# El Camino Real Master Planning Study

## City of Palo Alto


## Appendices

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Prepared by:

Community Design + Architecture
Fehr & Peers Associates
Reid Ewing
LCC, Inc
Joe R. McBride
Urban Advantage

# *List of Appendices*

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# *Appendix 1*
# Goals and Objectives

The Goals and Objectives for the El Camino Project stated here are the result of several rounds of review and discussion among members of the Advisory Committee. Refinements were made following the two Community Workshops on June 1st and September 30th, and the Council Study Session on July 15th.

## Project Goals

September 11, 2002

The following is an adaptation of the "overall goal of this project" as stated in Palo Alto's request for proposal and grant application to Caltrans:

> *The overall goals of the future design are to change the character of El Camino Real from a highway designed primarily for motor vehicle mobility to:*

- A fully multimodal urban thoroughfare that maintains mobility and improves safety for transit, trucks, and autos, while improving safety and convenience for pedestrians and bicyclists; and,
- A center of community activity rather than a barrier between activities on either side of the street.
- An aesthetically attractive corridor that projects a positive image of Palo Alto;

Other goals for the future of El Camino Real are to:

- **Improve quality of life** along El Camino Real while protecting its adjacent neighborhoods and districts; and,
- **Create economic benefits** for both businesses and property owners along El Camino Real and for the City of Palo Alto.
- **Make positive change** soon with full development occurring incrementally over time.

## Project Objectives

The following defines the objectives of the project and the ultimate redesign of El Camino Real.

*Objective: Provide Equity and Balance for All Modes*

Redesign El Camino Real to reduce potential conflicts between and balance the needs of all modes of transportation - local and subregional auto, transit, and truck traffic; bicyclists of varied skill levels, and all pedestrians (including seniors, school children, and the disabled).

*Objective: Improve Safety for All Modes*

Improve El Camino Real to be a safer place for all pedestrians (including seniors, school children, and the disabled), bicyclists, transit riders, buses, autos, and trucks.

*Objective: Design Street to Encourage Motorized Traffic to Drive at Safe Speeds and not Exceed the Speed Limit*

Redesign El Camino Real to encourage traffic to drive at safe speeds that do not exceed the speed limit and to allow aesthetic and multimodal improvements to El Camino Real. This objective will be balanced with traffic and transit needs for mobility along the length of the corridor.

*Objective: Improve Ability to Cross the Street*

Make El Camino Real safer and more convenient for pedestrians and bicyclists to cross by improving intersections and possibly by adding some mid-block crossings.

*Objective: Create a Street and Streetscape that Complement Community Character*

Redesign El Camino Real with a character and function that is more directly related to the existing and desired future character and function of the community along it.

*Objective: Minimize Direct and Indirect Impacts on Quality of Life and the Environment*

Minimize direct and indirect impacts on quality of life along the street and in adjacent neighborhoods and districts through the design, construction, and function of the new El Camino Real. In addition, impacts on the environment should be reduced, particularly as relates to water and air quality and the solar "heat island" effects associated with larger areas of pavement in urban settings.

*Objective: Improve Landscape Quality and Quantity*

Increase the amount of land area within the r.o.w. for landscaping, and the number, health, and size of trees and other landscaping along the edges of the street and in the median.

*Objective: Improve Aesthetic Quality of Street Design*

Improve the quality and condition of streetscape elements (lighting, benches, bus stops, etc.) and the paving of the roadway and sidewalks. Public art and new landscape must also contribute to this objective.

*Objective: Create Cost Effective Improvements*

The improvements to El Camino Real will be of high quality to the extent feasible. Both in regards to cost to benefit and initial cost compared to life-time cost need to be considered.

*Objective: Define Some Immediate Improvements*

Identify a set of improvements that can be implemented as soon as possible to build incrementally to the ultimate vision for the future of El Camino Real; particularly in regards to planting trees and making other landscape improvements in the near term.

## Linkage Between Goals and Objectives

The following defines the relationship between the project Goals and Objectives for the future of El Camino Real. Some objectives are listed under more than one goal. The objectives are followed by a more detailed discussion of the linkage between that objective and the accompanying goal.

## Primary Goal - Create a Multimodal Street

*Objective: Provide Equity and Balance for All Modes*

*Redesign El Camino Real to reduce potential conflicts between and balance the needs of all modes of transportation - local and subregional auto, transit, and truck traffic; bicyclists of varied skill levels, and all pedestrians (including seniors, school children, and the disabled).*

El Camino Real is primarily designed to serve its subregional function for motorized traffic traveling through Palo Alto. But the street also needs to serve pedestrians, bicyclists, and local traffic. A balance needs to be achieved to better serve all of these users, particularly given the community's concerns regarding pedestrian and bicycle safety along and across El Camino Real.

*Objective: Improve Safety for All Modes*

*Improve El Camino Real to be a safer place for all pedestrians (including seniors, school children, and the disabled), bicyclists, transit riders, buses, autos, and trucks.*

Many parts of the corridor are perceived to have and actually have safety issues. All modes of transportation must be able to use the street safely or they will not be able to use the street or cross it effectively. This is a particular concern for pedestrians and bicyclists who will not use the street without actually being safe or if they perceive that they are not safe, especially for school children who must cross the street to get to school.

*Objective: Design Street to Encourage Motorized Traffic to Drive at Safe Speeds and not Exceed the Speed Limit*

*Redesign El Camino Real to encourage traffic to drive at safe speeds that do not exceed the speed limit and to allow aesthetic and multimodal improvements to El Camino Real. This objective will be balanced with traffic and transit needs for mobility along the length of the corridor.*

If traffic can be slowed so that more people are driving at the posted speed limit, the "design speed" of the roadway can be reduced which will support design changes that improve the function of the street for other modes. This will also allow more changes that will improve the aesthetics of El Camino Real. The need to slow traffic to the speed limit needs to be balanced with the need for traffic to travel efficiently along the street. If congestion is perceived to be unacceptable traffic may divert to other routes within Palo Alto which could have a negative effect on the neighborhoods or districts along those other routes.

*Objective: Improve Ability to Cross the Street and at Intersections*

*Make El Camino Real safer and more convenient for pedestrians and bicyclists to cross by improving intersections and possibly by adding some mid-block crossings.*

Many intersections signalized or not, are barriers to those who need to cross the street; and in some portions of the corridor the distance between safe crossing locations is so long that it discourages pedestrians and could encourage them to jay walk. This is both a safety and a modal equity concern, particularly for school children who must cross El Camino Real if they are walking or riding their bicycles to school. Public art should be used to define and highlight crosswalks particularly at mid-block locations.

## Primary Goal - Create a Center of Community Activity

### *Objective: Provide Equity and Balance for All Modes*

*Redesign El Camino Real to reduce potential conflicts between and balance the needs of all modes of transportation - local and subregional auto, transit, and truck traffic; bicyclists of varied skill levels, and all pedestrians (including seniors, school children, and the disabled).*

In order for El Camino Real to become a center of community activity it must provide for more than auto, transit, and truck traffic. Particularly within the nodes along the corridor, the provision of transportation equity and improved safety for pedestrians and bicyclists will support the goal of broader community activity, allowing the street to be a part of vibrant mixed-use commercial districts, rather than being a barrier.

### *Objective: Design Street to Encourage Motorized Traffic to Drive at Safe Speeds and not Exceed the Speed Limit*

*Redesign El Camino Real to encourage traffic to drive at safe speeds that do not exceed the speed limit and to allow aesthetic and multimodal improvements to El Camino Real. This objective will be balanced with traffic and transit needs for mobility along the length of the corridor.*

Traffic must be encouraged to travel at a safe speed, the posted speed, along El Camino Real in order for the street to function as a welcoming center of community activity.

### *Objective: Improve Ability to Cross the Street*

*Make El Camino Real safer and more convenient for pedestrians and bicyclists to cross by improving intersections and possibly by adding some mid-block crossings.*

In most portions of the El Camino Corridor, the street currently creates a barrier between activities and neighborhoods on either side of the street. People must be able to move safely from on side of the street to another in order for the land uses along El Camino to support community activity.

### *Objective: Improve Aesthetic Quality of Street Design*

*Improve the quality and condition of streetscape elements (lighting, benches, bus stops, etc.) and the paving of the roadway and sidewalks. Public art and new landscape must also contribute to this objective.*

The design and selection of streetscape elements, public art, and the landscaping of the street will reinforce the segments and nodes of activity along the street that are defined in the City's Comprehensive Plan. This will create a legible "structure" to the Corridor, reinforcing its function as a center of activity within the community.

## Primary Goal - Create an Aesthetically Attractive Street

### *Objective: Improve Linkage Between Adjacent Community Character and Streetscape Design*

*Redesign El Camino Real with a character and function that is more directly related to the existing and desired future character and function of the community along it.*

The character and function of the uses along El Camino Real changes as one moves through Palo Alto, but the character and functional design of the street does not change in relation to community character in any meaningful way. For example, parking is provided in many locations where there is little or no parking demand today or expected in the future. Sidewalk width is relatively consistent for the entire length of the corridor (where sidewalks exist), but some areas have more pedestrian activity and restaurants or cafes that could provide outside activity.

### *Objective: Improve Landscape Quality and Quantity*

*Increase the amount of land area within the r.o.w. for landscaping, and the number, health, and size of trees and other landscaping along the edges of the street and in the median.*

The current impression of most of the existing El Camino corridor in Palo Alto is a paved environment dominated by motorized traffic. While trees and other landscaping do exist they do not make a strong impression in much of the corridor. More landscape, particularly healthier and larger trees will improve the aesthetic of the street and make it a more comfortable environment, especially for pedestrians.

### *Objective: Improve Aesthetic Quality of Street Design*

*Improve the quality and condition of streetscape elements (lighting, benches, bus stops, etc.) and the paving of the roadway and sidewalks. Public art and new landscape must also contribute to this objective.*

The majority of the built elements along the street are all scaled to the motorized traffic in the roadway, not pedestrians and bicyclists. Also, the quality of materials both in the roadway and in the pedestrian realm does not reflect the importance of the street within Palo Alto or the community character of the districts and neighborhoods along the street. Improving the aesthetic quality of the street will support the economic vitality of businesses along the street.

### *Objective 4: Improve Safety for All Modes*

*Improve El Camino Real to be a safer place for all pedestrians (including seniors, school children, and the disabled), bicyclists, transit riders, buses, autos, and trucks.*

The design of the street, both within the roadway and the pedestrian realm, is dominated by elements that are oriented to the El Camino Real's function as a major vehicular route. Street lighting, sidewalk width, intersection design, and many other elements can be improved to create a more attractive and safe environment for **all** the people and vehicles that use El Camino. El Camino Real as a whole is not more or less safe than other similar roadways. However, several locations have existing or potential safety issues that must be addressed to ensure that this roadway is safe for all modes including automobiles, transit, bicycles, and pedestrians. Safety for pedestrians and bicyclists is of primary concern to the community.

## Other Goal - Make Positive Change Soon

### *Objective: Create Cost Effective Improvements*

*The improvements to El Camino Real will be of high quality to the extent feasible. Both in regards to cost to benefit and initial cost compared to life-time cost need to be considered.*

Both the initial construction cost of improvements and the maintenance and operation of the improvements over time will be an important consideration. Sharing of costs between the public and the private sector will need to be considered, as will the sharing of costs between public entities: the City of Palo Alto, the VTA (both as the transit provider and the Congestion Management Agency), MTC, and Caltrans.

### *Objective: Define Some Immediate Improvements*

*Identify a set of improvements that can be implemented as soon as possible to build incrementally to the ultimate vision for the future of El Camino Real; particularly in regards to planting trees and making other landscape improvements in the near term.*

Many of the improvements being considered will require reconstruction of the roadway, including new curb and gutter locations. It may take time for funding to be made available for these improvements. The alternatives will explore opportunities to make some improvements prior to these more major reconstruction projects. In addition, the plan will need to indicate how changes to El Camino can be made incrementally in order to allow positive changes to made sooner rather than later.

## Other Goal - Improve Quality of Life

### *Objective 2: Improve Landscape Quality and Quantity*

*Increase the amount of land area within the r.o.w. for landscaping, and the number, health, and size of trees and other landscaping along the edges of the street and in the median.*

The California Regional Water Quality Control Board, San Francisco Region; the Santa Clara Valley Water District, and the City of Palo Alto, amongst other Santa Clara County agencies, are in the midst of implementing new water quality regulations which require both the treatment of and flow reduction of stormwater run-off. The regulations apply to the planned improvement of El Camino Real – "Significant redevelopment projects…on a previously developed site that results in addition or replacement which [have a] combined total [of] 43,560 square feet or more of impervious surface." (California Regional Water Quality Control Board, San Francisco Region, Order No. l 01-119, NPDES Permit No. CAS029718, adopted October, 2001).

Increasing the landscaped area within the El Camino Real r.o.w. and planting more trees will help meet these regulations. The use of a variety of "green" infrastructure techniques or more mechanized methods of stormwater treatment and peak run-off reduction will be needed to meet the regulations. Also, increasing the number and size of trees will help to reduce peak run-off, because rain that falls onto a tree and its leaves has the opportunity to evaporate or is delayed in the time it takes to reach a drain intake.

Decreasing pavement area and increasing the number and size of trees will also help to reduce the "urban heat island" effects caused by the sun heating paved surfaces. Minimizing the solar heat on pavement will both serve to make the street more comfortable during hotter times of the year and will reduce air quality impacts. Also, the transpiration of water from plant's leaves helps to reduce heat.

Landscape can be used to highlight and distinguish the character of El Camino Real's segments and activity nodes. The selection of trees can highlight major changes in character and frame major gateways. Ground cover, shrubs, and plantings of flowers can give seasonal character to the corridor and highlight the corridor's segments and nodes, such as areas with high pedestrian activity.

### *Objective 8: Minimize Direct and Indirect Impacts on Quality of Life and the Environment*

*Minimize direct and indirect impacts on quality of life along the street and in adjacent neighborhoods and districts through the design, construction, and function of the new El Camino Real. In addition, impacts on the environment should be reduced, particularly as relates to water and air quality and the solar "heat island" effects associated with larger areas of pavement in urban settings.*

In addition to the discussion above under Objective 1, there are a variety of other strategies that can be used to minimize potential environmental impacts. For example, air quality will be effected by both encouraging non-motorized and transit modes, and by improving the consistency of traffic flow through the corridor. Noise impacts along the corridor can be reduced by slowing and improving the consistency of traffic flow, by improving paving and potentially through using particular types of paving.

There are also general practices in selection of construction materials and in construction practices that will be encouraged in all of the alternatives to the extent that costs can be justified. The roadway and associated improvements will be designed to avoid the diversion of traffic into adjacent neighborhoods and districts.

## Other Goal - Provide Economic Benefits

### *Objective 1: Improve Linkage Between Adjacent Community Character and Streetscape Design*

*Redesign El Camino Real with a character and function that is more directly related to the existing and desired future character and function of the community along it.*

### *Objective 3: Improve Aesthetic Quality of Street Design*

*Improve the quality and condition of streetscape elements (lighting, benches, bus stops, etc.) and the paving of the roadway and sidewalks. Public art and new landscape must also contribute to this objective.*

Matching the design and character of the street with adjacent uses will help to support business activity. For example, improving pedestrian amenities around the intersection with California Avenue will make it more desirable for workers in the employment areas to the west to walk to businesses along El Camino Real and California Avenue at lunch or after work. In general a more visually attractive street will support business activity.

### *Objective 7: Improve Ability to Cross the Street and at Intersections*

*Make El Camino Real safer and more convenient for pedestrians and bicyclists to cross by improving intersections and possibly by adding some mid-block crossings.*

Making the street more comfortable to cross will help to create districts of supporting activities on both sides of the street. For example, the area between California Avenue and Stanford Avenue would be a stronger shopping district if patrons were more comfortable parking once and walking to various businesses along El Camino Real.

### *Objective 8: Minimize Direct and Indirect Impacts on Quality of Life and the Environment*

*Minimize direct and indirect impacts on quality of life along the street and in adjacent neighborhoods and districts through the design, construction, and function of the new El Camino Real. In addition, impacts on the environment should be reduced, particularly as relates to water and air quality and the solar "heat island" effects associated with larger areas of pavement in urban settings.*

Minimizing impacts will make the new El Camino Real easier to achieve and more cost effective to maintain into the future.

### *Objective 9: Create Cost Effective Improvements*

*The improvements to El Camino Real will be of high quality to the extent feasible. Both in regards to cost to benefit and initial cost compared to life-time cost need to be considered.*

The cost and quality of physical improvements to El Camino Real needs to be balanced with the resulting longer term maintenance and replacement costs. Achieving an appropriate balance will minimize cost impacts to Caltrans and the City of Palo Alto.

### *Objective 10: Define Some Immediate Improvements*

*Identify a set of improvements that can be implemented as soon as possible to build incrementally to the ultimate vision for the future of El Camino Real; particularly in regards to planting trees and making other landscape improvements in the near term.*

Making immediate improvements along El Camino Real will strongly illustrate the community's commitment to the corridor. Initial improvements can start to make positive change in the corridor and support further private and public investment in development along the street and in the character of the street itself.

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# *Appendix 2*
# Caltrans Director's Policy

California Department of Transportation
Director's Policy
Number: 22

Effective Date: 11-29-01

## Context Sensitive Solutions

### *POLICY*

The Department uses "Context Sensitive Solutions" as an approach to plan, design, construct, maintain, and operate its transportation system. These solutions use innovative and inclusive approaches that integrate and balance community, aesthetic, historic, and environmental values with transportation safety, maintenance, and performance goals. Context sensitive solutions are reached through a collaborative, interdisciplinary approach involving all stakeholders.

The context of all projects and activities is a key factor in reaching decisions. It is considered for all State transportation and support facilities when defining, developing, and evaluating options. When considering the context, issues such as funding feasibility, maintenance feasibility, traffic demand, impact on alternate routes, impact on safety, and relevant laws, rules, and regulations must be addressed.

### *INTENDED RESULTS*

In towns and cities across California, the State highway may be the only through street or may function as a local street. These communities desire that their main street be an economic, social, and cultural asset as well as provide for the safe and efficient movement of people and goods. In urban areas, communities want transportation projects to provide opportunities for enhanced non-motorized travel and visual quality. In natural areas, projects can fit aesthetically into the surroundings by including contour grading, aesthetic bridge railings, and special architectural and structural elements. Addressing these needs will assure that transportation solutions meet more than transportation objectives.

The Department can be proud of the many contributions it has made to improve highways that are main streets and the aesthetics of its highways and structures; however, there is a strongly expressed desire across California for this concept to be the norm.

Context sensitive solutions meet transportation goals in harmony with community goals and natural environments. They require careful, imaginative, and early planning, and continuous community involvement.

The Department's Highway Design Manual, Federal Highway Administration (FHWA) regulations, FHWA's Flexibility in Highway Design publication, and the American Association of State Highway Transportation Officials' A Policy on Geometric Design of Highways and Streets all share a philosophy that explicitly allows flexibility in applying design standards and approving exceptions to design standards where validated by applying sound engineering judgment. This design philosophy seeks transportation solutions that improve mobility and safety while complementing and enhancing community values and objectives.

## *RESPONSIBILITIES*

### Director:

- Creates an environment in which innovative actions, such as context sensitive solutions, can flourish.
- Recognizes and highlights individuals, teams, and projects that advance the goals of this policy.
- Encourages staff to conduct and participate in meetings and conferences to expand the knowledge of context sensitive solutions internally and externally.

### Chief Counsel:

- Evaluates and provides opinions on legal issues associated with context sensitive solutions.

### Deputy Director, Maintenance and Operations; Chiefs, Divisions of Traffic Operations and Maintenance:

- Support context sensitive solutions in the maintenance and operation of transportation facilities.
- Revise manuals and procedure documents to facilitate the application of context sensitive solutions.
- Initiate and coordinate research to enable context sensitive solutions.

### Chief, Division of New Technology and Research:

- Conducts research and develops and improves techniques and materials to enable context sensitive solutions.
- Revises manuals and procedure documents to facilitate the application of context sensitive solutions.

### Chief Engineer (Deputy Director, Project Delivery):

- Supports context sensitive solutions in the design and construction of transportation facilities.
- Encourages innovation and flexibility in design.
- Ensures projects are well coordinated to support the application of context sensitive solutions through the life of projects.

### Chief, Division of Engineering Services:

- Conducts research and develops and improves techniques and materials to enable context sensitive solutions.
- Trains staff in the application of context sensitive solutions.
- Revises manuals and procedure documents to facilitate the application of context sensitive solutions.

### Chief, Division of Project Management:

- Ensures resources are distributed to enable implementation of context sensitive approaches.

### Chiefs, Divisions of Right of Way and Construction:

- Train staff in the application of context sensitive solutions.
- Revise manuals and procedure documents to facilitate the application of context sensitive solutions.

### Chief, Division of Design:

- Works in cooperation with district and other functional units to develop guidance on design flexibility.
- Identifies good examples of the application of context sensitive solutions to share with departmental and local agency staff.
- Initiates and coordinates research to enable context sensitive solutions.
- Trains staff in the application of context sensitive solutions.
- Revises manuals and procedure documents to facilitate the application of context sensitive solutions.

### Chief, Division of Environmental Analysis:

- Facilitates coordination with resource agencies to assure facilities and activities are in harmony with the surrounding environment.
- Ensures communities have the opportunity to be actively involved in the environmental stage of the project development process.
- Ensures context sensitive commitments are sustained, as warranted, as a project moves through the environmental approval process.
- Trains staff in the application of context sensitive solutions.
- Revises manuals and procedure documents to facilitate the application of context sensitive solutions.

### Chief Financial Officer (Deputy Director, Finance); Chief, Division of Transportation Programming:

- Support the inclusion of context sensitive solutions when programming transportation projects.
- Communicate the importance of context sensitive solutions to the California Transportation Commission.
- Facilitate district development of funding partnerships for context sensitive solutions.

### Deputy Director, Administration:

- Supports context sensitive solutions in the planning, design, construction, maintenance, and operation of offices, maintenance stations, and other departmental support facilities.

### Deputy Director, Planning and Modal Programs:

- Supports context sensitive solutions in the planning of transportation programs and facilities.

### Chief, Division of Local Assistance:

- Facilitates training of local agencies in the principles of context sensitive solutions.
- Trains staff in the application of context sensitive solutions.
- Revises manuals and procedure documents to facilitate the application of context sensitive solutions.

### Chief, Division of Transportation Planning:

- Develops and maintains community planning guidance.
- Trains staff in the application of context sensitive solutions.
- Revises manuals and procedure documents to facilitate the application of context sensitive solutions.
- Works with regional transportation planning agencies, metropolitan transportation organizations, counties, cities, and the private sector to support and incorporate context sensitive solutions in planning, programming, and developing transportation facilities and services.

### District Directors:

- Provide leadership in the application of context sensitive solutions in all planning, programming, project development, construction, maintenance, and operational activities of the district.
- Proactively ensure early and continuous involvement of stakeholders.
- Are responsive to requests by local communities, resource and other agencies, and the general public for context sensitive solutions.
- Assure that context sensitivity is applied to local and other projects within the State right-of-way.
- Train staff in the application of context sensitive solutions.

### *APPLICABILITY*

All employees and others involved in the planning, development, construction, maintenance, and operation of State transportation and support facilities.

Originally Signed by: JEFF MORALES, Director

Date Signed: 11-29-01

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# Appendix 3

# Existing Conditions Assesment (Full Text)

## Introduction

This Report summarizes the key findings of the Existing Conditions Assessment conducted for the El Camino Real Master Schematic Design Plan project.

Chapter 1 addresses the Transportation Data Collection and Assessment, including:

- General Data Collection
- Accident Data
- Existing Traffic Data Analysis

Chapter 2 summarizes information related to the assessment of existing Land Uses, and current Planning and Development Activities.

Chapter 3 addresses findings related to the Analysis of the existing Streetscape and Urban Design Characteristics and Conditions, including Street and Block Pattern, Character of Street Frontage, Lighting, Street Furnishings, Pedestrian and Bicycle Facilities, and Landscaping. This chapter includes the full tree report.

## Chapter 1:

## Transportation Data Collection and Assessment

### *General Data Collection*

Fehr & Peers Associates collected a variety of transportation data throughout the El Camino Real corridor. This newly collected data was combined with other data sources and is reported and assessed in this chapter.

Much of the new data collected related to vehicular traffic counts along with bicycle and pedestrian counts. These traffic counts were analyzed to indicate intersection Level of Service (LOS). In addition, Fehr & Peers Associates conducted an extensive set of travel-time surveys along El Camino Real and parallel travel corridors. These surveys provided information on commute period travel speeds, stops and delays, and overall time used to travel the length of El Camino Real and other nearby streets. Caltrans provided current traffic signal operations data and signal coordination.

Other data sources included the Santa Clara Valley Transportation Authority (VTA) that provided counts at the four intersections under their jurisdiction along El Camino Real. VTA also provided transit ridership for the existing bus routes along El Camino Real.

The City of Palo Alto provided accident data from the Police Department. Caltrans provided additional accident data from their TASAS accident database.

### *Accident Data*

Two sources of accident were obtained for the El Camino Real Corridor. The first source of the accident data was the accident reports compiled by the City of Palo Alto Police Department. The second source was the Caltrans TASAS accident database. Each of these sources were analyzed to determine if unsafe conditions existing on the corridor. This analysis considered the following factors:

- Number of accidents by location and severity level
- Involvement of pedestrians or bicyclists
- Accident rate as a function of traffic count
- Yearly distribution;
- Monthly distribution;
- Hourly distribution;
- Corridor accident rate vs. statewide average;
- Intersection accident rate vs. statewide average;
- Accident type; and
- Accident cause.

The City of Palo Alto Police Department Database was the most complete database and contained over 2,400 individual records for 1,177 accidents. The number of records exceeds the number of accidents because the Police Department keeps a record of each individual vehicle involved in an accident. The police department data was analyzed to determine if there was a yearly variation in the number of accidents. The yearly accident totals are shown in Table 1:1

**Table 1:1**

**City of Palo Alto Police Department Accident Data**

**Yearly Summaries**

| Year | Number of Accidents | Variation from Average |
|---|---|---|
| 1999 | 367 | -9% |
| 2000 | 440 | +9% |
| 2001 | 370 | -8% |
| **Average of High and Low** | **404** | |

Sources: City of Palo Alto Police Department, 2001

As shown in the table above, there has been no consistent trend in number of accidents over the past three years, and the annual number of accidents in the corridor varies by about plus-or-minus 9%.

The second source of accident data was the Caltrans TASAS database. This database contains data from the California Highway Patrol Statewide Integrated Traffic Records System (SWITRS), which contains a majority of accidents occurring on state highways. According to a Caltrans publication, "the department estimates that it receives collision reports for approximately 100 percent of all fatal accidents, 90 percent of all injury accidents, and 40 percent of property-damage-only accidents occurring on state highways" (Caltrans, 1998). The TASAS data addressed the last three years of data in the corridor from 1999 to 2001.

While the Caltrans TASAS database does not contain records of each accident in the corridor, it is still valuable since it is summarized by roadway segment, signalized intersection, month, time of day, accident cause, and type of accident. The TASAS database allows better comparisons to statewide data given the relative uniformity in accident data collection and aggregation.

The following table reports the number of accidents occurring in each segment of the roadway. These roadway segments were developed by Caltrans and correspond approximately to the southern, middle, and northern segments of the corridor. The table reports the overall accident rate that is the number of accidents per million vehicle miles. Calculation of this rate for the corridor allows comparisons to statewide averages for similar facilities.

**Table 1:2**

**TASIS Corridor Accident Data**

| Segment | Accident Rate(1) | Statewide Average(2) | Exceeds Statewide Average (Yes/No) |
|---|---|---|---|
| South City Limits to Matadero Avenue | 2.36 | 2.40 | No |
| Matadero Avenue to California Avenue | 2.36 | 2.40 | No |
| California Avenue to Sand Hill / Alma Avenue | 2.75 | 2.40 | Yes |

June 2002

Notes:

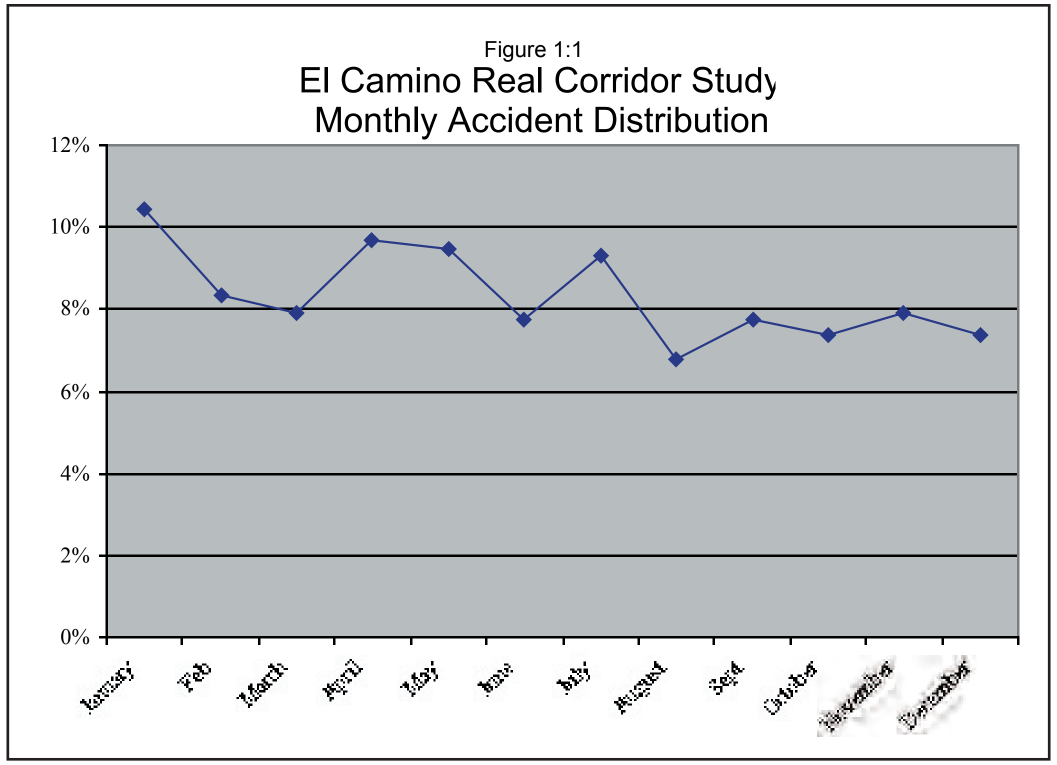
1- Per million vehicle miles

2- 1998 accident data on California State Highways

Sources: Caltrans TASAS Data, District 4 (1999 to 2001)

As shown in the Table 1:2, the segment north of California Avenue exceeds the statewide average for a six-lane divided arterial by about 15%. The remainder of the corridor was slightly below the statewide average.

Additional analysis was conducted to determine the distribution of the accidents throughout the year. This analysis indicated that the accidents were distributed throughout the year. This data is shown in Figure 1:1. As shown in both the charts, the accidents are distributed throughout the year with no appreciable peaks and valleys.



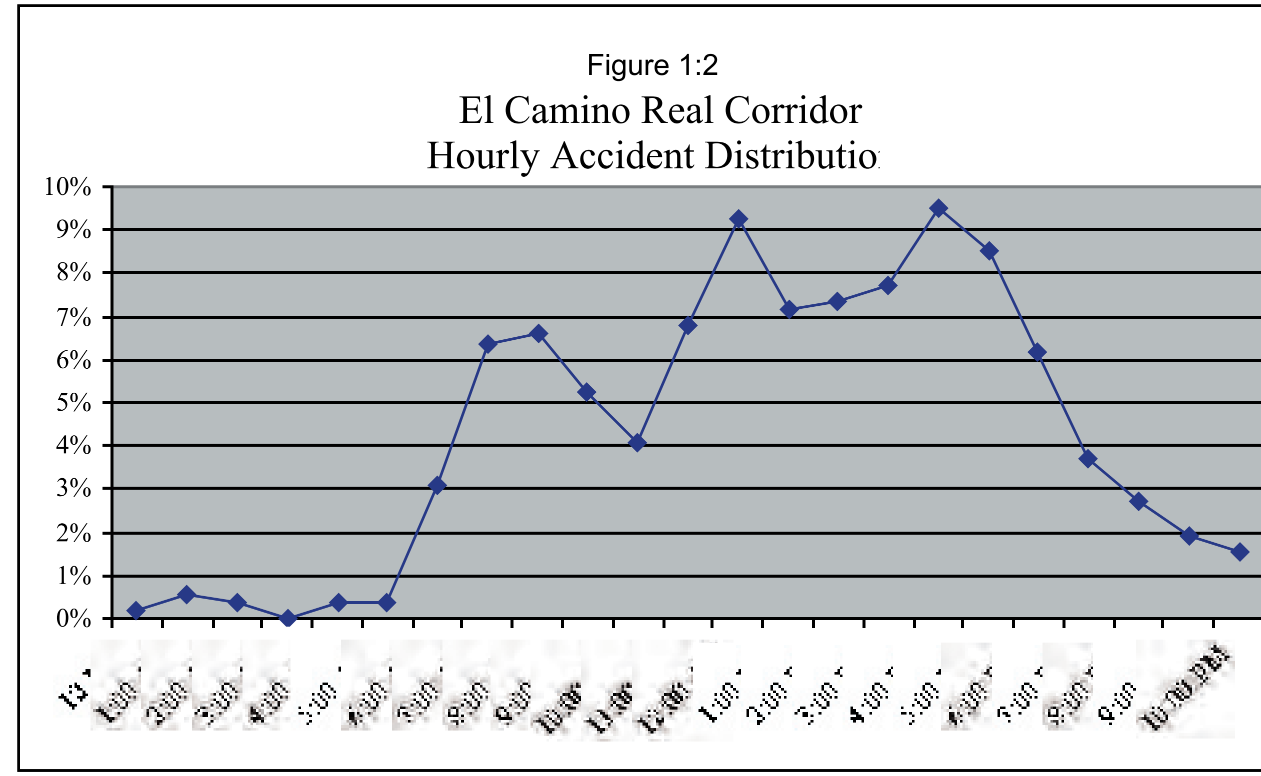




Figure 1:2 displays hour distribution of the accident occurrences. This hourly distribution roughly approximates the peak traffic conditions and is indicative of a high volume corridor with significant traffic volumes throughout the travel day from a variety of activities found throughout the corridor.

The analysis of the monthly and hourly distribution of traffic did not indicate any significant aberrations, therefore FPA conducted additional analysis at the intersection level. This analysis involved the number of accidents, the type of accidents, and the accident causes. The first area of investigation was the number of accidents per intersection, based on the TASAS database. Table 1:3 provides the number of accidents per intersection, as well as a rate of accidents per million entering vehicles. This calculated rate allows for the comparison of intersections with different volume levels to determine if an intersection location has a higher accident incidence. Eight intersections had rates that exceeded the statewide average for the type of intersection. These intersections are listed below:

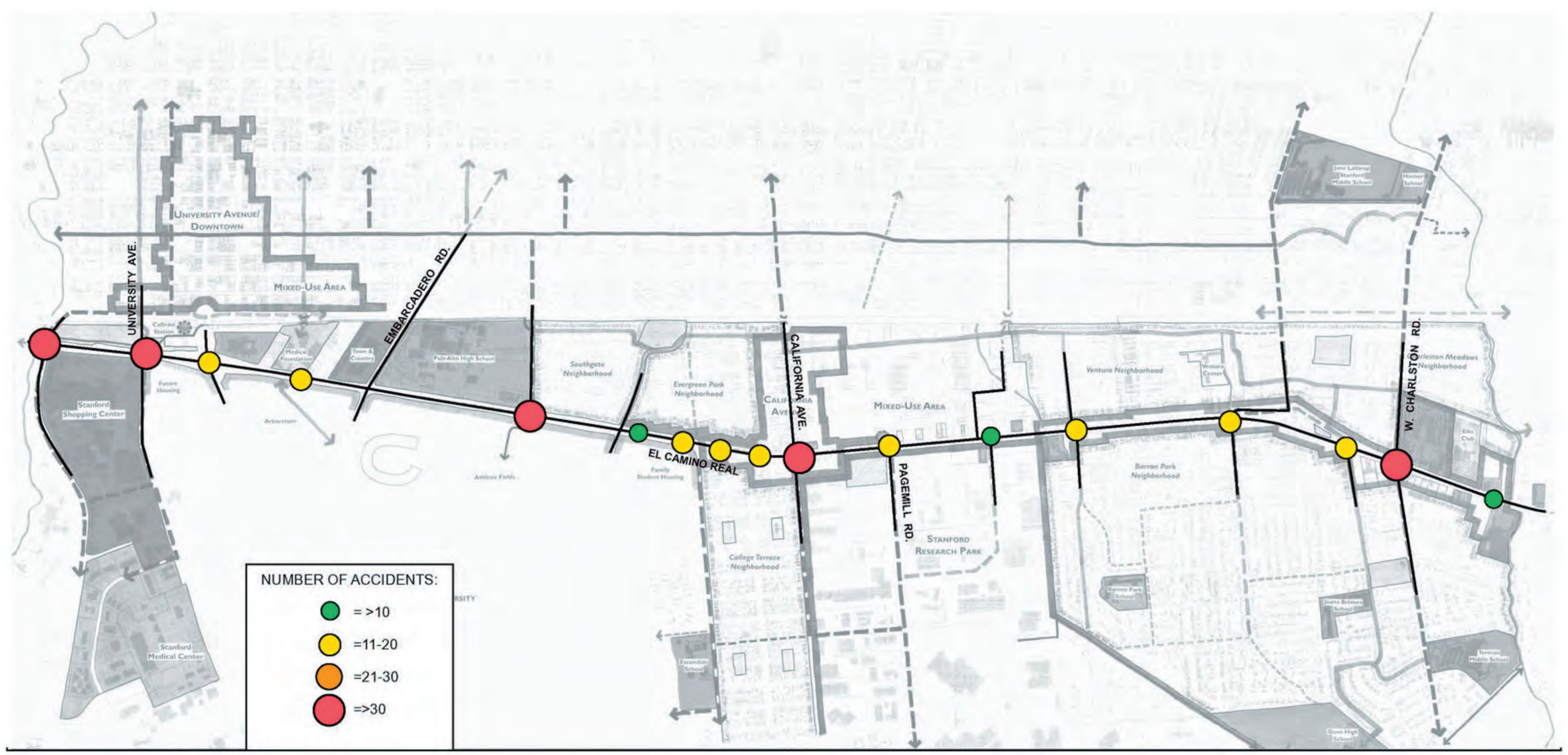
- El Camino Real / Charleston / Arastradero;
- El Camino Real / Maybell Avenue;
- El Camino Real / Curtner Avenue;
- El Camino Real / Page Mill Expressway
- El Camino Real / Churchill Avenue;
- El Camino Real / Embarcadero Drive / Galvez Street; and
- El Camino Real / Quarry
- El Camino Real / Sand Hill / Alma Street.

Four of the intersections on the corridor vastly exceeded the statewide average in terms of rate of accidents. These intersections were at:

- El Camino Real / Charleston / Arastradero,
- El Camino Real / Churchill Avenue,
- El Camino Real / Quarry
- Sand Hill / Alma Street.

During the study period, the intersections at El Camino Real / Quarry and El Camino Real / Sand Hill / Alma were under construction involving major modification/relocation of the intersecting streets, driveways and traffic signals. The higher-than-average accident rate at the location is probably attributable to those temporary conditions.

In conclusion, eight of the intersections along El Camino Real experience accident rates above the Statewide average for similar locations, and two of those (Churchill and Arastradero/Charleston experienced rates well above the Statewide average. Table 1:3 indicates the number of accidents for the intersection, the actual accident rate, the statewide average accident rate, and whether or not the intersection exceeds the statewide average. There was one fatality in the corridor at the Page Mill intersection.

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**NUMBER OF ACCIDENTS**
*Figure 1:3*

**Table 1:3**

**TASIS Intersection Accident Data- Accident Incidence Per Intersection**

| Intersection | Number of Accidents | Accident Rate | Statewide Average Accident Rate | Exceeds Statewide Average (Yes/No) |
|---|---|---|---|---|
| El Camino Real/ Dinah's Court | 8 | 0.14 | 0.43 | No |
| El Camino Real / Arastradero Road* | 42 | 0.56 | 0.43 | Yes |
| El Camino Real / Maybell Avenue | 18 | 0.32 | 0.28 | Yes |
| El Camino Real / Los Robles Road | 19 | 0.32 | 0.43 | No |
| El Camino Real / Curtner Avenue | 17 | 0.30 | 0.28 | Yes |
| El Camino Real / Matadero Avenue | 10 | 0.18 | 0.43 | No |
| El Camino Real / Hansen Way / Portage | 19 | 0.32 | 0.43 | No |
| El Camino Real / Page Mill Road* | 37 | 0.45 | 0.43 | Yes |
| El Camino Real / California Avenue | 18 | 0.31 | 0.43 | No |
| El Camino Real / Cambridge Avenue | 17 | 0.33 | 0.43 | No |
| El Camino Real / Stanford Avenue | 16 | 0.28 | 0.43 | No |
| El Camino Real / Serra Street | 10 | 0.18 | 0.43 | No |
| El Camino Real / Churchill Avenue | 34 | 0.63 | 0.28 | Yes |
| El Camino Real / Embarcadero Road / Galvez Street* | 32 | 0.49 | 0.43 | Yes |
| El Camino Real / Palm Drive Ramps | 18 | 1.24 | 1.50 | No |
| El Camino Real / Quarry | 35 | 0.57* | 0.28 | Yes* |
| El Camino Real / Sand Hill / Alma Street* | 33 | 0.71* | 0.28 | Yes* |

Intersection under construction during survey period.

Note: Bolded intersections indicate those intersections that exceed the statewide average. Those highlighted intersections exceed the statewide average by more than 20%.

Source: Caltrans, TASAS Database (1999 to 2001)

The accident rate analysis was supplemented with an examination of the types and causes of accidents. This investigation determined that a majority of the accidents were attributed to speeding and involved rear end collisions. The accident type and proximate cause are shown in Table 1:4.

**Table 1:4**

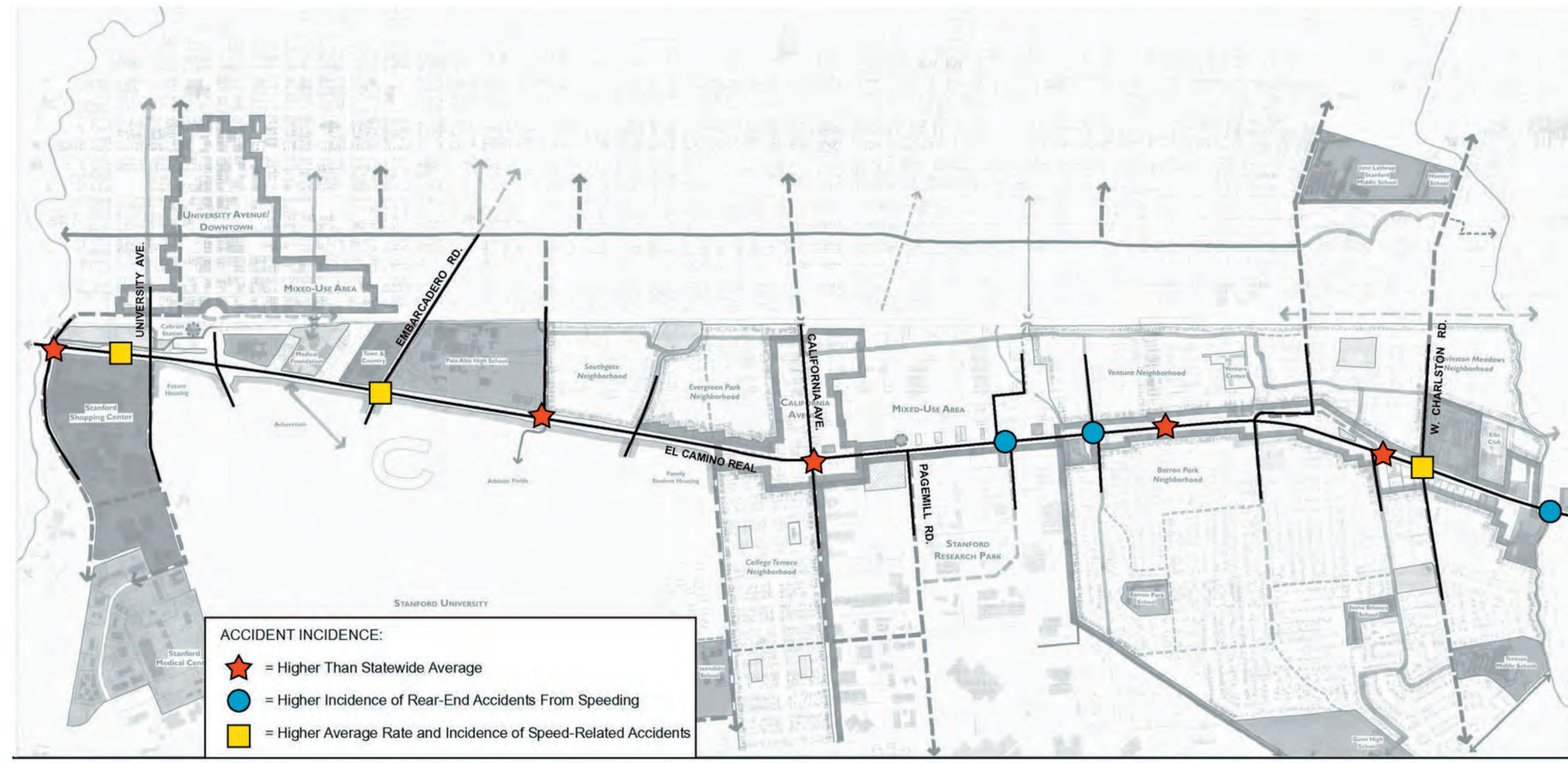
**TASAS Accident Data- Type and Causes of Accidents**

| Intersection | Number of Accidents | Rear-Ends as % of Accidents | % of Accidents with Speeding as Cause |
|---|---|---|---|
| **El Camino Real/ Dinah's Court** | 8 | 50% | 63% |
| El Camino Real / Arastradero Road* | 42 | 24% | 31% |
| El Camino Real / Maybell Avenue | 18 | 61% | 61% |
| El Camino Real / Los Robles Road | 19 | 37% | 42% |
| El Camino Real / Curtner Avenue | 17 | 47% | 59% |
| El Camino Real / Matadero Avenue | 5 | 60% | 80% |
| El Camino Real / Hansen Way / Portage | 19 | 58% | 74% |
| El Camino Real / Page Mill Road* | 37 | 46% | 51% |
| El Camino Real / California Avenue | 19 | 33% | 50% |
| El Camino Real / Cambridge Avenue | 17 | 29% | 29% |
| El Camino Real / Stanford Avenue | 18 | 38% | 44% |
| El Camino Real / Serra Street | 10 | 20% | 30% |
| **El Camino Real / Churchill Avenue** | 34 | 59% | 65% |
| El Camino Real / Embarcadero Road / Galvez Street* | 32 | 31% | 44% |
| El Camino Real / Palm Drive Ramps | 18 | 33% | 33% |
| **El Camino Real / Stanford Shopping* Center** | 35 | 40% | 43% |
| **El Camino Real / Sand Hill / Alma* Street*** | 33 | 48%* | 64%* |

* Intersection under construction during survey period.

Note: Intersections exceeding corridor average for speeding and rear end collisions are indicated in bold. Intersections that exceed the corridor average rate are shaded.

Source: Caltrans, TASAS Database (1999 through 2001)

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**ACCIDENT INCIDENCE**
*Figure 1:4*

A review of the data indicated that five of the eight intersections, which exceeded the statewide average rate for accidents, also exceeded the corridor-wide average for rear end collisions and speeding accidents.

- El Camino Real / Maybell Avenue
- El Camino Real / Curtner Avenue;
- El Camino Real / Page Mill Expressway
- El Camino Real / Churchill Avenue; and
- El Camino Real / Sand Hill / Alma Street.

Therefore, it can be concluded that speeding is a major cause of accidents at various locations throughout the corridor. These locations also coincide with several areas of the corridor with the largest spacing between traffic signals, and the greatest travel speeds, as shown in the following sections of this report.

## Bicycle and Pedestrian Accidents

The accident data also indicated the number of bicycle and pedestrian accidents in the corridor at each intersection location. This analysis indicated that the bicycle and pedestrian accidents were evenly distributed throughout the corridor. There were no bicycle or pedestrian fatalities.

**Table 1:5**

**TASAS Accident Data- Type and Causes of Accidents**

| Intersection | Number of Accidents | Bike Accidents | Pedestrian Accidents |
|---|---|---|---|
| El Camino Real/ Dinah's Court | 8 | 0 | 0 |
| El Camino Real / Arastradero Road | 42 | 2 | 0 |
| El Camino Real / Maybell Avenue | 18 | 1 | 0 |
| El Camino Real / Los Robles Road | 19 | 1 | 0 |
| El Camino Real / Curtner Avenue | 17 | 2 | 0 |
| El Camino Real / Matador Avenue | 5 | 1 | 1 |
| El Camino Real / Hansen Way / Portage | 19 | 1 | 0 |
| El Camino Real / Page Mill Road | 37 | 3 | 0 |
| El Camino Real / California Avenue | 19 | 0 | 1 |
| El Camino Real / Cambridge Avenue | 17 | 1 | 3 |
| El Camino Real / Stanford Avenue | 18 | 0 | 0 |
| El Camino Real / Serra Street | 10 | 1 | 0 |
| El Camino Real / Churchill Avenue | 34 | 1 | 0 |
| El Camino Real / Embarcadero Road / Galvez Street* | 32 | 1 | 0 |
| El Camino Real / Palm Drive Ramps | 18 | 1 | 3 |
| El Camino Real / Stanford Shopping* Center | 35 | 2 | 1 |
| El Camino Real / Sand Hill / Alma* Street* | 33 | 3 | 0 |

Note: Intersections exceeding corridor averages are indicated in bold.

Source: Caltrans, TASAS Database (1999 through 2001)

## Conclusion

A review of the accident data indicated that the overall accident rate was at or below the statewide average for a similar facility. However, an in-depth analysis of the accident data revealed locations along the corridor where the accident rate exceeded the expected level. It also indicated that many of these locations had high percentages of rear-end accidents with speeding cited as a cause. Therefore, it can be inferred from the accident data that excessive travel speeds are contributing to accidents at several locations.

# *Existing Traffic Data and Analysis*

## Traffic Counts

Peak hour traffic levels were measured for all traffic movements at all twenty signalized intersections along El Camino Real during the 2001/2002 fall-through-spring period.

Intersection counts were obtained from the City of Palo Alto for the four Santa Clara County Valley Transportation Authority (VTA) intersections. The VTA serves as the administrator of the Congestion Management Program (CMP) for Santa Clara County. These CMP intersections are indicated below:

- El Camino Real / Arastradero Road;
- El Camino Real / Page Mill Road;
- El Camino Real / Embarcadero Road / Galvez Street; and
- El Camino Real / Sand Hill / Alma Street.

The traffic counts at the CMP intersections were obtained during the regular traffic count process for CMP intersections that generally occurs during October-November of each year. These counts were taken during October 2001.

Fehr & Peers Associates conducted traffic counts at the remaining sixteen signalized intersections in the study area. These counts were conducted for weekday AM and PM peak periods during March and April of 2002. These intersections are indicated below:

- El Camino Real / Dinah Court;
- El Camino Real / Maybell Avenue
- El Camino Real / El Camino Way;
- El Camino Real / Curtner Avenue;
- El Camino Real / Matador Avenue;
- El Camino Real / Hansen Way;
- El Camino Real / Portage Avenue;
- El Camino Real / California Avenue;
- El Camino Real / Cambridge Avenue;
- El Camino Real / Stanford Avenue;
- El Camino Real / Serra Street;
- El Camino Real / Churchill Avenue;
- El Camino Real / Medical Fountain Drive;
- El Camino Real / Quarry;
- El Camino Real / Palm Drive Ramps NB; and
- El Camino Real / Palm Drive Ramps SB.

These counts were taken during the morning peak period (7-9 AM) and the evening peak period (4-6 PM). The traffic volume for the highest single hour of each period was reported as the period's peak hour. For many of the intersections, the highest traffic levels occurred from 7:45 AM to 8:45 AM. The highest evening peak hour traffic occurred from 5 PM to 6 PM.

Figure 1:5 indicates the morning and evening peak period traffic counts for both the CMP intersections and the other signalized intersections in the study area.

A review of the counts indicated that El Camino Real carries significant daily volumes, between 45,000 to 55,000 average daily vehicles (ADT). Page Mill Expressway carries nearly 50,000 vehicles per day near the El Camino Real Corridor. Other significant roadways include University Avenue / Palm Drive (30,000 ADT), Embarcadero Road / Galvez (28,000 ADT), Charleston Road / Arastradero (25,000 ADT), and Sand Hill / Alma / Sand Hill Road (18,000 ADT). The remainder of the cross-streets carry volumes less than 10,000 ADT.

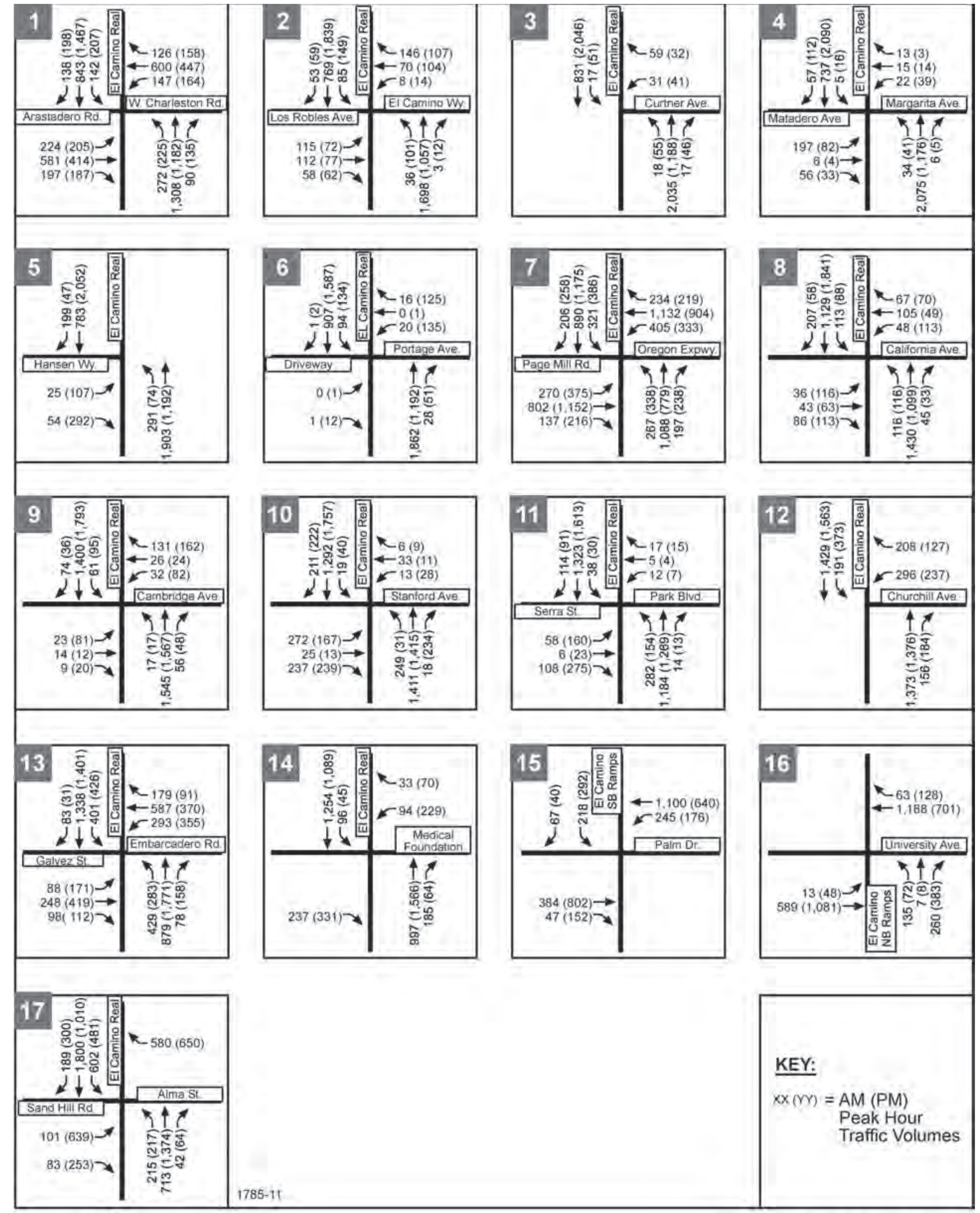
Figure 1:6 indicates the daily traffic volumes on the corridor.

## Bicycle & Pedestrian Counts

Bicycle and pedestrian counts were also taken at five intersections in the corridor, identified as among the highest-activity locations:

- El Camino Real / Serra Street;
- El Camino Real / Stanford Avenue;
- El Camino Real / California Avenue;
- El Camino Real / Arastradero Road; and
- El Camino Real / Page Mill Road.

Like the traffic counts, these bicycle and pedestrian counts were taken during April 2002 during the morning and evening peak periods (7-9 AM and 4-6 PM). These counts indicated that the overall level of bicycle and pedestrian activity was limited. The highest bicycle and pedestrian volumes occurred at the intersection of El Camino Real and California Avenue. There was some bicycle and pedestrian traffic at both the Page Mill and Charleston/Arastradero intersections with El Camino Real. Minimal bicycle and pedestrian activity was found at the remaining two intersections. These bicycle and pedestrian counts are shown on Figure 1:7.

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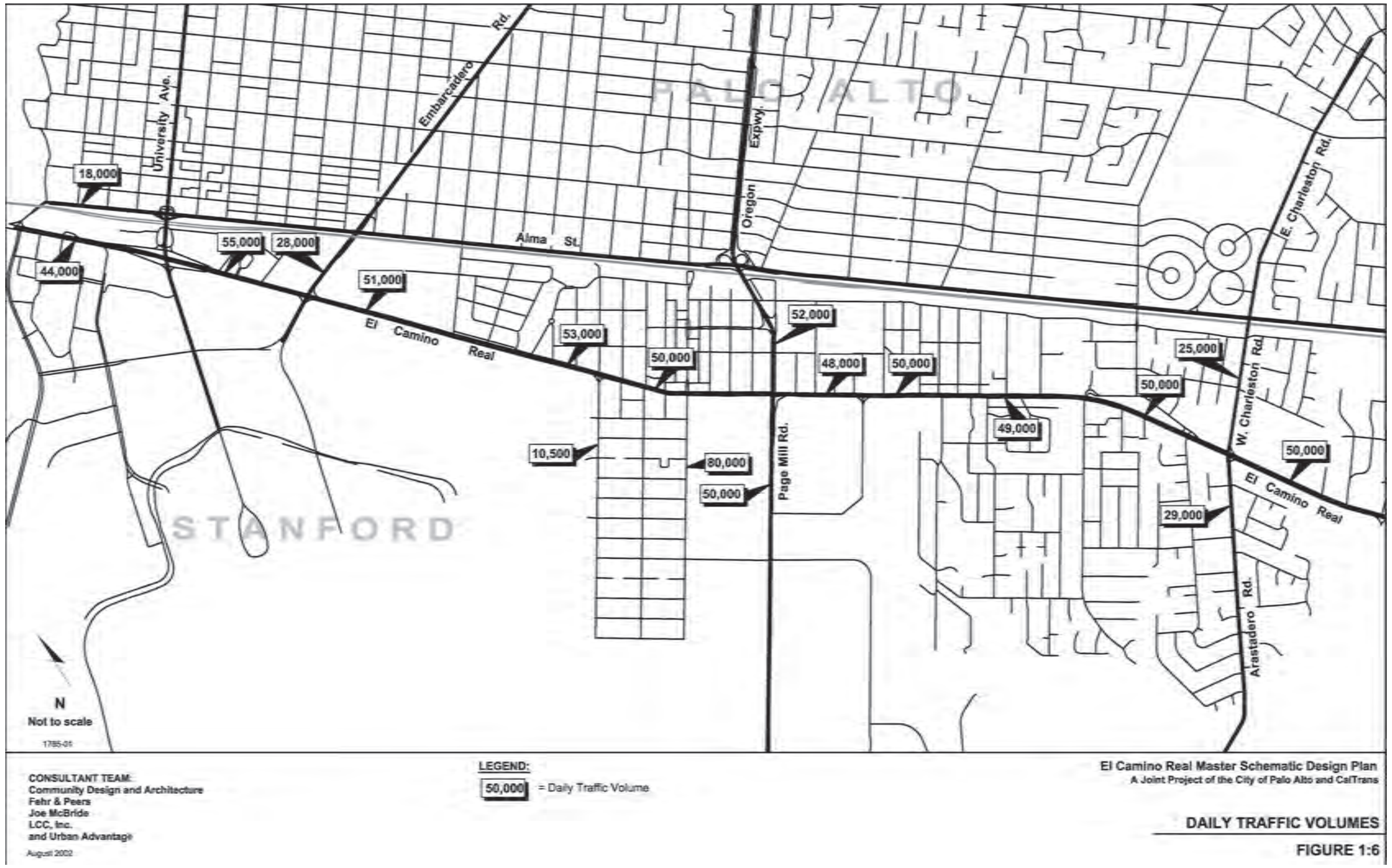
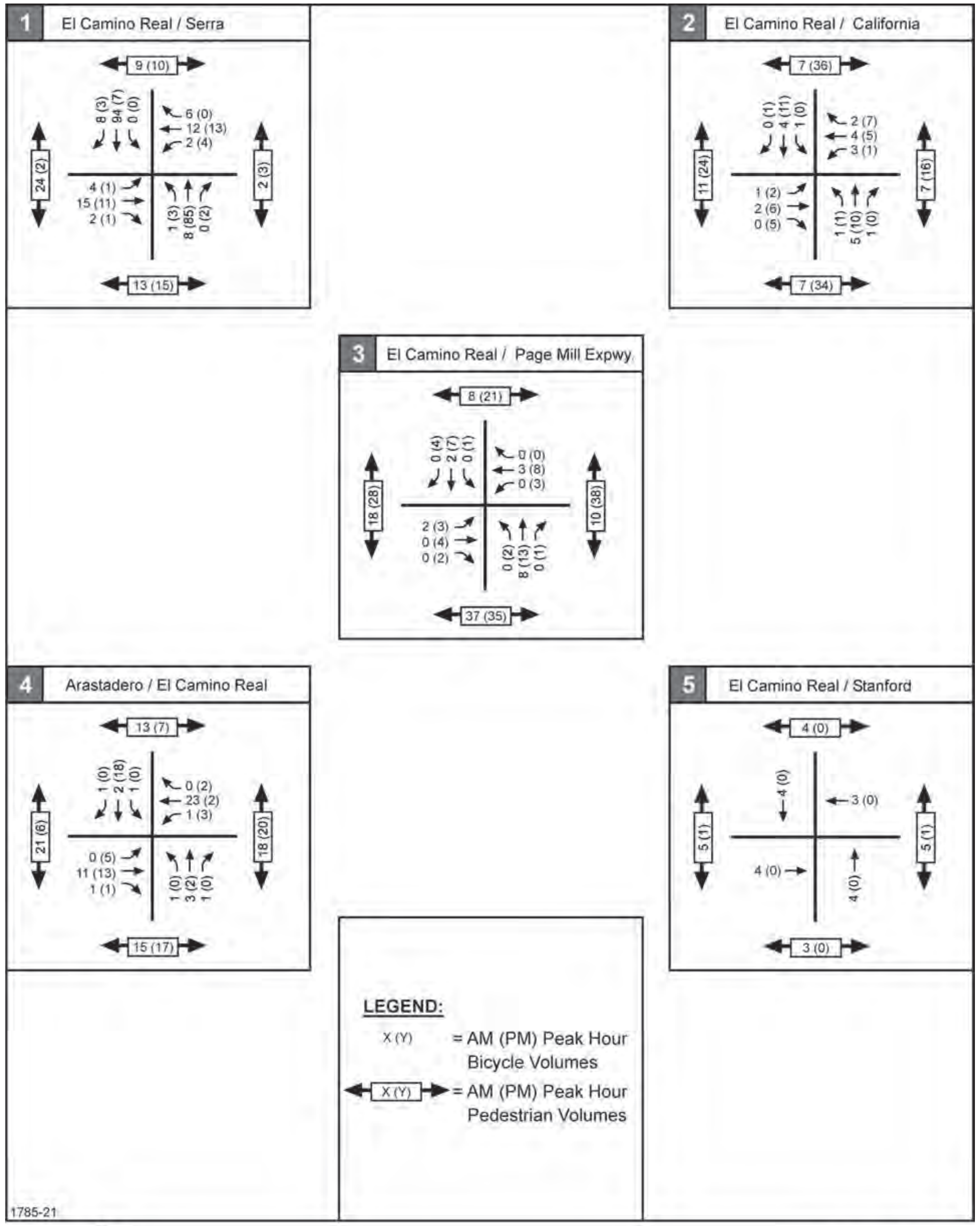
El Camino Real Schematic Design
**EXISTING PEAK HOUR TRAFFIC VOLUMES**
**FIGURE 1:5**




DAILY TRAFFIC VOLUMES

FIGURE 1:6

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El Camino Schematic

**EXISTING**
**BICYCLE AND PEDESTRIAN VOLUMES**

**FIGURE 1:7**

## Traffic Level of Service

Caltrans provided traffic signal data and traffic signal coordination segments. The traffic counts were combined with the traffic signal data to determine the intersection operations during the existing conditions.

The LOS analysis consisted of a two-step approach. The first step was to analyze the intersections under the jurisdiction of the VTA. These intersections were analyzed utilizing VTA's procedures and methodologies, which are based on the *1985 Highway Capacity Manual*. The second step was to employ CORSIM to analyze the intersection performance for all study area intersections utilizing the delay and LOS calculations contained in the *2000 Highway Capacity Manual.*

Table 1:6 provides the corresponding Level of Service for the level of stopped delay, which is applicable to the VTA intersections only. These LOS thresholds and delay calculations are taken from VTA's *Transportation Impact Analysis (TIA) Guidelines*. VTA analysis addresses the evening peak hour period only. LOS E is considered an acceptable condition by the VTA.

**Table 1:6**

**Signalized Intersection Level of Service Definitions (VTA Intersections)**

**Using Average Stopped Vehicular Delay**

| Level of Service | Average Stopped Delay Per Vehicle (Seconds) | Description |
|---|---|---|
| A | ≤ 5.0 | Operations with very low delay occurring with favorable progression and/or short cycle length. |
| B+ | 5.1 to 7.0 | Operations with low delay occurring with good progression and/or short cycle lengths. |
| B | 7.1 to 13.0 | |
| B- | 13.1 to 15.0 | |
| C+ | 15.1 to 17.0 | Operations with average delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures begin to appear. |
| C | 17.1 to 23.0 | |
| C- | 23.1 to 25.0 | |
| D+ | 25.1 to 28.0 | Operations with longer delays due to a combinations of unfavorable progression, long cycle lengths, and high V/C ratios. Many vehicles stop and individual cycle failures are noticeable. |
| D | 28.1 to 37.0 | |
| D- | 37.1 to 40.0 | |
| E+ | 40.1 to 44.0 | Operations with high delay values indicating poor progression, long cycle lengths, and high V/C ratios. Individual cycle failures are frequent occurrences. |
| E | 44.1 to 56.0 | |
| E- | 56.1 to 60.0 | |
| F | > 60.0 | Operations with delays unacceptable to most drivers occurring due to over-saturation, poor progression, or very long cycle lengths. |

Source: VTA's CMP Transportation Impact Analysis Guidelines, May 7, 1998, and Transportation Research Board, Highway Capacity Manual, Special Report 209, 1994.

As shown in Table 1:7, all of the intersections under jurisdiction of the VTA operate at acceptable LOS standards. These LOS calculations were provided by the City of Palo Alto and reflect the VTA assumed signal timings and LOS methodologies as implemented by Traffix.

**Table 1:7**

**Existing (Year 2002) Intersection Levels of Service- VTA Intersections**

| Intersection | Peak Hour | Average | LOS2 |
|---|---|---|---|
| El Camino Real / Arastradero Road* | PM | 36.4 | D |
| El Camino Real / Page Mill Road* | PM | 41.4 | E |
| El Camino Real / Embarcadero Road / Galvez Street* | PM | 46.9 | E |
| El Camino Real / Alma Street* | PM | 31.8 | D |

Notes: 1 Average stopped delay expressed in seconds per vehicle. 2 LOS = Level of service. Calculations performed using the 1985 Highway Capacity Manual (HCM) methodology for signalized intersections*

Source: City of Palo Alto, June 2002

The second LOS analysis employed CORSIM software to analyze the intersection LOS at all study area intersections. The CORSIM software implemented the *2000 Highway Capacity Manual* delay and LOS methodologies as opposed to the Traffix analysis from the City of Palo Alto, which implemented the *1985 Highway Capacity Manual*.

The primary difference between the two programs is that Traffix analyzes intersections in "isolation", and does not include the effects of upstream and downstream intersections. CORSIM analyzes intersections as a "system", with intersections directly effecting traffic flow through the entire corridor. In addition, CORSIM presents a detailed microscopic traffic simulation that is used effectively to evaluate the operational benefits of signal coordination, especially between closely-spaces signalized intersections. The LOS standards applied by CORSIM are provided in Table 1:8 and implement the *2000 Highway Capacity Manual*. Figure 8 indicates the LOS for each of the study area intersections.

**Table 1:8**

**Signalized Intersection Level Of Service Definitions (CORSIM)**

| Level of Service | Description of Traffic Conditions | Total Control Delay (seconds/vehicle) |
|---|---|---|
| A | No approach phase is fully utilized and no vehicle waits longer than one red indication. | < 10.0 |
| B | An occasional approach phase is fully utilized. Drivers begin to feel restricted. | 10.1 to 20.0 |
| C | Major approach phase may become fully utilized. Most drivers feel somewhat restricted. | 20.1 to 35.0 |
| D | Drivers may wait through more than one red indication. Queues may develop but dissipate rapidly, without excessive delays. | 35.1 to 55.0 |
| E | Volumes approaching capacity. Vehicles may wait through several signal cycles and long vehicle queues form upstream. | 55.1 to 80.0 |
| F | Represents conditions at capacity, with extremely long delays. Queues may block upstream intersections. | > 80 |

Source: Highway Capacity Manual, Special Report 209 and Transportation Research Board, 2000.

**Table 1:9**

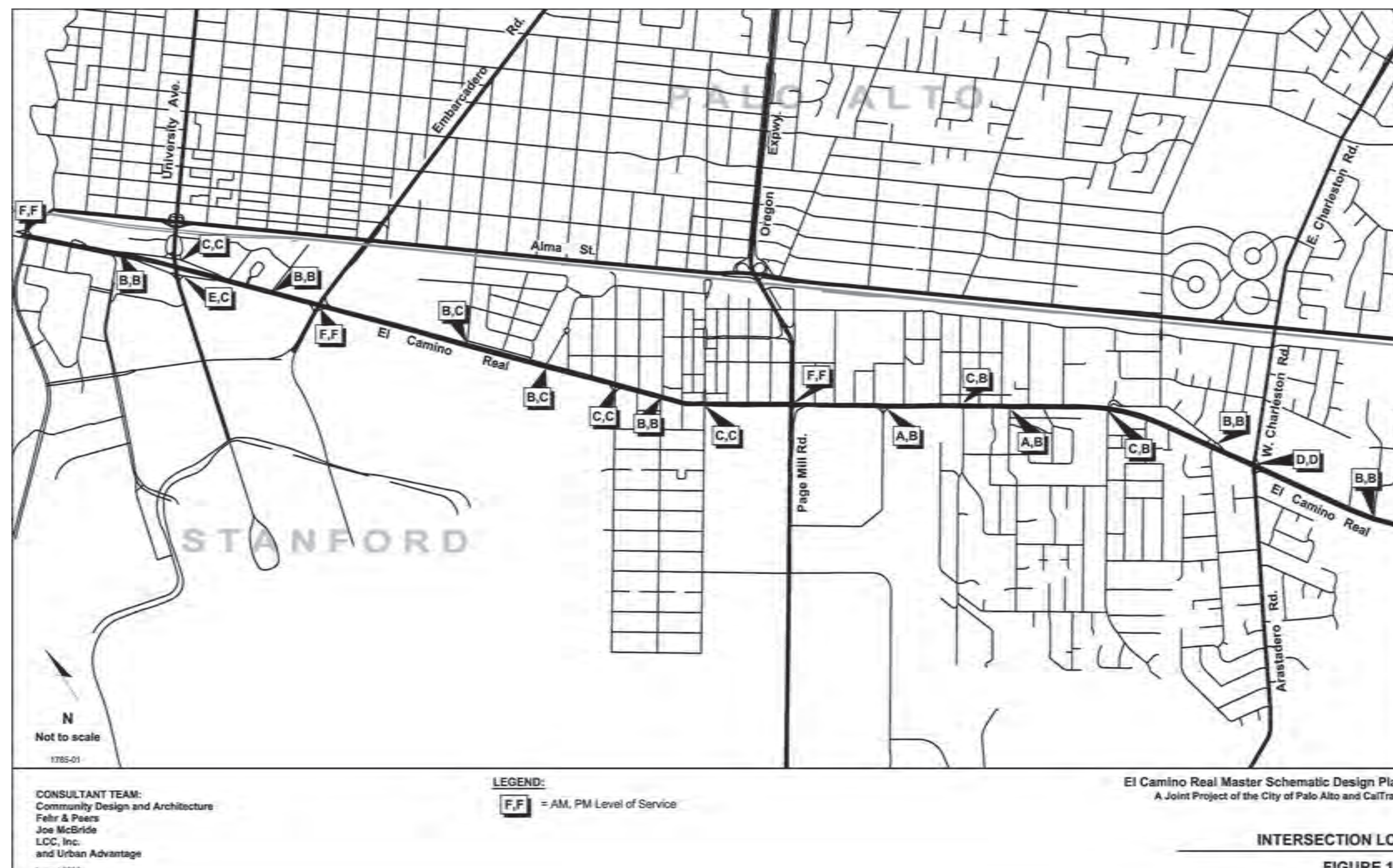
**Existing (Year 2002) Intersection Levels of Service- (All Intersections analyzed with CORSIM)**

| Intersection | Peak | Average Intersection Delay1 | LOS2 |
|---|---|---|---|
| El Camino Real / Dinah's Court | AM | 8.9 | A |
| | PM | 11.8 | B |
| El Camino Real / Arastradero Road* | AM | 35.1 | D |
| | PM | 40.8 | D |
| El Camino Real / Maybell Avenue | AM | 28.2 | C |
| | PM | 24.5 | C |
| El Camino Real / Los Robles Avenue | AM | 18.4 | B |
| | PM | 23.0 | C |
| El Camino Real / Curtner Avenue | AM | 11.6 | B |
| | PM | 11.8 | B |
| El Camino Real / Matador Avenue | AM | 23.4 | C |
| | PM | 16.3 | B |
| El Camino Real / Hansen Way | AM | 17.8 | B |
| | PM | 13.9 | B |
| El Camino Real / Portage Avenue | AM | 12.1 | B |
| | PM | 29.1 | C |
| El Camino Real / Page Mill Road* | AM | 54.5 | D |
| | PM | 48.2 | D |
| El Camino Real / California Avenue | AM | 24.1 | C |
| | PM | 22.4 | C |
| El Camino Real / Cambridge Avenue | AM | 10.8 | B |
| | PM | 12.3 | B |
| El Camino Real / Stanford Avenue | AM | 27.1 | C |
| | PM | 18.2 | B |
| El Camino Real / Serra Street | AM | 20.1 | C |
| | PM | 15.6 | B |
| El Camino Real / Churchill Avenue | AM | 22.8 | C |
| | PM | 25.2 | C |
| El Camino Real / Embarcadero Rd / Galvez Street* | AM | 75.6 | E |
| | PM | 75.9 | E |
| El Camino Real / Medical Fountain Drive | AM | 18.7 | B |
| | PM | 21.2 | C |
| El Camino Real / Palm Drive Ramps NB** | AM | 13.2 | B |
| | PM | 15.6 | B |
| El Camino Real / Palm Drive Ramps SB** | AM | 9.0 | A |
| | PM | 12.9 | B |
| El Camino Real / Quarry Road | AM | 12.7 | B |
| | PM | 24.1 | C |
| El Camino Real / Alma Street* | AM | 27.2 | C |
| | PM | 43.2 | D |

Notes: 1 Average stopped delay expressed in seconds per vehicle. 2 LOS = Level of service. Calculations performed using the 2000 Highway Capacity Manual (HCM)

* Designated Congestion Management Program (CMP) Intersection.

** Intersections located on bridge over El Camino Real rather than on El Camino Real itself.



## Pedestrian Crossings

In addition to the vehicular level of service, each intersection was further analyzed to determine if sufficient crossing times are provided to pedestrians. Sufficient crossing time ensures that pedestrians who push a walk button are provided with enough time to cross the roadway. Currently, Caltrans bases the walk time on an assumed 4–feet-per-second pedestrian walking speed. Caltrans provides 3 seconds of solid “WALK” symbol on the crossing signal, before the signal begins flashing “DON’T WALK”. As a comparison, the City of Palo Alto provides, wherever possible, longer crossing times, allowing a slower walking speed of 3.5 feet per second, and providing 7 seconds of solid “WALK”.

Table 1:10 indicates the pedestrian crossing time provided at each El Camino Real intersection and determines whether this time is sufficient or not by both the Caltrans and City of Palo Alto standard. Based on this data, it can be concluded that sufficient pedestrian crossing times are not provided by many of the intersections along the corridor. Intersections such as Hansen and Portage provide only a little more than half of the Palo Alto preferred pedestrian crossing time, and intersections such as Serra, Stanford, and California provide only about 70% of the desired time. In general, the distance required to cross all six lanes of El Camino Real is 104 feet.

**Table 1:10**

**Intersection Crossing Times for Pedestrians**

| Intersection | Crossing Time Provided 1 | Distance 2 | Adequate by Caltrans Standard | Adequate by Palo Alto Standard |
|---|---|---|---|---|
| El Camino Real / Arastradero Road | 30 | 104 | Yes | No |
| El Camino Real / El Camino Way | 31 | 104 | Yes | No |
| El Camino Real / Curtner Avenue | 30 | 104 | Yes | No |
| El Camino Real / Matador Avenue | 27 | 104 | Yes | No |
| El Camino Real / Hansen Way | 21 | 104 | No | No |
| El Camino Real / Portage Avenue | 21 | 104 | No | No |
| El Camino Real / Page Mill Road | 28 | 104 | Yes | No |
| El Camino Real / California Avenue | 26 | 104 | Yes | No |
| El Camino Real / Cambridge Avenue | 29 | 104 | Yes | No |
| El Camino Real / Stanford Avenue | 26 | 104 | Yes | No |
| El Camino Real / Serra Street | 26 | 104 | Yes | No |
| El Camino Real / Churchill Avenue | 26 | 104 | Yes | No |
| El Camino Real / Embarcadero Road / Galvez Street | 30 | 104 | Yes | No |
| El Camino Real / Medical Fountain Drive | 37 | 104 | Yes | Yes |
| El Camino Real / Alma Street | 25 | 104 | No | No |

Notes: 1 Don’t Walk Time Provided + Yellow & Red Time

2 Assumes Walking Speed of 3.5 feet per second

Source: Fehr & Peers Associates
June 2002

## Transit Operations and Ridership

The El Camino Real corridor has extensive transit service from a variety of operators including VTA, SamTrans, and the Stanford Marguerite Shuttle.

The most complete transit service is provided by VTA, which operates two bus lines along the entire length of the corridor. These lines are Line 22, and Line 33. Line 22 is the regular service while Line 300 is express service. These lines extend through Palo Alto to San Jose.

For Line 22, service begins at 5:30 AM and terminates at 2 AM on throughout the week. Buses run at 9-11 minute on the weekday peak periods and 15 minute intervals on the weekends. Headways for the other periods range from 20 to 60 minutes. Line 300 service begins at 6 AM and ends at 8 PM. Headways average 20 minutes during the peak periods and 30 minutes during the off-peak periods.

Within Palo Alto, Line 22 has about 2,500 daily passenger boardings in northbound direction and an equal number of boardings for the southbound route. These total boardings represent approximately 20 percent of the total boardings for the entire line. The major boarding locations of this line through the corridor include the Palo Alto Transit Center on University Avenue near El Camino Real (1,400 total boardings) and the El Camino Real / California Avenue area (400 total boardings). The Palo Alto Transit Center has the second highest boardings along Line 22/300.

Additional transit operators include SamTrans and the Stanford Marguerite Shuttle. SamTrans regular service includes routes 280, 281, 282, which operate on 30-minute headways. Express routes operated by SamTrans include RX and PX, which stop at the Palo Alto Caltrain Station and the Page Mill Expressway respectively.

The Marguerite Shuttle, which serves Stanford University and other locations throughout Palo Alto and Menlo Park, operates on a 12-15 minute headway.

Much of the transit on El Camino Real accesses the Palo Alto Transit Center and the Caltrain Station located on University Avenue. This station serves 3,000 passengers per day with over 700 buses stopping at this station per day from all the different transit companies (VTA, SamTrans, Marguerite).

It should be noted that the VTA is developing plans to upgrade bus service by implementing Bus Rapid Transit (BRT). BRT represents upgraded bus service through the use of specialized stations, automated vehicle systems, and other recent transit advances (this is discussed further at the end of this Chapter in the *Transportation Planning* Section).

## Truck Routes

El Camino Real is a designated truck route along its entire length in Palo Alto, and is one of the only north/south truck routes in the City. According to Caltrans counts, about 2% to 3% of the average daily traffic on El Camino Real is medium and large trucks.

Several of the major streets that intersect El Camino Real are also truck routes: Page Mill, Embarcadero, and Alma. To accommodate the special turning requirements of large trucks, any re-design of the maneuvering radii at their intersections with El Camino need to provide adequate turning radii for large vehicles.

## Travel Time Analysis

Data was collected related to relative travel speeds and travel times for El Camino Real and other parallel roadways:

- Middlefield
- Alma Street
- Cowper-Waverly

These roadways were selected based on consultations with City of Palo Alto Staff. Travel times were collected for each of these routes during May 2002.

The data was collected utilizing GPS receivers. These units were installed in Fehr & Peers staff vehicles who then drove the corridor during morning and evening peak hour travel times, maintaining consistent speeds with other vehicles on the road. Approximately 80 travel time runs were performed on all four roadways.

The analysis of the travel times considered the overall speed on each corridor, the number of stops, the free flow speed, and a graphical depiction of all travel time runs. While data was collected for each of the corridors, the analysis focuses on the travel times for the El Camino Real Corridor.

Based on the collected travel times, travel speeds were computed for each of the routes. Travel speeds are presented given the differences in length for each of the routes. These travel speed comparisons indicate that Alma Street has the highest travel speed, which is reasonable given its lack of traffic signals and cross-streets. El Camino Real has one of the lowest travel speeds along with Cowper-Waverly.

**Table 1:11**

**Average Total Travel Speed Comparison**

**(Includes impacts of congestion and traffic signal delay)**

| | AM | | PM | |
|---|---|---|---|---|
| | Southbound | Northbound | Southbound | Northbound |
| Middlefield | 17.61 mph | 17.24 mph | 17.68 mph | 17.33 mph |
| Alma Street | 24.35 mph | 26.02 mph | 21.48 mph | 27.24 mph |
| Cowper-Waverly | 16.67 mph | 16.44 mph | 18.03 mph | 18.15 mph |
| El Camino Real | 19.44 mph | 19.20 mph | 17.83 mph | 16.80 mph |

Note: This is the average travel speed over the entire study area, which stretched from the South Palo Alto City Limit to the North Palo Alto City Limit on El Camino Real. This speed includes the impacts of congestion and delays due to traffic signals.

Source: Fehr & Peers Associates, June 2002

This data was analyzed further to determine travel speed variations along the El Camino Real Corridor. The analysis considered the average number of stops, the average free flow travel speed, and the maximum speed. This analysis indicated that the overall travel speed was highest during the morning period and lowest during the PM period thereby indicating that the level of congestion was highest in the afternoon period. A graph of each study period is provided as Figures 1:9 through 1:16.

Additional analysis was taken in regards to the speed profile. Speed profiles are graphs of travel speed over time. As shown in Figures 1:17-1:20, the speed profile is quite uneven with numerous peaks and valleys during the peak periods. These peaks and valleys indicate that the drivers are racing from location to location and slowing down and stopping when forced by the traffic signals along the corridor.

**Table 1:12**

**Average Travel Speed (mph) and Number of Stops**

**(Excluding Time Spent Stopped due to Traffic Signals)**

| Date | Time | Direction | Average Speed (mph) | Average # of Stops Per Run |
|---|---|---|---|---|
| May 14, 2002 (Tuesday) | AM | NB | 29.54 | 7.60 |
| May 14, 2002 (Tuesday) | AM | SB | 27.73 | 8.50 |
| May 14, 2002 (Tuesday) | PM | NB | 30.12 | 6.20 |
| May 14, 2002 (Tuesday) | PM | SB | 26.78 | 7.75 |
| May 16, 2002 (Thursday) | AM | NB | 29.15 | 7.00 |
| May 16, 2002 (Thursday) | AM | SB | 27.43 | 8.67 |
| May 16, 2002 (Thursday) | PM | NB | 30.53 | 7.75 |
| May 16, 2002 (Thursday) | PM | SB | 26.90 | 9.33 |

Note: This is the average free-flow travel speed over the entire study area, which stretched from the South Palo Alto City Limit to the North Palo Alto City Limit on El Camino Real. This speed includes the impacts of congestion but does not include any delay from traffic signals.

Source: Fehr & Peers Associates June 2002

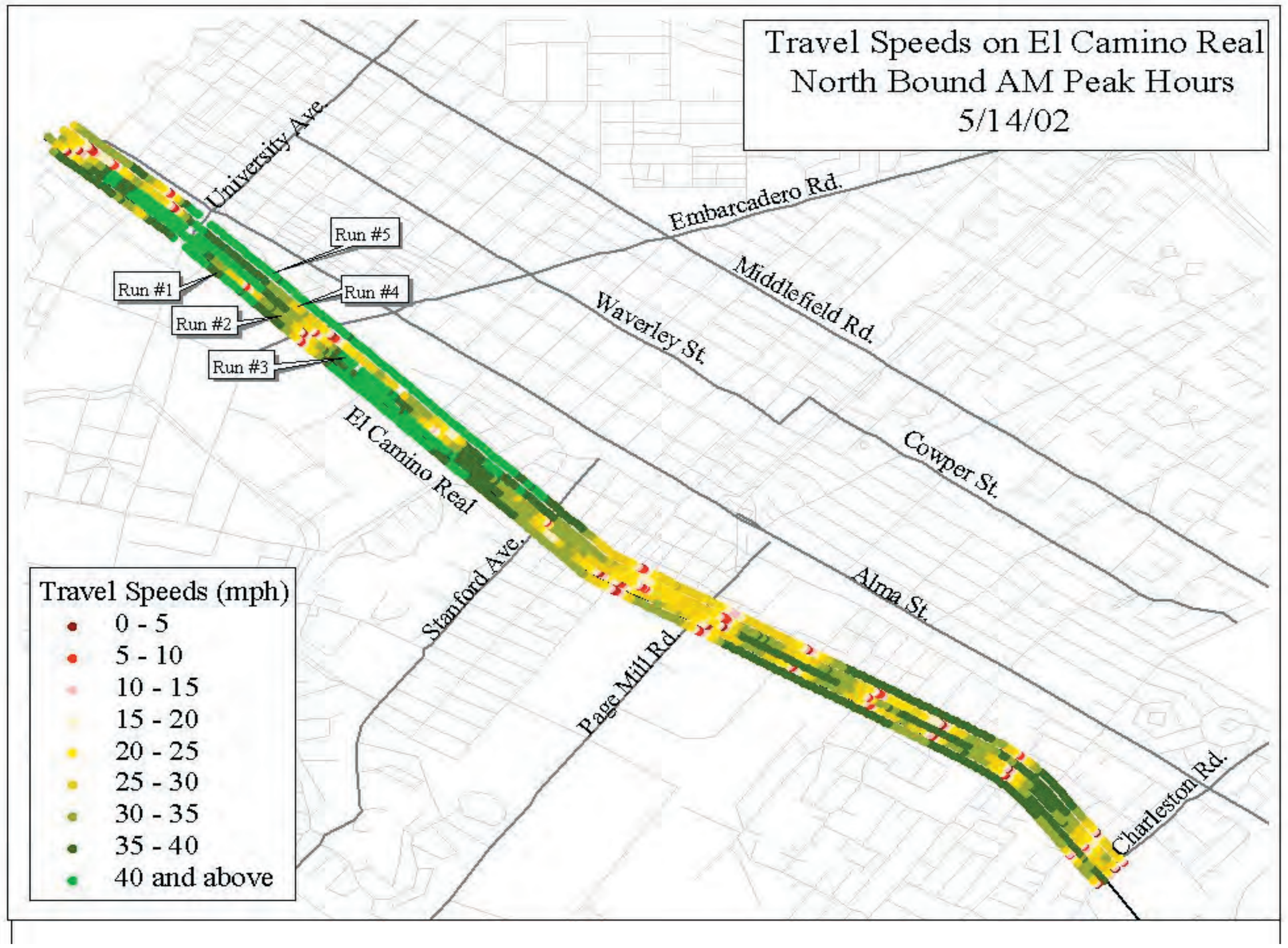
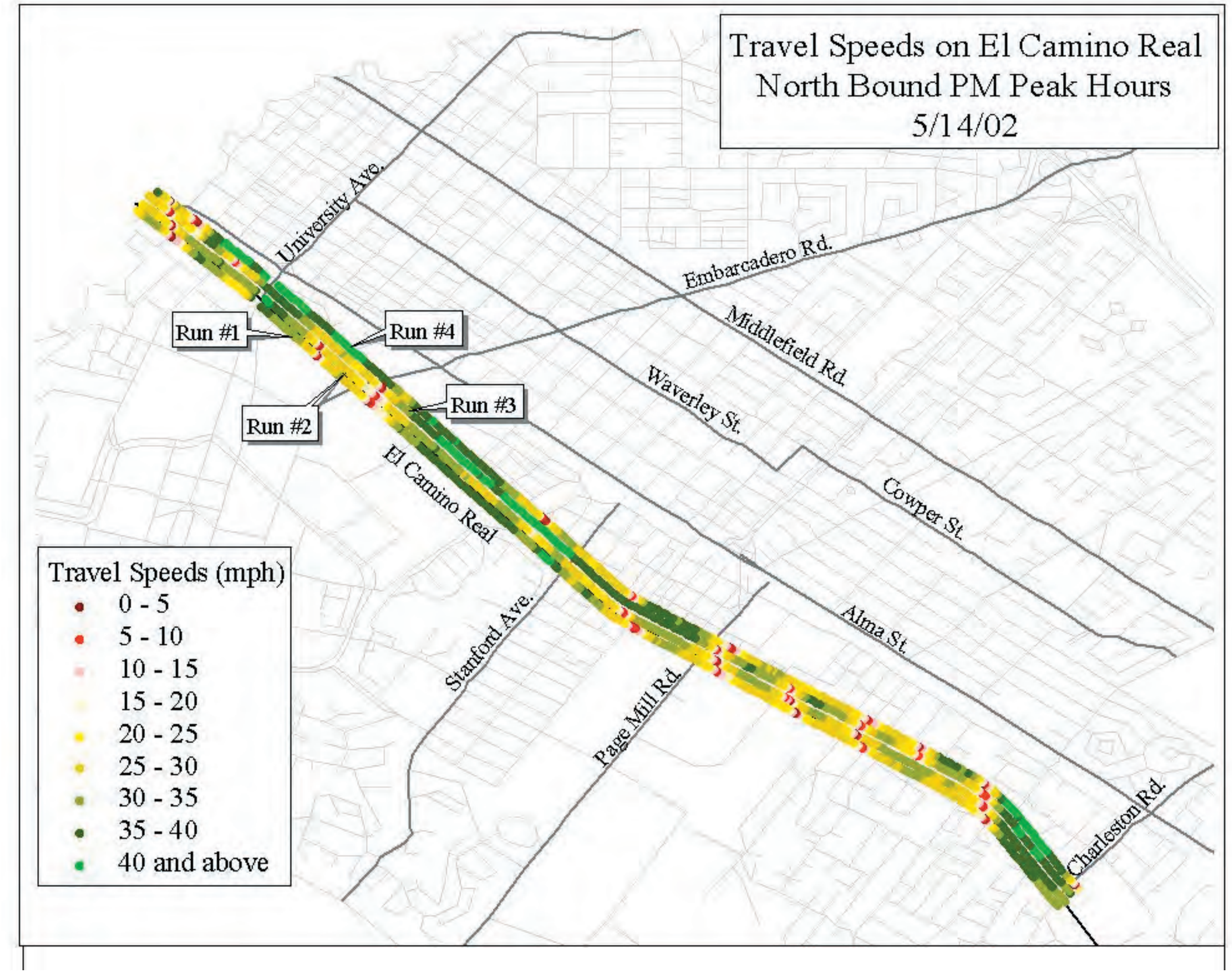



**Figure 1:9**

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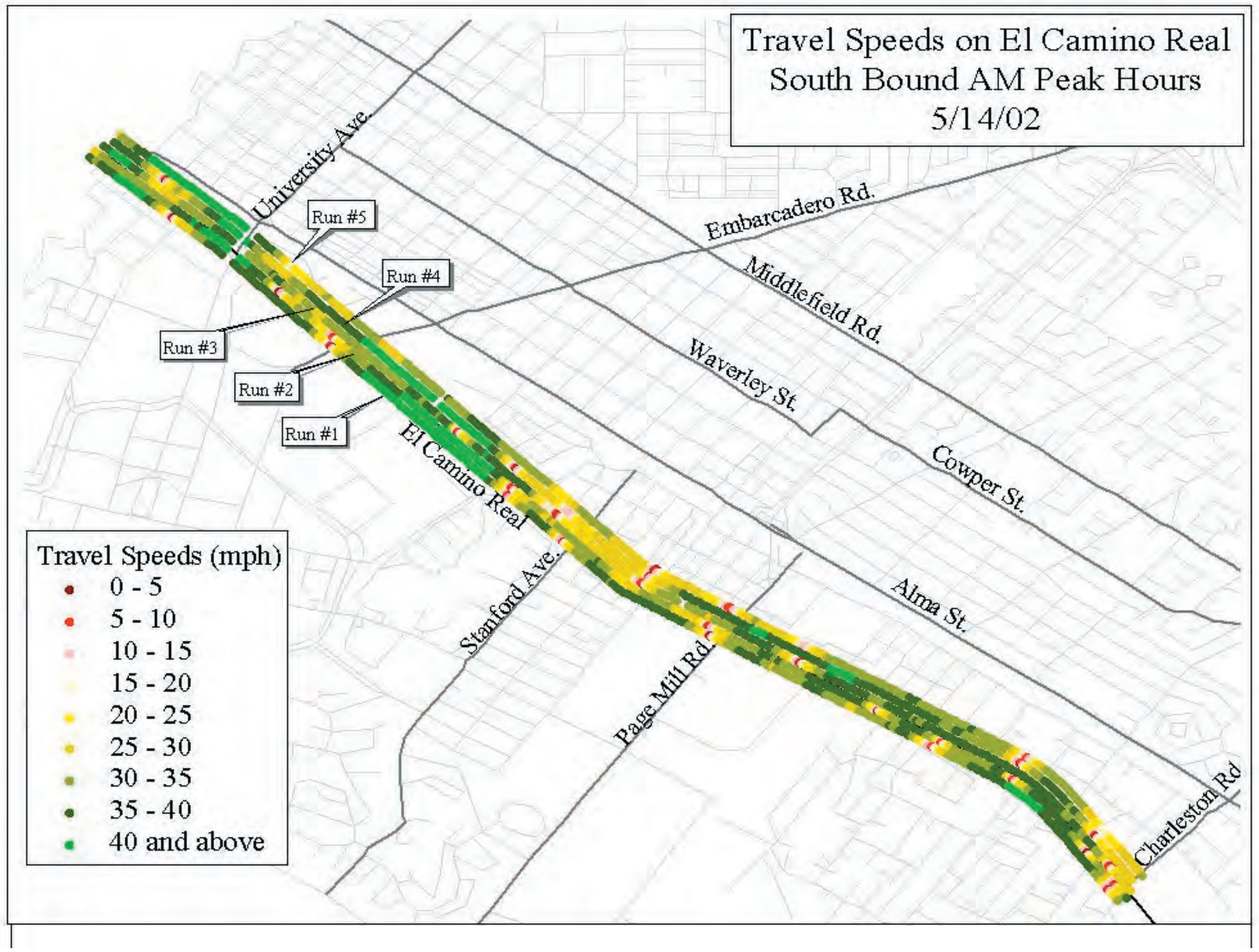


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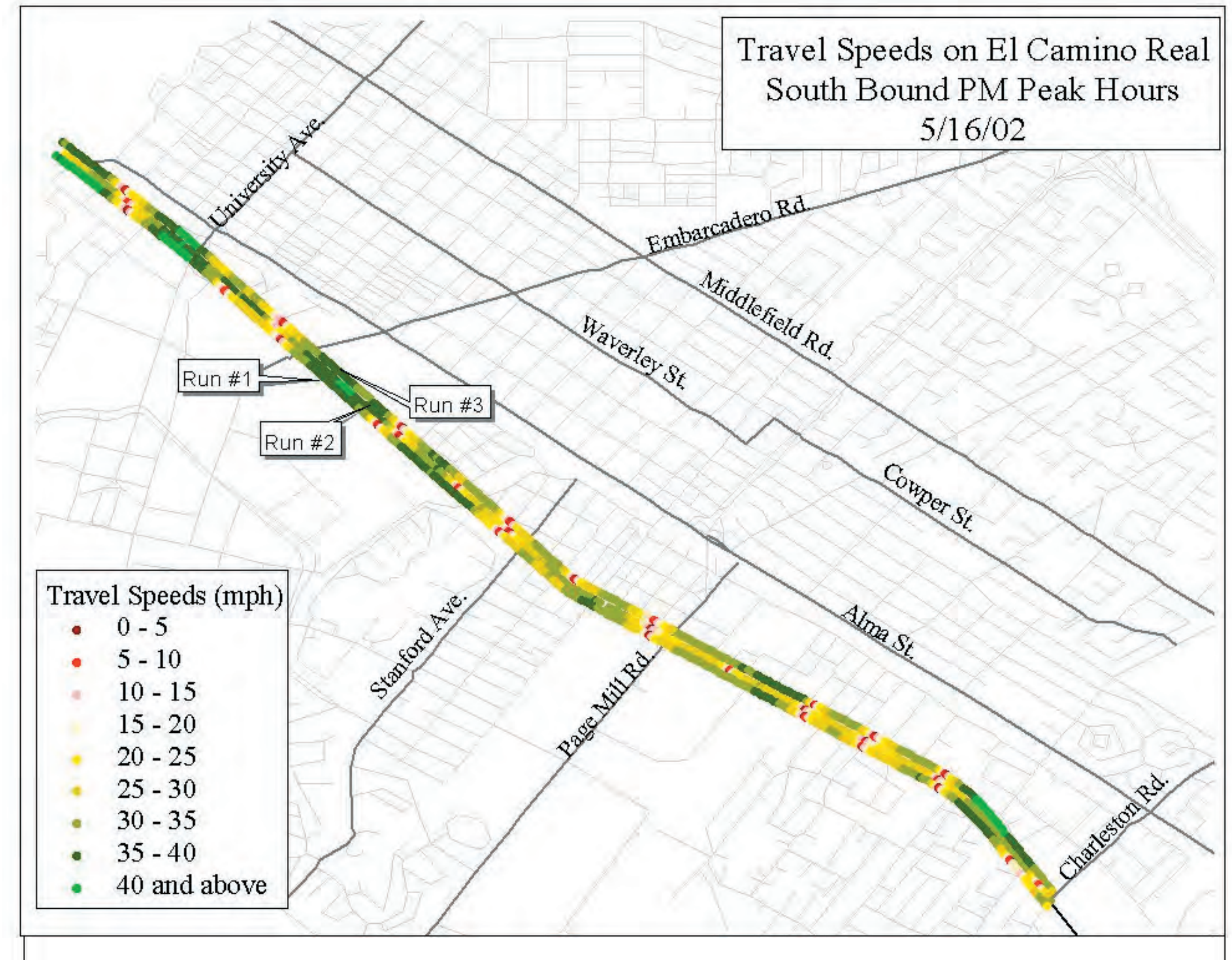
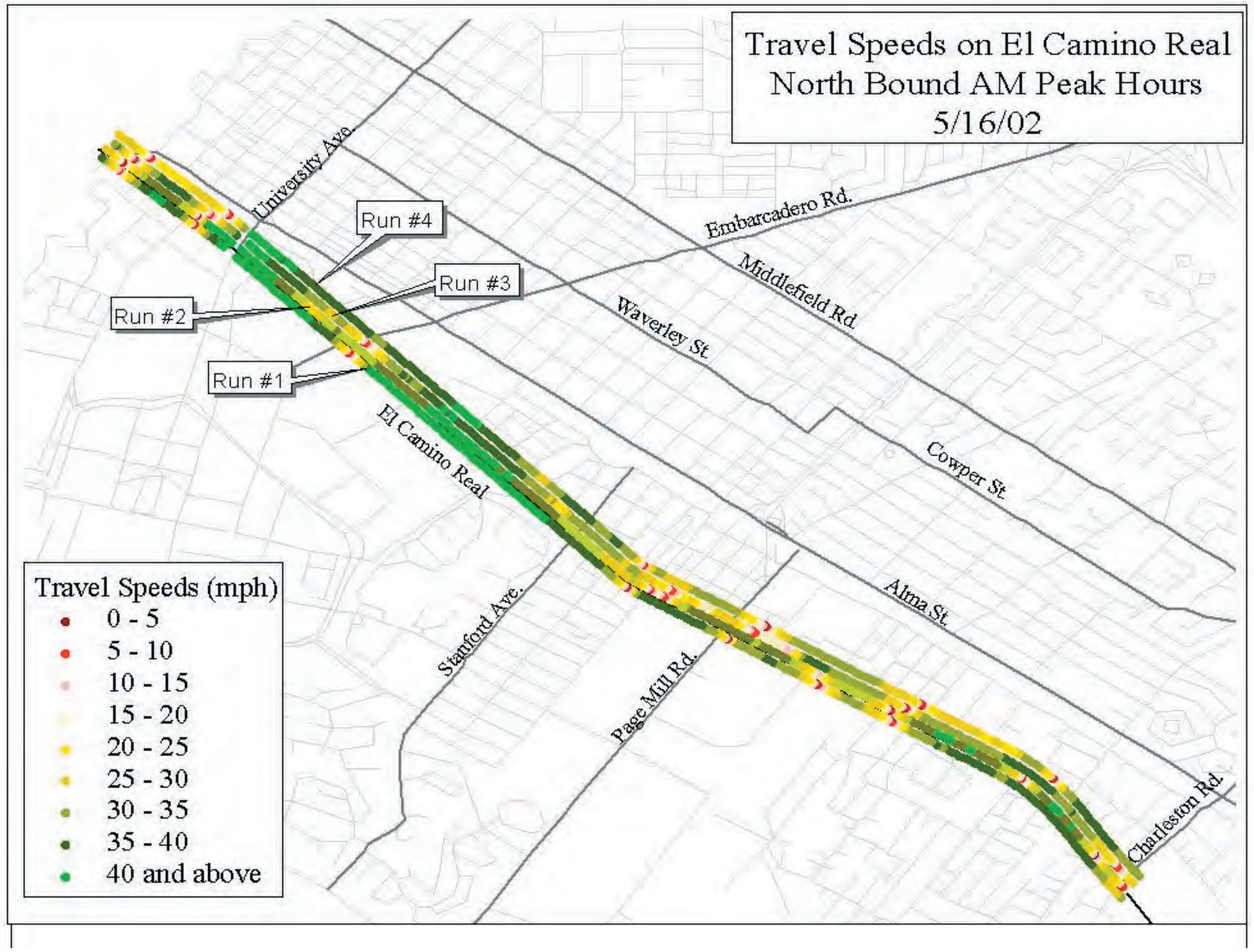



**Figure 1:12**

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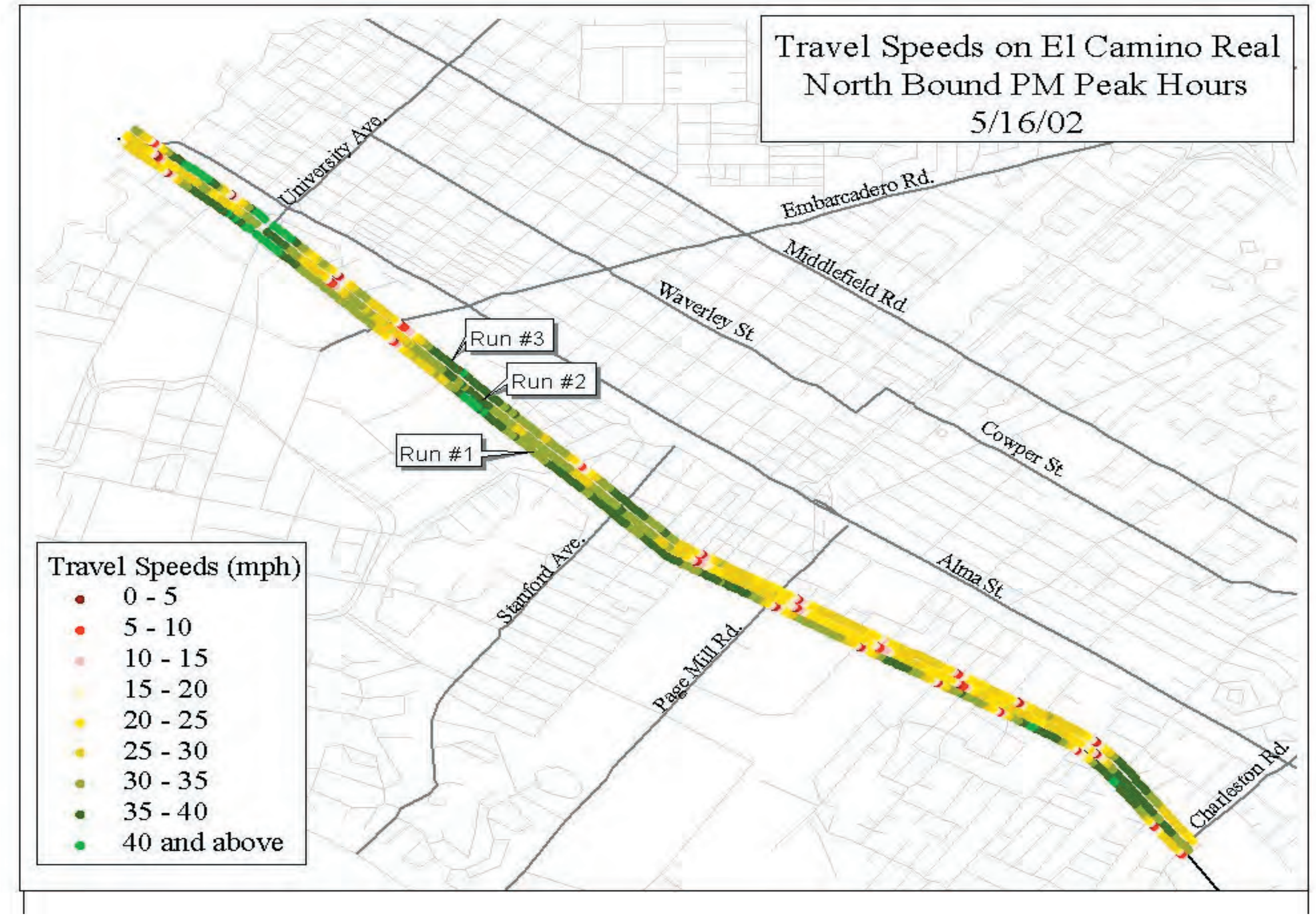


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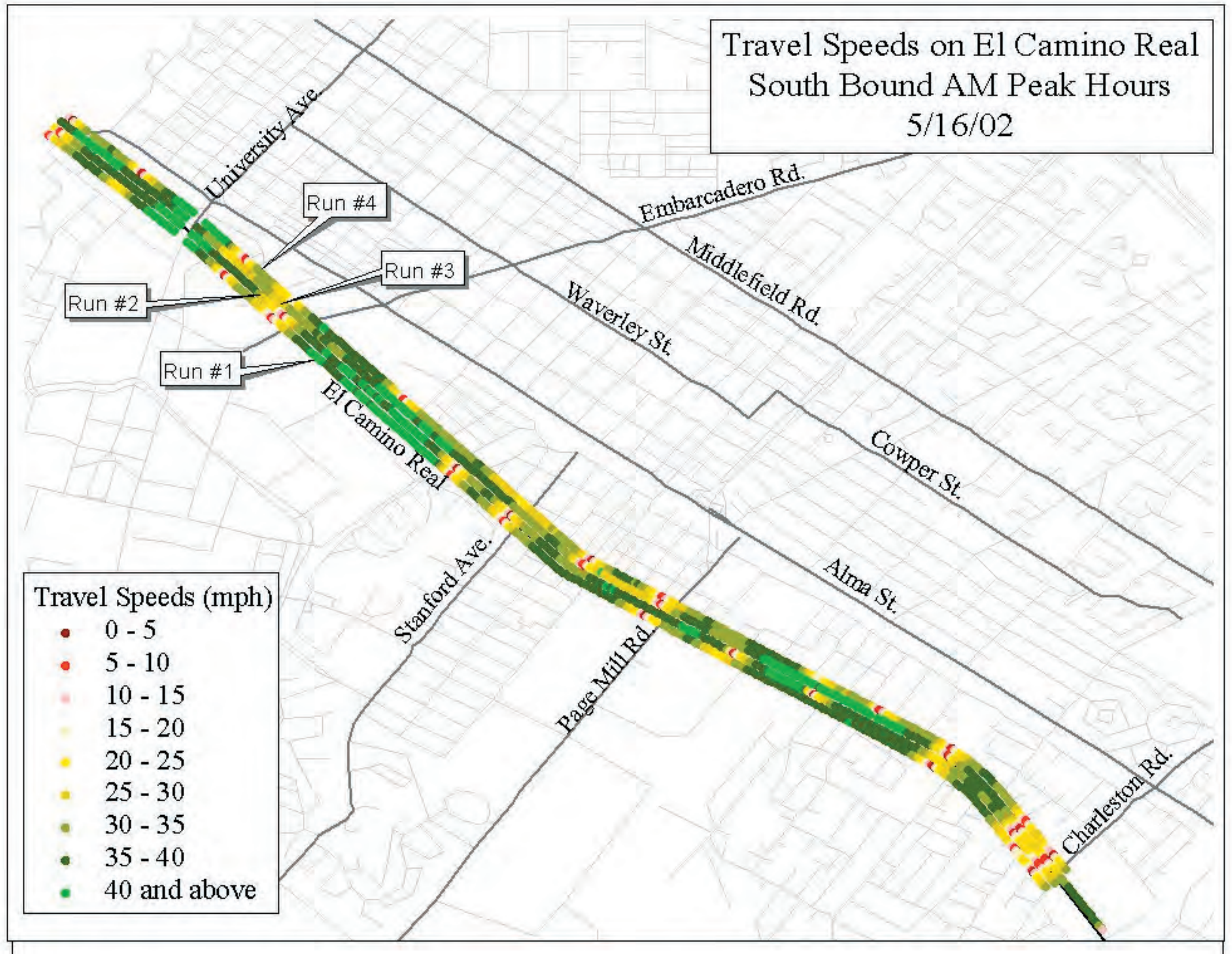


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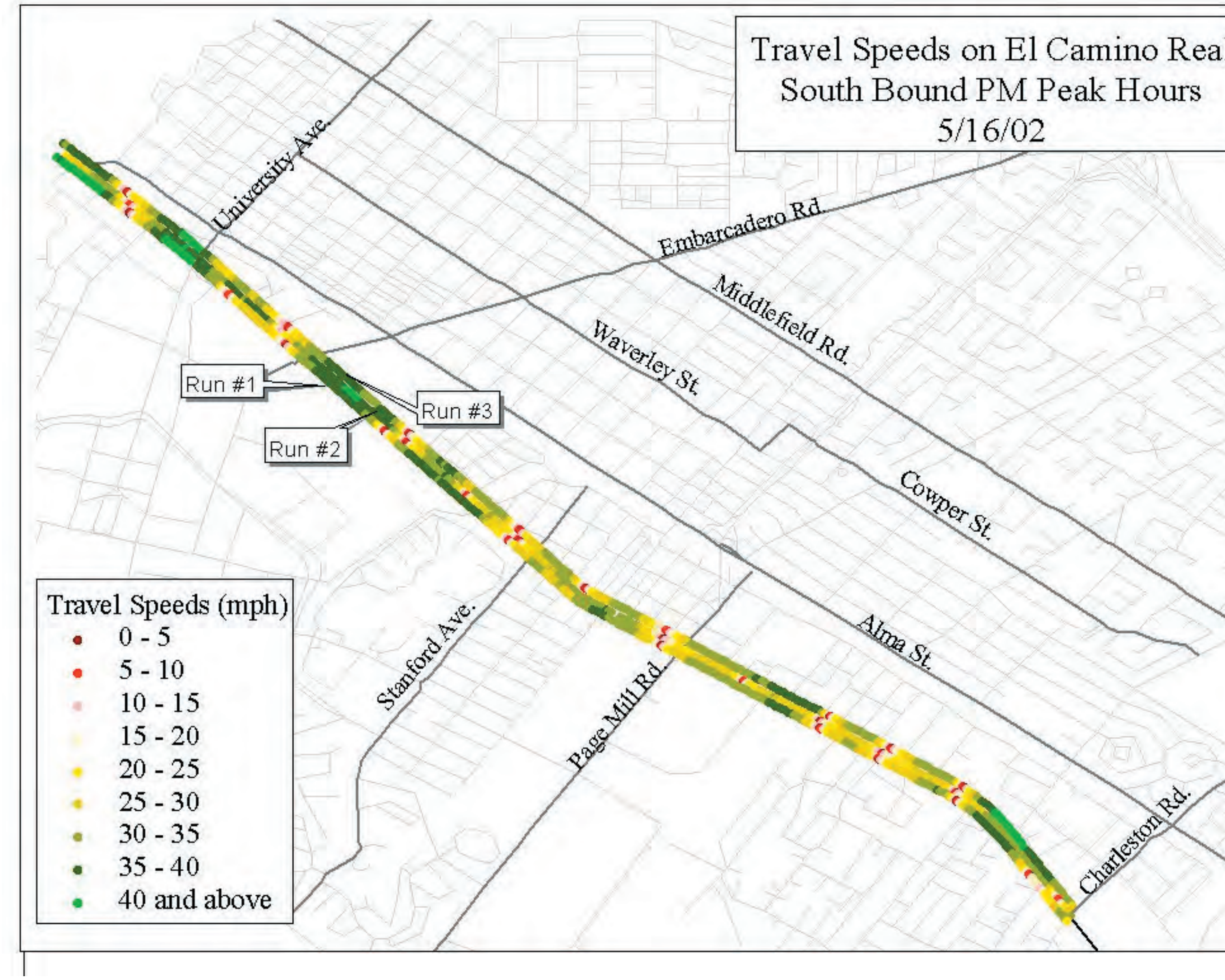



**Figure 1:16**

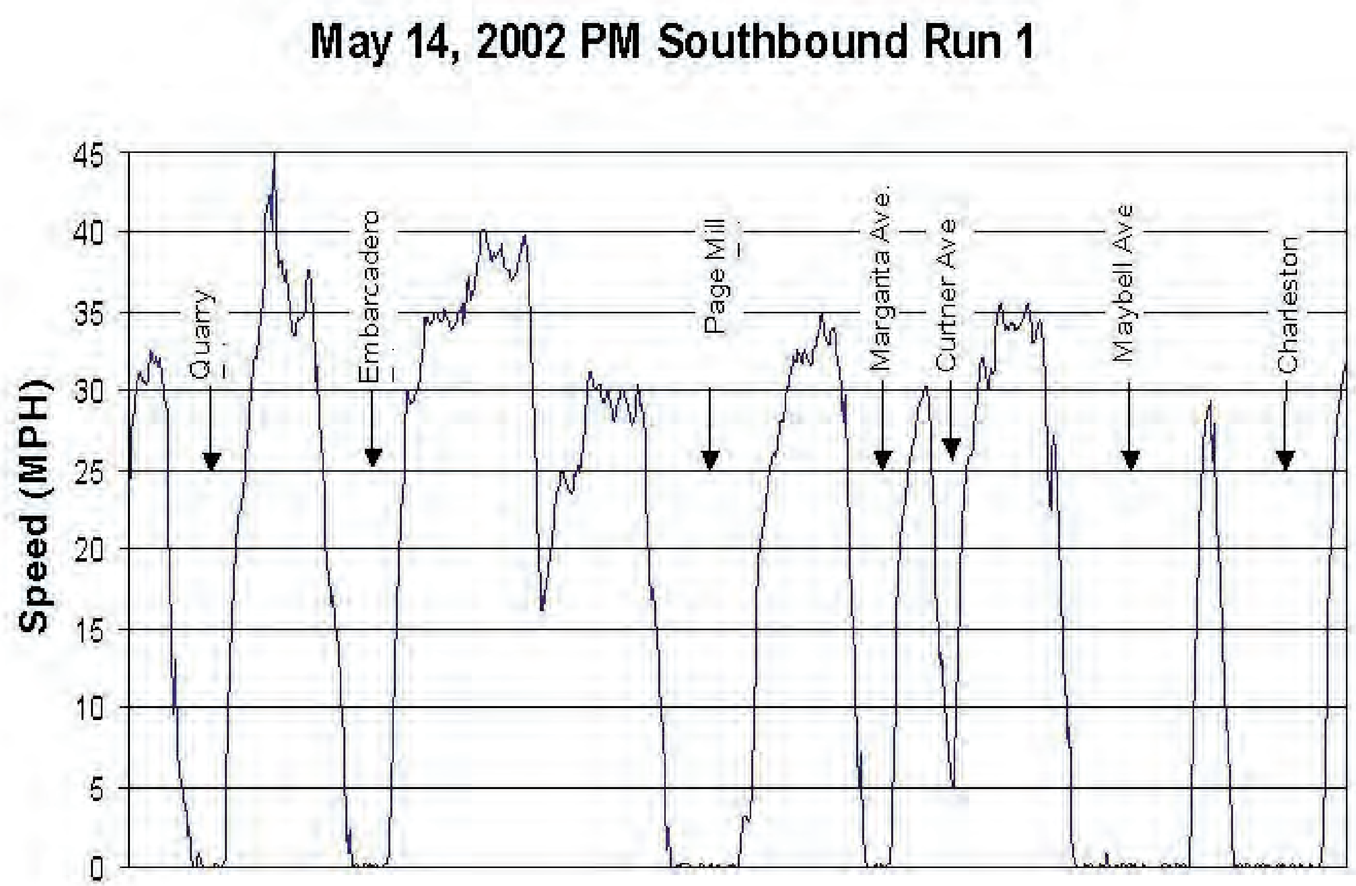



**Figure 1:17**

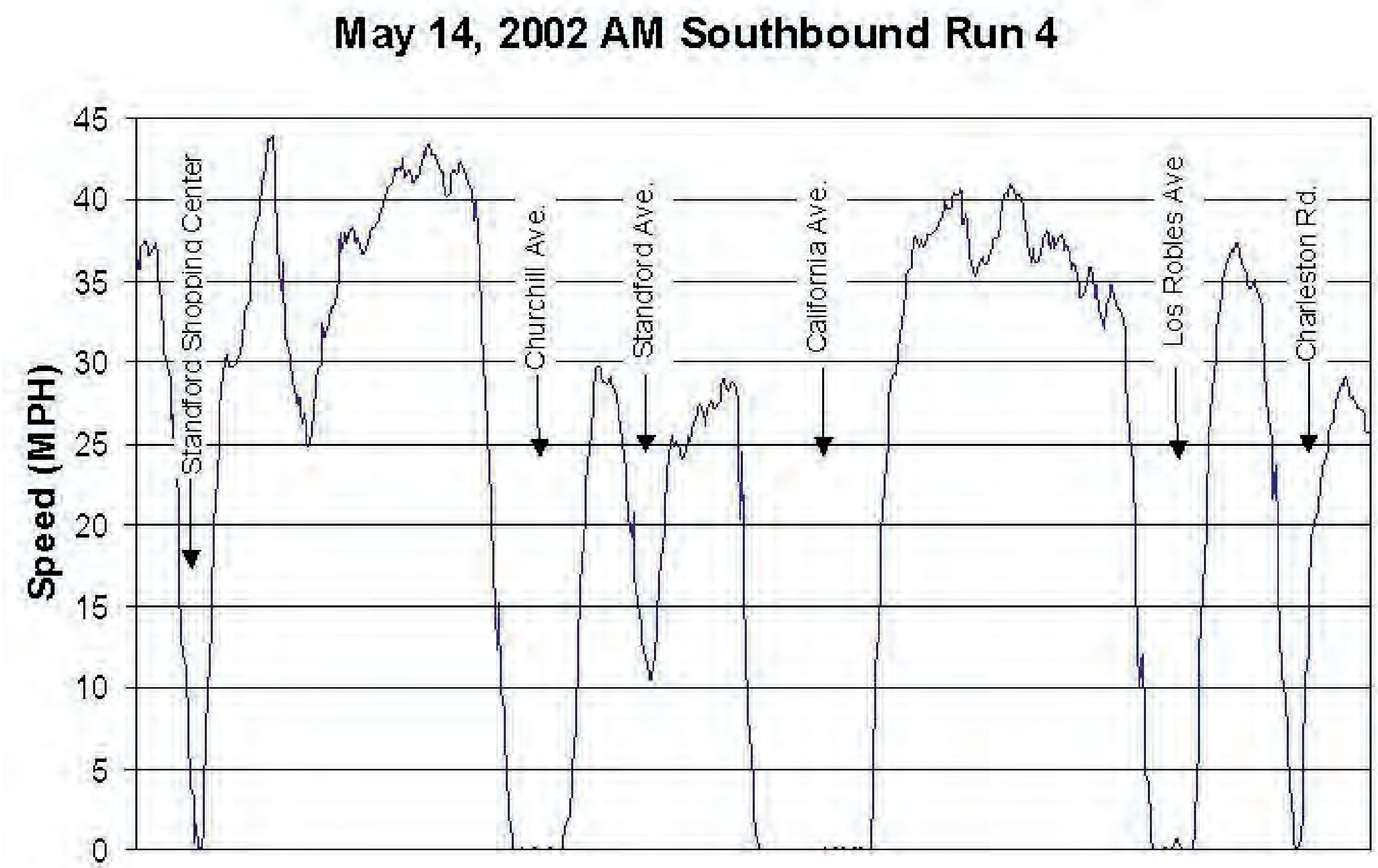



**Figure 1:18**

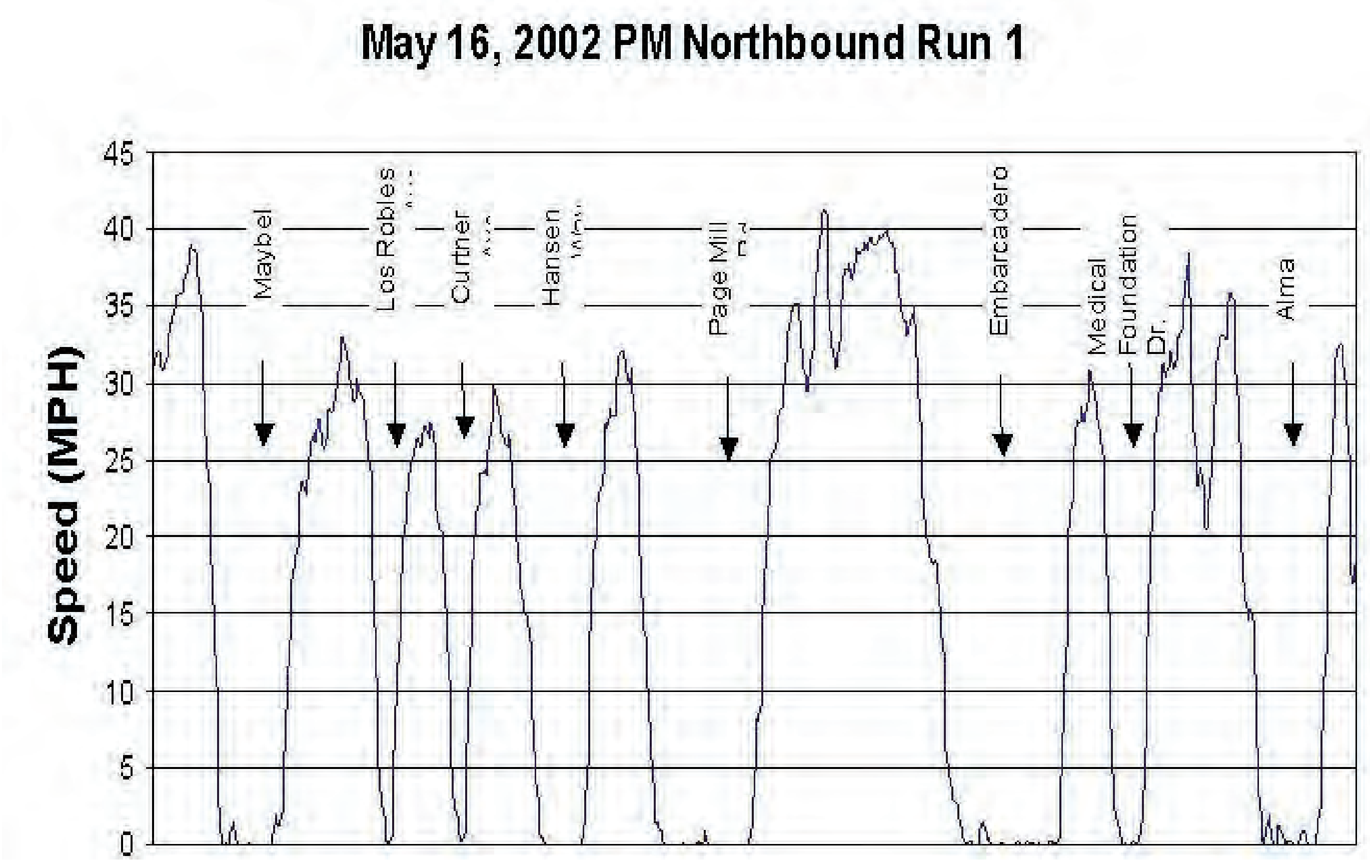



Figure 1:19

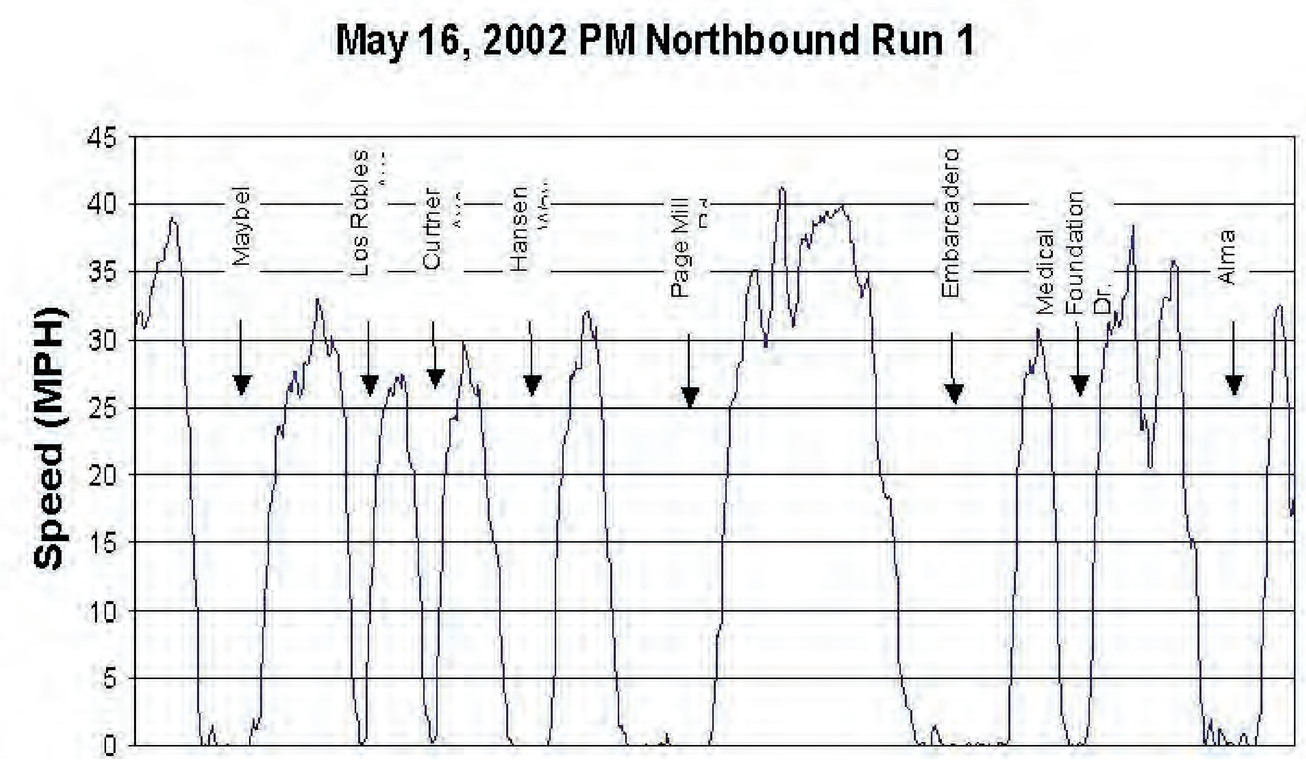



Figure 1:20

From the travel time analysis, several conclusions can be reached. First, the speed profile is uneven. This lack of a consistent speed can be attributed to poor signal coordination as well as traffic congestion. As indicated in Table 1:12, the number of stops is higher in the PM than the AM, which can be attributed to higher levels of traffic congestion. Secondly, even during peak hour travel speeds occasionally approach or exceed the speed limit at a number of locations throughout most of the corridor. Third, peak period free flow speeds exceed 40 mph along several sections of El Camino during the peak hours. This fact suggests that there may be opportunities to balance out the speeds throughout the corridor, raising the lowest speeds through reducing stop delays and lowering the highest speeds (which may be associated with high accident rates at some locations) to preserve the overall corridor travel times throughout the corridor.

# *Transportation Planning*

There are several recent or on-going transportation planning projects which will have an affect on the future of the El Camino Real Corridor, these are discussed below:

## Draft Bicycle Plan

The Draft Bicycle Plan proposes to establish El Camino Real as a bicycle route. Such a designation does not necessarily include the striping of a bicycle lane but acknowledges the importance of bicycling on this street and creates the basis for discussions between the City of Palo Alto and Caltrans about traffic signal-related improvements for bicycling purposes. The Draft Bicycle Plan also lays out the long-term vision for a bicycle facilities network. New bicycle paths, routes, lanes, and boulevards would complement already existing facilities in the El Camino Corridor area (see the 'Context Map' Figure 2:1 in Chapter 2). It is noteworthy to point out that locations in which several of the envisioned new and some of the existing network components cross El Camino Real correlate with crossings identified as important routes used by school children (and their parents) on their way to and from school (see *Routes Between Neighborhoods and Schools* in Chapter 3). Bicycle system's crossings include:

- Stanford Avenue (new Bike Route on east side, existing bike lane on west side);
- Matadero Avenue (new Bike Boulevard on east and west sides);
- El Camino Way/Los Robles Avenue (existing bike lane on east and west sides);
- El Camino Way/Maybell Avenue (new bicycle boulevard on east and west sides);
- West Charleston/Arastradero (existing bike lane on east and west sides).

## Palo Alto Intermodal Transit Center (PAITC)

The Palo Alto Intermodal Transit Center (PAITC) redesign study addresses the highest-use Caltrain station other than downtown San Francisco. The station serves almost 3000 Caltrain passengers a day and is also an active bus transfer terminal, accommodating almost 700 buses a day, from four different transit operators. It occupies an extremely confined site, bounded by downtown Palo Alto, a major arterial State Highway (El Camino Real), and the railroad tracks themselves, as well as sensitive neighboring land uses.

The PAITC conceptual plan consists of both transportation elements and community amenities. Transportation elements include expanded rail and bus passenger service capacity, an at-grade intersection of Alma Street and University Avenue, the re-design of University Avenue between Alma Street and Palm Drive, and provision of a bicycle and pedestrian undercrossing of Caltrain near Alma and Everett. Community amenities include an urban park and civic space, public art, and urban design features.

A process for project implementation and a financing strategy have been developed to identify potential sources of funding for needed infrastructure and other capital improvements, and the uses of those funds. Project costs are expected to range from $196 million to $247 million. The key steps for implementation are identified with an estimate of 10 to 15 years for planning, design, funding and construction.

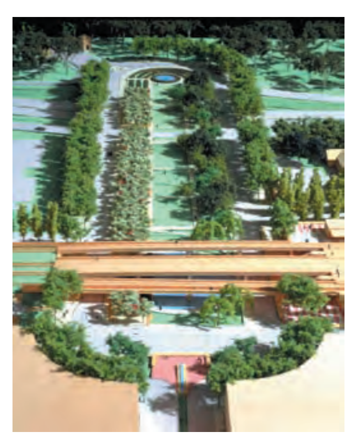


**Figure 1:21:** PAITS Concept Plan

## BRT – Bus Rapid Transit Planned Improvements

The Valley Transportation Agency (VTA) is currently developing plans to introduce limited-stop Bus Rapid Transit (BRT) service on El Camino Real. The agency will convert the current 300 Line and its three stops along El Camino. The project will be a series of incremental improvements leading up to an official launching of 'BRT' at a point in the future, likely 5 years from now or sooner. Given current conditions VTA expects to see bus signal priority aspects of the BRT project operating early in 2003. However, while VTA has funding for much of the ITS work, the physical station improvements are still without funding. The BRT busses would be articulated busses and operate with a headway of approximately 10 minutes and receive bus signal priority at all traffic signals in the corridor. The 22 Line would continue to provide its frequent stop conventional service. Queue-jump lanes are not being considered for El Camino given right-of-way constraints and potential negative impacts to pedestrian crossing distance. In the long-term (by ca. 2007), VTA plans to improve the locations of BRT stops with features and furnishings that are consistent with operational needs and provide a distinct identity for this special service bus line. These improvements will include curb extensions (bulb-outs) which allow for more efficient boarding while the bus remains in the outermost traffic lane, bus shelters, information kiosks, special lighting, benches and trash receptacles.)

Through conversations with VTA, it became clear that the agency currently neither has mid nor long-range plans for the introduction of light rail service, particularly a center-running system, on the El Camino Corridor. The consultants were told that if there were enough demand in the corridor that a side-running, streetcar-type light rail would be a conceivable future upgrade from the currently planned BRT service. Under this scenario, streetcars would travel in mixed flow in the outside lane in replacement for the BRT busses.


**Figure 1:22:** Bus Rapid Transit shelter and signage (DKS Associates/ Amphion)

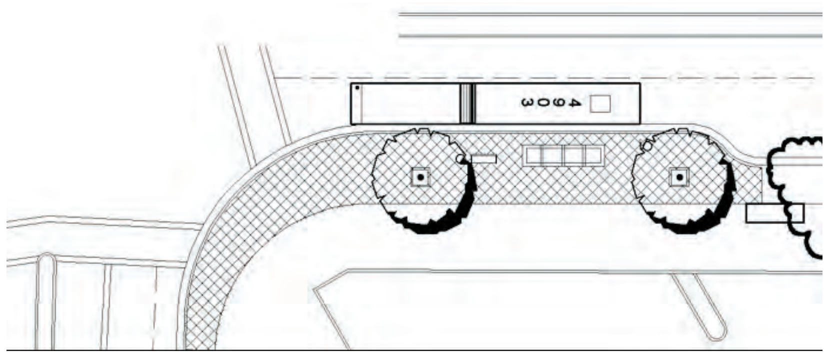


**Figure 1:23:** Articulated bus and 'Bulb-out' transit stop

# Chapter 2: Land Use and Planning Data Collection and Assessment

## *Context and Existing Land Use*

A generalized existing land use pattern along El Camino Real is illustrated in Figure 2:1. Large-scale individual land uses, such as the Palo Alto Medical Foundation, 'Town & Country' Shopping Center, and the Palo Alto High School are located on the east side of the northern third of the Corridor, while the west side in this area is dominated by the Stanford Shopping Center and the Stanford University Campus. South of Churchill Avenue and south of the Stanford Campus a land use pattern unfolds that is characterized by commercial frontage along El Camino with residential neighborhoods backing directly onto these commercial properties. In a few cases narrow alleys separate commercial and residential properties (between Fernando and Curtner Avenue on the east side, and Matadero Avenue and La Selva Drive on the west side). Roughly at the half way mark of the corridor through Palo Alto, this pattern is interrupted by three major land use areas:

East of El Camino:

- the California Avenue business/retail area

- a mixed-use area (between Grant and Fernando Avenues), that consists of a mix of commercial and residential uses.

  Together the two areas are known and refereed to in the Comprehensive Plan as the Cal-Ventura Area.

West of El Camino:

- Stanford Research Park, a major employment area.

It is important to note that the street patterns of the Ventura mixed-use area and even more so that of the Stanford Research Park offer only very limited routes for travel parallel to El Camino Real. As a result, residential communities in the south of the corridor are separated from those in the north. It also makes El Camino Real the only effective connector between these residential neighborhoods and between neighborhoods and businesses along the corridor away from a given neighborhood.

On the west side of El Camino Real, between Los Robles and Maybell Avenue, two larger, new residential projects have been built in the past few years. Neither includes commercial frontage and therefore they are a notable exception to the otherwise continuous commercial character of El Camino Real. The Community Plan has recognized this condition and it is likely that further development of single-use residential projects will continue in some parts of the corridor, as the economic market is not present to support retail development along the entire frontage of El Camino Real.

Similarly to the land use pattern at the northern end, the southern end of the corridor is characterized by larger scale uses, such as the Rickey's Hyatt, the Elks Club, and the Hyatt Cabana Hotel. In addition, there is a notable concentration of car sales and services in this area.

The Context Map also illustrates the relationship between neighborhoods, school sites and open spaces in the area. (also see the *Routes between Neighborhoods and Schools* section below).

## *Palo Alto Comprehensive Plan*

Palo Alto's Comprehensive Plan recognizes complexities of El Camino Real's land use and transportation function and context, and addresses the street and uses along it in several policies. Following is a list of the key policies and associated programs that either addresses the intended character for land uses along the corridor or El Camino's streetscape directly:

- **POLICY B-25:** Encourage the development of pedestrian-oriented neighborhood retail and office centers along the El Camino corridor.
- **POLICY L-31:** Cal-Ventura offers exceptional opportunities for new transit-oriented development…New housing in this area could provide the momentum for new pedestrian amenities.
- **POLICY L-32:** Maintain Town and Country Village as an attractive community-serving retail center. Future development at this site should preserve its existing amenities, pedestrian scale, and architectural character…The street edge should be strengthened with wider sidewalks, street trees, and a low hedge to screen the pavement and parked cars.
- **PROGRAM L-32:** Improve pedestrian connections across El Camino Real.
- **PROGRAM L-33:** Study ways to make South El Camino Real more pedestrian-friendly, including redesigning the street to provide wider sidewalks, safe pedestrian crossings at key intersections, street trees, and streetscape improvements…two-story structures with retail-oriented street frontage and rear parking should be encouraged. Second, redesign of the public right-of-way should be encouraged to make it more suitable for pedestrians without reducing the number of travel lanes. These improvements should be focused at retail nodes and along segments of the street where they can benefit from existing positive design features, such as street trees.
- **POLICY L-34:** Encourage improvement of pedestrian and auto circulation and landscaping improvements, including maintenance of existing oak trees and planting additional oak trees.
- **PROGRAM L-34:** Provide better connections across El Camino Real to bring the Ventura and Barron Park neighborhoods together and to improve linkages to local schools and parks.
- **POLICY L-35:** Establish the South El Camino Real area as a well-designed, compact, vital, Multi-neighborhood Center with diverse uses, a mix of one-, two-, and three-story buildings, and a network of pedestrian-oriented streets and ways.
- **POLICY L-67:** Balance traffic circulation needs with the goal of creating walkable neighborhoods that are designed and oriented towards pedestrians. A few, like El Camino Real, serve only to move traffic and have a negative effect on community design.
- **PROGRAM L-71:** Recognize Sand Hill Road, University Avenue, Embarcadero Road, Page Mill Road,…Arastradero Road (west of Foothill Expressway),…as scenic routes.
- **POLICY L-71:** Strengthen the identity of important community gateways, including…Embarcadero Road at El Camino Real.
- **PROGRAM L-72:** Develop a strategy to enhance gateway sites with special landscaping, art, public spaces, and/or public buildings. There are opportunities for distinctive gateways that highlight the connection between the City and its natural setting at the bridges across these creeks on El Camino Real, Sand Hill Road.

## *Plans for Future Development*

At the moment, only few plans for development of private properties along El Camino Real are known to the City's Planning Department. The two key sites that are expected to redevelop in the near future are:

- Rickey's Hyatt: will likely include a new hotel and conference facilities as well as a housing component of undetermined size;
- The Elks Club: senior housing development along the El Camino Real frontage.

In addition, it is expected that the triangular area between El Camino Real and El Camino Way will continue to transform into an active mixed-use area. No plans currently exist for the largest vacant site along the corridor, a property located just northwest of the Page Mill intersection, a former school site.

## *Stanford University Campus*

In conversations with Stanford University Planning staff, the following key aspects long-range planning for the Stanford Campus were found to have a bearing on or interrelationship with future changes within the El Camino Real public right-of-way:

- Stanford University Planning views existing on-street parking areas along the Stanford Campus frontage as non-essential to activities occurring on campus. In fact, planning staff explored in the past how a wider sidewalk and street trees along the campus could be accommodated if the area currently occupied by on-street parking (or an 8 foot shoulder) were used for this purpose.
- In the long-term, Stanford is interested in creating a new bicycle connection through the eastern portion of campus (the Arboretum) to the traffic signal on El Camino Real at the Palo Alto Medical Foundation. Here the bicycle path would connect to the one continuing eastward and through an underpass of the Caltrain r.o.w., as envisioned by the City's Draft Bicycle Plan.
- Stanford University has long-term plans for changing the character of the landscaping in the Arboretum area. Currently mature eucalyptus trees dominate much of the area, with oak trees interspersed throughout. It is the University's intention to phase out the eucalyptus trees and replace failing specimen with oaks, tuning the area into an oak-woodland.
- New housing will eventually be built in two locations on campus land along El Camino Real. In the south, the existing family student housing will expand toward El Camino Real, but currently it is not envisioned that such an expansion will front directly onto the street. It is rather planned that buildings will remain separated from the street edge by a significant landscape buffer. In the north, future faculty housing will be built just south of the Quarry Road intersection. This development will be principally located on a clearing within an existing stand of trees in this area. These trees will largely separate housing and El Camino Real.

## *Draft Design Guidelines*

The City of Palo Alto has contracted an urban design consultant for developing urban design guidelines for private development along the El Camino Real Corridor. Completion of work on these guidelines is expected by the end of the year 2002. Although the guidelines will have an overall long-term impact on the quality of development along the Corridor, there is one aspect that is of particular interest as it relates to the potential future allocation of space within the public right-of-way. The draft guidelines suggest that future development along El Camino Real set back from the street by a minimum of 3 feet (less than what is currently required in the Zoning Code), creating an easement to increase the width of the existing 8-foot public sidewalks, effectively creating an 11-foot sidewalk for the length of frontage of the proposed development.

# Chapter 3: Streetscape and Urban Design Data Collection and Assessment

This chapter describes the existing streetscape and urban design conditions in the El Camino Real Corridor, and assesses their relationship to the goals for the future of El Camino Real as a main street within the City of Palo Alto.

## *Street and Block Pattern*

The length of individual city blocks and the frequency and intervals of streets intersecting with El Camino Real largely determines the level of access people are afforded to uses along the street and to uses on the opposite side of the street. The latter is also dependent on whether crosswalks are located at a given street intersection, allowing for pedestrian movements from one side of the street to the other. Generally the length of blocks between intersecting streets in a pedestrian-supportive area should be no longer than 600 feet and ideally is between 300 to 400 feet. Such block lengths allow for convenient access from residential neighborhoods, are appropriate for pedestrian walking speeds, and support the kind of visual and architectural diversity that cannot be achieved on blocks that are oversized ('superblocks') that are occupied by a single use or large-scale building.

The block and access street pattern between the northern city limit and Park Boulevard is largely determined by large-scale uses located along this part of the corridor, such as the Stanford Shopping Center, the Palo Alto Medical Foundation, Palo Alto High School, the Stanford Campus and others, as well as the grade separation of University/Palm Avenue. Here, block lengths on the eastside of the street range between 700 and 2,200 feet, while those on the west side measure between 900 and 3,400 feet. The long block lengths on the west side are mostly a result of the small number of streets that access into Stanford Campus (see Figure 3:1).

Between Park Boulevard and Ventura Avenue a largely regular street pattern unfolds with blocks of approximately 300 foot in length; with the exception of some larger blocks or parcels, such as the continuation of the Stanford Campus up to Stanford Avenue, and the Palo Alto Business Park around Page Mill Road. In addition, the street pattern of the neighborhoods east of El Camino Real is mostly based on a regular grid and thus further supports easy access to uses along El Camino Real. It is noteworthy that a large number of T-intersections (where a street intersects El Camino Real without continuing on the opposite side of the street) occur south of California Avenue, making it the dominant intersection type in this part of the corridor.

Overall, 67 % of all (43) intersections throughout the El Camino Real Corridor are T-intersections. Many of these intersections are currently unsignalized and/or do not provide marked pedestrian crosswalks; drivers traveling on the side of the corridor not intersected by the side street are less aware of pedestrians (legally) crossing El Camino Real at those intersections.

Blocks south of Ventura Avenue measure up to 1,500 feet long. In this area streets in adjacent neighborhoods are not based on a regular street grid, creating a less direct access between streets within the neighborhoods and to uses along El Camino Real. The longer spacing between intersections likely contributes to traffic moving at higher speeds in this portion of the corridor.

## *Character of Street Frontage*

The character of the street frontage - as determined by a combination of presence of street trees and other landscaping, and setback of buildings - is a critical component in defining a streets appearance and pedestrian-friendliness.

The street edge between the northern city limit and Stanford Avenue is largely defined by the landscaped edge of the Stanford Campus (including the Arboretum with its tall Eucalyptus trees, and the deep view into the grassy Athletic Fields) and the landscaped edges of properties whose buildings are somewhat set back from the street (Marriott Hotel, Palo Alto Medical Foundation, Palo Alto High School). Altogether, the street has a more rural appearance.

Between Stanford Avenue and Grant Avenue buildings typically range from one to three stories in height and have little or no setbacks, defining El Camino Real's street edge more strongly than in other parts of the corridor. Here the street appears to be somewhat narrower, a result of the heavier utilization of parking and the absence of setback buildings.

On the west side of the street, south of Page Mill, a densely landscaped edge of parking lots holds the street edge although the tall buildings of the Palo Alto Square development are far removed from the street. On the east side of the street, south of Page Mill, smaller scale buildings and openings between buildings create an inconsistent, frequently changing street edge. Here, only the presence of sidewalk trees lends some sense of continuity to the streetscape character of the rest of El Camino Real.

South of Maybell Avenue the street edge is often defined by off-street parking areas, car sales lots, and other automobile-oriented uses (including a larger concentration of smaller and larger hotels), which adds to the wide appearance of the street in this segment of the corridor.

In summary, the most distinct differences in the character of street frontage exist between the corridor segments north and south of Stanford Avenue. The first has an almost rural character based on the many setback uses and mature landscaping, whereas the latter has a more urban character based on the number of buildings that come up to the sidewalk and the closer relationship between uses and the public realm of the street. The policies of the Comprehensive Plan and the Urban Design Guidelines which are currently being prepared will encourage the continued transition of these areas to a more pedestrian-supportive character with buildings and activities fronting onto the street.

# *Existing Cross Sections*

A look at El Camino Real's street cross sections and overall right-of-way widths in different locations, it becomes clear that the majority of the street is based on a typical cross section that changes in only a few locations (see Figure 3.2, Urban 6-Lane). Most perceived changes in character along the corridor are based on changes of other factors, such as land use, the character of street frontage (building height and setbacks, architecture, and landscaping), and the frequency of streets intersecting El Camino Real. Following are brief descriptions of the prevailing typical cross section as well as key deviations from this pattern.

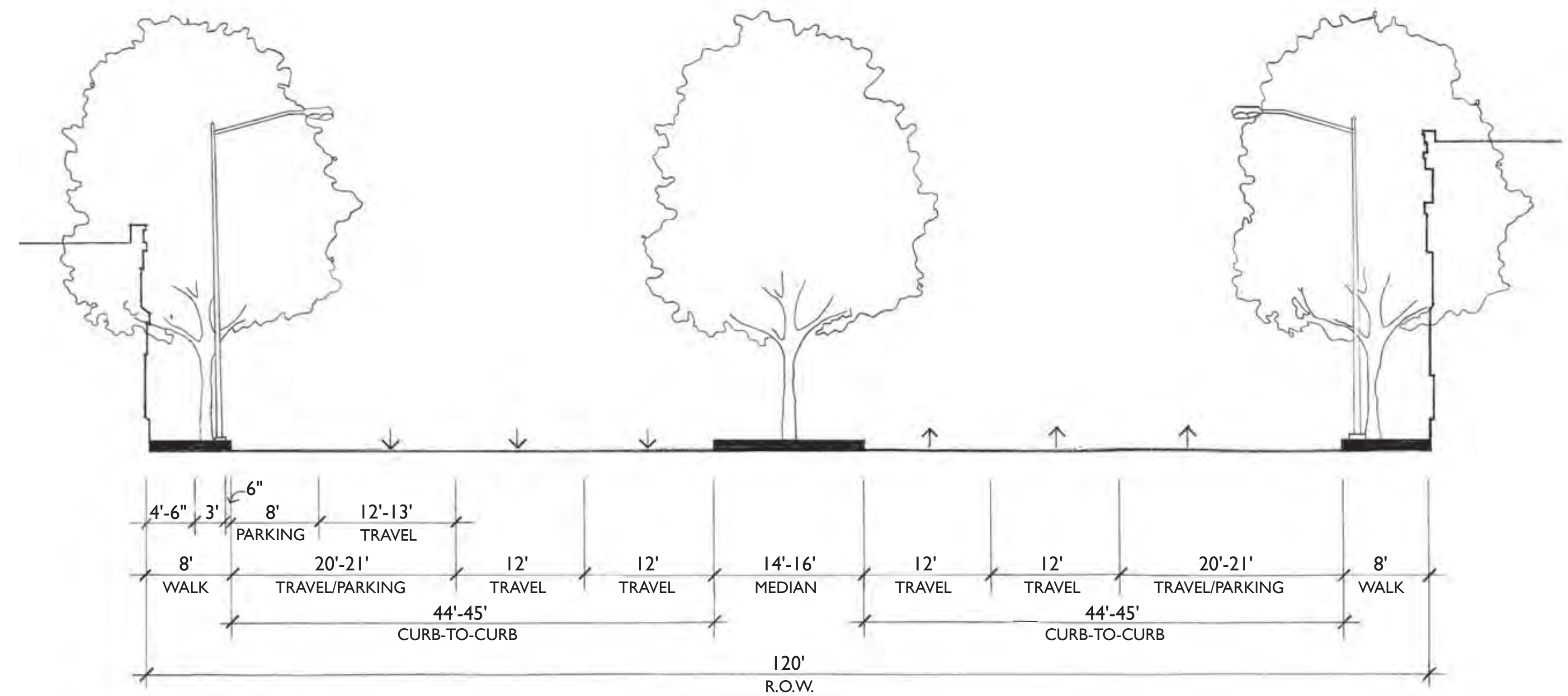



**Figure 3.2:** Urban 6-Lane

## Typical Sections

### *Urban 6-Lane*

- **Park Avenue to Southern City Limit** (see Figure 3.2): This 120 foot cross section represents the prototypical section in the urban portion of the corridor. However, two key exceptions exist with the Page Mill and Arastradero Avenue intersections, where the right-of-way has been widened to 130 feet to allow for the accommodation of an additional left turn lane in each direction.[1]

### *Stanford 6-Lane:*

- **University Underpass to Embarcadero** (see Figure 3.3): The cross section of this 120 foot r.o.w. represents the typical cross section along much of the Stanford Campus.

## Other Sections (from north to south)

- **Northern City Limit to University Avenue Underpass:** This area has recently been reconstructed. Up to the University Underpass, the roadway has an average width of 109 feet, 6 inches and widens dramatically at the University and Palm Avenue access roads. The median in this area varies from 20 feet wide at the turn lanes at the Stanford Shopping Center to just 2 feet wide south of Quarry Road.

- **University Avenue Underpass:** In this special condition the roadway that continues through the University Avenue underpass has an overall width of 82 feet curb to curb. The median in this area narrows from 10 feet, 8 inches before the underpass to 5 feet, 8 inches at its low point and then widens again to 6 feet, 11 inches. In addition, south and north of the underpass, a total of four access roads lead from El Camino Real to University Avenue/ Palm Drive.

- **Embarcadero to Churchill Avenue** (Transition - see Figure 3.3:) This segment represents a transition zone between the typical cross-section described in the previous paragraph and the special cross-section along the Southgate Neighborhood. Here, along the Palo Alto High School frontage the right-of-way on the east side of the street widens from 120 to 146 feet, with most of the additional right-of-way east of the eastern sidewalk being occupied by a landscape buffer between the high school grounds and El Camino Real.

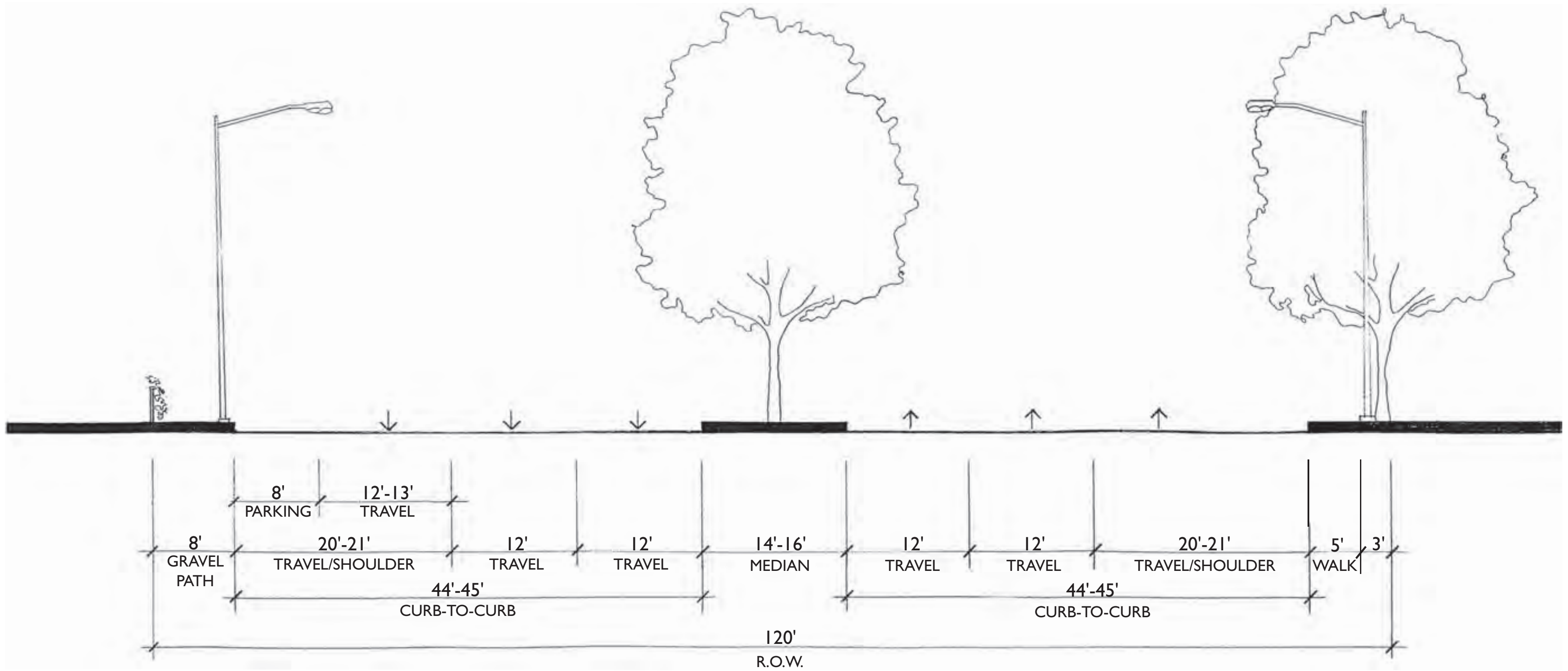



**Figure 3.3:** Stanford 6-Lane (up to 146 foot r.o.w. at Palo Alto High School)

- **Churchill Avenue to Park Boulevard** (see Figure 3:4). This street segment is set apart from the rest of the corridor because of its inclusion of a frontage road along El Camino Real that gives access to homes in the Southgate neighborhood. This is the only location where a residential neighborhood directly abuts the El Camino Real right-of-way. Here, the right-of-way widens to a total width of 146 feet.

- **Park Boulevard to Park Avenue (Transition):** this short segment represents the southern transition zone, where the right-of-way transitions from its 146-foot width along the Southgate Neighborhood back to the typical section of 120 feet.

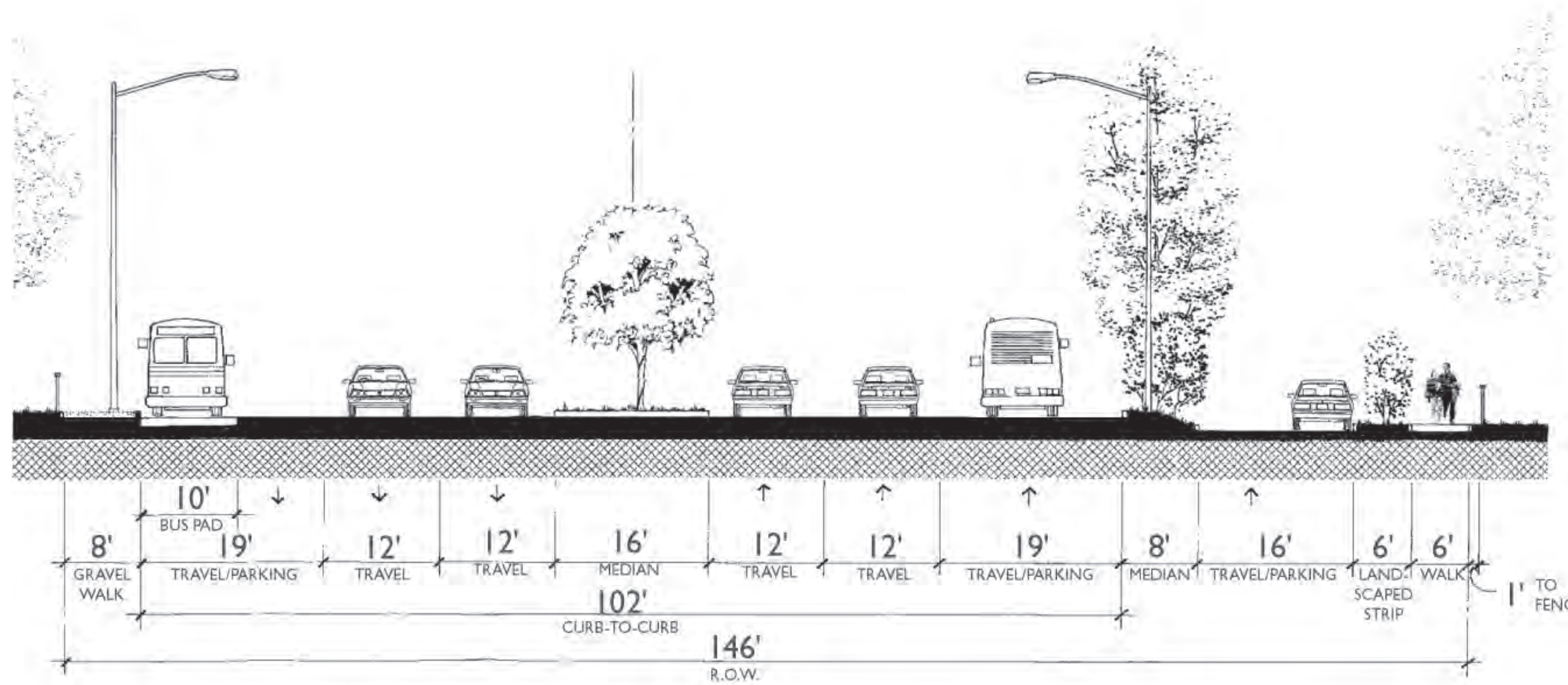



**Figure 3.4:** Southgate Neighborhood

## On-Street Parking

On-street parking can be a major asset for businesses along the street if off-street parking is insufficient or hard to reach. At the same time, some underutilized on-street parking areas add unnecessary paved surface and unused roadway width to the streetscape. Therefore, where no parking zones or underutilized on-street parking are present this space presents a unique opportunity for improvements for pedestrians, bicyclists, and additional landscaping. While this Study does not include a parking utilization assessment, a windshield survey was conducted to determine where on-street parking is or is not permitted (including bus stop areas). The results are illustrated in Figure 3.5.

Parking along El Camino Real is accommodated in an 8-foot wide portion of the 20 to 21-foot (average) lane next to the sidewalk (the remaining 12 to 13 feet serve as travel lane). Notably, the 20 to 21 foot width of this part of the cross section is maintained even in segments of the corridor where on-street parking is not permitted. This results in a paved roadway section that is overly wide, and can contribute to speeding by vehicles driving along El Camino Real. The continuous presence of this roadway element is explained by Caltrans highway design standards that require a 'shoulder' for the potential accommodation of disabled vehicles. In urban areas Caltrans accepts parking or a bicycle lane as uses within the shoulder.

Between the northern city limit and Park Avenue no on-street parking is allowed on most of the street frontage, with exception of three longer segments along the Stanford Campus. Usage of those segments was intermittent and it was observed that many of the cars parked here were offered for sale, as evidenced by *'For Sale'* signs. During evenings and on some weekends these areas are used by people who are accessing the recreational facilities within the Stanford Campus, and some people who work on campus, particularly building contractors also appear to use these parking spaces.

South of Park Avenue on-street parking is generally allowed with only few exceptions. Use of the parking varies, but it appeared to be used most frequently in the California Avenue commercial area. A parking utilization study would be needed to determine which areas might be able to function without on-street parking in the future.

# *Segments and Nodes*

## Segments

Traveling along the length of El Camino Real through Palo Alto it becomes clear that the street consists of several distinct segments. This is based on differences in land use, building scale, landscaping and street frontage. An assessment of these conditions leads to the following segments and nodes or activity along El Camino Real (also see Figure 3:6):

### *Segment 1: Between Northern City Limit and Stanford Avenue*

This area is dominated by large-scale properties, such as the Stanford Shopping Center, the Palo Alto Medical Foundation, the Town & Country Shopping Center, the Stanford Campus, and the Palo Alto High School. Building footprints on these properties are respectively large and most structures are set back from the street. The segment is also characterized by large scale landscaping along most of its edges, including Palo Alto Park across from the Stanford Shopping Center, the Arboretum area, with its substantial stands of mature trees, and the athletic fields on the Stanford Campus. If viewed in combination with the tree-planted edge along Palo Alto High School this area has an almost rural character.

### *Segment 2: Between Stanford Avenue and Ventura Avenue*

This segment includes the most urban portions of El Camino Real in Palo Alto, particularly around California Avenue. In general this area is characterized by buildings fronting directly onto the street with parking located behind or to the side of the buildings, and parcels also tend to be smaller. Some notable exceptions to this characterization do exist and are discussed below by 'sub-segment.'

*Segment 2-A*: This area extends from Stanford Ave. to Grant Ave. and exemplifies the description provided above. A variety of retail and commercial uses front along the street. On-street parking tends to be utilized most frequently in this area and there is also a relatively high level of pedestrian activity, particularly during weekday lunchtimes when employees in the area and from Stanford Research Park come to the areas many restaurants, including those along California Avenue to the east of El Camino Real.

*Segment 2-B*: This area extends from Grant Avenue to southern edge of Stanford Research Park around Portage Avenue and Hansen Way. The east side of the street tends to have a character that is similar to Segment 2-A, with one and two story buildings fronting directly onto the street, with the Stanford Nissan Dealership being a notable exception (to the south of Olive). The west side of the street is dominated by the vacant parcel to the north of Page Mill, while the area to the south of Page Mill is dominated by Stanford Research Park parking lots and some landscape buffers with the actual office buildings being set far back from the sidewalk.

*Segment 2-C*: This area includes the street from the southern edge of Stanford Research Park to Ventura Avenue. The area has similarities to Segment 2-A, but in general there are more exposed off street parking areas, so the activity on the sidewalk is reduced and the street appears to be wider in many locations. The frequency of intersections is also lower which reduces the potential for people to cross the street.

### *Segment 3: Between Ventura Avenue and Southern City Limit*

The uses and building fabric in this area tend to be more auto-oriented, and more infrequent intersections encourage traffic to travel at higher speeds (often above the speed limit). Several new and future planned uses, as well as Comprehensive Plan policies will continue to change the character of this area making it more pedestrian-oriented over time. The landscape character of the median becomes more noticeable in this area as it is more continuous with fewer left turn pockets.

## Nodes

The following areas stand out for their particular pedestrian, bicycle, and more concentrated commercial/retail activity, and were therefore identified as current or future nodes, which may inform later decisions related to streetscape design in these areas:

- University Avenue/Palm Drive/Caltrain Stop;
- Embarcadero Avenue/Town and Country/Palo Alto High School;
- California Avenue Area; and,
- The Future El Camino Way Triangle Area.

In addition, it was pointed out by several Advisory Group members that many pedestrian crossings occur spread out through the street segment south of Stanford Business Park. The area's activity level is not as focused as in the California Avenue area, but is nonetheless noteworthy. In particular, the area between Los Robles and Maybell (the El Camino Way Triangle) carries particular importance, a fact that is reflected in Palo Alto's Comprehensive Plan, which contains policies that specifically address the potential and desired character of development for this area. Also, many school children cross El Camino Real at Maybell and Los Robles, thus contributing to the general activity level. In combination, all of the above factors may be viewed as a sign that this area is an emerging node.

# Street Lighting and Street Furnishings

## Lighting

Street lighting is needed to achieve proper illumination for vehicular traffic, but what is often missing on highways is proper lighting for pedestrian visibility and safety. The existing roadway light fixtures on El Camino Real are - for their shape - often referred to as 'cobra-head' fixture. The light source is located about 30 feet above ground, at the end of a light standard that arches out over the roadway by approximately 10 feet. The light posts are spaced at an average distance of 130 feet. Variations of this distance most commonly occur to adjust for the presence of driveways or cross streets. The existing fixtures illuminate both, roadway and, to a lesser extent, the sidewalks along El Camino Real.

Pedestrian-scaled lighting, which is characterized by a spacing of light standards between 30 to 50 feet on center and a light source height between 12 and 15 feet does currently not exist along El Camino Real. Pedestrian-scaled lighting is desirable especially on tree-lined streets because it brings illumination to the sidewalk below the tree canopy thus adding to the sense of safety for pedestrians and the spatial definition to the sidewalk space. This will be an important consideration in the redesign of the street, particularly in those areas that are expected to have more pedestrian activity.

## Street Furnishings

Furnishings provided in conjunction with active pedestrian-friendly public streets commonly include trash and recycling receptacles, benches, and bicycle racks, and depending on the character and function of the street additional information panels or kiosks, banners, and news racks. With exception of many individual and some modular news racks, no pedestrian-oriented furnishings are currently provided throughout the El Camino Real corridor. The modular units accommodate 6 to 8 individual rack modules each and are typically located at the backside of sidewalk. It should be noted that several of the many Caltrans signal and metering boxes (each with approximate footprints of 1.5 by 2 feet up to 2 by 3 feet) are located within the 8-foot sidewalks thus severely limiting the space available for passing pedestrians.

## Furnishings at Transit Facilities

Public amenities typically located at bus stops of the Valley Transportation (VTA) 22 Line and 300 Line include the combination of one bench and one trash receptacle per stop. In addition, shelters have been placed at several of the stops. A special information display is located at the Page Mill stop where bus lines operating on Page Mill and El Camino Real intersect. While these provide some pedestrian amenity to the street, transit facilities should not be seen as a substitute for the street furnishings discussed above.

VTA is currently advancing plans for the operation of a Bus Rapid Transit service on El Camino Real. The stops for this service coincide with those currently served by the 300 Line (West Charleston/Arastradero, Page Mill, and California Avenue). Although no final decision about a design has been made at this point, VTA plans to install custom design shelters, light fixtures, information displays, and other amenities at all three stops after the service is introduced in 2003.

# Gateways

The project area stretches between the Palo Alto's northern and southern city limit lines. The possibility of highlighting this transition between cities is being considered as part of this study. Some elements exist that could support this concept, and in one case the City of Palo Alto is already planning some improvements that will help to highlight the transition.

The northern limit line between Menlo Park and Palo Alto coincides with San Francisquito Creek. Here, El Camino Real passes over the creek via a modest bridge with narrow somewhat dilapidated sidewalks. For those travelers on the street headed south, the Stanford Shopping Center on the west side of the street is the most noticeable and widely known landmark and indication for having traversed into Palo Alto.

In the south, the city limit west of El Camino Real is located where Adobe Creek passes underneath the street. However, the southeastern city limit line between Palo Alto and Mountain View is located just south of Cesano Court. Between these two points, the City limit line runs along the eastern edge of the El Camino Real r.o.w., which itself is located in Los Altos. However, businesses on the eastern side of this stretch of the street are located in Palo Alto. Currently, a modest entry design is located at the Adobe Creek crossing. It consists of two traditional street lamps, located on either side of the street. These are complemented by a pair of carved-wood '*Welcome to Palo Alto*' signs, with painted lettering. One of the signs is located on private property near Adobe Creek at the western street edge, the other at the southern tip of the median ending at Tamarack Court. Currently under construction is a major upgrade to this gateway. The improvements will include sidewalk extensions with viewing areas located above the creek on either side of the bridge across Adobe Creek, special paving, pedestrian street lighting and public art. It is expected that the improvements are either readily compatible or modifiable to any future condition (such as widened sidewalks or a different type of pedestrian streetlight) as they might be proposed in the Master Schematic Design Plan.

The study is considering some landscape improvements to highlight the entries into Palo Alto along El Camino Real.

# Pedestrian and Bicycle Facilities and Amenities

## Sidewalk Widths

The width of El Camino Real's roadway (typically 104 feet from curb to curb) and heavy traffic represent a significant barrier to pedestrian and bicycle movements across the street. At the same time, narrow width of existing sidewalks (8 feet), traffic noise and the proximity of automobiles, trucks and busses to sidewalks negatively impact the pedestrian experience for longitudinal travel along the street. Adjacent traffic is particularly a concern where no parking areas exist, because the buffer of parked cars is missing and the sidewalks typically remain only 8 feet wide.

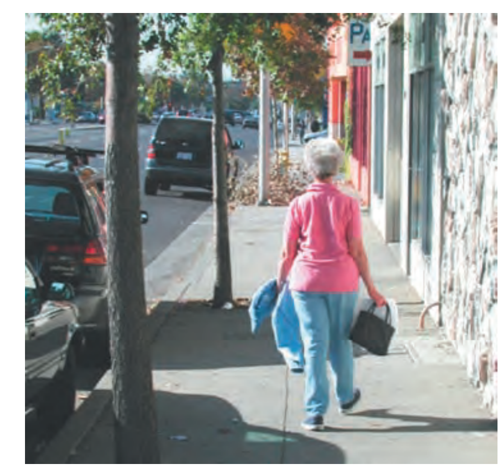


**Figure 3.7-** Pedestrian on El Camino Real

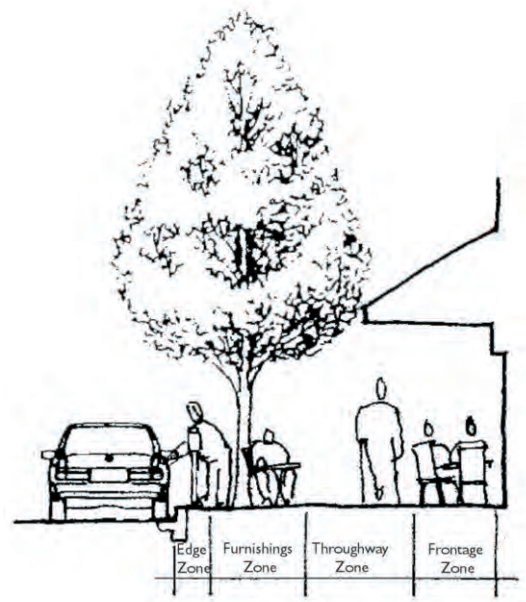



**Figure 3.8-** Sidewalk Zones

The desired width of a sidewalk along a street like El Camino Real in order to support a higher level of pedestrian activity is somewhere between 13 and 16 feet. This breaks down into several functional 'zones.' For example, a 13 foot wide sidewalk would have an Edge Zone of 1 foot – 6 inches to allow for the 6 inch curb, parking meters, and door swings; a 5 foot Furnishing Zone for street trees, lamp posts, planters, benches, trash can, bicycle racks, etc.; a 5 foot Throughway Zone for pedestrian movement and the desired minimum clear width for ADA access; and a 1 foot – 6 inch Frontage Zone which allows for building door swings, and provides an area for people to slow down and window shop.

The existing 8 foot wide sidewalk only provides for a 6 inch curb area, a 2 foot – 6 inch combined Edge and Furnishing Zone, a 5 foot Throughway Zone, and no Frontage Zone. Please refer to the *Trees in Sidewalks and Medians* section below to get an understanding of the conditions for trees that result from only a 2 foot – 6 inch wide Furnishing Zone.

## Signalized and Unsignalized Crossings

Given the width of El Camino Real from curb to curb, crossing distance, safety. and frequency of crossings are a key criteria in judging the safety of movements and convenience of access for pedestrians and bicyclists alike (also see Chapter 1 on this subject). In many locations there is a lack of marked pedestrian crosswalks at intersections

Please refer to Figure 3:9 for the following discussion of crosswalks.

Between northern city limit and Stanford Avenue all crossings in this area are signalized, they are, however, spaced as far apart as 2,400 feet (distance between signal at Embarcadero and Churchill Avenue). This condition is undesirable from a pedestrian circulation point of view, maximum distances between marked crosswalks should not exceed 600 feet whenever possible. In the segment just north of Quarry Road, pedestrians have been observed to jay walk across El Camino Real from one bus stop to another, rather than walk about 200 feet further south to cross at the Quarry Road intersection. Similarly high school students were seen crossing El Camino Real between Embarcadero and Churchill where no crosswalk is provided to reach the bus stop located there on the west side of El Camino Real, half way between the two intersecting streets.

Signalized crossings are more closely spaced in the California Avenue area, where average distances between signals are about 350 feet. This helps to create the more pedestrian friendly condition in this area.

Farther south, the area between Hansen Way and Los Robles Numerous is characterized by the presence of a number of marked, unsignalized crosswalks. These are complemented by those crossings located at key signalized intersections. Several of the unsignalized crosswalks are located within the only significant bend of El Camino Real in Palo Alto between Ventura and Maybell Avenues. This raises potential safety concern as sight lines for drivers are somewhat reduced as they approach these crossings. In addition, many of the crosswalks are located at T-intersections, which provide a reduced 'set of clues' to the driver traveling on the side of the corridor that is not intersected by the side street.

South of Los Robles, the spacing between crossings increases again and reaches up to 1,500 feet. Crossings in this area are provided only at signalized intersections.

There is a clear correlation between the presence of crosswalks and the scale of adjacent uses, as is evident in the north and south of the corridor.

## Routes Between Neighborhoods and Schools

The following schools are located nearby the El Camino Real Corridor (refer to Figure 2:1).

East of the Corridor:

- Palo Alto High School, and Jane Lathrop Stanford School

West of the Corridor:

- Escondido School, Barron Park School, Gunn High School, Juana Briones School, and Terman Middle School

From conversations with Palo Alto's 'Safe Routes to School' interest group it is clear that many students need to cross El Camino Real in order to get to their school. This is particularly important for Gunn High School, which serves all of Palo Alto and not just adjacent neighborhoods.

The following intersections have been identified as particularly important for student movements (on bicycle or on foot) across El Camino Real (from north to south):

- Stanford Avenue,
- Matadero Avenue (west),
- El Camino Way/Maybell Avenue, and
- West Charleston/Arastradero.

The situation at Palo Alto High School requires attention in light of the fact that students have been observed crossing the street in a mid-block location without a marked crosswalk between Embarcadero Avenue and Churchill. Here a VTA bus stop and an entrance to Stanford's sports facilities are located opposite of the high school on the west side of El Camino Real.

## Encroachment of Private Uses into Public Right-of-Way

In several locations, it was observed that landscaping or buildings on properties adjoining the sidewalk encroach into the public right-of-way. This typically results in the reduction of effective sidewalk width by the margin of encroachment. The City will need to address this situation when final designs for improvements are drawn up, as any future street section will make use of the entire width of the constricted public right-of-way.

## Curb Ramps

Curb ramps on El Camino Real are consistently provided at all marked or signalized pedestrian crossings. At intersections without crossings across El Camino Real itself curb ramps are installed for the crossing of the intersecting street. All curb ramps are single ramps located at the center of the curb return, thus serving two crosswalks at once.

However, this diagonal arrangement has been criticized as it directs the ramp user's path of travel toward the center of the intersection and requires additional maneuvering to redirect i.e. a wheelchair toward the desired of the two crosswalks. The new draft federal ADA guidelines currently being developed will set a new preference and standard in which two ramps are provided, one each per direction of travel (across the major street and across the intersecting street). The design of the ramps will also be modified, future improvements will need to comply with these requirements.

## Bicycle Facilities

Bicyclists currently travel within the 20 to 21-foot wide (average) curbside lane, which accommodates a 12 to 13-foot travel lane and in various segments of the corridor also an 8-foot parking lane. Where parking is not permitted bicycles travel in the space between the edge of the travel lane and the curb, a shoulder by Caltrans' definition. Where parking is permitted they travel in the space between parked cars and passing cars in the travel lane. El Camino Real does not provide striped bike lanes. However, Palo Alto's Draft Bicycle Plan suggests El Camino Real's designation as a 'Bicycle Route', which would give bicycling on El Camino Real a formal standing and allow for discussions with Caltrans on signal timing, that takes the presence of bicyclists into account.

## *Trees in Sidewalks and Medians*

The conducted tree survey determined the location of each tree on the public right-of-way along El Camino Real in Palo Alto (see Figure 3.11). The survey distinguished between trees in sidewalks and trees in medians. Trees in sidewalks were separated according to the side of the street on which they occurred (east or west). Measurements of tree dimensions (DBH-diameter at breast height, height, radius of crown) and tree condition are presented in the attached El Camino Real Tree Survey Data section of this report.

Twenty-three tree species were encountered along El Camino Real (Table 3.1). London plane trees accounted for 75% of the 502 street trees found in the survey. The next most common species was ginkgo that made up only 5% of the street tree population (Figure 3.12). Fifteen tree species occurred in the median strips. The most common of these was ginkgo with 50% of the population (Figure 3.13). A few very large trees of heritage status occurred in or adjacent (within 15 feet) of the public right of way. Coast live oak was the most common species of these heritage trees.

**Table 3.1: Tree species occurring along El Camino Real**

| Species | Scientific Names | Street | Median |
|---|---|---|---|
| Acacia | *Acacia melanoxylon* | • | |
| American Elm | *Ulmus americana* | • | |
| Bottle Brush | *Callistemon lanceolatus* | | • |
| Canary Island Pine | *Pinus canariensis* | | • |
| Cherry* | *Prunus sp.* | | • |
| Chinese Tree of Heaven | *Ailanthus glandulosa* | • | |
| Coast Live Oak | *Quercus agrifolia* | • | • |
| Crepe Myrtle | *Lagerstroemia indica* | • | |
| Deodora Cedar | *Cedrus deodara* | • | • |
| Eucalyptus | *Eucalyptus sp.* | • | • |
| Ginkgo | *Ginkgo biloba* | • | • |
| Glossy Privet | *Ligustrum lucidum* | • | • |
| Incense Cedar | *Calocedrus decurrens* | | • |
| Italian Stone Pine | *Pinus pinea* | | • |
| London Plane | *Platanus acerifolia* | • | • |
| Ornamental Pear* | *Pyrus sp.* | • | • |
| Pin Oak | *Quercus palustris* | • | • |
| Red Oak | *Quercus ruba* | • | |
| Redwood | *Sequoia sempervirens* | • | |
| Scarlet Oak | *Quercus coccinea* | • | |
| Sweetgum | *Liquidambar* | • | • |
| Valley Oak | *Quercus lobata* | | • |
| Water Gum | *Nyssa sylvatica* | • | |

* not leafed out at time of survey, identification incomplete at time of this report

**Fig. 3.12 Street Tree Population**

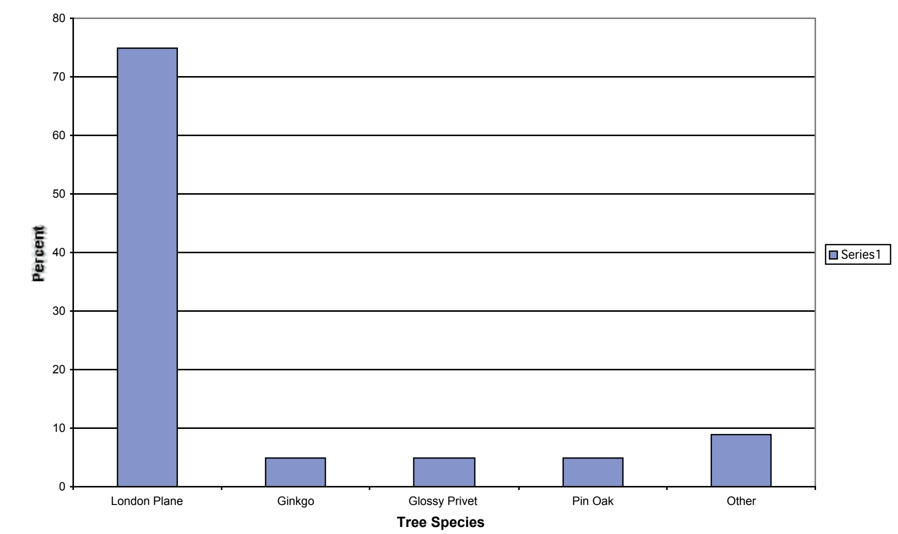
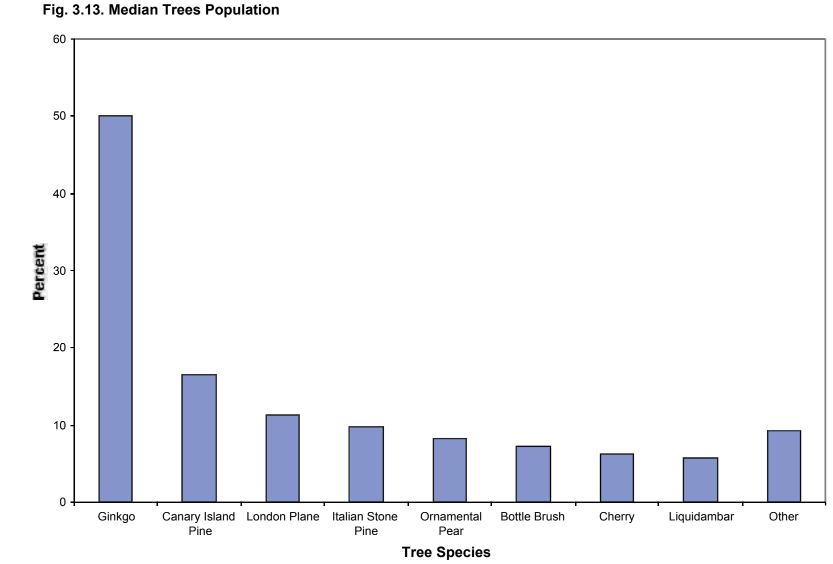



**Fig. 3.13. Median Trees Population**




Street and median trees ranged in size from 1 to 35 inches in diameter and from 4 to 74 feet in height. The largest heritage tree was 46 inches in diameter and 108 feet tall. The size distribution of street and median trees is shown in Table 3.2. The size of the trees is a function of their age and growing condition. Many of the trees along El Camino Real appear to be restricted in growth due to limited water supplies. There is considerable variation in crown radius of the trees along El Camino Real due to variation in age and pruning practices. It was noted that crown radii tended to be greater on the south sides of the trees. This difference is related to prevailing north-west winds that tend to suppress growth on the northern and western sides of the tree crowns.

**Table 3.2: Size Distribution of Street and Median Trees**

**Street Trees:**

| Species | Diameter at Breast Height (inches) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0-3" | 3-6" | 6-9" | 9-12" | 12-18" | 18-24" | 24-30" | >30" |
| London Plane | 20.3 | 29.9 | 22.3 | 16.8 | 7.6 | 1.5 | 0.5 | 1.0 |
| Ginkgo | 12.5 | 62.5 | 18.7 | 6.2 | 0 | 0 | 0 | 0 |
| Glossy Privet | 7.1 | 14.3 | 64.3 | 14.3 | 0 | 0 | 0 | 0 |
| Pin Oak | 0 | 35.7 | 57.1 | 7.1 | 0 | 0 | 0 | 0 |
| Other Species | 4.3 | 30.4 | 13.0 | 17.4 | 8.7 | 8.7 | 0 | 17.4 |

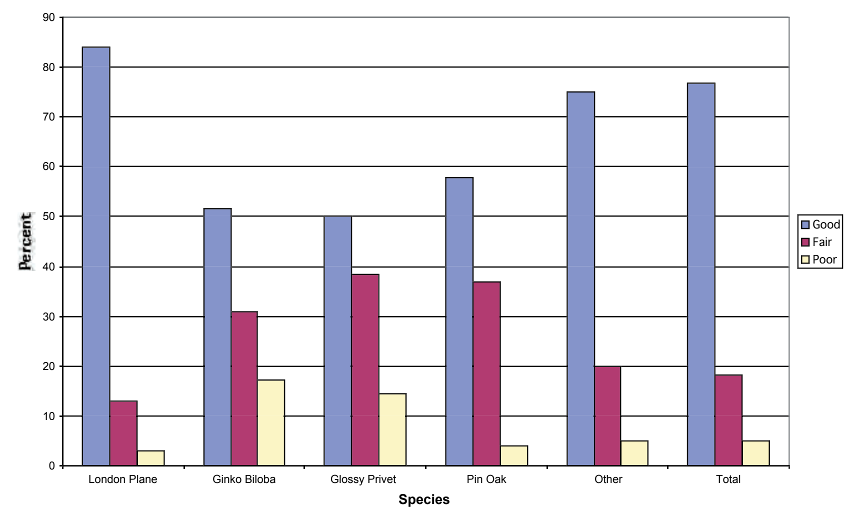
**Median Trees:**

| Species | Diameter at Breast Height (inches) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0-3" | 3-6" | 6-9" | 9-12" | 12-18" | 18-24" | 24-30" | >30" |
| Ginkgo | 50 | 46 | 4 | 0 | 0 | 0 | 0 | 0 |
| Canary Island Pine | 3.1 | 12.5 | 6.2 | 6.2 | 50 | 22 | 0 | 0 |
| London Plane | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ornamental Pear | 11.1 | 11.1 | 22.2 | 27.8 | 27.8 | 0 | 0 | 0 |
| Bottlebrush | 0 | 18.1 | 27.3 | 27.3 | 27.3 | 0 | 0 | 0 |
| Cherry | 44.4 | 44.4 | 11.2 | 0 | 0 | 0 | 0 | 0 |
| Sweetgum | 0 | 11.2 | 0 | 22.4 | 66.4 | 0 | 0 | 0 |
| Other Species | 26.3 | 31.6 | 21.0 | 15.8 | 5.2 | 0 | 0 | 0 |

The overall condition of the trees along El Camino Real is good. Only 17.7% of the street trees were rated as being in fair condition and only 5.2% in poor condition (Figure 3.14). Many of the street trees (especially ginkgo and pin oak) were ranked as being in poor condition because of the crude way that they had been pruned. The condition of median trees varied with species (Figure 3.15). Ginkgo, Canary Island pine, and London plane trees growing in the median had relatively small percentages (less than 10%) of trees, which were rated as being in fair or poor condition.

In contrast, 20 to 55% of the Italian stone pine, ornamental pear, and bottle brush trees growing in the medians were ranked as in fair or poor condition.

Fig. 3.14 Street Trees-Condition

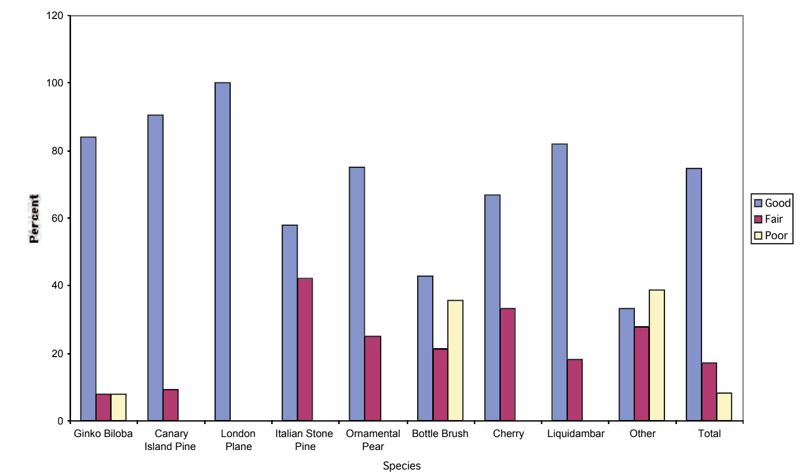



Twenty-two percent of the trees had caused damage to the sidewalks and 1.5% to the adjacent curbs. This damage was usually associated with trees over 6 inches in diameter that were growing in tree basins less than 3 feet wide (Table 3.3). Analysis of the sidewalk damage data collected along El Camino Real suggests that tree basins need to be at least 4 by 6 feet to accommodate large London plane trees.

**Table 3.3 Street tree sidewalk damage (%)**

| Species | Planting Space (feet) | DBH (inches) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0-3 | 3-6 | 6-9 | 9-12 | 12-18 | 18-24 | 24-30 | 30> |
| London Plane | 2 | 0 | 0 | 50 | 50 | 50 | | | |
| | 2 x 4 | | | 100 | 100 | | | | |
| | 3 x 4 | 45 | 7.3 | 40.5 | 63 | 54.5 | | | |
| | 4 x 4 | | | 0 | | | | | |
| | 4 x 6 | | | | | 0 | | | |
| | 5 x 6 | | | | | | 0 | | |
| | 5 x 7 | | | | | | | 0 | |
| | 5 | | | | | | | | 0 |
| | 6 | 0 | 0 | | | | | | |
| Ginkgo | 2 | | 100 | | | | | | |
| | 2 x 4 | | | | | | | | |
| | 3 x 4 | 0 | 13.0 | 25.0 | 100 | | | | |
| | 4 x 4 | | | | | | | | |
| | 4 x 6 | | | | | | | | |
| Glossy Privet | 2 | | | | | 100 | | | |
| | 2 x 4 | | | | | | | | |
| | 3 x 4 | | 0 | 0 | 25 | 25 | | | |
| Pin Oak | 2 | | | | | | | | |
| | 2 x 4 | | | | | | | | |
| | 3 x 4 | | 0 | 23.1 | | | | | |
| | 4 x 4 | | | | | | | | |
| All Species | 2 | 0 | 33 | 50 | 50 | 50 | | | |
| | 2 x 4 | | | 100 | 100 | | | | |
| | 3 x 4 | 4.5 | 8.4 | 37.4 | 39.5 | 46.7 | | | |
| | 4 x 4 | | | 0 | | | | | |
| | 4 x 6 | | | | | 0 | | | |
| | 5 x 6 | | | | | | 0 | | |
| | 5 x 7 | | | | | | | 0 | |
| | 5 | | | | | | | | 0 |
| | 6 | 0 | 0 | | | | | | |

**Fig. 3.15 Median Trees-Condition**




Soils along El Camino Real have developed on alluvial deposits ranging in texture along El Camino Real in Palo Alto. The names and locations of these soil types are shown in Table 3.4. Characteristics of these soils are summarized on Tables 5A and 5B. The textures of these soils range from loam to clay loam to clay and gravelly loam to gravelly clay loam. Soil pH was neutral for most soils, with a couple of soils being slightly acidic and one soil alkaline. Generally speaking these alluvial soils are deep with rather thick A horizons. These soils are in general excellent soils for tree growth. Various orchard crops were planted in Santa Clara County in the 19th century because of the quality of these soils for tree growth. The only limits for tree growth associated with the soils are the restricted drainage associated with the Pleasanton series (Pleasanton clay loam, Pleasanton loam, Pleasanton gravelly loam), Clear Lake clay, and the San Ysidro loam. Clay pans common to San Ysidro loam may also restrict root penetration. Unfortunately, most of the trees planted along El Camino Real have roots, which have been restricted from growing into the native soils by a gravel layer put down as a bed for the expansion of El Camino Real in the early 1960. This gravel was topped by a l2 to 24 inch layer of sandy loam in the median strips and in the tree basins cut into the sidewalks (Table 3.5). Tree roots have largely been restricted to this layer of sandy loam and have not grown through the gravel bedding laid down for the road. The low water holding capacity of this relatively thin layer of sandy loam combined with the rapid drainage of water through the gravel has been the major limiting factor for tree growth. Although all trees are provided 15 gallons of water each week during the dry season, very little growth has occurred on a large number of trees planted in 1985. About 70% of these trees are less than 6 inches in diameter as a result of limited water resources. Where trees planted in 1982 were adjacent to irrigated lawns, these tree are generally over 10 inches in diameter. The problem of soil volume and water holding capacity must be addressed the redesign of El Camino Real if the street and median trees are to obtain their potential growth.

**Table 3.4.A. Characteristic of soils along El Camino Real in Palo Alto, CA**

| Map Symbol | Soil Type | Parent Material | Surface Soil | Sub Soil | Root Penetration | Surface Soil | Sub Soil | Surface Runoff | Occurrence of High Water Table | Water Holding Capacity | Fertility | Workability |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yg | Yolo loam | loam | loam | loam | deep | moderate | moderate | slow | none | high | high | easy |
| Ya | Yolo clay loam | alluvium | clay loam | clay loam | deep | moderate | moderate | slow | none | high | moderate | rather difficult |
| Pf | Pleasanton clay loam | alluvium | clay loam | gravelly clay loam | deep | moderate | slow | slow | moderate | moderate | moderate | easy |
| Ps | Pleasanton loam | gravelly clay loam | loam | gravelly clay loam | deep | moderate | moderate | slow | none | moderate | moderate | easy |
| Po | Pleasanton gravelly loam | gravelly alluvium | gravelly loam | compact gravelly loam | deep | moderate | moderate | slow | none | moderate | moderate | rather difficult |
| Dh | Dublin clay (adobe) | fine textured alluvium | adobe clay | clay | deep | slow | slow | slow | none | high | moderate | difficult |
| Dl | Dublin clay loam | medium textured alluvium | deep | moderate | deep | moderate | moderate | slow | none | high | moderate | easy |
| Cm | Clear Lake clay (adobe) | alluvium of valley basins | adobe clay | clay | deep | slow | very slow | occasional | occasional | high | moderate | difficult |
| Ze | Zamora gravelly clay loam | young alluvium from sedimentary rocks | gravelly clay loam | compacted gravelly clay loam | deep | moderate | moderate | slow | none | high | moderate | rather difficult |
| Sd | San Ysidro loam | older alluvium from sedimentary rocks | loam | compact clay pan | shallow | moderate | very slow | slow | none | low | moderate | easy |

Soil Types: Cm=Clear Lake clay (adobe), Dh=Dublin clay loam, Dl =Dublin clay loam (adobe), Pf=Pleasanton clay loam, Po=Pleasanton gravel loam, Ps=Pleasanton loam, Sb=San Ysidro clay loam, Ya=Yolo clay loam, Yg=Yolo loam

**Table 3.4.B. Additional characteristic of soils along El Camino Real in Palo Alto, CA**

| Map Symbol | Soil Type | Depth of | | pH | Comments |
|---|---|---|---|---|---|
| | | Surface soil | Sub soil | | |
| Yg | Yolo loam | 8-28" | 6'+ | neutral | excellent for orchards |
| Ya | Yolo clay loam | 10-24" | 6'+ | slightly acidic to neutral | good for orchards |
| Pf | Pleasanton clay loam | 10-17" | 27-58" | neutral | compact subsoil restricts drainage |
| Ps | Pleasanton loam | 11-20" | 32-43" | neutral | compact subsoil interferes slightly with water penetration |
| Po | Pleasanton gravelly loam | 16-22" | 38-45" | slightly acid to neutral | water penetration is fairly easy |
| Dh | Dublin clay (adobe) | 14-20" | 26-41" | slightly acid to neutral | water penetrates slowly; may overlay clay pans |
| Dl | Dublin clay loam | 9-20" | 28-40" | neutral | moderately permeable |
| Cm | Clear Lake clay | 9-13" | 32-40" | alkaline | water penetrates very slowly |
| Ze | Zamora gravelly clay loam | 15-30" | 36-48" | neutral to slightly acid | slight retardation of water penetration |
| Sb | San Ysidro loam | 15-25" | 43-55" | neutral to slightly acid | clay pans retard water and root penetration |

**Table 3.5: Analysis of soil conditions along El Camino Real in Palo Alto, CA**

| Soil Type | Location | Map | Depth (inches) | Texture | Comments |
|---|---|---|---|---|---|
| Po | 1 | 1 | 0-10<br>10-12 | sandy loam<br>clay | soil mixed with red lava |
| Po | 2 | 1 | 0-12<br>12- | sandy loam<br>gravel | |
| Cm | 3 | 5 | 20-24<br>24-30<br>20-6 feet | sandy gravely<br>gravelly clay loam<br>very gravelly clay loam | construction site, fill over native soil |
| Cm | 4 | 6 | 0-24<br>24-36 | sandy clay loam<br>sandy clay with yellow clay infusions | median may be all new fill |
| Cm | 5 | 8 | 0-12<br>12-15<br>15-24 | sandy clay loam<br>sandy clay<br>stiff clay | |
| Cm | 6 | 8 | 0-12<br>12-28 | sandy clay loam<br>gravelly, sandy clay loam | broken glass @ 26" suggests fill |
| Cm | 7 | 9 | 0-14<br>14-26 | sandy loam<br>stiff mottled clay | |
| Cm | 8 | 9 | 0-40 | gravely sand loam | |
| Dl | 9 | 10 | 0-20<br>20- | very sandy loam<br>clay | new fill |
| Dl | 10 | | 0-14<br>14-30<br>30- | sandy clay<br>slightly gravelly sandy clay<br>gravel | very wet |
| Dh | 11 | 12 | 0-14<br>14- | sandy clay loam<br>gravel | |
| Dh | 12 | 12 | 0-8 | gravelly sandy loam | dry below 4" |
| Dh | 13 | 15 | 0-12<br>12-14 | sandy loam<br>sandy gravel layer | could not penetrate below 14" due to gravel |
| Dh | 14 | 15 | 0-8<br>8-24<br>24- | sandy loam<br>clay loam<br>gravel | |
| Sb | 15 | 16 | 0-14<br>14-24<br>24- | sandy clay loam<br>sandy clay<br>stiff clay, slightly sandy | |
| Sb | 16 | 16 | 0-6<br>6- | very sandy loam<br>gravelly sandy loam | could not penetrate below 6" due to gravel |
| Ps | 17 | 18 | 0-14<br>14- | gravely sandy loam<br>gravelly layer | could not penetrate below 14" due to gravel |
| Ps | 18 | 18 | 0-10<br>10- | fine sandy loam<br>gravel layer | could not penetrate below 10" due to gravel |
| Po | 19 | 21 | 0-10<br>10- | gravelly sandy loam<br>gravel | could not penetrate below 10" due to gravel |
| Po | 20 | 21 | 0-4 | clay loam | could not penetrate below 4" due to gravel |
| Pf | 21 | 23 | 0-11<br>11-24 | gravelly sandy loam<br>medium stiff clay | |
| Pf | 22 | 23 | 0-33<br>33- | slightly gravelly sand clay loam<br>stiff clay | air pockets in this soil<br>33" water table on perched clay |
| Ps | 23 | 26 | 0-15<br>15- | gravelly sandy clay loam<br>gravely clay | gravely at surface, could not penetrate below 15" due to gravel |
| Ps | 24 | 26 | 0-12 | gravelly clay loam | newly planted median |
| Ya | 25 | 28 | 0-10<br>10- | slightly gravelly clay loam<br>gray gravel layer | could not penetrate below 10" due to gravel |
| Ya | 26 | 28 | 0-6<br>6-12 | sandy clay loam<br>gravel | angular gravel (suggests fill) at 12" could not penetrate below 12" due to gravel |
| Yg | 27 | 28 | 0-26<br>26- | sandy loam<br>sandy clay loam | |

Soil Types: Cm=Clear Lake clay (adobe), Dh=Dublin clay loam, Dl =Dublin clay loam (adobe), Pf=Pleasanton clay loam, Po=Pleasanton gravel loam, Ps=Pleasanton loam, Sb=San Ysidro clay loam, Ya=Yolo clay loam, Yg=Yolo loam

The definitive characteristics of the Palo Alto climate are the relatively mild winter temperatures, dry summers, and prevailing northwest winds (Table 3.6). The average January temperature in Palo Alto is 48° F, while the lowest minimum temperature recorded was 22° F. Average summer precipitation for June, July, and August amounts to only 0.2 inches. These conditions put Palo Alto in Plant Climate Zone 15, which is not too restrictive in terms of trees which can be grown. Zone 15 is cold enough to limit the planting of some subtropical species of *Ficus* and *Eugenia*, but does not limit the growth of temperate zone species. The summer drought does, however, require summer irrigation to maintain a number of tree species not common to Mediterranean climates. The major influence of the prevailing northwest wind has been to cause excessive lean in some trees planted along El Camino Real and to produce lopsided tree crowns having southern radii exceeding their northern radii. The prevailing wind, which can exceed 10 mph in velocity in any season of the year, has and must continue to be addressed with an aggressive tree staking program for newly planted trees.

The existing conditions along El Camino Real are suitable for a number of tree species, which can be used as median and/or street trees. A preliminary list of these trees is attached (Table 3.7). This list will serve as a starting point for identification of different alternatives for tree planting.

**Table 3.6. Climatic Characteristics of Palo Alto, CA**

| Parameter | Winter* | Spring | Summer | Fall | Annual |
|---|---|---|---|---|---|
| Temperature (°F) | | | | | |
| Average | 48 | 56 | 65 | 59 | 57 |
| Highest Max | 79 | 94 | 102 | 99 | 102 |
| Lowest Min | 22 | 30 | 40 | 31 | 22 |
| | | | | | |
| Precipitation (inches) | | | | | |
| Average | 9.7 | 3.5 | 0.2 | 2.4 | 15.8 |
| Driest | 3.4 | 1.7 | 0.02 | 0.2 | 6.4 |
| Wettest | 20.2 | 7.3 | 1.2 | 1.0 | 28.5 |
| | | | | | |
| Killing Frost | Ave. Last in Spring | Ave. First in Fall | Ave. Last in Spring | Ave. First in Fall | |
| Average Date | Feb. 15 | Dec. 21 | April 10 | Oct. 29 | |
| | | | | | |
| Prevailing Wind | | | | | |
| Direction | NW | NW | NW | NW | NW |

*winter=Dec., Jan., Feb.; spring=Mar., Apr., May; summer=June, July, Aug.; fall=Sept., Oct., Nov.

**Table 3.7. Potential Trees for El Camino Real, Palo Alto, CA**

| No. | Common Name | Scientific Name | Deciduous/ Evergreen/ Conifer | Mature Height (ft) | Minimum Planting Width (ft.) | Recommended Spacing (ft.) | Comments |
|---|---|---|---|---|---|---|---|
| 1 | Big Leaf Maple | Acer macrophyllum | D | 30-60 | 8 | 35-40 | M&M, B |
| 2 | California Buckeye | Aesculus californica | D | 20-40 | 6 | 25-30 | B |
| 3 | Atlas Cedar | Cedrus atlantica | C | 50-100 | 8 | 35-40 | B |
| 4 | Deodora Cedar | Cedrus deodara | C | 40-100 | 8 | 35-40 | B |
| 5 | Camphor | Cinnamomum camphora | E | 20-40 | 8 | 35-40 | B |
| 6 | European Copper Beech | Fagus sylvatica 'Reversli' | D | 30-60 | 8 | 35-40 | B |
| 7 | Evergreen ash | Fraxinus uhdei | E | 60-100 | 8 | 35-40 | B |
| 8 | Sweet Gum 'Palo Alto" | Liquidambar styracifllua 'Palo Alto' | D | 60-100 | 8 | 35-40 | B, GS |
| 9 | Southern magnolia | Magnoila grandiflora | E | 25-60 | 8 | 35-40 | M&M, B, GS |
| 10 | Flaxleaf Paperbark | Melaleuca linariifolia | E | 15-30 | 6 | 25-30 | B |
| 11 | Canary Island Pine | Pinus canariensis | C | 60-80 | 8 | 35-40 | B |
| 12 | Eldarica Pine | Pinus eldarica | C | 50-70 | 8 | 35-40 | B |
| 13 | Aleppo Pine | Pinus halepensis | C | 30-60 | 8 | 35-40 | B |
| 14 | Bishop Pine | Pinus muricata | C | 45-70 | 8 | 35-40 | B |
| 15 | Italian Stone Pine | Pinus pinea | C | 30-70 | 8 | 35-40 | B, GS |
| 16 | Longleaf Pine | Pinus roxburgii | C | 70-100 | 8 | 35-40 | B |
| 17 | Torrey Pine | Pinus torreyana | C | 20-40 | 8 | 35-40 | B |
| 18 | London Plane | Platanus acerifolia | D | 30-70 | 8 | 35-40 | M&M, B, GS |
| 19 | California sycamore | Platanus racemosa | D | 40-90 | 8 | 35-40 | B |
| 20 | Fremont Cottonwood | Populus fremontii | D | 40-100 | 8 | 35-40 | B problems with seed cotton, allergic pollen |
| 21 | Coast Live Oak | Quercus agrifolia | E | 30-75 | 8 | 35-40 | M&M, B |
| 22 | Valley Oak | Quercus lobata | D | 40-125 | 8 | 35-40 | B potential limb breakage |
| 23 | Cork Oak | Quercus suber | D | 20-50 | 6 | 35-40 | M&M, B |
| 24 | Red Oak | Quercus borealis | D | 40-60 | 6 | 35-40 | B |
| 25 | Pin Oak | Quercus palustris | D | 50-80 | 6 | 35-40 | B |
| 26 | California Pepper Tree | Schinus molle | E | 20-50 | 8 | 35-40 | M&M, B |
| 27 | Coast Redwood | Sequoia sempervirens | C | 80-125 | 8 | 35-40 | B, GS |
| 28 | Frontier Elm | Ulmus americana 'Frontier' | D | 60-100 | 8 | 35-40 | B |
| 29 | Sycamore Maple | Acer pseudoplatanus | D | 30-90 | 8 | 35-40 | B |
| 30 | Red Horsechestnut | Aesculus carnea | D | 25-60 | 8 | 35-40 | M&M, B |
| 31 | Horsechestnut | Aesculus hippocastanum | D | 25-60 | 8 | 35-40 | M&M, B |
| 32 | American Ash | Fraxinus americana | D | 60-80 | 8 | 35-40 | M&M, B |
| 33 | Ginkgo | Ginko biloba | D | 40-100 | 8 | 35-40 | M&M, B |
| 34 | Tulip Tree | Liriodendron tulipfera | D | 40-100 | 8 | 35-40 | B, GS |
| 35 | American Linden | Tilia americana | D | 60-100 | 8 | 35-40 | M&M, B |
| 36 | Maul Oak | Quercus chrysolepis | D | 40-80 | 8 | 35-40 | M&M, B |
| 37 | Plume Palm | Cocos plumosa | E | 15-40 | 6 | 25-30 | M&M, B |
| 38 | Chinese Fan Palm | Livistona chinensis | E | 18-25 | 6 | 25-30 | M&M, B |
| 39 | Canary Date Palm | Phoenix canariensis | E | 25-60 | 6 | 25-30 | M&M, B |
| 40 | Date Palm | Phoenix dactylifera | E | 25-75 | 6 | 25-30 | M&M, B |
| 41 | California Fan Palm | Washingtonia filifera | E | 20-70 | 6 | 25-30 | M&M, B |
| 42 | Mexican Fan Palm | Washington gracilis | E | 40-100 | 6 | 25-30 | M&M, B, GS |
| 43 | Chinese Hackberry | Celtis sinensis | D | 40-60 | 8 | 35-40 | M&M, B, GS |
| 44 | Blackwood Acacia | Acacia melanoxylon | E | 70-80 | 8 | 35-40 | GS can become a pest |
| 45 | Nichol's Willow leafed Peppermint | Eucalyptus nicholii | E | 35-40 | 8 | 25-30 | GS susceptible to limb breakage |
| 46 | Scarlet-flowered gum | Eucalyptus ficifolia | E | 30-35 | 8 | | GS substantial work to keep trees pruned |
| 47 | Raywood Ash | Fraxinus oxycarpa | D | 50-60 | 8 | 35-40 | GS summer irrigation required |
| 48 | Evergreen Ash | Fraxinus uhdei | E | 80-90 | 8 | 35-40 | GS needs frequent trimming |
| 49 | Idaho locust | Robinia idahoensis | D | 35-40 | 8 | 25-30 | GS brittle wood |
| 50 | Silver Dollar Tree | Eucalyptus polyanthemos | E | 55-60 | 8 | 35-40 | GS susceptible to limb breakage |
| 51 | Red Ironbark | Eucalyptus sideroxyoln | E | 65-70 | 8 | 35-40 | GS tips easily in strong wind |
| | | | | | | | |

# *Assessment of Major Utility Alignments*

## Summary

Most underground utilities in the project area are concentrated near the existing curbs. The most significant effect that existing underground utilities will have is on the location of tree wells and light standard foundations. Otherwise the effect on the project appears to be minimal. Some utilities could be relocated where required at widely varying expenses. There is probably room between utilities to set some tree wells and lamp foundations, but the underground facilities will need to be located precisely during the design phase. In other cases, with consent of the utility owner (in all cases except telephone and some major water mains the City of Palo Alto) trees and light standards may be located close to or on top of deeper underground facilities. Utilities in the roadway by virtue of a franchise agreement (telephone, CATV) may be relocated if required at the expense of their respective owners.

## Storm Drainage

There are existing storm drainage facilities for most of the entire length of the project. Longitudinal drainage for the most part is on the west side of the existing roadway. Relocating longitudinal drainage facilities would be very expensive but transverse facilities could be relocated at a moderate cost. It would be best to respect the location of longitudinal drainage in so far as the location of trees and light standards. Low landscaping, sidewalk paving, curbs and roadway paving may occupy space above storm drainage facilities without adverse effect. Obviously, any curb relocation, roadway narrowing or widening would require modification and addition of storm drain inlets and manholes. The anticipated costs for such modifications would not be large.

## Sanitary Sewers

Sanitary sewers, like storm drainage facilities are gravity systems, and as such, are more difficult to relocate, although less so than typical storm drain relocations. The pipe sizes are typically smaller than storm drains. There are longitudinal sanitary sewers in El Camino Real. For the most part longitudinal sewers are located near the existing curbs, either in the sidewalk areas or in the existing parking lane. However, there are a few blocks between Stanford Avenue and Cambridge Avenue where the sanitary sewer runs under the median in the center of the street, and several blocks north of Cambridge where the longitudinal sewer is in the #1 (left) lane north or south bound. While most of these mains would be deep enough to accommodate trees and lamp foundations, placing trees or lamp foundations over sanitary sewers is considered poor practice from a sewer operations and maintenance point of view and would be resisted by the sewer department.

## Water

There are longitudinal water lines throughout most of the project area. In the Stanford campus area waterlines are generally on the northeast side of the roadway in the rightmost (northbound) traffic lane while heavy storm drainage facilities occupy the opposite side of the street. Most of the remainder to the project has longitudinal water lines on both sides of El Camino Real.

## Gas and Electric

Longitudinal electric conduits for street lighting exist throughout the project area. Underground electric power distribution and gas lines are located in the sidewalk areas on most of the commercial frontages. There are numerous large electrical boxes in sidewalk locations that are relatively difficult to relocate horizontally but less difficult to adjust to vertical grade.

## Communications

While the consultants have been unable so far to view system maps from the telephone and cable companies we have observed evidence of major underground telephone facilities in the rightmost northbound traffic lane in the northerly half of the project area. To date, we assume that there are lesser telephone facilities and CATV facilities in most of the sidewalk areas or sharing joint trenches with electric and gas facilities.

Bicycle facilities such as bicycle loops or other furnishings for bicycle parking do currently not exist within the public right-of-way. Please see the *Transportation Chapter* for a discussion of bicycle crossing and intersection design issues.

**(Footnotes)**

[1] Measurements taken from GIS maps and aerial photographs provided by the City of Palo Alto indicate that there may also be exceptions where the overall right-of way is <u>less</u> than 120 feet wide, along the order of 2 to 2-1/2 feet. It is likely that sidewalks and/or medians would need to be slightly narrower in these locations.

# Appendix 4

# Traffic Analysis (Additional Data)

## MEMORANDUM

Date: February 1, 2006

To: Heba El-Gundy, City of Palo Alto

From: Chris Gray, Fehr & Peers

***Subject: Traffic Data and Analysis for El Camino Real Schematic Design***

*1021-1785*

This memorandum summarizes all transportation work done to date regarding the El Camino Real Schematic Design project. The following information is summarized:

1. Traffic counts and volumes
2. Accidents
3. Travel times
4. Intersection Level of Service

**Existing Traffic Counts**

Traffic counts were taken from a variety of sources including published CMP counts (2001) and counts collected by Fehr & Peers in February and March 2002. Counts were taken initially at 17 study locations, including 4 CMP count locations. The existing traffic counts are shown on Figure 1. Bicycle and pedestrian counts were taken at several selected intersections and are shown as Figure 2.

**Existing Accident Data**

The accident data is presented in Tabular form and represents a 3-year period prior to 2001. We have both vehicular and bicycle/pedestrian accident summaries. Please note that for the accident data presentation, results from several closely spaced intersections were combined.

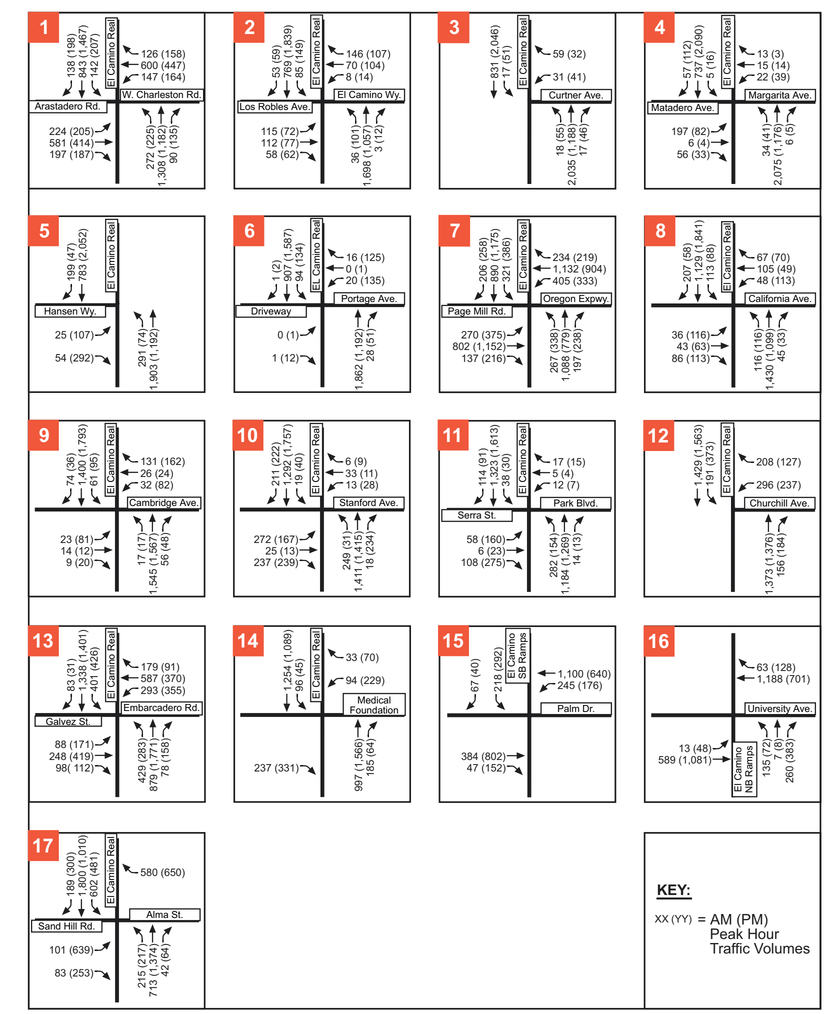
**Table 1**

**TASIS Corridor Accident Data**

| Segment | Accident Rate | Statewide Average | Exceeds Statewide Average (Yes/No) |
|---|---|---|---|
| Arastadero Road to Matadero Avenue | 2.36 | 2.40 | No |
| Matadero Avenue to California Avenue | 2.36 | 2.40 | No |
| California Avenue to Alma Avenue | 2.75 | 2.40 | Yes |

Sources: Caltrans TASAS Data, District 4

15707 Rockfield Boulevard, Suite 155 Irvine, CA 92618 (949) 859-3200 Fax (949) 859-3209
www.fehrandpeers.com




El Camino Real Schematic Design

**EXISTING PEAK HOUR TRAFFIC VOLUMES**

**FIGURE 1**

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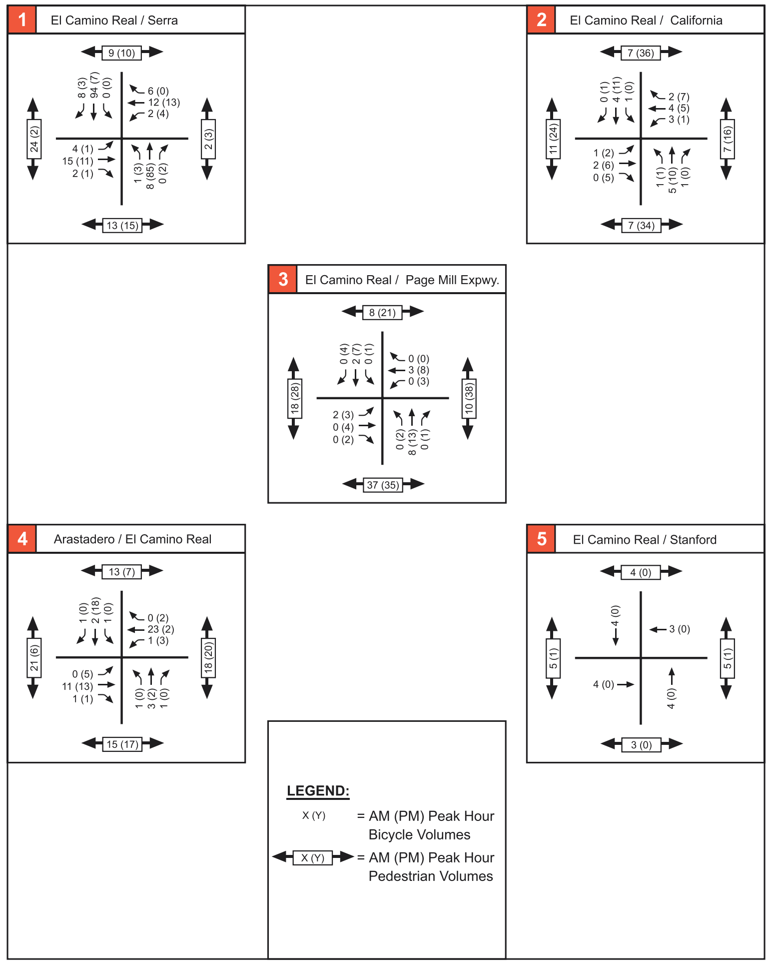
April 2002
1785-11




FEHR & PEERS TRANSPORTATION CONSULTANTS
August 2002
1785-21

El Camino Schematic
**EXISTING BICYCLE AND PEDESTRIAN VOLUMES**
FIGURE 2

**Table 2**

**TASIS Intersection Accident Data**

| Intersection | Number of Accidents | Accident Rate | Statewide Average Accident Rate | Exceeds Statewide Average (Yes/No) |
|---|---|---|---|---|
| El Camino Real / Arastradero Road | 42 | 0.56 | 0.43 | No |
| El Camino Real / Maybelle Avenue | 18 | 0.32 | 0.28 | **Yes** |
| El Camino Real / Los Robles Road | 19 | 0.32 | 0.43 | No |
| El Camino Real / Curtner Avenue | 17 | 0.30 | 0.28 | **Yes** |
| El Camino Real / Matadoro Avenue | 10 | 0.18 | 0.43 | No |
| El Camino Real / Hansen Way / Portage | 19 | 0.32 | 0.43 | No |
| El Camino Real / Page Mill Road | 37 | 0.45 | 0.43 | **Yes** |
| El Camino Real / California Avenue | 18 | 0.31 | 0.43 | No |
| El Camino Real / Cambridge Avenue | 17 | 0.33 | 0.43 | No |
| El Camino Real / Stanford Avenue | 16 | 0.28 | 0.43 | No |
| El Camino Real / Serra Street | 10 | 0.18 | 0.43 | No |
| El Camino Real / Churchill Avenue | 34 | 0.63 | 0.28 | **Yes** |
| El Camino Real / Embarcadero Road / Galvez Street | 32 | 0.49 | 0.43 | **Yes** |
| El Camino Real / Palm Drive Ramps | 18 | 1.24 | 1.50 | No |
| El Camino Real / Alma Street | 33 | 0.71 | 0.28 | **Yes** |

Sources: Caltrans TASAS Data, District 4

**Table 3**

**TASAS Accident Types & Causes**

| Intersection | Number of Accidents | Rear-Ends as % of Accidents | % of Accidents with Speeding as Cause |
|---|---|---|---|
| El Camino Real / Arastradero Road | 42 | 24% | 31% |
| El Camino Real / Maybelle Avenue | 18 | 61% | 61% |
| El Camino Real / Los Robles Road | 19 | 37% | 42% |
| El Camino Real / Curtner Avenue | 17 | 47% | 59% |
| El Camino Real / Matadoro Avenue | 10 | 60% | 80% |
| El Camino Real / Hansen Way / Portage | 19 | 60% | 80% |
| El Camino Real / Page Mill Road | 37 | 58% | 74% |
| El Camino Real / California Avenue | 18 | 46% | 51% |
| El Camino Real / Cambridge Avenue | 17 | 33% | 50% |
| El Camino Real / Stanford Avenue | 16 | 29% | 29% |
| El Camino Real / Serra Street | 10 | 38% | 44% |
| El Camino Real / Churchill Avenue | 34 | 20% | 30% |
| El Camino Real / Embarcadero Road / Galvez Street | 32 | 59% | 65% |
| El Camino Real / Palm Drive Ramps | 18 | 33% | 61% |
| El Camino Real / Alma Street | 33 | 48% | 64% |

Sources: Caltrans TASAS Data, District 4

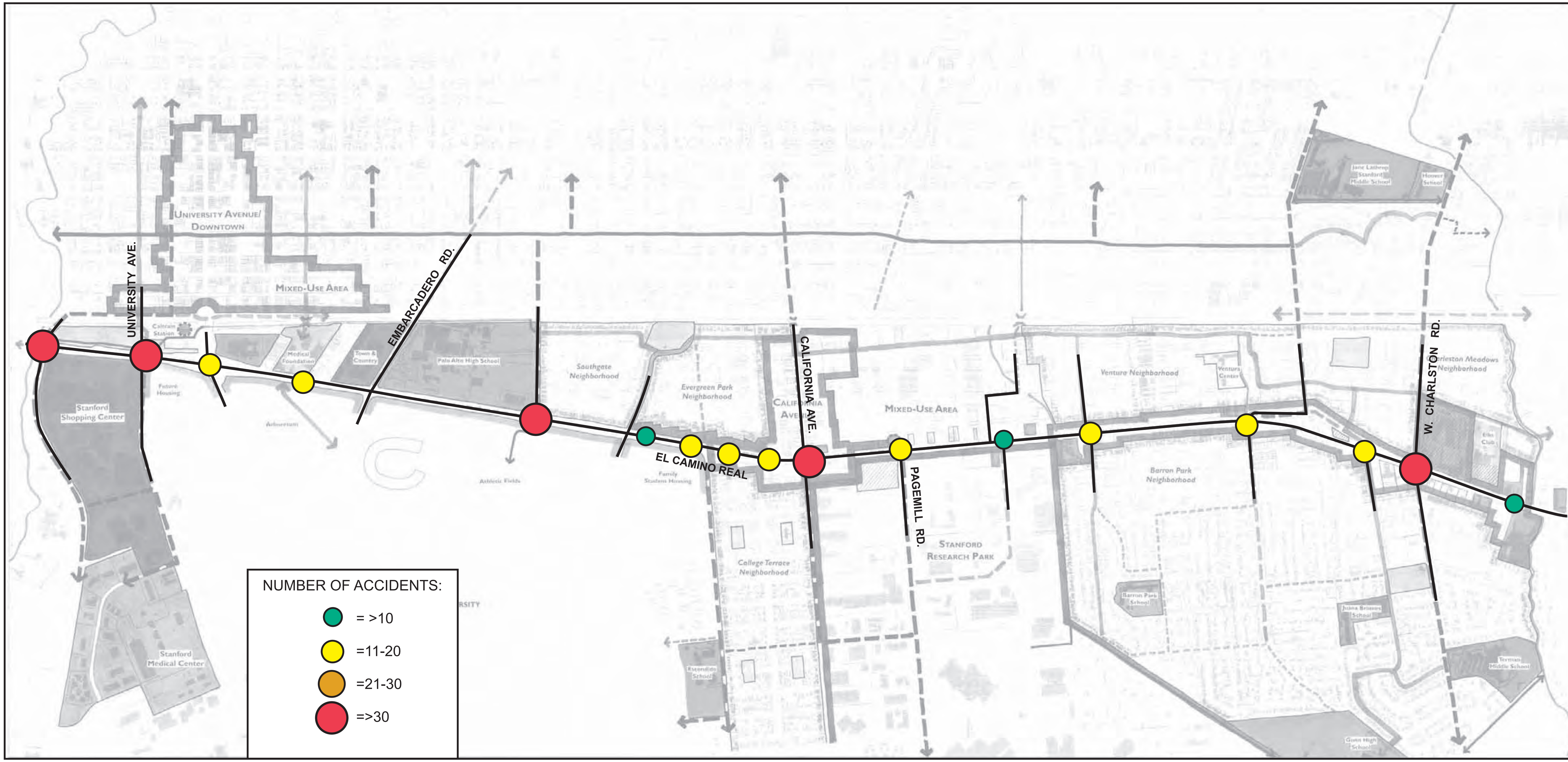
**Table 4**

**TASAS Accident Data- Type and Causes of Accidents**

| Intersection | Number of Accidents | Bike Accidents | Pedestrian Accidents |
|---|---|---|---|
| El Camino Real / Arastradero Road | 42 | 2 | 0 |
| El Camino Real / Maybelle Avenue | 18 | 1 | 0 |
| El Camino Real / Los Robles Road | 19 | 1 | 0 |
| El Camino Real / Curtner Avenue | 17 | 2 | 0 |
| El Camino Real / Matadoro Avenue | 5 | 1 | 1 |
| El Camino Real / Hansen Way / Portage | 19 | 1 | 0 |
| El Camino Real / Page Mill Road | 37 | 3 | 0 |
| El Camino Real / California Avenue | 19 | 0 | 1 |
| El Camino Real / Cambridge Avenue | 17 | 1 | 3 |
| El Camino Real / Stanford Avenue | 18 | 0 | 0 |
| El Camino Real / Serra Street | 10 | 1 | 0 |
| El Camino Real / Churchill Avenue | 34 | 1 | 0 |
| El Camino Real / Embarcadero Road / Galvez Street | 32 | 1 | 0 |
| El Camino Real / Palm Drive Ramps | 18 | 1 | 3 |
| El Camino Real / Sand Hill / Alma* Street* | 33 | 3 | 0 |

Source: Caltrans, TASAS Database (1999 through 2001)

Figures 3 and 4 present accident data summaries for both accident incidence and type of accidents.

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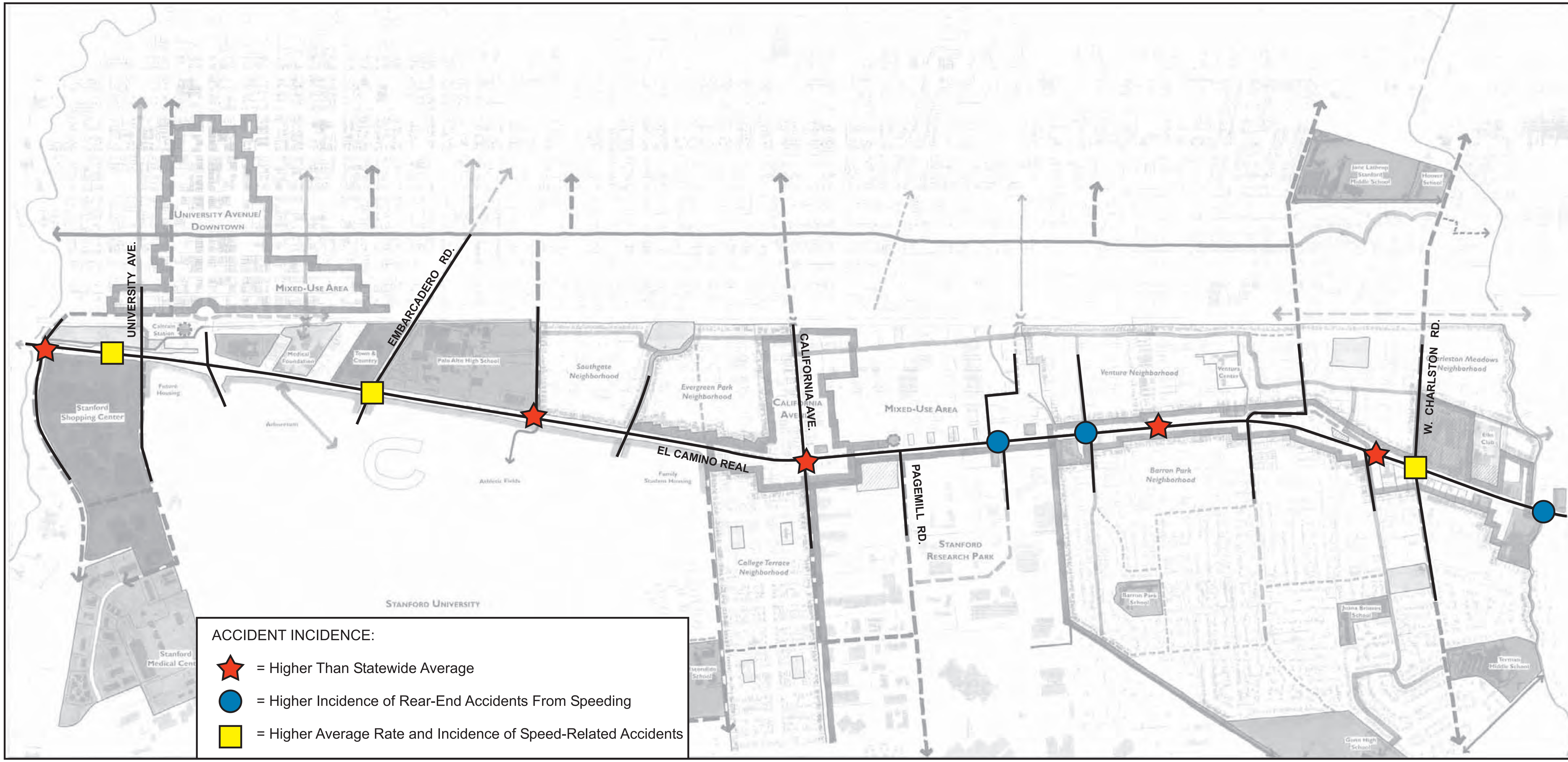
March 2003
1785-41

## NUMBER OF ACCIDENTS

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March 2003
1785-42

## ACCIDENT INCIDENCE

**Existing Travel Time Data**

We also conducted travel time analyses along the corridor to determine travel speeds along the corridor and parallel routes as well. The results for the corridors are summarized in the Table 5.

**Table 5**

**Average Total Travel Speed Comparison**
**(Includes impacts of congestion and traffic signal delay)**

| | AM | | PM | |
|---|---|---|---|---|
| | **Southbound** | **Northbound** | **Southbound** | **Northbound** |
| Middlefield | 17.61 mph | 17.24 mph | 17.68 mph | 17.33 mph |
| Alma Street | 24.35 mph | 26.02 mph | 21.48 mph | 27.24 mph |
| Cowper-Waverly Corridor | 16.67 mph | 16.44 mph | 18.03 mph | 18.15 mph |
| El Camino Real | 19.44 mph | 19.20 mph | 17.83 mph | 16.80 mph |

Source: Fehr & Peers Associates
June 2002

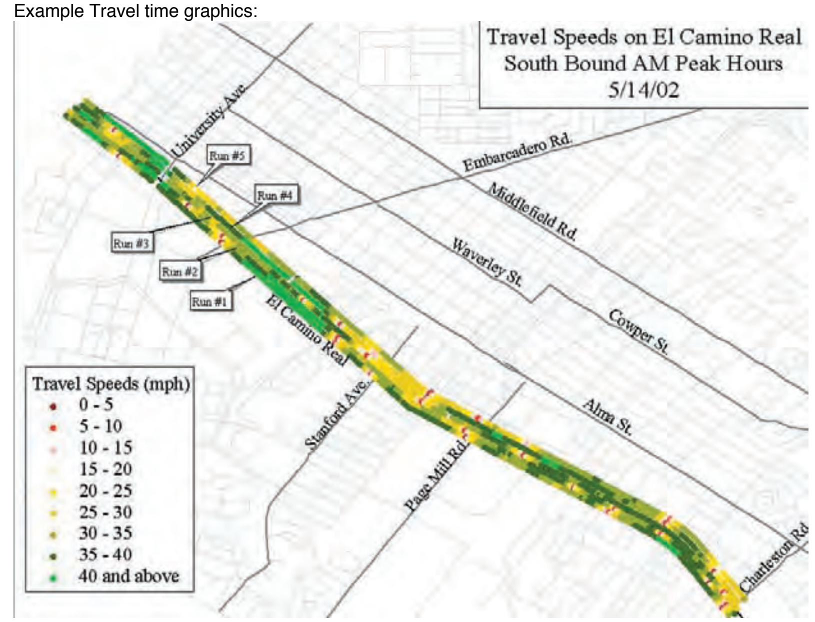
Table 6 summarizes the information for El Camino Real and provides a breakdown by day of the week, time, and direction.

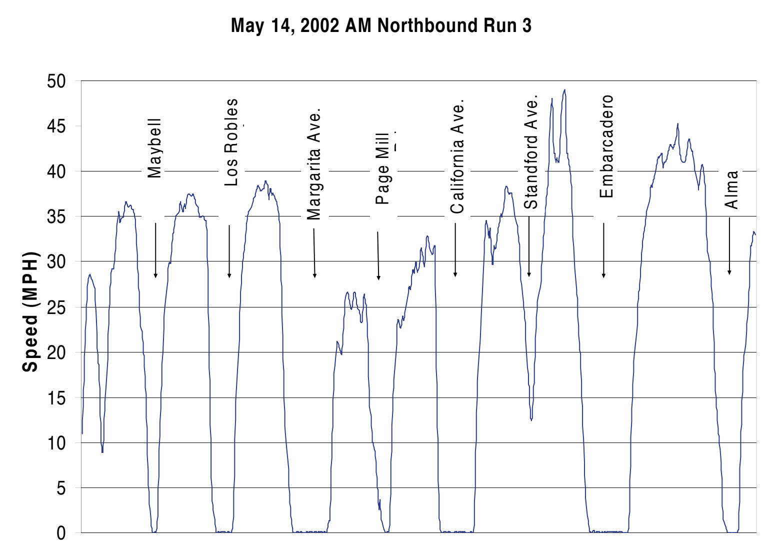
**Table 6**
**Average Travel Speed (mph) and Number of Stops**
**(Excluding Time Spent Stopped due to Traffic Signals)**

| Date | Time | Direction | Average Speed (mph) | Average # of Stops Per Run |
|---|---|---|---|---|
| May 14, 2002 (Tuesday) | AM | NB | 29.54 | 7.60 |
| May 14, 2002 (Tuesday) | AM | SB | 27.73 | 8.50 |
| May 14, 2002 (Tuesday) | PM | NB | 30.12 | 6.20 |
| May 14, 2002 (Tuesday) | PM | SB | 26.78 | 7.75 |
| May 16, 2002 (Thursday) | AM | NB | 29.15 | 7.00 |
| May 16, 2002 (Thursday) | AM | SB | 27.43 | 8.67 |
| May 16, 2002 (Thursday) | PM | NB | 30.53 | 7.75 |
| May 16, 2002 (Thursday) | PM | SB | 26.90 | 9.33 |

Source: Fehr & Peers Associates
June 2002

Example Travel time graphics:




**Future Traffic Volumes**

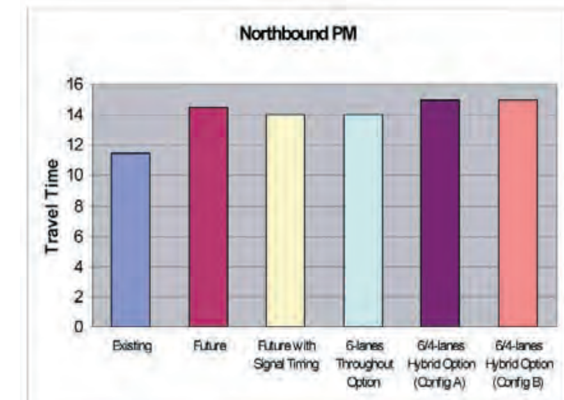
We applied a growth rate to the various study intersections of approximately 1% per year to yield the future traffic forecasts, which reflect 20 year growth from the period the traffic counts were collected. Future volumes for the 17 study intersections and are shown as Figure 5.

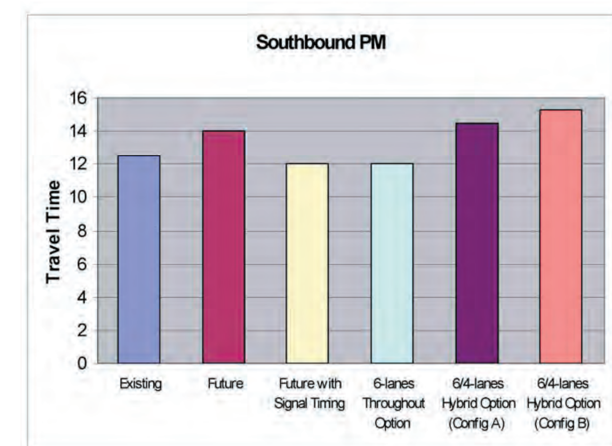
**Level of Service Analysis**

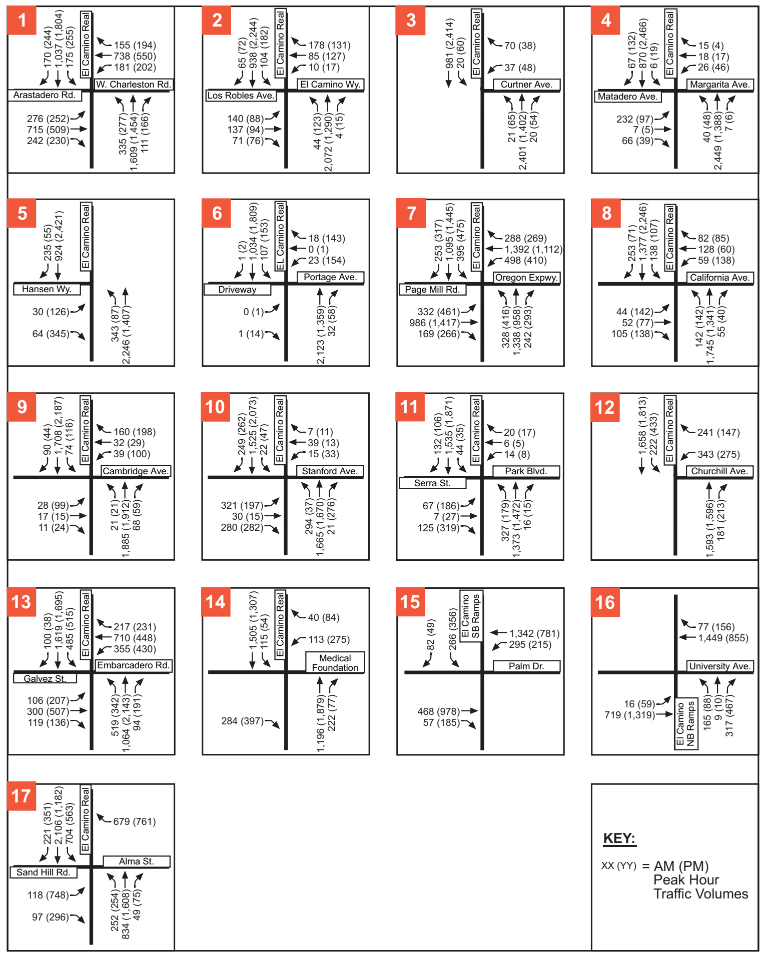
We developed a micro-simulation model of the corridor using CORSIM software. We extracted travel times and LOS results from this model. When reviewing the LOS and travel time results, please note the following:

1. We prepared an existing conditions model for both the AM and PM but focused our future year analysis on the PM only. Future LOS and travel time data is available only for the PM
2. Our LOS results may not be consistent with historical LOS analysis done by the CMP using Traffix Software and older LOS methodologies
3. LOS results from micro-simulation models allow for congestion to spill-back from adjacent intersections and congested turn lanes

LOS results are shown on Table 7 and the travel time results are provided below.






FEHR & PEERS
TRANSPORTATION CONSULTANTS
August 2002
1785-12

El Camino Real Schematic Design
**FUTURE**
**PEAK HOUR TRAFFIC VOLUMES**
**FIGURE 2**

**Table 7- LOS Results**

| | | Existing AM | | Existing PM | | Future PM, Existing Timings | | Future PM, Optimized Timings | | Future PM, Phase I Improvements | | Future PM, Buildout Improvements | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | El Camino Real / Arastradero Rd / Charleston | 36.0 | D | 50.0 | D | 84.0 | F | 45.0 | D | 42.0 | D | 47.0 | D |
| 2 | El Camino Real / Maybell Ave / El Camino Way | 27.0 | C | 24.0 | C | 34.0 | C | 31.0 | C | 30.0 | C | 33.0 | C |
| 3 | El Camino Real / Los Robles Ave / El Camino Way | 18.0 | B | 23.0 | C | 28.0 | C | 19.0 | B | 27.0 | C | 25.0 | C |
| 4 | El Camino Real / Curtner Ave | 10.0 | A | 12.0 | B | 14.0 | B | 13.0 | B | 15.0 | B | 16.0 | B |
| 5 | El Camino Real / Margarita Ave / Matadero Ave | 23.0 | C | 16.0 | B | 22.0 | C | 14.0 | B | 12.0 | B | 22.0 | C |
| 6 | El Camino Real / Hansen Way | 16.4 | B | 13.0 | B | 14.0 | B | 15.0 | B | 14.0 | B | 16.0 | B |
| 7 | El Camino Real / Portage Ave | 12.0 | B | 29.0 | C | 31.0 | C | 16.0 | B | 15.0 | B | 17.0 | B |
| 8 | El Camino Real / Page Mill Rd / Oregon Expressway | 47.0 | D | 48.0 | D | 142.0 | F | 61.0 | E | 57.0 | E | 56.0 | E |
| 9 | El Camino Real / California Ave | 21.0 | C | 22.0 | C | 28.0 | C | 28.0 | C | 33.0 | C | 36.0 | D |
| 10 | El Camino Real / Cambridge Ave | 11.0 | B | 12.0 | B | 14.0 | B | 11.0 | B | 17.0 | B | 22.0 | C |
| 11 | El Camino Real / Stanford Ave | 34.0 | C | 18.0 | B | 31.0 | C | 17.0 | B | 16.0 | B | 23.0 | C |
| 12 | El Camino Real / Serra St / Park Blvd | 19.0 | B | 16.0 | B | 17.0 | B | 19.0 | B | 27.0 | C | 24.0 | C |
| 13 | El Camino Real / Churchill Ave | 22.0 | C | 26.0 | C | 38.0 | D | 30.0 | C | 32.0 | C | 47.0 | D |
| 14 | El Camino Real / Galvez St / Embarcadero | 62.0 | E | 76.0 | E | 106.0 | F | 98.0 | F | 96.0 | F | 93.0 | F |
| 15 | El Camino SB Ramp / Palm Dr / University Ave | 13.0 | B | 15.0 | B | 17.0 | B | 18.0 | B | 18.0 | B | 18.0 | B |
| 16 | El Camino NB Ramp / Palm Dr / University Ave | 9.0 | A | 11.0 | B | 13.0 | B | 13.0 | B | 12.0 | B | 12.0 | B |
| 17 | El Camino Real / Alma St | 27.0 | C | 33.0 | C | 85.0 | F | 36.0 | D | 35.0 | C | 36.0 | D |

# *Appendix 5*
# Tree Reports (Full Text)

## El Camino Real Tree Survey

*Full text of the El Camino Real Tree Survey is included in Appendix 3, Existing Cnditions Assessment, beginning on page 38.*

## Report on Examination of Tree Roots along El Camino Real

The root systems of three trees occurring in tree wells along El Camino Real were exposed by Vac-con sewer line cleaning machine and examined on September 24, 2002. The purpose of the examination was to better understand the differences in the rates of growth of trees along El Camino Real. All three trees were London plane (Platanus x acerifolia). The Vac-con machine loosened the soils around the roots creating a slurry of soil and water. This slurry was vacuumed up by the machine exposing the root system. The condition of the root system of each tree is described in the attached "Characteristics of Root Systems". A general discussion of the findings is presented below. This report is concluded by recommendations for improving the soil environment for trees along El Camino Real.

### *Root Conditions and Tree Growth*

Many London plane trees planted along El Camino Real in 1984-85 have exhibited slow rates of growth. This slow growth raises a concern over the feasibility of planting addition London plane trees and the potential of the existing trees to form canopies over the street. Exposure of the roots of three trees growing along El Camino Real indicates root growth has been restricted by the characteristics of the native soils and the small volume of fill soil used in the planting of these trees. Some of the native soils along El Camino Real have a high clay content in their subsoils that restrict downward infiltration of water and in some cases restricts root penetration. The prime example of this type of soil is the San Ysidro clay loam that occurred beneath tree # 3 in the sample. The very low rate of infiltration of this soil resulted in a perched water table that restricted root growth to the gravel layer above the fill soil. In contrast, trees # 1 and 2 were planted on Zamora gravelly clay loam and have initially developed a root system in the fill soil (tree # 1) and, with time, sent roots down into the native soil (tree # 2). Although there was evidence of root platforming at the interface of the fill soil and the native soil, a substantial portion of the root system of tree # 2 (which is 11 years older than tree #1) had grown down into the Zamora gravelly clay loam.

Neither tree #2 nor tree # 3 have shown growth rates comparable to several trees planted at the same time on better soils or at sites where lawn irrigation has provides them with more water during the growing season. Adjacent to tree # 3 is an 11" DBH London plane tree (16W – 1) that was planted in 1985 and is 45' tall. It is evident from sidewalk lifting by the roots of this tree that its roots extend beneath the side walk and into the adjacent lawn. Reaching the lawn its root system has the opportunity to exploit a larger volume of soil that is periodically replenished by lawn irrigation. In contrast, tree #2 (also planted in 1985, but only 5.5" in diameter) is adjacent to a vacant lot that has been vacant since the tree was planted. This vacant lot has not been irrigated. There was no evidence of root growth under the sidewalk by this tree. Its slower rate of growth was due to the limited amount of irrigation this tree received.

The very slow rate of growth of tree # 3 was due largely to the high water table and anaerobic conditions resulting from the native soil's restriction of infiltration and the constant source of water from the adjacent planter box. Although the adjacent tree (16W – 1) was growing on the same native soil, the grasses in the lawn (through their transpiration) were effective in preventing an anaerobic condition from developing in the soil. Shading of tree # 3 by the adjacent building also contributed to its slow rate of growth.

The general conclusions that can be drawn from this analysis are (1) future tree planting must recognize the differences in the soils along El Camino real as they effect tree growth and (2) remedial action needs to be taken in the case of existing trees to improve soil condition for tree growth.

## Soil Types

Ten soil types occur along El Camino Real. Characteristics of these soils are presented in Table 1 and their distribution shown in Figure 1. Four of these soils (Clear Lake clay, Dublin clay loam (adobe), Pleasanton clay loam, and San Ysidro clay loam) have subsoils which interfere with water infiltration and is some cases with root penetration. These soils can be expected to have perched water tables during the rainy season. Trees planted in fill soil over these soils can also be expected to develop root platforms at the interface between the fill soil and the native soil. Future tree planting on these soils will be enhanced by the excavation of larger volumes of the native soil and its replacement with more permeable fill soil. Urban (1989)*[1] has suggested a minimum soil volume of 100 ft.3 for larger trees such as London plane. It may not be possible to provide this volume of soil for street trees along El Camino Real where some of the native subsoils restrict root penetration or impede water infiltration. Where redesigned sidewalks can provide space, a minimum tree well of 4' x 6' dug to a depth of 3' will provide 72 ft. 3 of soil volume. Kopina (1985) found that 75 ft.3 was adequate (but not optimum) for the growth of large trees.

Clay pans result in the slow rate of water infiltration in two of the four soils identified above. These are the Dublin clay loam (adobe) and the San Ysidro clay loam. Poor infiltration can be remedied in these soils by boring two 4 – 6" diameter drain hole through the hard pan beneath each tree planting well. These hole should be back filled with medium sand (0.25 to 0.5 mm) or fine gravel. A geotextile fabric should be inserted in each drain hole to prevent fine

particles of soil from filling in the pore spaces between the sand and gravel. A fiber glass matting approximately 1/2 thick should be inserted in the top of each drain hole to prevent clogging by fine particles. A more effective drain can be created by inserting a perforated plastic pipe (4" or 6" in diameter depending on the size of the drilled hole) that has been wrapped with a geotextile into the drilled hole. This pipe would then be filled with sand or gravel and capped with fiber glass.

Drain hole will not be very effective where a heavy textured, compacted-subsoil prevents infiltration of water during the rainy season. They will offer some relief during the dry season by providing space for excess irrigation water. Larger volumes of fill soil or the development of internal soil drainage can best help alleviate the seasonal high water tables of these soils. Along El Camino Real Pleasanton clay loam and Clear Lake clay are the two soils where heavy textured and compacted subsoils present this problem. New tree wells should be minimum 4' x 6' and 3' deep whenever possible when planting new trees in these soil types.

In locations along El Camino Real where a gravel bed was laid down as a part of the expansion of El Camino Real in the early 1960s, it will be necessary to remove this gravel layer and replace it with a sandy loam soil to insure proper root development and adequate tree growth of newly planted trees.

## Remedial Action

Many trees currently growing along El Camino Real would show increased rates of growth if remedial actions were taken to provide a better root environment. The most effective measure would be to increase the size of the tree wells. Tree well should be increased to 4' x 6' where future sidewalk expansion will permit enlarging tree wells. Where sidewalk expansion is not possible the side walks should be removed to provide an 8' to 10' long planting well with a width that meets ADA standards. The exposed space around the existing tree well should be excavated to a depth of 3' and back filled with structural soils. Appropriate drain holes and aeration tubes should be installed before refilling the enlarged tree wells.

Structural soils are soils made up of angular or rounded aggregate of roughly equal size. These aggregates form a matrix that locks together to provide a structure capable of supporting a load (sidewalk or street) without sacrificing the spaces between the aggregates. The aggregate used in a structural soil is mixed with soil to provide a rooting mixture in the pore space between the aggregates. Aggregate to soil mixtures range from 1:4 to 1:3. Structural soil not only provide for greater load bearing, they also often improve soil drainage and soil aeration.

Some concerns, however, have been raised over the use of structural soils (Sorvig, 2001)[2]. These include the potential problem of sufficient rooting volume for mature roots, potential for silt in the soil used with the aggregate to clog the pore space over time, costs, and lack of testing in more arid climates. The use of natural "compaction resistant" sandy loam soils is most likely to avoid the problems associated with artificial structural soils. Back filling of tree wells with sandy loam topped with a 6" layer of small gravel compacted to 95% Procter density is recommended except where greater bearing strength is required. If expanded tree wells are excavated under the adjacent street it will be necessary to use an artificial structural soil composed of aggregate inorder to support traffic on the street.

Along some section of El Camino Real there is a gravel layer at a depth of 12" dating from the expansion of El Camino real in the 1960s. For these trees that were planted over this gravel layer it is recommended that four holes (4' to 6" in diameter) be drilled through this layer and filled with sandy loam. These holes will allow roots to reach native soil beneath the gravel layer. These hole will not be necessary where it is possible to expand the tree wells and remove the existing soil and gravel layer adjacent to the existing tree well.

## Irrigation

More summer irrigation is needed to increase the growth of many of the existing trees along El Camino Real. The limited soil volume beneath these trees does not provide for enough soil moisture storage between waterings to support adequate growth. If tree wells can be enlarged, as suggest above, more water storage in the root zone can be achieved. An increased frequency of watering is recommended for those existing trees where tree well enlargement may not be possible. The recommended rate of watering is 10 gallons/month for each inch of tree diameter (at 54" above the ground). The current rate of weekly watering may exceeds this amount for smaller trees and be less than is needed for larger trees. An analysis of the distribution of irrigation water within the tree wells on the different soil types would reveal problems due to excessive drainage or the development of anaerobic conditions. More frequent irrigation should improve tree growth on those sites where the water holding capacity of the tree wells is limited. Where soils in the tree wells are poorly drained, less frequent irrigation will help to improve tree growth.

**Table 1. Characteristic of soils along El Camino Real in Palo Alto, CA**

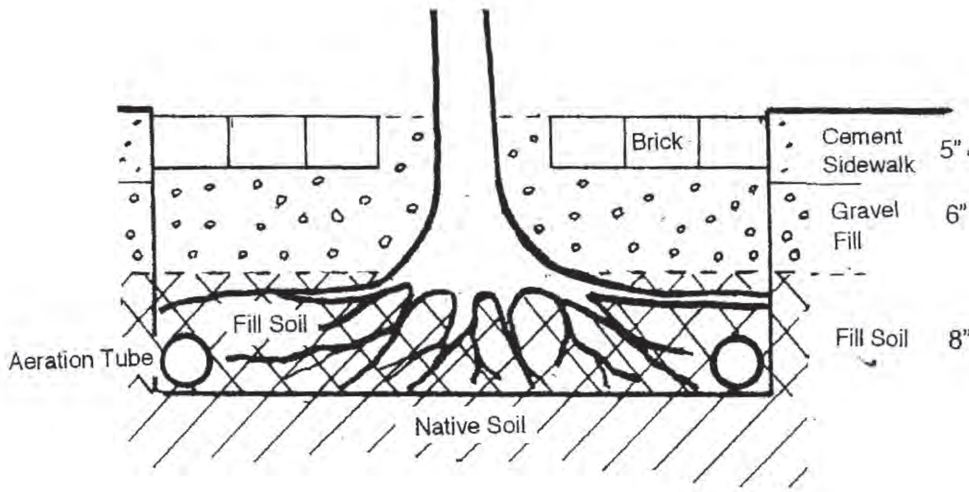
| Map Symbol | Soil Type | Depth of | | Comments |
|---|---|---|---|---|
| | | Surface soil | Sub soil | |
| Yg | Yolo loam | 8-28" | 6'+ | excellent for orchards |
| Ya | Yolo clay loam | 10-24" | 6'+ | good for orchards |
| Pf | Pleasanton clay loam | 10-17" | 27-58" | compact subsoil restricts drainage |
| Ps | Pleasanton loam | 11-20" | 32-43" | compact subsoil interferes slightly with water penetration |
| Po | Pleasanton gravelly loam | 16-22" | 38-45" | water penetration is fairly easy |
| Dh | Dublin clay loam (adobe) | 14-20" | 26-41" | water penetrates slowly; may overlay clay pans |
| Dl | Dublin clay loam | 9-20" | 28-40" | moderately permeable |
| Cm | Clear Lake clay (adobe) | 9-13" | 32-40" | water penetrates very slowly |
| Ze | Zamora gravelly clay loam | 15-30" | 36-48" | slight retardation of water penetration |
| Sb | San Ysidro clay loam | 15-25" | 43-55" | clay pans retard water and root penetration |

1 Urban, J. 1989. New techniques in urban tree planting. J. Arboricultural 15: 281-84.

2 Solvig, K. 2002. Soils under Pressure. Landscape Architecture (June 2001): 36-43.

## Characteristics of Root System

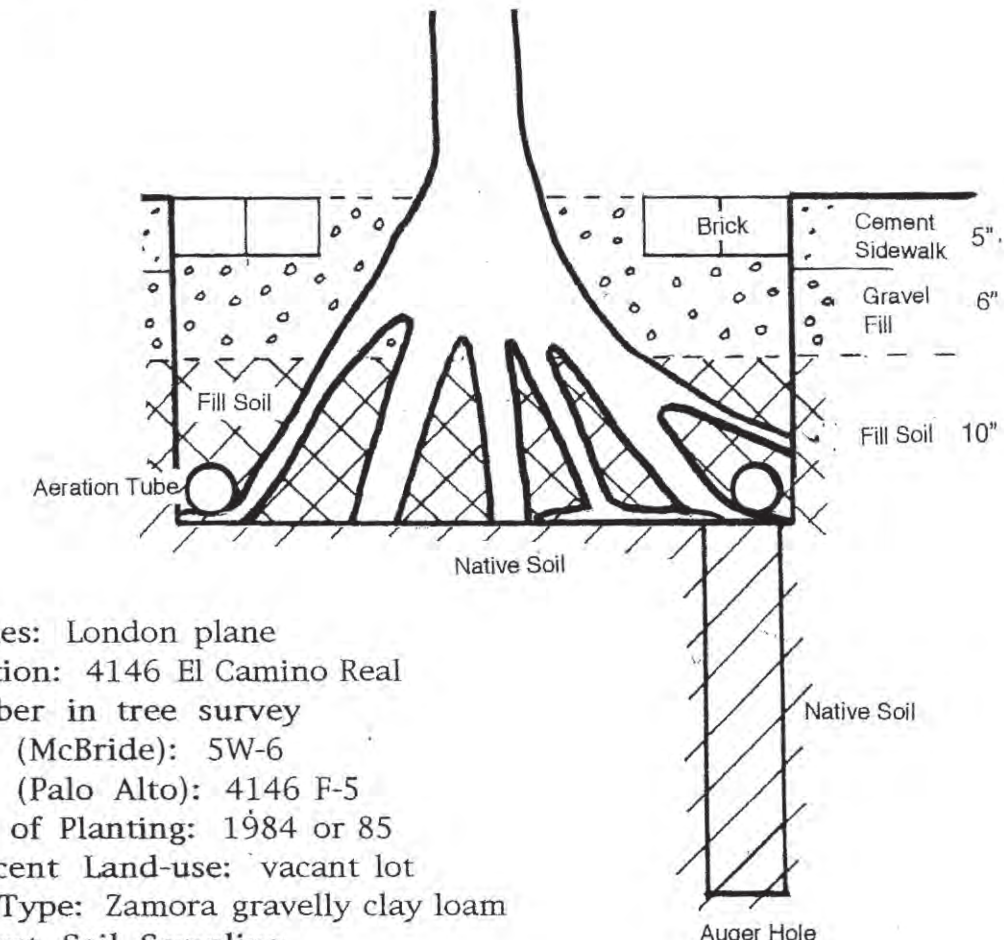
Tree #: 1




Species: London plane
Location: 4146 El Camino Real
Number in tree survey
(McBride): 5W-8
(Palo Alto): 4146 F-3
Date of Planting: 1996
Adjacent Land-use: vacant lot
Soil Type: Zamora gravelly clay loam
Nearest Soil Sampling
Locations: #3 across street
in tree well
(5E-6)
#4 in median
(between trees 5E-6
and 5W-8)
Width of Sidewalk: 8'
Size of tree well: 2'8" x 3'6"
DBH: 2.5"
Height: 15'
Remarks: The root system was restricted to the fill soil level. Few roots appear to have grown down below this level and into the native soil. Tree growth has been limited by a relatively small volume of fill soil and a lack of water. The subsoil of Zamora gravelly clay loam can show retardation of water infiltration where the gravelly clay loam is naturally compacted. This may be the reason for the limited root penetration into the native soil at this location.

## Characteristics of Root System

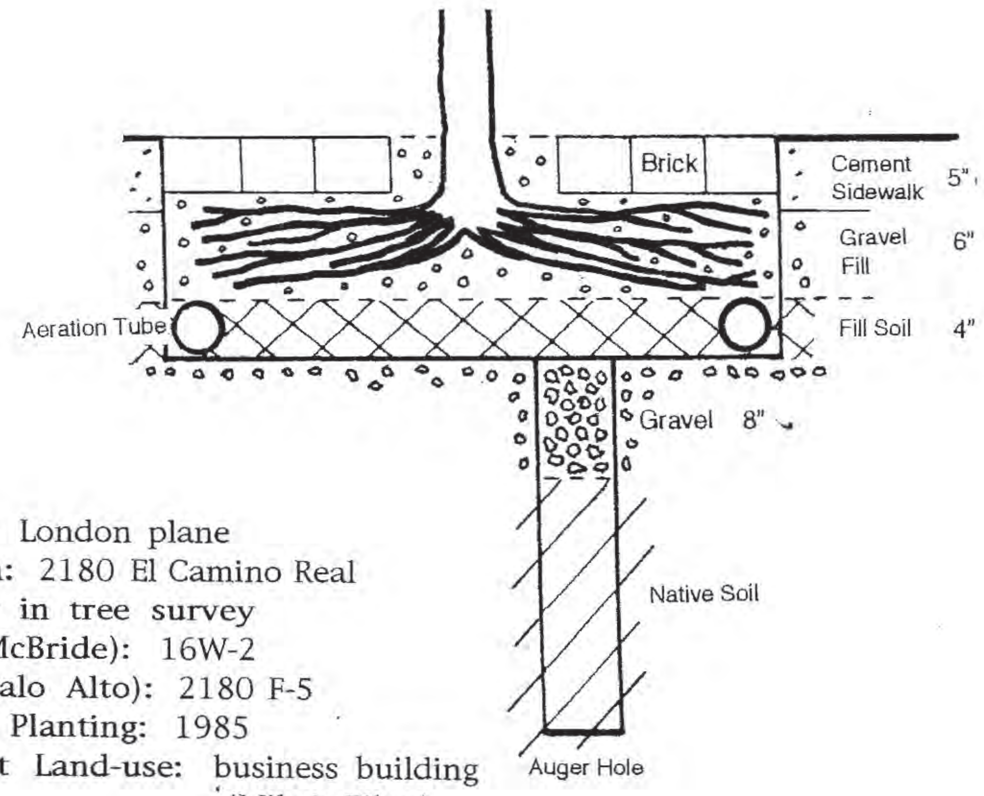
Tree #: 2




Species: London plane
Location: 4146 El Camino Real
Number in tree survey
(McBride): 5W-6
(Palo Alto): 4146 F-5
Date of Planting: 1984 or 85
Adjacent Land-use: vacant lot
Soil Type: Zamora gravelly clay loam
Nearest Soil Sampling
Locations: #3 across street
in tree well
(5E-6)
#4 in median
(between trees 5E-6
and 5W-8)
Width of Sidewalk: 8'
Size of tree well: 2'8" x 3'6"
DBH: 5.5"
Height: 20'
Remarks: Some tree roots have grown downward into the native soil, but others platformed at the interface between the fill soil and the native soil. No evidence of any large lateral roots in upper portion of the fill soil. Growth of this tree have been limited by the frequency of irrigation. No evidence of any gravel layer in the augered hole.

## Characteristics of Root System

Tree #: 3




Species: London plane
Location: 2180 El Camino Real
Number in tree survey
(McBride): 16W-2
(Palo Alto): 2180 F-5
Date of Planting: 1985
Adjacent Land-use: business building (Mike's Bikes)
Soil Type: San Ysidro clay loam
Nearest Soil Sampling
Locations: #15 across street in tree well (24E-6)
#16 in median about 200' north
Width of Sidewalk: 8'
Size of tree well: 2'8" x 3'6"
DBH: 3"
Height: 20'
Remarks: Most of the roots occurred in the gravel fill layer. Anaerobic conditions existed in the fill soil due to seepage from an adjacent planter box and the slow rate of infiltration in the San Ysidro clay loam. Although a gravel layer from the widening of El Camino Real was present, and may have restricted root development under normal conditions, the anaerobic character of the fill soil had limited the growth of this tree. Tree roots which had grown into the aeration tubes were rotted. Water seeped into the tree well once the excavation was completed.

# *Appendix 6*
## Caltrans Design Exceptions

| Item | Subject | Existing Condition/Standard | City's Desired Condition | Caltrans' Criteria for Design Exception and Comments | *Prepare Fact Sheet Justifying Generally Corridor-Wide (G), for a Class of Locations (C), for a Specific Location (L)* | Design Speed Related | *Excep-tion Priority* | *Action Items* |
|---|---|---|---|---|---|---|---|---|
| A | Design speed vs. posted speed | Straight alignment allows actual speed to be 40 to 50 mph or 5 to 10 mph over posted speed limit of 35 to 40 mph. | Incorporate design elements that will reduce *actual and posted* speed to 30 to 35 mph | Does not require a Fact Sheet Exception. Safety and operations are top priorities. Posted speed is determined by a standardized speed zone survey. May not always apply principle that design speed may exceed the posted limit by 5-10 MPH. There is a set range of design speeds that apply to every type of state highway, such as arterial streets bordered by extensive development. Must consider stopping, decision and corner sight distance. Need to analyze speed reduction elements and devices individually and collectively. Need consistency of speeds on the corridors as they relate to adjacent cities on El Camino Real. Caltrans agrees with City's initiative to consider geometric features to reduce speed, such as changing the current straight alignment to one that is more curved or varied. May consider on-site and other studies to validate traffic calming (speed reduction) elements.<br>*[Urban Arterial Streets should be designed for 50 to 70 kph (30 to 45 mph), Caltrans desires signing the corridor for 35 mph (55kph); portions where the City desires 30 mph (50kph) may be signed for 30 mph and then a speed zone survey would be required to determine if the speed limit can be enforced with radar]* | *Reduce design speed to 35 mph, with features that strongly enforce this travel at speeds below 35.(G)*<br><br>*[Possibly to 30 mph design in the two 4-lane "urban" segments(L)]*<br><br>*Justify based on accident history, and incompatability of 40 to 50 mph measured speeds with ped/bike safety and multi-modal Main street function.* | | *NA* | *Verify posted speed in adjacent communities.* |

| Item | Subject | Existing Condition/Standard | City's Desired Condition | Caltrans' Criteria for Design Exception and Comments | *Prepare Fact Sheet Justifying Generally Corridor-Wide (G), for a Class of Locations (C), for a Specific Location (L)* | Design Speed Related | *Excep-tion Priority* | *Action Items* |
|---|---|---|---|---|---|---|---|---|
| B | Number of Lanes | Caltrans has expressed a desire to maintain six through lanes. | Alternatives are being considered to reduce the number of through lanes to two in each direction to accommodate median, sidewalk widening and/or bike lanes to serve multimodal and aesthetic goals of the project. Proposals to reduce lanes would consider local and regional requirements for accommodating increased traffic volumes in the future and preserving El Camino Real's role as an arterial in the regional transportation system. Propose eliminating free right turn "slips" through the corridor. | Not mandatory Design Standard. Exception requires approval by the Caltrans District Director and HQ reviewer. Lane reduction is a function of the effects on operations based on a 20-year projection of demand; *and cannot reduce LOS (LOS D min. unless existing exceeds LOS D) or quality/safety of operational characteristics.* San Mateo County and Santa Clara County Congestion Management Agencies (CMAs) must support the decision for lane reduction. The elimination of right turn slips or pork chop islands will be evaluated individually with respect to the effect on traffic operations and pedestrian safety. | *This is not a design standards exception, it is an operations review and approval process (L).* | *No* | *NA* | *City to get letters of support from San Mateo and Santa Clara County CMAs, and from adjacent cities (Menlo Park, Los Altos, and Mountain View)* |
| C | Lane width | 12-foot for #1 and #2 lanes. 20 to 21-foot wide for #3 lane/parking/ shoulder. 12-foot single left turn lanes with 11-foot for additional left turn lane. Caltrans expressed minimum desired 11-foot for through lanes, 10-foot for single turn lanes and 11-foot double left turn lanes. | 10-foot +1-foot shy distance for #1 lane. *11-feet* for #2 lane in six-lane sections. 11-foot for #3 lane in six-lane sections and #2 in four-lane sections. 10-foot left turn and 11-foot for additional left turn or width as needed to accommodate truck turns. ~~AASHTO minimum for urban arterials is 10 feet width for through lanes and turning lanes.~~ *[Removed per discussion at meeting].* | Requires Fact Sheet Exception to Mandatory Design Standard. Caltrans maintains the position of an 11-foot minimum lane width requirement for through lanes, 10-foot minimum for single left turn lanes and 11-feet wide for double left turn lanes. Exceptions to the standard 12-foot wide lane width must be justified by authoritative studies and research. Such research and studies should provide safety data for low speed highway facilities which include trucks and buses and preferrably with comparable vehicle volumes. ~~If a reduction in lane width is allowed, City and Caltrans should consider prohibiting trucks in the left lane.~~ *[Removed per discussion at meeting].* | *10.5-feet for #2 lane in six-lane sections is no longer required. [may be required at intersections with double left turn lanes]*<br>*11-foot wide lanes (G)*<br>*11-foot median lane without shy distance (G)*<br>*10-foot turn lanes (G)*<br>*10-foot double turn lanes (L) [need to verify that this is needed]*<br>*Justify based on accident history, and incompatability of 40 to 50 mph measured speeds with ped/bike safety and multi-modal Main street function. Defend with accident history on high-volume, narrow-lane Caltrans streets like Van Ness and* | *Yes*<br>*Yes*<br>*Yes*<br>*Yes*<br>*Yes* | *1*<br>*1*<br>*1*<br>*1*<br>*1* | *This is a planning level exception and FPA recommends pursuing as* |
| D | Right shoulders for breakdown lanes | Where parking space exists, it serves as a breakdown lane. Where no parking is allowed, the #3 lane is typically 20 to 21-feet wide providing an 8-foot breakdown lane. The only areas without breakdown lanes are located adjacent to major arterials, such as Embarcadero, Page Mill and West Charleston/Arastradero, where the entire cross section is utilized for vehicle movements. | The current cross sections will be retained adjacent to major arterials. At other locations, breakdown lanes would be accommodated in the form of 7-foot wide parking spaces or 5-foot wide bike lanes - in most cases - where no parking exists, with the exception of the few 6-lane locations with a left turn lane and parking "pockets" on both sides of the street, here the bike lane would be 4 foot 6 inches. 6-foot deep curb extensions (a.k.a. bulb-outs) may intermittently interrupt the parking/breakdown lane. | Requires Fact Sheet Exception to Mandatory Design Standard. On through lanes, a ~~2-foot-wide left shoulder and~~ *[removed per discussion at meeting, update to HDM will remove this requirement] an* 8-foot-wide right shoulder ~~are~~ *is a* mandatory standards. In the context of a low speed urban facility, Caltrans is agreeable to having an 8-foot wide right side shoulder with a 5-foot wide bike lane contained therein. Caltrans is also agreeable to the removal of parking and the outside shoulder where a bike lane is accommodated. This would be evaluated on a case by case bases. | *5-foot bike lane with no parking is a possible planning level exception. (C)*<br><br>*Shoulder at curb extensions is being addressed in update to HDM - expected new standard would allow a 5-foot bike lane plus a 1-foot gutter pan for a total shoulder width of 6-feet.* | ***No*** | *1* | *No action at this time.*<br><br>*Planning level exception could be pursued, if City give consultants the go ahead to take on additional task.* |
| E | Sight distance setback for trees | Current design standards require trees in medians to be setback 100-feet from intersections. | Propose planting trees in medians 50-feet from intersections where left turns are signalized. Trees would be planted to provide sight distance in conformance with HDM based on 30 to 35 mph design speed (HDM table 202.1) or AASHTO standards. Trees in medians at unsignalized intersections where there are left turns from minor streets would be setback approximately 180 feet. | Requires Fact Sheet Exception to Mandatory Design Standard as a sight distance issue. Reduced setbacks may be allowed if supported by sight distance studies which conform to Caltrans standards. *[Section 405.1 of HDM, more space between trees may allow them to come closer to the intersection, understory clearance is important for signal and signage visibility].* | *Requires Fact Sheet Exception to Mandatory Design Standard as a sight distance issue. Reduced setbacks may be allowed if supported by sight distance studies which conform to Caltrans standards. (L)* | ***Yes*** | *3* | *No action at this time.* |

| Item | Subject | Existing Condition/Standard | City's Desired Condition | Caltrans' Criteria for Design Exception and Comments | *Prepare Fact Sheet Justifying Generally Corridor-Wide (G), for a Class of Locations (C), for a Specific Location (L)* | *Design Speed Related* | *Excep-tion Priority* | *Action Items* |
|---|---|---|---|---|---|---|---|---|
| F | Mid-block pedestrian crossings | Along several segments of El Camino Real, including adjacent to Palo Alto High school, there are no crossings for 2,000 feet or more, which may result in pedestrians crossing at undesignated and unprotected locations. Caltrans voiced opposition to adding unsignalized mid-block crosswalks, but indicated that mid-block crosswalks protected by signals may be considered. | Install signal protected mid-block crosswalks, where they meet warrants. Consider additional crosswalks at unsignalized locations only where justified by FHWA criteria and acceptable to Caltrans based on site specific criteria, such as placing crosswalks at intersections where motorists are most likely to expect them. Utilize a wide variety of traffic management tools to maximize pedestrian safety at mid-block crosswalks. | Caltrans has strong safety concerns about mid-block pedestrian crossings. Caltrans would review and consider warrents and design proposals, but would only approve signalized mid-block crossings. | *Identify ped vertical alignment elements, raised crosswalks, striping treatments and signing/ ligths/ signals to slow traffic to below 35 and make peds visibile or protected. This is not a planning level exception (L)*<br><br>***Need to clarify closure at 'T' intersections - does one half qualify as a mid-block intersection?*** | *Yes* | *2* | *No action at this time.* |
| G | Trees in medians | Planting large trees in medians require a 6-foot setback from face of curb to tree where speeds are 35 mph or less. Essentially requires a minimum 13-foot ***or more*** wide median. | Designs would accommodate trees in medians 6 to 8-feet wide at left turn pockets and over much of the corridor in medians 11 to 12-feet-wide. | ~~Any revisions to tree planting standards are subject to pending tree safety study. The administrative draft of the tree study is due 11/02. Refer to HDM Sec. 902.3.~~<br><br>*As of 12/20/02, Caltrans has agreed to allow Palo Alto to proceed with the placing of large trees in narrower medians along El Camino Real as a pilot project.* | *Not clear if a Fact Sheet is required.*<br><br>*Trees in medians 6 to 8-feet wide at left turn pockets and over much of the corridor in medians 11 to 12-feet-wide (G)* | *TBD* | *1* | *City to work with District 4 to determine acceptable conditions for planting trees in narrow medians as a pilot project, this should be integrated into the MOU.* |
| H-1 | Lane transitioning formula | Two-thirds width of transition times design speed (2/3WV). For example a transition which would remove a 10'-6" wide lane at 30 mph requires a 210-foot transition | Utilize the Manual of Uniform Traffic Control Devices standard formula which is width of transition times design speed squared divided by 60 ($WV^2/60$). For example a transition which would remove a 10'-6" wide lane at 30 mph requires a 157.5 foot transition. This formula would encourage motorists to travel at the posted speed limit. | Requires Fact Sheet Exception to Advisory Design Standard. Caltrans maintains the position of supporting the two-thirds width of transition times design speed formula (2/3WV) for lane shifts and lane reductions. A shorter transitioning distance may be acceptable for lane additions. Must justify safety aspects of reduction in transition distance. Refer to HDM Sec. 206.3 | *This is not a planning level exception.* | *Yes* | *NA* | *No action at this time.* |
| *H-2* | *Horizontal Alignment formula* | *Current Caltrans' Standard is not clear. There do not appear to be standards for 'lane shifts' (I.e.; in locations where the lanes shift to the left or right in order to accommodate the removal or addition of curbside parking).*<br><br>*Caltrans' standards do exist for widening the pavement to provide for a left turn pocket, see HDM Sec. 206.2 (2) and figure 405.2A. These allow a taper of $WV^2/150$ for V< 70 kph* | *Utilize the $WV^2/150$ taper formula for lane shifts and tapers throughout the Corridor.* | *NOTE: this issue has not been clearly discussed at this point.* | *To be determined. It is desired that this formula be used corridor-wide* | *Yes* | *1* | *Caltrans to review.* |

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| I | Minimum clearance from edge of traveled way to curb extensions (bulb outs) | Four-foot minimum from edge of traveled way to curb extensions. | ~~Where bike lanes are not included in the design, clearnace will be 1-foot with reflectors on the ends of curbs.~~ Where bike lanes are included in the design clearance will be 6 feet (5-foot bike lane plus 1 foot). As discussed in Item J, there are limited cases where the bike lane will be 4-foot 6-inches and the total clearance would be 5-foot 6 inches. | Requires Fact Sheet Exception to Mandatory Design Standard. Caltrans supports a 4-foot-wide minimum shoulder to accommodate bicycles on the entire corridor, included through intersections, regardless of whether there is a designated bike lane. Currently there is no design standard for bulb outs. HDM Revision 6 will address bulb outs. Revision 6 is under final review and is scheduled for approval by 1/03. | *In locations where bike lane is 4 foot-6 inches an exception may be necessary.*<br><br>*In other locations, proposed conditions should satisfy update of HDM.* | *No* | *TBD* | *No action at this time.* |
| J | Bicycle lane width | 4-foot minimum width where adjacent to parellel parking; *desired width of 5-feet.* | In most cases the 5-foot bike lane width is achievable with the combined width of 12 feet for parking and bike lane. The exception is needed in some sections of the 6-lane segments where parking is needed on both sides. A 4-foot 6 inches wide bicycle lane would be provided with a 7-foot wide parking lane (also see "D"). The combined traffic lane and bicycle lane width would be 15 feet 6 inches. | Requires Fact Sheet Exception to Mandatory Design Standard for anything less than the standard bicycle lane width. May be acceptable, but requires justification. May require restricting use 7-foot wide parking spaces to compact cars only. | *A 4-foot 6 inches wide bicycle lane would be provided with a 7-foot wide parking lane. The combined traffic lane and bicycle lane width would be 15 feet 6 inches. (C, L) Justify based on comparables, and fact that total parking + bike width would meet Caltrans standards shifte parking T's (or solid line) would guide more organized parking to benefit of bikes.* | *No* | *2* | *No action at this time.* |
| K | Curb return radii | Minimum radii controlled by bus/truck turn templates. | It is thought that no design exception is needed for this proposal. Curb return radii will be designed to accommodate appropriate vehicle turn templates; minimum standard of (AASHTO) 30-foot single unit truck. Bus and semi-truck templates will be used on existing truck routes and where zoning and existing and proposed land use would justify their use. ~~In some cases, mountable curbs would be used to accommodate infrequent truck and emergency vehicle use.~~ *It should be noted that in some cases pre-existing condions to not meet STAA vehicle standards.* | Requires Fact Sheet Exception to Advisory Design Standard. Each corner must be studied individually. El Camino Real is a designated Surface Transportation Assistance Act of 1982 (STAA) truck route and trucks must be accommodated. May require advisory signage to trucks. Mountable curbs on corners will not be approved because of safety concerns. Refer to HDM Sec. 404.3 | *Design radii for SU truck or bus rather than STAA (L).*<br><br>*Design for P passenger vehicle at locations where there are no truck or bus turns (L)* | *No* | *2* | *No action at this time.* |
| L | Angled parking buffer between parking and travel lane. | Provide buffer between diagonal parking and travel lanes. | It is thought that no design exception is needed for this proposal. No angle parking is proposed at this time. This could be an option where parallel "local Access lanes" are used at the option of adjacent development. | Agree with City's statement that a physical separation will be required between mainline and diagonal parking and related access lane. This is consistent with Caltrans policy. | | ***No*** | *NA* | *This is not an issue.* |
| M | Left shoulder widths | 1 foot minimum with 2 feet preferred. | It is thought that no design exception is needed for this proposal. Left shoulder is 1 foot *with an 11 foot lane.* | Currently requires Fact Sheet Exception to Mandatory Design Standard. An HDM revision being considered eliminate the requirement for a 2-foot wide left shoulder on facilities with a speed limit of 60 KMH or less. | *Update to HDM should resolve this issue.* | *TBD* | *TBD* | *Review standard in update of design manual.* |