2.1e-f: Number of pedestrian & bicycle trips • PM 4.2a-b: Percent of sidewalk and bike lane mileage in fair or better condition • PM 5.1a-b: Employee training for Complete & Green Streets 	<ul style="list-style-type: none"> • PM 1.2: Perceptions of safety • PM 1.4a-b: Pedestrian & bicyclist hotspots • PM 2.1d: Percent of complete street projects
	Low (Requires adjustment to validate)		<ul style="list-style-type: none"> • PM 4.1a: Pervious to impervious surface ratio • PM 4.1b: Percent of tree canopy coverage 	
	Unknown (Based on field test, cannot validate w/o additional)		<ul style="list-style-type: none"> • PM 1.3a-b: Intersection design for pedestrians • PM 1.3c: Intersection design for bicyclists 	<ul style="list-style-type: none"> • PM 1.3d: Complete Streets (posted speed limit)

	validate w/o additional testing)			
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As Table shows, only a few of the proposed performance measures fall into the optimal ‘High Validity’ & ‘High Ease of Application’ category. None of the measures are designated ‘Low Validity’ at this time, but several do require additional testing before they can be recommended for use by Caltrans. This finding speaks to the difficulty of developing performance measures based cutting-edge research and best practices—in this case, some of the recommended treatments were not present in high enough quantities on the test corridor to adequately evaluate their impact. These findings also emphasize the value of conducting even small-scale field-testing of proposed performance measures, through providing the opportunity for critical feedback on the validity and implementation potential of the measures.

Some of the proposed performance measures may also benefit from modifications aimed at improving their ease of implementation. As noted in the measures’ descriptions, there are ways to ease the implementation of some of the proposed performance measures as they currently exist. Caltrans can continue to fund research that develops tools to facilitate data gathering for all types of analysis. This could include, for example, improved pedestrian count models and databases of critical street design information (e.g., width of sidewalks, presence of crosswalks, etc.). Such work could be carried out through existing partnerships with University Transportation Centers. In addition, Caltrans can make use of community volunteers and advocacy groups who may be willing to gather the information needed to evaluate aspects of safety and mobility. For example, volunteers were used to gather the data necessary to develop the pedestrian count model used in this paper (Schneider, Arnold et al. 2009). While the research team has an opinion about the “relative ease of application” of the proposed performance measures, the final judgment belongs to the Caltrans employees who will be performing the analysis in the future.

Field-testing the proposed performance measures has been a critical step in the development of Caltrans’ *Complete, Green Streets Performance Measures Framework for Urban Arterials*. Field tests revealed that performance measures based on the latest research vary in their ease of implementation and potentially in their validity. While this is not a shocking finding, some organizations may wish to develop performance measures without expending the time or costs associated with field tests. It is possible, as was the case with this project, that it may prove difficult to field-test some of the metrics, or that parts of the metrics may need adjustment. While this may be discovered early, particularly with issues related to ease of implementation, it may also be some time before issues are identified and performance measures are revised or discarded. This phase of the project demonstrates that relatively small-scale field tests can contribute significantly to the development of performance measures that are valid and easy to apply in practice.

V. Conclusions and Next Steps

This chapter summarizes the results of the four study phases and describes future research and next steps for Caltrans.

Conclusions

The research findings presented in this report reflect a multiyear effort to develop and test performance measures for evaluating the impacts of transportation corridor design features, such as landscaping and pedestrian and bicyclist facilities, on the safety, mobility and economic vitality of Caltrans' urban arterial network. This is one of the first studies to explore the impact of these features on non-motorized modes of transportation and on community economic vitality.

The research project began with a comprehensive literature review of studies regarding the effects of roadside design features on pedestrian, bicyclist, and driver behavior and safety; pedestrian and bicyclist mobility; environmental quality; and community economic vitality. These findings formed the basic platform upon which the performance measures were built. The performance measures were developed after a comprehensive literature review of related research and best practices in performance measurement, as well as a thorough examination of Caltrans' current performance measurement system, to ensure that the proposed measures would fit well with the Caltrans culture and way of business. However, as the Performance Measures Evaluation in Chapter IV showed, performance measures must be field-tested in order to assess their validity. Working with extensive facility and survey data from the test corridors San Pablo Avenue in the eastern San Francisco Bay Area and Santa Monica Boulevard in the Los Angeles area, the research team had the opportunity to field-test the proposed performance measures, with good results. Of the 23 proposed measures, 19 were deemed valid and 4 were determined to need further testing because they were unable to be tested due to lack of presence and variety in the study corridors. This suggests that Caltrans can confidently move forward and begin setting targets for the bulk of the proposed performance measures, strengthening its commitment to multimodal mobility, safety, and complete streets.

The various analyses also revealed notable findings about strategies for corridor design. The most salient findings from the survey analysis included an alignment between all user groups (pedestrians, drivers, bicyclists, and transit users) about what would increase their perceptions of traffic safety along San Pablo Avenue and Santa Monica Boulevard. All user groups showed a general agreement on the desire for more bicycle lanes and improved pedestrian crossings. There was also general agreement on the desire for more landscaping, beautification, cleanliness, and maintenance. Based on these findings, Caltrans has the opportunity to benefit all users and communities by focusing its resources in a few select areas such as bicycle lanes, improved pedestrian crossings, and landscaping.

The survey analysis also suggested that a community's economic vitality is created by the complex interaction of many highway corridor elements. Urban arterials that include design features such as street trees, landscaping, street lighting, bike lanes, trash receptacles, public art, and other beautification measures attract all user groups (drivers, pedestrians, bicyclists, and transit users) to the area, contributing to improved economic vitality along the corridor. Clean well-maintained roadways and sidewalks were also found to attract all user groups to visit urban

arterial corridors and further improve economic vitality.

Users of these corridors all expressed a desire for pedestrian and bicycle facility improvements. However, a better understanding of perceptions is required for users of the corridor who use this as a travel arterial rather than making stops along the corridor.

Findings from the policy analysis suggested that policies and plans such as general plans and transportation plans do affect the design of the roadway corridor to the benefit or detriment of users. Although many of the plans reviewed were fairly new and have not necessarily had time to affect change, it was clear that the longer term plans that addressed walkability and bikability had led to more walkable and bikable city environments. To affect the design of the built environment, Caltrans policies and guidance must address requirements for bicycle and pedestrian improvements.

Finally, the safety analyses suggest that user safety is also a complicated concept to measure in certain environments. The mix of factors that affect roadway safety on an urban arterial is complex and it is difficult to isolate the effects of specific corridor features. Some features may create a false sense of safety and change behavior for some users. This may be mitigated by careful placement of features so that critical views of intersections are preserved. Increases in pedestrian, bicyclist, and vehicle volume can affect safety as well. Although the survey analysis revealed that features do attract users to the corridors and improved perceptions of safety, Caltrans must continue striving to make the corridors truly safer in addition to attracting users.

As expected, pedestrian safety was found to be associated with some variables such as pedestrian and motor vehicle traffic volume on San Pablo Avenue and on Santa Monica Boulevard. This also indicates that better measures of volume are needed because the volumes reflected in the crash models may not have captured all true fluctuations throughout the corridor. Safety was not found to be associated with some of the pedestrian countermeasure land use variables such as ADA curb ramps and enhanced crosswalks established in previous research identified in the literature review. This may have been due to a different study approach or manner of measurement, a lack of variability and presence of important features along the corridor, or additional unknown factors.

Similarly, the driver safety analysis followed some expectations based on findings from previous studies, but also revealed that there may be additional, previously unstudied roadway design features that could affect driver safety and behavior. For example, on both study corridors the percent of ADA-accessible corners at each intersection is associated with an increase in driver crashes. It may be that these features are associated with pedestrian volume and land use. These relationships should be interpreted with caution.

Next Steps

The findings of this study point to several actions that may be implemented to improve the safety, mobility, and economic vitality of highway corridors. Although additional research and data collection is needed in some areas, the study findings support Caltrans Deputy Directive DD-64-R1 Complete Streets to improve safety, access, and mobility for all travelers in California while recognizing bicycle, pedestrian, and transit modes as integral elements of the

transportation system. Caltrans' implementation of Complete Streets is intended to result in more options for people to go from one place to another, produce less traffic congestion and greenhouse gas emissions, and provide more walkable communities (with healthier, more active people) that have fewer barriers for older adults, children, and people with disabilities. To reach these intended results, Complete Streets implementation efforts should include installing bicycle lanes, improving pedestrian crossings, installing traffic calming measures, adding more traffic lights, and additional street lighting.

The economic vitality of portions of San Pablo Avenue and Santa Monica Boulevard was shown to be associated with a vibrant transportation corridor that includes design features such as street trees, landscaping, street lighting, trash receptacles, outdoor seating, public art and other beautification measures. Implementing these types of corridor features in improvement projects along other conventional highways should likewise attract users and improve community economic vitality along the corridor.

Several of the proposed performance measures concerning pedestrian and bicycle safety requires the collection of pedestrian and bicyclist volumes, accident rates, and exposure data. The collection of this data is currently not part of Caltrans standard practices. Caltrans should begin to use the capabilities of their existing data collection processes, such as SWITRS, to collect pedestrian and bicyclist data and also develop and implement new data collection processes as necessary to implement these performance measures.

Further Research

This research provides Caltrans with some of the tools needed to improve multi-modality on State right-of-ways. In addition, although the research and proposals documented in this report were created for Caltrans, the information provided, particularly the performance measures and their rationale, will be useful for state highway departments across the United States and similar agencies elsewhere.

This research revealed the complexity in evaluating complete streets and landscape design elements of a highway corridor. To further encourage complete streets projects, Caltrans should develop an evaluation protocol to be used to measure the effectiveness of Complete Streets on mobility and safety for all modes. By creating a standardized system for measuring how Complete Streets impact attractiveness and safety of a corridor, effectiveness of the elements can be better tracked.

Research in this area could be furthered by: (1) developing and validating various composite measures; (2) improving measurements of pedestrian and bicycle exposure; and (3) observing pedestrian, driver, and bicycle behavior in the context of various design, facility, and countermeasure features. This information will assist in describing how roadway users respond in places: (1) with higher volumes; (2) with additional accommodations for mobility of all roadway users; (3) that potentially have an increased sense of safety; and (4) that impose additional constraints for reducing conflict.

In addition, it is important to understand the impact, if any, Complete Streets has on the surrounding neighborhoods and community. For example, changes in an urban corridor could have positive impacts in air quality in a community. Or changes in an urban corridor could

disperse traffic-related problems.

Further Research: Highway 82 Longitudinal Study, San Jose

This report provides the findings of two cross-sectional studies, which show how variations in corridor features throughout the length of the corridor affect pedestrian, bicyclist, and driver mobility and safety. Conducting a longitudinal study, also known as a before-and-after study, will provide an opportunity to evaluate newly implemented changes on a corridor in terms of perceived and observed safety and mobility.

To support such a study in the future, “before” data were collected for a 1.5 mile long section of Highway 82, known as The Alameda, in San Jose. The segment runs from the intersection of I-880 and Highway 82 south and east to Diridon station. The City of San Jose has successfully had this portion of Highway 82 relinquished from Caltrans in preparation for a project to implement various landscape, pedestrian, and bicyclist design elements along the corridor. These elements planned for construction include, among other features, landscaped medians and bicycle lanes.

Data were collected for this corridor using the same methodology implemented for the Santa Monica Boulevard study corridor. Design and landscape elements were recorded using the same instrument as that of Santa Monica Boulevard (Appendix C.) Data were collected using Google Earth and verified during a site visit in August 2012. Intercept surveys were conducted during October 2012. Pedestrian and bicycle counts were conducted between 2 p.m. and 6 p.m. during weekdays in November 2012.

A summary of the data collected for the Highway 82 corridor is presented in Appendix N. The data files will be provided to Caltrans for use in the event that Caltrans decides to conduct a longitudinal study on the corridor after the improvements are complete.

APPENDICES

Appendix A. Caltrans' Current Performance Measures

Appendix B. Estimating Tree Canopy and Pervious Surface Coverage

Appendix C. Checklist for Corridor Design Features

Appendix D. Frequency of Various Street Treatments and Events along San Pablo Avenue

Appendix E. Comparison of Plans and Policies for Selected Pedestrian and Bicycle Accommodations

Appendix F. Specific Goals, Policies, and Actions of Plans

Appendix G. Figures from the Pedestrian and Bicyclist Intercept Survey for San Pablo Avenue

Appendix H. Figures from the Pedestrian and Bicyclist Intercept Survey for Santa Monica Boulevard

Appendix I. Final Intersection List with Post Miles for Santa Monica Boulevard

Appendix J. Summary of Injury and Fatality Information for Santa Monica Boulevard

Appendix K. Codebook for Variable Names for Santa Monica Boulevard

Appendix L. Bivariate Tables from Phase IV Crash Analysis

Appendix M. Intercept Survey Questionnaires

Appendix N. "Before" Data for Highway 82 in San Jose

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