TRANSPORTATION DIVISION

STAFF REPORT

TO:       PLANNING & TRANSPORTATION COMMISSION
FROM:     Joseph Kott
DEPARTMENT: Planning and Community Environment

AGENDA DATE: December 10, 2003

SUBJECT: Review and Recommendations to Council on a Proposed Charleston/Arastradero Corridor Plan of Improvements from Fabian to Miranda

RECOMMENDATION
Staff recommends the following Charleston/Arastradero Corridor Plan:

1. Implementation of traffic adaptive (automated) signal technology on the Charleston/Arastradero Corridor to add traffic capacity and reduce stopped delay on the Corridor. This is an essential pre-condition that should be met prior to reducing the number of travel lanes on any section of the Charleston/Arastradero Corridor.
2. Installation of raised median pedestrian refuges at selected intersections on the Corridor.
3. Installation of lighted (in-pavement, pedestrian actuated) crosswalks to enhance pedestrian crossing safety on Arastradero west of Georgia, on Arastradero between Suzanne Drive and Clemo Avenue, on Charleston Road near Mumford Place, and on Charleston Road at Louis and Montrose.
4. Deployment of additional fixed, electronic radar read-out speed advisory signs along the Corridor to reduce the incidence of motor vehicle speeding.
5. Installation of bulbouts (extended curbs) to reduce pedestrian crossing distance at selected intersections.
6. Removal of the two free right turn ("pork chop") islands to improve bicycle and pedestrian safety on the southern leg of the El Camino Real and West Charleston/Arastradero Road intersection.
7. Provision of continuous bicycle lanes along the entire Corridor to enhance cycling safety.
8. Tinting or painting the bicycle lanes for higher visibility to both motorists and cyclists along the entire Corridor.
9. Selected improvements in Shuttle service, both bus trips and service routes, along the Corridor sufficient to meet the Council-adopted Performance Measure of a 20 percent increase in public transit ridership along the Corridor by 2010 and a 40 percent increase in 2020. The transit improvement plan is still in preparation, but will likely feature a change in Shuttle service frequency on the Corridor (e.g. changing from 30 minutes to 15 minute frequency).
10. Provision on Arastradero of a three-lane cross-section with two through lanes (one in each direction) and an intermittent left turning pockets or lanes interspersed with raised center median islands from Foothill Expressway to El Camino Real. Four travel lanes (two in each direction) will be maintained at Foothill, in the vicinity of Gunn High School, and at El Camino Real. These changes create space (by reallocating space from use as travel lanes to wider bicycle lanes, sections of landscape medians and “tree islands (small landscaped medians), raised center median pedestrian refuges, and center left turn lanes for more efficient and safer traffic operations. An alternative cross-section of four travel lanes (two in each direction) throughout is available and is also feasible on Arastradero Road.
11. Creation of a new dedicated right turn lane at the Gunn High School driveway for westbound vehicles on Arastradero Road.
12. Widening the Gunn High School driveway throat to permit simultaneous eastbound left turns into Gunn and westbound right turns. The left and right turning vehicles are to be separated and channelized by a small raised median.
13. Retaining a four travel lanes (two in each direction) on Charleston from El Camino Real to Alma with intermittent “tree islands” (small medians).
14. Provision on Charleston Road of a three-lane cross-section with two through lanes (one in each direction) and one intermittent left turning lane interspersed with raised center median islands from Fabian to El Camino Real. These changes create room (by reallocating space from use as travel lanes to wider bicycle lanes, sections of landscape medians and “tree islands (small landscaped medians), raised center median pedestrian refuges, and center left turn lanes for more efficient and safer traffic operations. An alternative cross-section of four travel lanes (two in each direction) throughout is available and is also feasible on Arastradero Road.
15. Four travel lanes (two in each direction) will be maintained at Middlefield, Alma and El Camino Real.
16. Provision of a center left turn lane leading and just west of the easterly Hoover Elementary School driveway (presupposing reversal of the existing circulation from Charleston into and out Hoover).
17. Redesign of the existing median at Louis and Montrose to retain it as a block to through movement between Louis and Montrose while improving left turn vehicular movements in and out of Louis.
18. Installation of frontage improvements, including street trees and new street lighting along the Corridor.
19. Demonstration trial of the Corridor Plan with paint, signage, and asphalt curbing in selected sections prior to construction or deployment of final improvements.

Recommended Corridor Plan phasing is as follows:

1. Installation of a new dedicated westbound right turn lane and Gunn High School and associated driveway improvements to separate right turning from left turning vehicles.
2. Deployment of traffic adaptive traffic signal operation along the entire Corridor.
3. Demonstration trial of three-lane section (two travel lanes, one in each direction) from west of Fabian to east of Foothill Expressway, retaining two travel lanes in each direction at both the east and west approaches of Middlefield, from the east approach to Alma to the west approach to El Camino Real, at the east and west approaches to the Gunn High School driveway, and at the east approach to Foothill Expressway.
4. At the conclusion of the demonstration trial, make such permanent changes as proven to be desirable in the trial.
5. Installation of frontage improvements, including street trees and new street lighting.

BACKGROUND
At its April 14, 2003 meeting, Council directed staff to prepare a plan of transportation and urban design/landscape improvements for the Charleston/Arasradero Road Corridor (CMR:237:03). A map of the corridor is included as Attachment A. Council also directed staff to return with a report on land use assumptions, to be included in projecting future traffic conditions on the corridor before such predictions were undertaken. The range of land use projections was reviewed by the Council on June 9, 2003 (CMR:310:03). The expected outcomes of the Charleston/Arasradero redesign include safer; more attractive routes to schools; well-landscaped medians where possible; and pedestrian, bicycle, and bus transit improvements all along the corridor. Other key purposes of the transportation plan will be to provide safer traffic flow along the corridor and to reduce the incidence of vehicle speeding, without reduction in vehicle travel times or causing diversion of through traffic to other streets.

An initial set of performance measures for the Corridor, based on best practices in traffic engineering assessment, was presented for discussion at public meetings on July 10 and July 15. A refined and expanded set of road performance measures was then presented to an informal focus group of Corridor stakeholders. The set of road performance measures was
further refined and expanded for presentation to the Planning and Transportation Commission and Council (CMR:430:03), which approved them on September 22, 2003.

Conceptual plans and alternatives for improving the Charleston/Arastradero corridor were presented and discussed at public meetings on October 15 and October 22, 2003 (see Attachment B for public comments from these workshops) and at meetings of the informal focus group of Corridor stakeholders. Staff and a project consultant made a presentation on the conceptual alternatives to Corridor PTA representatives and one principal (Terman Middle School) on November 13. Staff also presented information of the Corridor Plan conceptual alternatives to the Palo Alto Bicycle Advisory Committee on November 12. Conceptual plans were presented at a joint study session of City Council and the Planning and Transportation Commission (CMR:524:03). A variety of information on the Corridor plan effort is being disseminated on the project web site: http://www.cityofpaloalto.org/charleston-arastradero/index.html. A full narrative description of the Corridor Plan is contained in Attachment C.

DISCUSSION
Morning weekday peak hour traffic volume on the Corridor is projected to rise from the current average of from 765 to 866 (depending on street section) to from approximately 1,000 to 1,200 (depending on street section and land development scenario) by the year 2015. These projections do not take into account increases in public transit and Palo Alto Shuttle use (a 50 percent increase in passenger boardings by 2010), bicycling (a 20 percent increase by 2010 and a 40 percent increase by 2020), and walking (a 20 percent increase by 2010 and a 40 percent increase by 2020). Traffic engineers consider that a three lane cross-section is capable of accommodating up approximately 1,000 vehicles per hour before cross street and residential driveway motorists begin to experience difficulty entering the vehicle stream. In these circumstances, entering motorists have an average time gap for entry of 3.6 seconds.

The proposed Charleston/Arastradero Road Corridor improvement plans comprise a set of physical, operational, electronic, and aesthetic measures to improve safety for all modes of travel (with particular emphasis on cycling and walking conditions) while ensuring efficient traffic flow and avoiding traffic shift onto nearby residential streets. The plans were developed to meet expected traffic conditions to the year 2015, as forecast by Palo Alto’s new citywide computer traffic model, according to two future land use scenarios approved for traffic modeling purposes by Council on June 9, 2003. The two scenarios are: 1) Comprehensive Plan EIR growth scenario extended to 2015, and 2) “known (development) proposals” to the year 2015. These computer forecasts and traffic analysis of the current and expected conditions on the Corridor suggest that Charleston/Arastradero Road can be re-designed to enhance traffic safety without inducing increased vehicle travel time or vehicle delay at signalized intersections.
Integral to this finding is the conclusion that the potential traffic capacity (up to a 20 percent increase according to the Federal Highway Administration) can be handled by automating the traffic signals along the Corridor to operate in “traffic-adaptive” mode (i.e. electronic reallocation in the next signal cycle of green time at each signalized intersection along the entire Corridor in response to real time traffic conditions); and providing dedicated left-turn pockets and lanes, which move left-turning vehicles out of the through traffic stream. Attachment D presents the traffic analysis for the Corridor and information about traffic-adaptive signal operation. The traffic analysis includes the effect of achievement of the non-auto mode (transit, cycling, and walking) using performance targets for the Corridor under a three-lane cross section scenario (excepting major intersections and Alma to El Camino Real, which will be kept at two travel lanes in each direction). Both travel time on the entire Corridor and stop delay at each of the Corridor’s signalized intersections decreases with deployment of traffic adaptive signal technology and falls even further with attainment of alternative modes performance measures compared to 2015 traffic projections without implementation of the Corridor Plan.

The major physical, operational, electronic, and aesthetic measures proposed for the Corridor, along with their likely advantages and disadvantages, are as follows:

Traffic Capacity and Flow:

1. Implement automated, “traffic-adaptive” traffic signal operation along the entire corridor to improve traffic capacity and traffic flow efficiency at signalized intersections.

Advantages: If funding were available, signal automation could be implemented as the next phase of the City of Palo Alto’s Advanced Transportation Management System (ATMS - CMR:273:03), since the ATMS upgrades to the traffic signal system are an essential pre-requisite to traffic-adaptive operation. The Federal Highway Administration estimates that traffic-adaptive signal operation can increase efficiency, hence capacity, of a street by approximately 20 percent without adding lanes, removing parking, or grade separating streets. Since traffic delays occur at intersections, not in between them, more efficient operation of traffic signals along the Corridor will reduce both delay and travel time along the entire Corridor and open up opportunities for re-allocating travel lane space between signalized intersections to such purposes as widening bicycle lanes, creating pedestrian refuges, and providing landscape center medians or “tree islands” (small center medians).

Disadvantages: Implementing traffic-adaptive signal operation is expensive. Staff has estimated the cost of traffic-adaptive signalization on the Corridor to be approximately
$1.3 million, inclusive of design and construction contingencies. Vehicle detection (either through in-pavement inductive loops or digitized video imaging) data has to be comprehensive and accurate, so that more detection devices and vigilant maintenance of detection devices are required than at more conventional signalized intersections. It should be noted that staff has already applied for grant funding through the Valley Transportation Authority’s Local Streets and County Roads program, to install traffic-adaptive signalization on five residential arterial streets, including Charleston/Arastradero Road (CMR:454:03).

Alternative: Better coordination of traffic signal timing can be implemented in the shorter term or as an alternative to signal automation. While much less expensive, this alternative will only yield a fraction of the efficiency benefits of traffic-adaptive operation.

2. *Provide a dedicated westbound right-turn lane at the Gunn High School driveway to reduce vehicle queuing and enhance safety.*

Advantages: Construction of a dedicated right-turn lane at this location will mitigate the long morning queue for westbound drivers waiting to turn into the Gunn driveway; reduce traffic intrusion onto Georgia Avenue and other nearby residential streets; improve access to and egress from Georgia Avenue and other residential cross streets east of Gunn High School during the morning school commute period, as well as enhance safety by reducing abrupt lane changes by drivers and the crowding out of cyclists in the vicinity of the Gunn driveway.

Disadvantages: This will entail a construction project. Depending on construction timeline, not all of this work may be possible during school vacation, thus traffic conditions could be exacerbated temporarily before being mitigated thought the planning improvements.

Alternative: Reserving the current outside westbound through lane on Arastradero east of the Gunn High School entrance for peak period only (e.g. for 30 minutes or an hour each weekday morning during the school year) right turn use was considered, but not recommended. This solution is highly unconventional and requires considerable attention to transitioning through drivers out of the outside lane during the stated time period (via road striping and signing). Since for approximately 98 percent of the year the outside lane would function as a standard through lane, driver expectations during the remaining 2 percent of the year may be violated, resulting in last moment lane changing (unsafe driving behavior) and relatively low compliance with the lane use restriction, both of which would eliminate some of the efficiency gains from the right-turn lane designation.
3. Provide a center left-turn lane from East Charleston Road into the easterly driveway of Hoover School should the school agree to reverse the circulation flow of its two driveways onto East Charleston.

Advantages: Left turns are now prohibited into Hoover on eastbound Charleston, partly due to the proximity of the Carlson intersection to the current (westerly) Hoover driveway. By reversing the circulation into and out of Hoover School so that ingress is via the easterly driveway onto Charleston, it will be possible to provide a long enough left-turn lane from Charleston to accommodate peak demand. As a result, parents will be able to access Hoover from both the westbound and the eastbound direction of travel. The current problem of some drivers making u-turns on Nelson, or one of its cross-streets, to reverse direction on Charleston, to make an allowed right turn into Hoover will be eliminated.

Disadvantages: Hoover School will have to agree to this change and parents will have to adjust to the new ingress and egress arrangements. Staff is assessing whether sufficiently long gaps in traffic will be available for left turns during the morning peak hour in the circumstances of a three-lane cross-section (one opposing through lane). However, since traffic signals at Nelson and Middlefield will create gaps in westbound Charleston the opposing traffic flow will not be continuous.

Alternative: Creating a short eastbound left-turn pocket on Charleston for turns into the existing Hoover ingress drive was considered but discarded, since the short distance between the westerly Hoover driveway and Carlson would only allow room for a left-turn pocket too short to meet morning peak demand. This would likely cause spillback onto the Carlson intersection and attendant safety and efficiency concerns.

Traffic Safety:

1. Install electronic radar read out ("V-Calm") signs at additional selected locations along the corridor.

Advantages: This device, which is relatively inexpensive ($7,000 to $10,000 each, installed depending on proximity to a power source). It has been deployed successfully in Palo Alto in six locations and has high public acceptance to date.

Disadvantages: Driver awareness of the electronic speed advisory signs may lessen over time, and with it the speed reduction effect of these devices.
Alternative: Radar speed trailers could be deployed and periodically re-positioned along the Corridor. Re-positioning the trailers periodically over time will entail ongoing labor costs. The trailer and car set will require on-street parking space. Experience has shown that the speed reduction effect of radar trailer disappear in a given location after the trailer leaves.

2. **Shorten pedestrian crossing distance, improve aesthetics, and enhance traffic safety** ("prudent driver sets the pace" to moderate vehicle speeds) along East Charleston from Fabian to Alma and potentially West Charleston and Arastradero Road from Alma to Miranda (excepting reservation of four lanes for adequate space for storage of motor vehicles at both approaches to major signalized intersections–Middlefield, El Camino Real, and Charleston and the Caltrain tracks) through provision of two through lanes and sections of landscaped medians interspersed with left-turn pockets in place of four through lanes.

**Advantages:** The three-lane design will reduce prevailing vehicle speeds and increase safety for pedestrians, cyclists, and vehicle users. Pedestrians would enjoy shorter through lane crossing distance and time, as well as the protection of raised center refuge medians at crosswalks. Cyclists would enjoy wider bike lanes due to the reallocation of road space, as one through lane in each direction (except in the vicinity of major intersections and Caltrain) is dropped. The safety benefits to pedestrians and cyclists would induce more walking and cycling along the Corridor, thereby reducing motor vehicle volumes and the attendant impacts of motor vehicle use (e.g. noise and air pollution). Provision of continuous bike lanes and intermittent center left-turn pockets, along with any available empty curbside parking, will provide adequate room for emergency and other vehicles to maneuver around inoperative vehicles in the travel lane.

**Disadvantages:** Interspersing medians in the middle lane (to discourage use of the lane for potentially unsafe “by-pass” maneuvers), even while retaining all vehicle movements at all cross-streets, may prevent some residents on the Corridor from making left turns out of and into their driveways. Should future traffic growth be much greater than projected, the three-lane design alternative may not be sufficient to meet vehicle demand and not induce driver shortcutting onto nearby residential streets due to travel time delays. It should be noted that since Arastradero Road has more cross streets per mile than does Charleston Road, a three-lane section may have more interruption to traffic flow on Arastradero, as cross-street drivers turn to merge into the traffic flow. Preliminary cost estimates for these improvements range from $2,131,000 to $2,649,000, depending on the extent of the median treatment.
Alternative: A four lane cross-section on Arastradero is a viable alternative, but does not yield the safety benefits to all modes of travel or the amount of improvement in walking and cycling conditions that are provided by a three-lane cross-section design.

3. **Install center medians in selected locations to physically separate motor vehicle traffic in opposing directions.**

**Advantages:** Center medians provide safety benefits through separating opposing traffic streams. The medians may also provide opportunities for tree planting and other landscaped amenities.

**Disadvantages:** Depending on location, center median can prevent residents along a roadway to make left turns into and out of their driveways and increasing circuity of vehicle trips (e.g. a left turning movement out of a driveway may be replaced by a right turn out, then a u-turn at a nearby intersection to reverse direction).

**Alternative:** Center medians are “scalable” in that a greater or lesser number of them in lesser or greater dimension can be provided along a roadway depending on design objectives. As examples, narrower center medians can thus be provided with a four-lane section and both fewer and shorter center medians can be provided with a three-lane cross-section. Continuous center medians (interspersed with left-turn pockets or lanes at signalized intersections), which provide the greatest safety enhancement, were considered for Arastradero, but are not recommended since they also provide the most access restrictions for both on-street residents and cross street drivers. Staff is recommending a balanced approach to safety and access with emphasis on improving safety of the most vulnerable street users: those on foot and those riding bicycles.

**Bicycling Safety and Comfort:**

1. **Paint or tint continuous bicycle lanes for the entire corridor, including through intersections.**

**Advantages:** This sends a clear visual message to drivers and cyclists about the presence of cycling facilities on the two streets, thus has both practical (as guidance to both motorists and cyclists) and symbolic (“bikes belong”) importance. Making the bike lanes more visible means that drivers will be more aware of cyclists and prepared for taking bicyclists into account as fellow travelers. Portland, Oregon, and many Dutch communities have has good success with tinted or painted bike lanes. The preliminary cost estimate for this improvement is $217,500.
Disadvantages: This is not a convention treatment for bicycle lanes in Palo Alto or statewide, thus would need to undertaken as a demonstration project. Some cyclists have expressed concern that continuing the tinted or painted lanes into and through the intersection does not give drivers adequate guidance, particularly in making right turns. Staff will work with the Palo Alto Bicycle Advisory Committee to during the design process. An alternative to striping and tinting or painting bicycle lanes through an intersection is to dash (along with paint or tint) the bicycle lanes, as is standard practice when bicycle lanes approach an intersection (to signal to right-turning drivers that they can cross over the bicycle lane and to signal to bicyclists that drivers may be making this maneuver).

Alternative: The tinted or painted bicycle lanes could be dashed in both the approach to and through intersections. It should be noted that standard practice is to dash bicycle lanes on the approach to intersections, which gives drivers guidance that crossing the bicycle lane near the intersection to make a right turn is permissible.

An off-road side path (separated from the street by both the curb and a planting strip) alternative to continuous on-street bike lanes was considered for a section of Charleston Road where sufficient right of way was available or could be obtained, but was discarded due to concerns by staff and members of the bicycling community. The reasons for this are that drivers at cross streets will not expect bicyclists to cross their path in advance of an intersection and that some bicyclists will not slow down or stop at cross streets without being forced to by placement of bollards and other restrictive devices. This safety concerns are the reasons why side paths are not considered a good alternative to on street bicycle lanes. Sufficient right-of-way exists for this purpose.

2. *Widen bicycle lanes to 7 feet on Arastradero/West Charleston and to 6 feet on the south and 8 feet on the north side of East Charleston Road.*

Advantages: Wider bicycle lanes provide both bicyclists and drivers a larger “forgiveness zone” in the event of human error or mechanical problem, as well as greater psychological security for cyclists. This combination will induce more people to bicycle on a street with wide bicycle lanes, all other things considered equal.

Disadvantages: Widening bicycle lanes will require re-allocating space for other uses. Depending on location and design (three lane or four lane), these uses include through movement and daytime parking. While much of the Corridor is characterized by eleven-foot lane widths, in some locations space will be reallocated from a reduction of through lane width from eleven feet to ten feet. Ten-foot lane widths are acceptable on streets such as Charleston and Arastradero, which have low proportions of trucks and full-size...
urban transit vehicles on them; however, some drivers may prefer 11-foot lanes for added maneuverability.

**Alternative:** Maintenance of five-foot bicycle lanes on arterial streets like Arastradero and Charleston is the desirable minimum in Palo Alto. Bicycle lanes above eight feet are likely to be violated by some drivers using them as (illegally) as travel lanes, thus creating a potential safety hazard.

3. *Replace the free right turn (“pork chop islands”) on the southwest and southeast corners of the El Camino Real and West Charleston/Arastradero intersection to enhance pedestrian and bicycle safety.*

**Advantages:** Bicycle and pedestrian safety is enhanced in that vehicle approach and merge speeds on right turns onto and off on El Camino Real at Arastradero/West Charleston will be reduced. The preliminary cost estimate for this improvement is $25,000.

**Disadvantages:** Right turns at these locations will take slightly longer and vehicle delay and queues for these turns at peak congestion periods will also be somewhat longer. This will not result in a degradation of overall intersection efficiency as measured by level of service, however.

**Alternative:** These free right turn islands can be left in place, although staff believes that the safety benefits to pedestrians and bicyclists of removing them far outweighs any consequent inconvenience to motorists.

4. *Implement attractive bicycle lane signage along the entire corridor.*

**Advantages:** Driver awareness that “bikes belong” would be increased by such signage and heightened awareness should have safety benefits. The encouragement given to bicyclists should have a positive impact on use of the bicycle lanes.

**Disadvantages:** Unless attractive, additional signs can contribute to aesthetic concerns (“sign pollution”).

**Alternative:** Conventional bicycle lane legends and logos can be used or the more visible tinted or painted bicycle lanes with or without logos and legends, in either case without a signage program.

**Pedestrian Safety and Comfort:**
1. **Shorten pedestrian crossing distance, improve aesthetics, and enhance traffic safety** (“prudent driver sets the pace”) along East Charleston from Fabian to Alma and potentially West Charleston and Arastradero Road from Alma to Miranda (excluding reservation of four lanes for adequate space for storage of motor vehicles at both approaches to major signalized intersections—Middlefield, El Camino Real, and Charleston and the Caltrain tracks) through provision of two through lanes and sections of landscaped medians interspersed with left-turn pockets in place of four through lanes. See “Traffic Safety”.

2. **Provide center median islands for pedestrian refuge at intersection crosswalks.**

   **Advantages:** Safer pedestrian conditions and as a result more walking along and across the corridor with some congestion relief and other public benefits (air quality, reduced noise, etc.)

   **Disadvantages:** The space needed for these refuges must be acquired through re-allocation from other uses, such as parking spaces.

   **Alternative:** Enhanced crosswalk striping can be provided at each signalized crosswalk location without provision of a center median refuge. Staff recommends installation of center median pedestrian refuges since they provide a protected space for pedestrians to regroup and shift their focus (e.g. to look right instead of left). Without such a refuge, pedestrians have to maintain focus on both directions for much of their crossing and have no place to wait in case they cannot complete a full crossing safely.

3. **Provide of bulb-outs at selected locations to shorten pedestrian crossing distance.**

   **Advantages:** Enhances pedestrian safety by shortening crossing distance and time and can at the same time provide a protected parking bay if applicable.

   **Disadvantages:** Can be expensive in that it requires breaking down the existing curb line and installing new curbing and may – depending on location – require movement of catch basins and portions of storm drains.

   **Alternative:** Conventional or enhanced crosswalks can be provided. Enhanced striping and yellow-green pedestrian crosswalk warning signs can raise driver awareness of a crosswalk and enhance safety.
4. Enhance crosswalk striping and install more visible texture or paving on crosswalk surfaces at the El Camino Real and West Charleston/Arastradero.

**Advantages:** Enhances pedestrian safety at the busiest Corridor intersection while also enhances visual aesthetics.

**Disadvantages:** Can be expensive, depending on materials and treatment.

**Alternative:** Enhanced crosswalk striping and crosswalk warning signage can be installed without also installing textured or specially paved crosswalks.

5. Replace the free right turn ("pork chop islands") on the southwest and southeast corners of the El Camino Real and West Charleston/Arastradero intersection to enhance pedestrian and bicycle safety. See "Bicycling Safety and Comfort".

**Advantages:** Enhances pedestrian and bicycle safety at the busiest Corridor intersection by reducing the turning speed of vehicles crossing crosswalks and bicycle lanes.

**Disadvantages:** Adds a small amount of time to the right turn movement.

**Alternative:** Rely on enhanced crosswalk striping, crosswalk warning signage, and painted or tinted bicycle lanes to alert drivers of the need to slow down while crossing the travel path of pedestrians and bicyclists.

6. Install pedestrian "countdown" signals at the major signalized intersections along the corridor.

**Advantages:** Enhances pedestrian safety by giving useful information to pedestrians on how long they have to complete a crossing. The countdown device at Bryant and Hamilton has been successful in this respect.

**Disadvantages:** Some pedestrians may misjudge their walking pace and not make good use of the countdown information.

**Alternative:** Conventional pedestrian symbol signal heads.

7. Enhance pedestrian crossing safety between signalized intersections at selected locations through provision of lighted crosswalks or pedestrian-actuated traffic signals.
Advantages: Enhances safety by increasing the visibility of crosswalks and raises motorists' awareness and alertness. In addition, pedestrian-actuated signals provide positive right of way control and a higher level of pedestrian safety than when such control is not provided.

Disadvantages: Lighted crosswalks cannot be installed at signalized intersections due to concerns about distracting attention from the essential information provided by the traffic signal. Prevailing car speeds should be below 30 miles per hour for installation of lighted crosswalks; pedestrian demand should be high, for driver expectancy and cost-effectiveness; and they are safer on two lane instead of four lane cross-sections (in the latter case, one driver may yield to a pedestrian, while another alongside and slightly behind may not see the pedestrian being yielded to). Pedestrian-actuated signals are effective for safety but do induce added vehicle delay and make traffic signal foreordination on a street corridor more difficult.

Alternatives: Enhanced crosswalk striping and signing at existing pedestrian crosswalks.

Visual Aesthetics:

1. Shorten pedestrian crossing distance and improve aesthetics along East Charleston from Fabian to Alma and potentially West Charleston and Arastradero Road from Alma to Miranda (excepting reservation of four lanes for adequate space for storage of motor vehicles at both approaches to major signalized intersections—Middlefield, El Camino Real, Charleston, and the Caltrain tracks) through provision of two through lanes and sections of landscaped medians interspersed with left-turn pockets in place of four through lanes. See “Traffic Safety”.

2. Enhance the roadside planting strip in selected locations. (Attachment F illustrates schematically and in representative fashion improvements recommended along the Corridor.)

Advantages: Makes the roadway environment more pleasant and adds value to the travel experience. While some trees will be removed as the Corridor Plan is implemented, on net more trees will be added in planting strips, landscaped medians, and “tree medians”.

Disadvantages: Can be costly to install, irrigate, and maintain.

Alternative: Conventional planting strips and existing street trees can be maintained.
3. Install vertical gateway monuments with aerial connections between each side of the street near Fabian and near Miranda.

**Advantages:** Provides an attractive entry to the Corridor and can be used for seasonal displays. The preliminary cost estimate for this improvement is $200,000.

**Disadvantages:** It may be difficult to come to a community consensus on design and aesthetics for this improvement.

**Alternative:** A Charleston/Arastradero Corridor Improvement Area sign could be installed on either end of the Corridor.

**Improvements Being Evaluated and Not Yet Recommended:**
A conceptual plan has been prepared for a new pedestrian and bicycle undercrossing of Alma and Caltrain near Charleston (see Attachment G). This design, which would not require acquisition of any additional right of way, would require cyclists to dismount before entry into the tunnel. A design and construction cost of from $2.5 million to $3.0 million has been estimated for this facility, exclusive of contingencies. Given the preliminary nature of this estimate, a contingency of up to 50 percent would be advisable, which would increase the estimated cost to from $3.75 million to $4.5 million. Staff is still evaluating this design for feasibility, so it is not recommended at this time. A more elaborate design, which would not require bicyclists to dismount, would require elaborate “switch-backs” and acquisition of additional right of way. The cost of this approach, while not yet estimated, would be significantly higher than the design illustrated in Attachment G.

**Assessment under the Corridor Plan Performance Measures**

*Performance Measure #1: no increase in Corridor travel time.*

The Corridor Plan will likely reduce travel time compared to 2015 traffic conditions without implementation of the Plan.

*Performance Measure #2: no increase in delay or critical movement delay along the Corridor.*

The Corridor Plan will likely reduce both vehicle delay and critical movement delay at all signalized Corridor intersections compared to 2015 traffic conditions without implementation of the Plan.
Performance Measure #3: Reduce 85th percentile speeds by at least 20 percent along the Corridor.

The Corridor Plan will likely reduce 85th percentile speeds by at least 20 percent along those sections with two travel lanes rather than four. The Plan is not likely to do so in those sections retaining four travel lanes.

Performance Measure #4: Reduce crash rates by at least 25 percent.

The Corridor Plan will likely reduce crashes by at least 25 percent along those sections with two travel lanes rather than four. The Plan is not likely to do so in those sections retaining four travel lanes.

Performance Measure #5: Increase pedestrian volumes by at least 20 percent by 2010 and 40 percent by 2020

The Corridor Plan will likely increase pedestrian volumes by at least 20 percent by 2010 and by at least 40 percent by 2020 along those sections with two travel lanes rather than four. The Plan is not likely to do so in those sections retaining four travel lanes.

Performance Measure #6: Increase bicycle volumes by at least 20 percent by 2010 and 40 percent by 2020.

The Corridor Plan will likely increase bicycle volumes by at least 20 percent by 2010 and by at least 40 percent by 2020 along those sections with two travel lanes rather than four. The Plan is also likely to meet these performance targets should four travel lanes be retained, although the bicycle volume percentage increase will not likely be as great as in those sections with two travel lanes rather than four.

Performance Measure #7: Increase public transit boarding by at least 50 percent by 2010.

Conclusion
Installation of traffic-adaptive signal technology, along with mode shift performance measures, could result in less congestion on the Corridor than at present or projected for 2015. Assuming these changes, overall travel time is projected to fall from Fabian to Miranda from 2 to 3 minutes, depending on land development scenario and cross-section design (three-lane or four-lane). Similarly, vehicle delay at traffic signals is projected to fall by up to 2 minutes. Tables I and II in Appendix C provides detail on these current and projected traffic conditions. Even without the targeted shift toward alternatives modes, deployment of
traffic-adaptive signal technology itself will result in a reduction in overall corridor travel time in the year 2015 from 1 to 2 minutes, even with a three-lane cross-section.

These findings suggest that implementation of traffic-adaptive technology, along with achievement of the mode shift performance standards, will enable re-design of all portions of the Corridor to accommodate a three-lane cross-section without increasing delay or travel time or, as a consequence, induce traffic shift onto nearby residential streets. While this result may appear "counter-intuitive", it is important to remember that traffic congestion on urban arterial streets occurs at intersections, not between intersections.

Funding

On April 14, 2003, the City Council authorized an expenditure of $200,000 for preparation of the Charleston/Arastradero Corridor Plan. The Corridor plan itself will include a funding element, comprising an assessment of a variety of financing options, including federal, state, and regional grants, traffic impact fees, and other sources. The Corridor plan will also include estimated costs of any improvements and a phasing plan for implementation. Project implementation after Council approval of a preferred plan for the Corridor will proceed within the context of the City’s capital improvements planning process. Preliminary construction and installation cost estimates for implementing the Corridor Plan are $6.4 million, including $1.2 million for deployment of traffic-adaptive signal technology. Adding on 15 percent for detailed architectural and engineering design work and 5 percent for construction project management increases the preliminary cost estimate for the Corridor Plan to $7.4 million. These estimates are exclusive of any costs for a new pedestrian and bicycle under crossing of Alma and Charleston and also do not include increased Shuttle bus service costs due to increased service frequency along the Corridor. It should be noted and emphasized that these are preliminary cost estimates, thus will likely change with more refinement of design detail. It is also important to note that a decrease or increase in the number of improvements will change cost estimates accordingly. Council can choose to authorize a Corridor Plan in phases, matching availability of grant and other funding with City resources; and/or reduce the proposed Corridor Plan scope to manage the resource impact of the Plan. Attachment E comprises a report on alternative sources for funding the Corridor Plan. It is anticipated that federal, state, and regional transportation grants, along with proceeds from a proposed citywide traffic impact fee will provide all or most of the funding required.

Council has already authorized staff to apply for grant funding for installation of traffic-adaptive technology on Charleston and Arastradero Road (CMR:454:03). Both traffic-adaptive technology and bicycle and pedestrian facility improvements are included in a draft expenditure plan for a proposed citywide traffic impact fee presented to the Planning and
Transportation Commission at a study session on August 27, 2003. Such a fee and expenditure plan, if adopted by Council, could partially fund bicycle and pedestrian improvements on the Corridor. Selected other potential funding sources are the following grant programs: the Metropolitan Transportation Commission’s Transportation for Livable Communities, Caltrans’ Safe Routes to School, the California Office of Traffic Safety, the Bay Area Air Quality Management Districts’ Transportation Fund for Clean Air, the US Department of Transportation’s Congestion Management and Air Quality Improvement and Enhancements, and future calls for projects from the Santa Clara Valley Transportation Authority’s Local Streets and County Roads.

POLICY IMPLICATIONS
The Charleston/Arastradero Road Corridor Plan addresses the first six goals of the Palo Alto Comprehensive Plan:

- T-1: “Less Reliance on Single Occupant Vehicles”.
- T-2: “A Convenient, Efficient Public Transportation System that Provides A Viable Alternative to Driving”.
- T-3: “Facilities, Services, and Programs that Encourage and Promote Walking and Bicycling”.
- T-4: “An Efficient Roadway Network for All Users”.
- T-5: “A Transportation System that Minimizes Impacts on Residential Neighborhoods”.
- T-6: “A High Level of Safety for Motorists, Pedestrians, and Bicyclists on Palo Alto Streets”.

In addition, the Corridor Plan should facilitate achievement of Policy B-19: “Use street corridor improvements as catalysts for economic revitalization in selected Centers.”

While the Corridor plan is a transportation and not a land use plan, the Corridor Plan will be consistent with Comprehensive Plan Housing Goal H-1: “A supply of Affordable and Market Rate Housing that meets Palo Alto’s share of Regional Housing Needs” and Goal B-1: “A Thriving Business Environment that is Compatible with Palo Alto’s Residential Character and Natural Environment.”

ENVIRONMENTAL REVIEW
An initial study has been prepared for the project and a Mitigated Negative Declaration (MND) will be issued by the Department of Planning and Community Environment on Monday December 8. The MND will have a public review period of 20 days. Copies of the initial study and MND will be available in the Planning Department office on the fifth floor of City Hall.
ATTACHMENTS
A. Map of Charleston Road/Arastradero Road Corridor
B. Charleston/Arastradero Corridor Plan Public Meeting Notes, October 15 and October 22, 2003.
C. Narrative Description of Corridor Plan
D. Draft Traffic Analysis and Description of Traffic-adaptive Coordination
E. Preliminary Assessment of Funding Sources
F. Schematics of representative Charleston/Arastradero Road Corridor improvements
G. Schematic of potential new pedestrian and bicycle undercrossing of Alma and Caltrain

Prepared by: Joseph Kott, Chief Transportation Official

Division Head Approval: [Signature]
Joseph Kott, Chief Transportation Official

cc: Charleston/Arastradero Corridor Plan Informal Input Group
City of Palo Alto
Arastradero / Charleston Corridor Study
Community Meeting #2: Street Design Options – 10/15/03
Community Comments Summary

The comments summarized below were made by participants and recorded during the course of the meeting. (R) indicates a response by City staff or consultants

• Keeping curbside parking may not be a crucial concern of residents who live along or in the vicinity of the corridor.

• There are different kinds of cyclists. Are the proposed grade-separated paths only for kids? What is the goal of these design options as regards cycling speed?

• As a serious cyclist I prefer to ride on the street, rather than on a bike path.

• Regarding process, how are solutions reached? There are too many alternatives. Where is the analysis of community needs? What are the options and choices? (R) The basic options and choices relate to medians, bikeway locations, pedestrian crossings, planting, and street signs and lighting. There are a number of ways to combine these different elements to create a street that has a more neighborhood-oriented character.

• It is important to create visual cues for drivers. An example of this is the electronic speed sign near Fabian. Drivers instantly reduce their speed from 40mph to 25mph, at least until they hit Middlefield Road. Then they speed back up.

• Serious cyclists do use grade-separated bike paths. You’d be surprised. Once they’re installed you just can’t help but ride on them. Also they increase the value of properties located along the paths.

• Two-way bike paths can be unsafe at intersections and can make it difficult to reach the opposite side of the street. I prefer one-way grade-separated bike paths located on both sides of the street.

• I prefer maintaining outside lanes for vehicular travel lanes (on the 4-lane options), rather than programming them for parking during off peak times.

• Painting the bike lanes doesn’t go far enough in preventing vehicles from veering into bike lanes. Have you considered a raised surface strip to separate the bike lane from vehicle lanes? Little round domes? (R) A raised surface, or even a change in surface textures can be hazardous for cyclists. At the city we are conservative about using any kind of raised surface along bike lanes.

• Near the cemetery it is very dangerous for cyclists. They try to cross to the south/east side of Arastradero from Foothill. A safe crossing is needed there. Also, many Terman students travel in the bike lane against traffic on that side of the street; this is not safe.

• I like the grade-separated bike paths. I have kids and would feel good about allowing them to ride their bikes to school on these paths. I also think the safety benefits (to motorists, pedestrians) of medians outweigh any inconvenience they may cause. My concern involves how bike paths may work at the major intersections like Alma,
Middlefield, and El Camino. I prefer the idea of over-crossings for pedestrians and cyclists.

- Community participation in Palo Alto is an illusion. The parameters are already set. Why don’t you just tell us what they are? Shouldn’t you base your options on these parameters?
- I don’t think traffic diversion (that could result from street improvements) onto residential streets is an issue.
- Oh yes it is!
- I am a homeowner across from Hoover School and I prefer grade-separated bike paths. I would be more than happy to sacrifice curbside parking for the safety and beauty (offered by those plan options).
- Do these plans extend to San Antonio Road? (R) As of now the improvement concepts end at Fabian Way.
- I think grade-separated bike paths and medians are a good idea for East Charleston and should be extended to the rest of the corridor (including Arastradero). Currently, there is more traffic, relatively, east of El Camino. But in the near future it is not expected to be that much different there. Safety should be the number one priority along the entire corridor.
- Are there funds available for grade separated bike paths? (R) We have applied for a grant to pay for additional electronic speed signs. There are other grants we can and will apply for. And the city is looking at funding projects from its traffic impact fee program.
- It is important to get drivers to slow down. Safety is the issue, so I like the idea of the medians.
- Does expense effect the timeline of implementation? (R) Yes. It would take time to package the funding needed, especially if it includes grants.
- We need to improve travel on San Antonio to deter through traffic on this corridor. (R) There is a network of streets that we are part of, and what happens on other streets definitely affects us. The county is interested in improving efficiency on Page Mill and the Oregon Expressway, which are county highways, and this would relieve some of the traffic on this corridor.
- I am a cyclist commuter and would definitely use grade separated bike paths. I am however concerned about trees blocking visibility near intersections. Would treatment of the grade separated bike paths be the same at every intersection? (R) No, each intersection is different and would require some independent analysis and design. We would make sure visibility at intersections is very good.
- I like the Louis island. It prevents through traffic on Louis, which was a real problem before it was installed.
- The Louis Street island serves a good function but can stand improvement.
- The Louis island does not prevent through traffic on Montrose however. People use this as an alternate route to reach Fabian and avoid San Antonio.
- Street lighting should be more pedestrian-oriented than vehicle oriented. We don’t want the lighting to be so bright that it attracts cars (by making the street seem like it is supposed to be a through route).
• I am concerned about medians blocking access to streets.
• Off-peak parking is dangerous, especially for kids on bikes. They have to ride around parked cars (especially on Arastradero) and drivers don’t look out for them. One solution is towing.
• I have a concern regarding traffic between Middlefield and Gunn. Currently traffic is diverted onto residential streets. Drop-off zones would help. But how do we get cars off Maybell? (R) There will be more analysis of Maybell. It requires a custom solution.
• A potential solution would be to make Page Mill and Oregon freeways.
• A 60’ cross-section (curb to curb) is too constrained. We should consider taking room from some of the frontages to make the street better.
• I have a concern regarding medians and kids using them to cross the street rather than using designated (signalized) crossings. But the medians would be safer for elderly people. It is very difficult for my father to cross the entire width of a street (in the time allowed by a traffic signal).
• On West Charleston between Alma and El Camino parking is used for businesses and special destinations; in other areas it is just residential guest parking.
• If we are going to have grade separated bike paths I’d like to propose that we also have on street bike lanes (for commuter cyclists).
The comments summarized below were made by participants and recorded during the course of the meeting. (R) indicates a response by City staff or consultants

- Medians are an inconvenience to people turning left (into driveways). Would it be possible to combine medians and center turn lane? (R) Yes. Median wouldn’t be continuous. There would need to be places for left and u-turns.

- With a median is it possible to make a u-turn at intersections? (R) It depends on the location; e.g. cross street vs. mid-block. It may be possible to have shorter medians, making u-turns possible. Though this can reduce safety.

- Is it possible to make some sections four lanes and some three, as shown in the options (at Alma)? Won’t this create a back up, similar to when the number of lanes on a freeway is reduced? (R) Traffic on the corridor is different from that on a freeway. It is more complicated because it’s not a single direction flow through, but comes and goes at different intersections. It is possible to have a transition at intersections. Still, we do want to minimize transitions between different lane conditions to maintain traffic flow.

- Perhaps all we need along the corridor is traffic enforcement and shrub trimming. Also, not too many cars park on Arastradero. If you remove it that frees up extra space for bike lanes. Why do you need a six-foot median to create a pedestrian refuge? Wouldn’t three feet be sufficient? (R) Six feet is generally the preferred minimum for a refuge for safety, though any width is safer than no refuge.

- Which alternative would slow traffic the most? (R) Any of the alternatives with three narrowed lanes and pedestrian refuges.

- I like the option which maintains the four vehicle lanes on Arastradero with a median. This is a main road into and out of town. Traffic will flow slower and more smoothly. I also like the grade separated bike paths, but am unclear about how to get cyclists out of the streets and onto paths.

- I like grade separated bike paths and medians. Safety is the priority, not speed and convenience. Traffic will continue to get worse in the future. If people want to race down the street to reach the highways they should use the thoroughfares. This is a residential street. Our goal should be to improve the street for pedestrians and cyclists. I also like the idea of including street trees because they screen the sun and improve visibility along the street (relative to shrubs). This will make the street safer and prettier.

- I’m concerned about traffic gridlock. How are you going to synchronize signals with the railroad crossing? (R) The railroad crossing will not have a significant impact on the signal system. In the future the train will run more frequently and we may need to look at grade-separated streets. That would be the safest and most efficient configuration.

- When I ride my bike on the street the VTA buses cannot even stay in an eleven-foot lane. How will they stay in a ten-foot lane? (R) The bike lanes are proposed for
widening in all of the options.

- Regarding pedestrian refuges. How will these slow traffic, when drivers cannot see pedestrians in the refuge. (R) The purpose of the refuges is not to slow traffic, but rather to make it safer and more convenient for pedestrians to cross the street. The City of Palo Alto is conservative about using pedestrian crossings (without refuges) on four-lane streets because of the danger this may create for pedestrians.

- I live near Gunn High. Currently it is not recommended for cyclists to use Arastradero, but to use Maybell instead. If we had safe bike paths on the (Arastradero) corridor cyclists would use them.

- Regarding the electronic speed sign near Fabian. There should be a differentiation between the actual driver’s speed and the enforced speed. When it switches back and forth between the two it is difficult to determine what speed you are actually going. The speed limit should be shown as well as the driver’s speed.

- A nationally recognized bicycle accident study shows that most biking accidents occur at intersections. How do you minimize this occurrence with grade separated bike paths? (R) Bicyclists need to stop at intersections and cross with pedestrians.

- There is a Palo Alto study that compares on-street bike lanes with off-street bike paths. It determines that off-street bike paths are twice as unsafe at intersections and in instances where cyclists ride on the wrong side of the path. Drivers don’t expect to see cyclists coming from paths behind the curb. Therefore experts have serious reservations about grade separated bike paths. (R) Two-way bike paths on one side of the street were discouraged (at last week’s workshop). If we change the atmosphere of the street people can adapt to change. Adding bollards to the bike paths at intersections and a sign system along the corridor would be recommended to alert motorists and cyclists to the new conditions.

- If you put bollards cyclist will ride in the street. How will you put in street trees with storm drains and other utilities in the way? (R) We are mapping utilities including storm drains, and they are not in consistent locations. In certain locations street trees could conflict with utilities, in others they wouldn’t. Medians and sidewalk widenings could still be constructed, though trees may not be consistent.

- When you talk about the right-of-ways being behind the sidewalk does this mean you plan on taking portions of frontage properties? (R) The right-of-way actually extends behind the back of walk. We could add street trees in this strip to make the street more beautiful, but not take any property, no.

- I live on the corridor and it is very difficult to back out of my driveway. I use the parking lane to edge out of my drive and gain visibility. If you remove the parking it will make it even more difficult to back out.

- I have a seven-year-old son. I love the idea of a designated bike path and trees in a center median. I would never allow my son to ride on the street along the corridor, even with wider bike lanes.

- There is a problem with traffic back up at Gunn High. A right-hand turn lane would alleviate this problem. Also, in other locations there are flashing yellow lights alerting people to drive 15 mph in a school zone during active times; we should have that here too. If people need a cut-through street (between 101 and 280) let them use another road.

- Where would cyclists stop at intersections? On-street they have the same right-of-
way as traffic and off-street they are pseudo-pedestrians? (R) In all the options presented cyclists can ride in the street. There is a choice of where to ride in the bike path options.

- How does the combination of bike lanes with corner bulb-outs work at intersections? (R) You can only have bulbouts parallel to a bike lane where there is a parking lane, otherwise you would block the bike lane.
- In a three-lane alternative how do emergency vehicles fit on the street? (R) The sixteen-foot combined travel lane and bike lane provides sufficient room for emergency vehicles; or if there is just a bike lane the combination of the bike lane and travel lane.
- I am a cyclist on East Charleston and find the street extremely frightening. The idea is to regulate traffic flow. Simple things could be done to accomplish this.
- If there is a question regarding the safety of grade separated bike paths then I am not for them.
- I have a two-year-old and would like to have her ride her bike to school in the future. I am for maximum traffic calming. Bike lanes (on-street) won’t be safe if traffic is not slowed considerably.
- I support improving existing bike lanes and calming traffic. I am also for iron clad traffic enforcement. Currently enforcement is nonexistent. The cost would be about $1 million per year and the fear would deter speeders.
- A combination of medians and center turn lanes could be used to suit unique situations. They should be used flexibly.
- As long as we have four-lanes of traffic, speed will be problem. Perhaps if we have four-lanes we should have speed humps.
- Parking on Arastradero should not be eliminated.
- There is no enforcement to prohibit truck traffic along the corridor today; there should be.
- The two-way grade separated bike path alternatives should be eliminated. (R) That is the consensus.
- In terms of bike lane safety, color may not make a difference but widening bike lanes and eliminating parking lanes does.
- If we want a fast and cheap solution we should narrow traffic lanes, widen bike lanes, and paint a colored striped to delineate bike lanes. Also painting “>” in traffic lanes makes the lanes appear more narrow the faster the driver goes, and can calm traffic; this has been tested.
- As a cyclist I find intersections to be highly dangerous. Also, swinging car doors pose a hazard to cyclists when bike lanes are next to parking lanes. Storm drains are an additional hazard. The ridges run parallel to the lane catching bicycle tires and causing serious accidents. (R) In a four-foot bike lane the cyclist is in the swinging door zone. But a six-foot lane (within a fourteen-foot bike/parking zone) provides enough room for cyclists and open car doors. (R) Nowadays the storm drain covers are made of criss-cross bars to avoid bike tires catching in the ridges.
- There is an off-road bike path along the water company property near Gunn. It doesn’t quite reach Gunn yet but most likely will in the near future. It would then cross Arastradero and continue past Terman School. Currently there is no vehicle access between the area behind Terman School and El Camino. But the bicycle path
could extend from Gunn High to the south, thus allowing cyclists to avoid Arastradero altogether. The mid-block bike/ped crossing should be aligned with this route.

- Often people think of safety and comfort as one in the same. But really these are two different things. In this case, however, we can accomplish both. I believe the option with three lanes, including the left turn pocket, accomplishes this best.
- I would rather drive in traffic than risk swinging doors in bike lanes. If we cut down on cut-through traffic we will increase the safety of the corridor.
- It is very difficult to get out of driveways currently. This can be a problem in emergency situations.
- There should be a bicycle route behind Gunn High. (R) Currently there is one between Bull Park and Gunn High.
- There should be a law requiring cyclists to use bells in order to alert pedestrians when they are coming.
Introduction

In April 2003, the Palo Alto City Council mandated preparation of a Charleston-Arastradero Corridor Plan to address school commute and other travel safety concerns for pedestrians, bicyclists and drivers along with residential amenities along the corridor, without inducing traffic to shift onto nearby residential streets. As part of the City Council’s mandate for the preparation of the Plan, it provided that applications for certain development permits would not be formally considered, heard or approved by the City during the period of the preparation of the Plan. For the purposes of the development moratorium the project area was defined as one-quarter mile on either side of the Charleston-Arastradero Corridor, including San Antonio Avenue and the Foothills Expressway, and at intersection of Charleston Road and Alma Street the Corridor width was defined as one-half mile on either side of Charleston Road.

The proposed Charleston-Arastradero Road Corridor Plan area, as shown in the attached map is located in the southern portion of the City of Palo Alto. The Corridor begins on Charleston Road approximately ¼ mile from Interstate Highway 101 at Fabian Way, and continues 2.3 miles southwest as Charleston Road, crossing the railroad tracks near Alma Street and State Highway 82 (El Camino Real) where the road continues as Arastradero Road and ends at Miranda Avenue. The roadway improvements proposed in the Corridor Plan are contained within the existing 80-86’ right of way width (which includes the 60-foot curb-to-curb street width plus existing sidewalks and vegetation strip areas) along Charleston/Arastradero Road corridor and the existing rights of way at each of the ten signalized intersections.

Some improvements on the Corridor are already part of the “Travel Smart, Travel Safe” Residential Arterial program already approved by Council and funding is being pursued. These primarily include adjusting signal timing and installing a traffic adaptive system along the corridor. A traffic adaptive system allows signaling to be responsive to real-time changes in the traffic conditions. Some elements of the “Travel Smart, Travel Safe” Residential Arterials Project include advanced traffic detection, traffic-adaptive system, communication system upgrade, signal timing, V-calm electronic speed signs, and enhanced crosswalks. Additionally, the City will continue to work with the schools along the corridor and the School District on increasing alternative mode trips to and from their facilities as well as continuing to adjust start times of the schools to reduce morning peak time traffic.

Project Setting

The length of Charleston Road and Arastradero Road within the Corridor Plan limits (to be referred to henceforth as “the Corridor”) is approximately 2.3 miles. Charleston Road and Arastradero Road each have four through lanes within the Corridor Plan reach and there are ten signalized intersections along the Corridor. The typical curb-to-
curb pavement width along the Corridor is 60 feet.\(^1\) Eighty-fifth percentile vehicle speeds along the corridor range from 34.7 mph (Charleston Road, near Carlson) to 36.9 mph (Arastradero Road, near Pomona) and 37.3 mph (Charleston Road, west of Fabian).\(^2\) Charleston Road average daily motor vehicle volumes (both directions) range from approximately 13,600 just west of Fabian Way to 14,300 just west of Middlefield.\(^3\) Arastradero Road average daily motor vehicle volume (both directions) is approximately 20,500.

Bicycle lanes are marked on both sides of the Corridor section between Nelson and Miranda. There are no striped bicycle lanes on Charleston Road between Middlefield and Fabian Way and the bicycle lanes between Nelson and Mumford are only in force during the day. Long distances between pedestrian crossings characterize both Charleston Road and Arastradero Road, for example the approximately 1,100-foot distance between the crossings along Charleston at Wilkie Way and Alma.\(^4\)

Transit service along the corridor includes the Palo Alto Shuttle and the Santa Clara Valley Transportation Authority (VTA). The Palo Alto Shuttle serves two sections of the Corridor: from Middlefield to Carlson (Route C) and from El Camino Real to Gunn High School (Route G).\(^5\) The Santa Clara Valley Transportation Authority (VTA) provides service on most of the Corridor, from Louis Road to Miranda (en route to the VA Hospital) within the Corridor (Route 88).\(^6\)

Land uses along the corridor include Residential zones, several public and private schools, some commercial areas and community facilities including city parks. It is a frequently commuted school route traveled by children of all ages.

Existing and future traffic conditions were modeled by TJKM Transportation Consultants are their results reported in the analysis included with the Initial Study. For project future conditions and future land use developments, which would likely change traffic conditions along the corridor, the base analysis used the City Comprehensive Plan for land use growth. The City Comprehensive Plan EIR modeled all known developments at that time, however, some additional projects (such as Hyatt Rickeys, Sun Microsystem, etc.) have since been clarified and proposed, therefore the traffic analysis for the project also includes the modeling of land use projects (as currently proposed) and anticipated development (at maximum build out based on existing development standards). Therefore, there may be some discussion in the initial study of future

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Comprehensive Plan land use assumptions and future Comprehensive Plan plus proposals.

The Corridor plan itself will include a funding element, comprising an assessment of a variety of financing options, including federal, state, and regional grants, traffic impact fees, and other sources. The Corridor plan will also include estimated costs of any improvements and a phasing plan for implementation. Project implementation after Council approval of a preferred plan for the Corridor will proceed within the context of the City’s capital improvements planning process. Preliminary cost estimates for implementing the Corridor plan are approximately $2.3 million (roughly one half of this cost is for traffic-adaptive signal technology) without landscaped center medians, to $5.9 million with landscaped center medians on selected street sections from Fabian to Miranda. These estimates are exclusive of any costs for a new pedestrian and bicycle under crossing of Alma and Charleston. It should be noted and emphasized that these are preliminary cost estimates, thus will likely change with more refinement of design detail. It is also important to note that a decrease or increase in the number of improvements will change cost estimates accordingly. Council can choose to authorize a Corridor Plan in phases, matching availability of grant and other funding with City resources; and/or reduce the proposed Corridor Plan scope to manage the resource impact of the Plan.

Council has already authorized staff to apply for grant funding for installation of traffic-adaptive technology on Charleston and Arastadero Road (CMR:454:03). Both traffic-adaptive technology and bicycle and pedestrian facility improvements are included in a draft expenditure plan for a proposed citywide traffic impact fee presented to the Planning and Transportation Commission at a study session on August 27, 2003. Such a fee and expenditure plan, if adopted by Council, could partially fund bicycle and pedestrian improvements on the Corridor. Selected other potential funding sources are the following grant programs: the Metropolitan Transportation Commission’s Transportation for Livable Communities, Caltrans’ Safe Routes to School, the California Office of Traffic Safety, the Bay Area Air Quality Management Districts’ Transportation Fund for Clean Air, the US Department of Transportation’s Congestion Management and Air Quality Improvement and Enhancements, and future calls for projects from the Santa Clara Valley Transportation Authority’s Local Streets and County Roads.

The project will likely be phased as money is acquired for different elements and sections of the project improvements. Once money is acquired for specific areas improvements, temporary placements of improvements using paint, barriers, modifications of traffic flow patterns will be studied for a period of time before more permanent improvements installed.

**Project Goals**

The Palo Alto City Council mandated preparation of a Charleston-Arastadero Corridor Plan to address school commute and other travel safety concerns for pedestrians, bicyclists and drivers along with residential amenities along the corridor, without
inducing traffic shift onto nearby residential streets. Therefore, the project goals and objectives include the following.

- Maintain existing travel time on corridor to minimize diversion to other residential streets.
- Reduce crashes on corridor.
- Improve conditions for pedestrian and bicycle travel.
- Improve quality of life on the corridor.
- Enhance visual amenities of the corridor.

**Proposed Project**

The proposed Corridor Plan includes both small and larger scale improvements in the public right-of-way. The Corridor Plan is conceptual in nature in that proposed improvements are proposed for large corridor sections. Further design with area specific conditions (such as nearby trees, utility locations, etc.) will likely follow. Additional environmental review may still be required for improvements at specific areas.

Smaller-scale improvements, such as visual amenities are proposed along the entire corridor and are described first. The larger scale improvements follow and include a discussion of certain area improvements, such as locations near schools or intersections. Within the proposal, some improvements such as a median (which would increase pedestrian and vehicular safety) could be traded for others such as parking (which can also act as a buffer between vehicle travel lanes and bicycle or pedestrian facilities). As an example, with four 10’ travel lanes; a remaining 20’ is available for bike lanes, medians, or parking lanes, implying some potential tradeoffs between these facilities. The proposed improvement represents City staff recommendation on the project and trading off some improvements in areas would not increase impacts that are analyzed in the initial study.

**Improvements Throughout Entire Corridor:** Consistent throughout the corridor the Plan proposes small improvements that will not have any environmental impacts such as the following elements. A signage program, e.g. “Residential Boulevard” or “School Commute Corridor” signage program will be added throughout the corridor to enforce the message of reduced speed to drivers and to increase the overall safety for alternate mode travel. Sign placement will likely include vehicle speed monitoring and notification signs, for example “school zone” signs at school locations. Additionally, pedestrian scale lighting, street trees, and neighborhood amenities such as street furniture would be added all along the corridor, where utilities and space will allow them. Installing such elements increase the more residential appearance of the corridor, making it easier to slow vehicular traffic down and increase awareness of alternate modes of travel along the corridor. Additionally, to increase transit use along the
corridor, the city shuttle will be expanded. Expanding and improving bus service along the corridor will include improvements to existing and possibly some addition bus stops. Bus stop improvements would likely include adding or enhancing shelters, benches, and lighting as conditions permit. Improvements to enhance safety between travel modes will also be added throughout the corridor, such as improved pedestrian and bicycle crossings and refuges at most intersections and installing full and half bulbouts where possible. No new signals are proposed for the corridor; however, some additional enhanced mid-block pedestrian crossings may be added. Proposed locations include near Louis Road on the Corridor, near Mumford Place, near Suzanne Drive and Arastradero Road to serve Juana Briones Park, and near Georgia Avenue and Arastradero Road for the San Francisco Water District right-of-way bike path.

**Existing Conditions:**

**Miranda Avenue to Alma Street:** This segment of the proposed improvements extends from Miranda Avenue to Alma Street where the existing conditions, include:
- four travel lanes,
- two bicycle lanes,
- little to no landscaping strips,
- sidewalks, and
- 24-hour parking on the north side and evening/overnight parking on the south side of the street; and
- rolled curbs on some sections of Arastradero Road.

**Alma Street to Fabian Way:** This segment of the corridor improvements is from Alma Street to Fabian Way where existing conditions include:
- Four travel lanes
- No bike lanes from Middlefield to Fabian
- Two bike lanes from Alma to Middlefield
- A small median located at Louis Street
- 24-hour parking on south side and evening/overnight parking on the north side of street between Alma and Middlefield, and
- 24-hour parking on both sides of the street from Middlefield to Fabian.

**Corridor Improvement Proposal:**
The proposed improvements, as shown in the attached cross sections and conceptual designs include:
- In general, transition from four vehicular travel lanes to three travel lanes (10-11’ in width) for most portions of the corridor.
- The three travel lanes include one in each direction with a central 16’ wide median with a 10’ left turn pockets embedded within the median in sections. The median will include left turn pockets at most residential streets.
- Retain the four vehicular travel lane configuration from El Camino Real to Alma Street (some frontage improvements consistent with the Plan would occur, but this portion will not include traffic or pedestrian safety improvements.)
Either three or four vehicular travel lanes from Miranda Avenue to El Camino Real. Some small (6') vegetated medians may be possible for the 4 lane section from Miranda to El Camino Real.

- 24-hour parking retained on the south side of the street from Alma to Fabian.
- 24-hour parking will be on the north side of the street from Miranda to Alma.
- Parking would be allowed only in evening hours in the north side 8' bike lane from Alma to Fabian, and from Miranda to Alma evening parking would be on the south side.
- Colored and wider (7-8') bike lanes will also be installed on both sides of the street. In some tight areas, such as intersections, the bike lanes will be 5'.
- Landscaping, lighting, sidewalk and signage improvements will be made in the existing right-of-way/public utilities easement on both sides of the street.
- Replacing the rolled curbs on Arastradero with vertical curbs to prohibit parking on sidewalks.

Conceptual Designs of these elements are presented in the attached Cross Sections and Aerial Maps.

**Proposed Specific Area Improvements:**

**Gunn High School traffic:** The proposed improvements also address the specific issue of high school access by:

- Retaining the four 10' travel lanes and the 5th 10' left turn lane for eastbound traffic turning into high school
- Add a 10' right turn lane on westbound Arastradero into the high school driveway.
- Make the right turn more efficient and enhance it by installing markings or a "pork chop" to direct traffic into the outside lane of driveway, while the left turn movement from Arastradero Road eastbound would turn into the inside driveway lane.
- For this configuration, the roadway needs widening by 5', removing the existing planting strip on the north side of Arastradero Road.
- The existing intersection island will also be removed with this reconfiguration.
- The bike lanes at this location would remain 5', but the pavement would be colored and the westbound bike lane at the school would be relocated between the westbound travel lane and the proposed right turn lane.

**El Camino Real Intersection:**

At the El Camino Real (ECR) Intersection, the following improvements are proposed:

- Remove small separated right turn lanes and concrete “pork chops” from northbound ECR and Charleston and from eastbound Charleston at ECR. This will shorten the pedestrian crossing of El Camino Real on the south side of the Charleston intersection.
- Extend curb line of adjacent streets to create more typical corner configuration.
- Extend the 5' bike lanes to and across the intersection.
- Add countdown signals to the pedestrian crossings.
- Enhance the existing pedestrian median on the east side of the intersection, as well as providing pedestrian refuges for pedestrians crossing El Camino Real.
- Add colored pedestrian crosswalk pavements at the intersection.

El Camino Real is a State Route and therefore proposed improvements are dependant on CalTrans permission and approval.

**Hoover Elementary School traffic:** To further accommodate traffic into Hoover Elementary School the following improvements are proposed:

- Parking on the south side of the street would be retained to accommodate additional turn movements.
- Traffic flow for Hoover traffic will be reversed (with School Board approval) and a median two-way left-turn lane installed between Carlson Court and the westernmost driveway of Hoover Elementary allowing movements into the residential street and eastbound traffic to make a left-turn movement into Hoover Elementary (into what is now the exit).
- The westbound 8’ bike lane near the Hoover Elementary driveway will be dashed to indicate use as right turn lane into the easternmost Hoover Elementary driveway.

Traffic reversal at Hoover Elementary requires School District Board review and approval.

**Middlefield & Charleston Intersection:** The existing configuration will essentially remain, retaining the existing 4-lane and left turn lane configuration. Existing pedestrian crossings will be enhanced through colored pavement markings and countdown pedestrian signals. The bike lanes will be extended to and through the intersection, as well as adding colored pavement markings. The bike lanes can be extended through the intersection within the existing right-of-way by moving the curbs and removing the existing planter strips at this intersection.

**Existing Island Median at Louis & Montrose:** The proposed median would replace the existing island at this location, however the existing turn movements will be retained and designed into the new median.

**Additional Pedestrian Crossings:** Additional pedestrian crossings will be added throughout the corridor at several locations. These crossings will be well-marked including, lighting and signage. Additionally, some major pedestrian crossings, which would be pedestrian actuated or with embedded lights (lighted crosswalk) are also proposed. From west to east they include one lighted crosswalk just west of Georgia Avenue, which would serve pedestrians accessing the bike path along the San Francisco Water District right-of-way; one proposed between Suzanne Drive and Clemo Avenue providing easier pedestrian access to Juana Briones Park and Juana Briones Elementary School; one near Mumford Place and one near Louis Road.

**Signalized intersection & Side Street Improvements:**

Improvements at all the signalized intersections including those discussed above, would include highlighting pedestrian crossings by using alternate materials or coloring.
Additionally, countdown pedestrian traffic signals are proposed as part of signalized intersections improvements. Pedestrian refuges can also be added where space allows (because of constrictions noted above refuges are not proposed for Terman Middle School, Gunn High School, the Charleston and Arastradero Road pedestrian crossings at El Camino Real, the Middlefield intersection and Alma Street intersection. Bicycle improvements at intersections would include extending bike lanes across the intersection. Concurrent with these more physical improvements will be changes in the signal timings at all ten signalized intersections to make traffic flow more efficiently. Other pedestrian improvements both at intersections and side streets could include adding full or half pedestrian bulbouts to the Corridor or side streets as space and turn movements allow. For example, in Segment 1 of the Corridor (West Charleston/Arastradero), half bulbouts can likely be located on local side streets along, but not extending into the Charleston/Arastradero corridor (with the exception of the school driveways). In Segment 2 (Eastern portion of Charleston), half bulbouts can likely be located on the northside of the corridor, but full bulbouts can occur into the corridor or on side street sides of the corridor where space allows and no major right turn movement off the corridor is needed. As well as potential full and half bulbouts, side street improvements would also include the continuation of marked bicycle lanes and improved marking of pedestrian crossings.
DRAFT TECHNICAL MEMORANDUM

December 4, 2003

To: Joe Kott, City of Palo Alto           Project No.: 42-023
From: Christopher Thnay, PE, AICP        Jurisdiction: Palo Alto
Subject: Future Roadway Alternative, Travel Time and LOS Analysis

Existing Traffic Condition

The existing peak direction traffic volumes for the study corridor varies from a low of approximately 400 vehicles per hour (vph) to highs of approximately 1,200 vph. The roadway segment between Fabian Way and Alma Street are generally below 900 vph in the peak direction. The average is approximately 770 vph during the am peak hour and 790 during the pm peak hour.

Since a residential collector street can generally carry approximately 900 to 1,000 vph per lane per hour, this segment provides the most opportunity to create a three-lane section with median left-turn lane at intersections. A typical collector street could carry higher volumes, but the available gaps for pedestrian crossing would be much reduced.

The existing peak hour volumes on Arastradero Road (west of El Camino Road) in the peak direction generally carries between 900 and 1,200 vph. This higher volume does not lend itself to comfortably accommodate a three-lane section due to reduce gaps for pedestrian crossing. However, if future design provides for positive control that facilitate safe crossing for pedestrians, the impact of reduce gaps for pedestrians could be reduced.

Besides carrying higher volumes, this segment also includes several roadway and operational characteristics that are different from the East Charleston Road (Alma to Fabian). Arastradero Road serves both Gunn High School and Terman Middle School. During the morning school commute traffic queues could be quite long and sometimes extend over several blocks towards Terman Drive.

In addition there are more side streets that intersect with Arastradero Road than at East Charleston Road. A total of 14 streets intersect with Arastradero Road verses eight on East Charleston Road (Alma Street to Fabian Way). Consequently, there will be many more conflicts with side street traffic on Arastradero Road. A three-lane section will also mean more U-turns in this section. Lastly, there is a long 800-foot section adjacent to the Hoover Elementary School that provides for some queuing in the westbound direction without blocking any side streets.
Future Traffic Projections

TJKM has been working for the past several months on the City’s Travel Forecasting Model. Before TJKM is able to make any model forecast, the model needs to be calibrated. Model calibration is a process to ensure that the model accurately replicates the existing traffic condition.

For this project, TJKM used the regional CMA travel demand model as a base. To better reflect the local streets and land use access and loading onto the network, TJKM work with City staff to create finer zones for the whole City. The City provided the 2025 local land use while the regional land use was obtained from the CMA model. Demand forecasting models need to be demonstrably reliable and credible after the model calibration before being used on a project. A central point of many public hearings and meetings concerning city and private development plans and projects focus on the credibility of the forecasting models. It is important that the analysis tools not become a point of contention, so that the real issues can be properly understood and addressed. The results of our model calibration are shown in Table I below.

<table>
<thead>
<tr>
<th>Period</th>
<th>Volume</th>
<th>A</th>
<th>B</th>
<th>STD</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>Turn</td>
<td>-2.98</td>
<td>1.02</td>
<td>37.76</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>Link</td>
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<td>146.08</td>
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<tr>
<td>PM</td>
<td>Turn</td>
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<td>0.99</td>
<td>24.21</td>
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</tr>
<tr>
<td></td>
<td>Link</td>
<td>-19.63</td>
<td>0.99</td>
<td>159.5</td>
<td>0.98</td>
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</tbody>
</table>

Note:
A: Intercept of the regression line between the observed volumes and the computed volumes
B: Slope of the regression line between the observed volumes and the computed volumes
STD: Standard deviation of the regression line between the observed volumes and the computed volumes
R2: R-Square

In addition to obtaining satisfactory parameters for A and B values, TJKM has calibrated the link and turning movement traffic volumes to within two percents of observed counts. TJKM concluded the model calibration was completed with a high level of accuracy.

Working with City staff TJKM devoted an extensive amount of effort to develop the model forecasts. Two future scenarios were analyzed in this study: namely, 2015 Comp Plan and 2015 with Known Proposed Projects.

2015 Comp Plan

This scenario includes all the land use in the Comprehension Plan. In addition, the Terman Middle School was included in the scenario.

The Charleston-Arastradero Road corridor covers approximately a 2.2-mile section. Within the corridor, there are some distinct roadway and land use characteristics. For ease of comparison, the corridor has been divided into four roadway segments as shown in Figure 1 and briefly described as follows:
Segment 1: Fabian Way to Middlefield Road
Segment 2: Middlefield Road to Alma Street
Segment 3: Alma Street to El Camino Real (ECR)
Segment 4: ECR to Gunn High

The results of the model forecasts for these segments are shown in Table I.

2015 with Known Proposed Project

This scenario includes all the known proposed projects including the Terman Middle School, Hyatt Rickey’s, Elks Club and the Sun site. As shown in Table II, compared to the 2015 Comp Plan scenario, it is projected that there is generally a slight increase of approximately three to ten percent for most roadway links.

Potential Three-Lane Sections Based on the Projected Volumes

As mentioned earlier, the existing average am peak hour traffic volumes on Arastradero Road are approximately 1,100 vph, almost 50% higher than the average peak hour volumes of approximately 770 vph on East Charleston Road.

As shown previously in Table II, based on the 2015 model forecasts it is projected that the two roadway segments would be carrying almost an equal amount of traffic in the future. In the am peak hour, it is projected that the peak directional flow is approximately 1,100 vph while in the pm peak hour the peak directional flow is approximately 900 vph.

| Table II |
| Projected Link Level Peak Hour Roadway Volumes |
|----------|-----------------|-----------------|-----------------|
| Scenarios/Link Segments | Existing | 2015 Comp Plan | 2015 Known Proposal |
| | AM | PM | AM | PM | AM | PM |
| 1. Segment I: Fabian to Middlefield | 866/477 | 502/692 | 1,111/654 | 793/821 | 1,121/711 | 803/778 |
| 2. Segment II: Middlefield to Alma | 765/693 | 582/944 | 1,120/1,119 | 927/1,016 | 1,129/1,182 | 937/1,022 |
| 3. Segment III: Alma to ECR | 838/537 | 597/730 | 995/995 | 1,081/788 | 1,004/1,112 | 1,139/817 |
| 4. Segment IV: ECR to Gunn High | 846/1,136 | 828/903 | 1,142/1,052 | 1,051/806 | 1,163/1,142 | 1,071/815 |

Note: 866/477 = Eastbound/Westbound peak hour volumes
Therefore, based on the volume alone it seems like a case might be made for a three-lane treatment. However, based on the different roadway characteristics as mentioned above, it is still our opinion that a three-lane section is more appropriate on East Charleston Road. The current volume on Arastradero Road is much higher and the access to Gunn High School should be resolved before any three-lane segment could be considered. As part of this project, a design has been proposed to redesign the intersection to include a westbound right-turn lane on Arastradero Road at Gunn High driveway that will provide queuing distance for vehicles waiting to make a right-turn into Gunn High. Additional improvements at the intersection will improve the operations at the intersection.

In addition three or four additional crosswalks would be added to the corridor. These crosswalks would probably include special colored pavement treatment and be fitted with a lighted crosswalk. Instead of lighted crosswalks, the City might consider installation of pedestrian signals. If pedestrian signals were installed at all major crosswalks, pedestrians and bicyclists would be able to safely cross the street regardless of the available gaps. Under this scenario, a three-lane section could be considered on Arastradero Road. That is our best judgment based on the information available. Of course, City Council or staff might decide to install a three-lane segment in the whole corridor based on other information or priorities that we are unaware.

**Projected Travel Times**

A comparison of the travel times and delays for the 2015 forecasts were conducted. The evaluation is based on the travel time from San Antonio Road to the Foothill Expressway.

As a part of the study, it is our understanding that the City has applied for funds to install traffic signal adaptive capability on the whole corridor. Traffic signal adaptive technology has been proven to increase the signal efficiency by as much as 20 percent over current time of day signal timing. The details are contained in Appendix A.

Four future scenarios were analyzed: 2015 Comp Plan, 2015 Proposal, 2015 Known Proposal (meets non-auto mode criteria) and 2015 Known Proposal (three lane section from Alma to Fabian). The results of the analysis are shown in Table III. Based on our analysis, applications of traffic adaptive technology shows that compared to the existing conditions, the travel time through the study corridor under the four scenarios will be reduced from one to three minutes.

Besides the 2015 Comp Plan and 2015 Known Proposal forecasts scenarios, two additional alternatives have been developed based on the 2015 Known Proposal forecasts.

**The 2015 Known Proposal (Meets Non-Auto Mode Criteria)** was developed to meet the bike, walk and transit non-auto mode performance criteria. Based on the Gunn High mode shares information provided by the City, it was determined that the current non-auto mode use is approximately 39 percent (14 percent walk, 12 percent bike and 13 percent transit).

In addition, mode share information was also obtained for Terman Middle School. It was determine that approximately 63 percent of the students biked, walked or took the bus on the first Monday following the start of school.
As part of this study, bike and walk connectivity would be substantially improved. Full bike lanes would be provided throughout the whole corridor and either lighted crosswalks or pedestrian signals would be provided as well. To be conservative, TJKM only estimated that the combined increased of bike, walk and transit use would increase by no more than 20 percent at Gunn High. The potential increases at Terman Middle School and from the regular commuter traffic were not considered.

The analysis of the Embarcadero Ridership data between 2000 and 2002 shows almost 20 percent increase in ridership. And the Crosstown Weekday Ridership shows increase of approximately 45 percent (based on available 3rd/4th Quarter data in 2001 and 2002). Therefore, the potential for mode shifts to transit and bike use could be substantial with good service routes and improved bike lanes.

The 2015 With Known Proposal (Three Lane Section) scenario assume a three-lane segment with left-turn pocket on East Charleston Road from Alma Street to Fabian Way.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>EB</th>
<th>WB</th>
<th>Ave</th>
<th>Change (min)</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
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<td>AM</td>
<td>678</td>
<td>726</td>
<td>702</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>716</td>
<td>749</td>
<td>733</td>
<td>-</td>
</tr>
<tr>
<td><strong>2015 Comp Plan (A)</strong></td>
<td>AM</td>
<td>657</td>
<td>658</td>
<td>658</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>566</td>
<td>592</td>
<td>579</td>
<td>-3</td>
</tr>
<tr>
<td><strong>2015 Known Proposal (B)</strong></td>
<td>AM</td>
<td>670</td>
<td>667</td>
<td>668</td>
<td>-1</td>
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<td></td>
<td>PM</td>
<td>577</td>
<td>600</td>
<td>588</td>
<td>-2</td>
</tr>
<tr>
<td><strong>2015 Known Proposal (Meets Non-Auto Mode Criteria)</strong></td>
<td>AM</td>
<td>606</td>
<td>609</td>
<td>607</td>
<td>-2</td>
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<td></td>
<td>PM</td>
<td>531</td>
<td>580</td>
<td>556</td>
<td>-3</td>
</tr>
<tr>
<td><strong>2015 Known Proposal (Three Lane Section)</strong></td>
<td>AM</td>
<td>673</td>
<td>617</td>
<td>645</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>614</td>
<td>578</td>
<td>596</td>
<td>-2</td>
</tr>
</tbody>
</table>

**Note:**
* Three lane section from Alma St to Fabian Way.
Include effects of traffic adaptive system along the corridor.
All change statistics are as compared with existing conditions.

As shown in Table III, due to the improved signal coordination provided by traffic signal adaptive system, it is expected that the travel times for the corridor for all the future traffic scenarios would improve. The
travel time savings range from one to three minutes. It is also expected that the total signal delay for the corridor range from one minute increase to a reduction of two minutes. If the three-lane section is extended from Miranda Avenue to Fabian Way, it is expected that travel time and delay might increase marginally over the results of the three-lane section from Alma Street to Fabian Way. The biggest difference might be that the available gaps for pedestrian to cross the street would be reduced. Since the project will include more pedestrian crosswalks with refuge islands as well as potentially several pedestrian signals, the impact on pedestrians would likely be less than significant.

**Intersection Levels of Service Analysis**

Table III as shown previously details the travel time and signal delay for the whole study corridor. As such, the change in travel time and delays include both the intersection as well as the mid block travel time in the corridor.

The 2015 Comp Plan and 2015 Known Proposal intersection levels of service (LOS) analysis results are shown in Table IV. The levels of service shown in Table IV do not include the signal efficiency effects of implementing a traffic adaptive system. This would be the future base without the proposed study that will include the implementation of a traffic adaptive system.

As mentioned earlier, traffic signal adaptive technology has been proven to increase the signal efficiency by as much as 20 percent over current time of day signal timing. Factoring the effects of a traffic signal adaptive system, the resulting LOS is shown in Table V. Compared to the 2015 future base without the effects of traffic adaptive system, the proposed study project shows LOS improvements at two intersections from LOS E to LOS D and other general delay improvements in the corridor.
### TABLE IV: EXISTING, 2015 COMP PLAN AND 2015 KNOWN PROPOSAL LEVELS OF SERVICE (WITHOUT TRAFFIC ADAPTIVE SYSTEM)

<table>
<thead>
<tr>
<th>Location</th>
<th>Existing</th>
<th>2015 Comp Plan</th>
<th>2015 Known Proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A.M. Peak Hour</td>
<td>P.M. Peak Hour</td>
<td>A.M. Peak Hour</td>
</tr>
<tr>
<td></td>
<td>Delay (sec)</td>
<td>LO</td>
<td>Delay (sec)</td>
</tr>
<tr>
<td>1. San Antonio Rd/Charleston Rd</td>
<td>36.4</td>
<td>D</td>
<td>35.7</td>
</tr>
<tr>
<td>2. Fabian Way/Charleston Rd.</td>
<td>9.1</td>
<td>A</td>
<td>18.2</td>
</tr>
<tr>
<td>3. Middlefield/Charleston Rd</td>
<td>43.5</td>
<td>D</td>
<td>35.3</td>
</tr>
<tr>
<td>4. Nelson Dr/Charleston Rd</td>
<td>4</td>
<td>A</td>
<td>3.3</td>
</tr>
<tr>
<td>5. Alma St/Charleston Rd</td>
<td>53.7</td>
<td>D</td>
<td>68</td>
</tr>
<tr>
<td>6. Wilkie Way/Charleston Rd</td>
<td>10.1</td>
<td>A</td>
<td>3.3</td>
</tr>
<tr>
<td>7. El Camino Real/Arastradero/Charleston Rd</td>
<td>40.3</td>
<td>D</td>
<td>38.8</td>
</tr>
<tr>
<td>8. Coulombe Dr/Arastradero</td>
<td>5.1</td>
<td>A</td>
<td>2.7</td>
</tr>
<tr>
<td>9. Donald Dr/Terman/Arastradero</td>
<td>4.1</td>
<td>A</td>
<td>3.2</td>
</tr>
<tr>
<td>10. Gunn High School/Arastradero</td>
<td>16.2</td>
<td>B</td>
<td>5.5</td>
</tr>
<tr>
<td>11. Foothill Expwy/Charleston Rd</td>
<td>47.7</td>
<td>D</td>
<td>46.7</td>
</tr>
<tr>
<td>Location</td>
<td>Existing</td>
<td>2015 Comp Plan</td>
<td>2015 Known Proposal</td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td>----------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td>A.M. Peak Hour</td>
<td>P.M. Peak Hour</td>
<td>A.M. Peak Hour</td>
</tr>
<tr>
<td></td>
<td>Delay (sec)</td>
<td>LO S</td>
<td>Delay (sec)</td>
</tr>
<tr>
<td>1</td>
<td>San Antonio Rd/Charleston Rd</td>
<td>36.4</td>
<td>D</td>
</tr>
<tr>
<td>2</td>
<td>Fabian Way/Charleston Rd</td>
<td>9.1</td>
<td>A</td>
</tr>
<tr>
<td>3</td>
<td>Middlefield/Charleston Rd</td>
<td>43.5</td>
<td>D</td>
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<td>4</td>
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<td>A</td>
</tr>
<tr>
<td>5</td>
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<td>53.7</td>
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<td>D</td>
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<td>8</td>
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<td>A</td>
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<td>9</td>
<td>Donald Dr/Terman/Arasstradero</td>
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<td>A</td>
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<td>10</td>
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<tr>
<td>11</td>
<td>Foothill Expwy/Charleston Rd.</td>
<td>47.7</td>
<td>D</td>
</tr>
</tbody>
</table>

Note:
1. Three-lane section on East Charleston Rd from Alma St to Fabian Way.
2. Include effects of traffic adaptive system along the corridor.
APPENDIX A

Traffic Adaptive

TRAFFIC ADAPTIVE COORDINATION

Traffic Adaptive Control – Latest & Greatest Strategy for Traffic Control Systems

New control strategies and concepts have been lurking on the fringes of the mainstream traffic control system arena since the 1980s. The predominant “other” strategy is collectively known as traffic adaptive control. The main players in this category include SCOOT (Split Cycle and Offset Optimization Technique), SCATS (not an acronym for anything), and more recently Adaptive Control Systems (ACS). Less well-known players include Urban Traffic Optimization by Integration Automation (UTOPIA), Signal Progression Optimization Technology (SPOT), ContROI of Networks by Optimization of Switchovers (CRONOS), and (PRODYN). SCOOT was developed in England by the Transportation Road Research Laboratory of the U.K. government. SCATS was developed in Australia by the New South Wales Department of Main Roads government. Starting in the mid-1990s, the FHWA has partially funded the development of a collection of three competing traffic adaptive control strategies, ACS, previously called RT-TRACS (Real-time Traffic Adaptive Signal Control System). The common aspect of government sponsorship is not coincidence. Rather, it is out of necessity because the task of producing a workable, viable, marketable signal system based on a traffic adaptive strategy was clearly beyond the capability of any private enterprise. SCATS is available through TRANSCOR. RT-TRACS is available as an optional control strategy of PB Farradyne’s MIST system. SPOT and UTOPIA, developed in Italy, are available through Peek Traffic. PRODYN, developed in France, has not been deployed yet in the U.S.

The concept of most traffic adaptive control is that the supervising system monitors traffic flows on a whole lot of critical links in the system on a minute-by-minute (or even more frequent) basis. Given this much analytical information, it crunches numbers and decides on a cycle-by-cycle basis what each signal under its control needs to do. The system can require an intersection to revise its green splits, to use a different cycle length, to shift its end-of-coordinated-green offset value, or any combination of the three. Traffic adaptive systems, therefore, typically don’t utilize the UTCS concept of a “timing pattern”. They sort of look like timing patterns, but they stretch and shrink and bend and adjust on each subsequent cycle, all dancing at the behest of the master traffic system computer’s software program. In fact, there may not even be any stored patterns in the system that it pulls from. That library of stored patterns is a hallmark of all traditional traffic control systems.

Rather than the classic pattern matching process of comparing link flows to a look-up table in order to pick a ‘best’ pattern, the traffic adaptive system continually runs an optimization routine using those current flows. “The algorithm systematically evaluates combinations of phase termination points to determine the optimum time at which to end the arterial’s phases. The optimum set of phase termination times is defined as the combination that minimizes a weighted function of total intersection delay and stops, accumulated over the horizon in a simulation of traffic flow. The user selects the delay and stops
Weighing factors. For each combination, the algorithm begins with initial conditions for the intersection and then simulates traffic over the user-specified horizon, calculating queues and accumulating delay and stops. The combination that minimizes the function of delay and stops is chosen for implementation. This phase termination selection is reevaluated every interval with updated head and tail arrival patterns and timing information for each phase.” [Note: this phraseology is straight from a MIST document.]

Slightly different is SCATS, which decentralizes the optimization routine. SCATS calculates and implements the next intersection’s cycle length using the detectors at the stop line. SCATS allows for phase skipping. Offsets between adjacent intersections are predetermined and adjusted with the cycle time and progression speed factors. [Note: This class almost used SCATS rather than SPOT-Utopia for the virtual signal laboratory. The adaptation of the system for virtual operation could not be completed in time.]

An extraordinary amount of system detection is required for a traffic adaptive system. Unlike traditional systems that use system detectors (on maybe 5 percent of the system’s links) to determine when to change from pattern 11 to pattern 48 as an assist on making a pattern change that would have occurred anyway as a result of a time-of-day command, the traffic adaptive system needs all of these detectors (on maybe 25 percent of the system’s links?) in good operating condition all the time. Most signal system managers know that system detectors are notoriously flaky or defective, which have relatively lower maintenance priority. This simply cannot happen with a traffic adaptive system, or the system’s much sought after improved traffic flow will quickly disappear. The great benefit, on the other hand, of a traffic adaptive system, is that it is continually refining and improving its own plans. There are no timing plan libraries that contain ever more stale coordination plans, so there is no need to mount a major retiming effort every few years. Also, a properly operating traffic adaptive system produces better traffic flow than a traditional, classic traffic pattern-based system.

In this regard, traffic adaptive is significantly different from traffic responsive. A signal system that has traffic responsive operation engaged is actively and continually seeking to find the best coordination pattern (from its library) to implement. Because each pattern change will result in some degree of transition, as manifested in the green times presented to drivers, the pattern change can often take 2 or 3 cycles to complete. During this transition period, the signal operation is quite often not, well, great. As a result, a system that is in traffic responsive mode needs to be constrained so that it is not making a new pattern selection every several cycles. Otherwise, the intersections will be transitioning a greater percentage of the time than they are cycling in the new, better, optimum pattern.

Base on field implementation data, it has been estimated that a traffic adaptive system could achieve travel time savings in many practical situations of 20 percent or more depending on the quality and age of the previous fixed time plan and on the rapidity with which flows change.

The following is a summary of several major traffic adaptive systems.

Real-time Traffic Adaptive Signal Control System (RT-TRACS) - In 1991 the FHWA solicited proposals for the development of a real-time, traffic adaptive signal control system called RT-TRACS. Shortly thereafter, the FHWA contracted with PB Farradyne to develop and implement RT-TRACS. The RT-TRACS control logic assesses the current status of the network with forecasting capabilities, allowing proactive, not reactive, response. The most fundamental requirement of this system is to effectively
manage and respond to rapid variations in traffic conditions. RT-TRACS consists of a number of real-
time control prototypes that each function optimally under different traffic and geometric conditions.
When conditions dictate, RT-TRACS can automatically switch to another strategy. The FHWA realizes
that this control logic must be integrated with freeway performance data and provide network-wide
control. A thorough understanding of past experience with advanced traffic signal control strategies is
critical to the development of effective RT-TRACS strategies for ITS. Features of the RT-TRACS design
include:
- both distributed and centralized traffic control;
- dynamic priority control on selected routes;
- capability to interact with dynamic traffic assignment to implement proactive control;
- improved fallback capabilities in case of surveillance system failure;
- effective use of the accumulated experience with real-time control.

Five prototype strategies are currently being developed and evaluated for use in the RT-TRACS program.
The FHWA awarded five separate contracts to develop these real-time prototype strategies. The contracts
were awarded to the University of Arizona, the University of Minnesota, the University of Massachusetts
(Lowell)/PB Farradyne, Wright State University in Ohio, and the University of Maryland/University of
Pittsburgh. Kaman Sciences Corporation is responsible for evaluating these prototypes using the
CORSIM simulation model. In late 1997, the FHWA and the University of Arizona teamed to develop
and field test one of these prototypes, RHODES, an open architecture version of RT-TRACS that will
utilize an alternative database management system and NTCIP protocol.

Three of these prototypes, the RHODES prototype from the University of Arizona, OPAC (Optimization
Policies for Adaptive Control) from PB Farradyne/University of Massachusetts (Lowell), and RTACL
from the University of Pittsburgh/University of Maryland, are at an advanced state of development. Initial
simulation testing showed that these prototype strategies produced statistically significant improvements
in traffic throughput and reduced average delay. The results of the laboratory evaluation of the RHODES
prototype have indicated a reduction in delay, stops, and fuel consumption of 24 percent, 9 percent, and 6
percent, respectively, while maintaining the same throughput as the baseline case (vehicle actuated
control). A 16-intersection arterial in Reston, Virginia has been selected for the field implementation.
Instrumentation of the arterial is in progress. Further testing is expected to occur in Seattle, Washington,
and Chicago, Illinois.

Detailed System Descriptions

SCATS

Operation of the SCATS System: The SCATS system controls signals in groups, known as sub-systems,
where the critical intersection for each subsystem is specified by the traffic engineer. Sub-systems are
grouped together and a regional computer can control signals at up to ten intersections. Systems can
expand by the addition of extra regional computers that control traffic in their own area, but a central
monitoring computer usually controls data input and traffic monitoring to the different regional
computers.

Range of Operation: SCATS has been used in Sydney, Australia since about 1975 and has a user base of
26 systems in Australia and New Zealand and further systems in Shanghai, Shenyang (China),
Singapore, Sandakan (Malaysia), Rauia Lumpur and Dublin (Ireland). According to SAIC (consulting company) there are three installations in the United States: Oakland County, MI (350+ signals), Hennepin County, MN (71 signals), and Durham, NC.

System Evaluation: A survey carried out in Paramatta in 1981 by the Australian Road Research Board showed no significant reduction in travel times compared with operation using TRANSYT; however there was a large reduction in the number of stops, some 9 percent in the central area and 25 percent on arterial roads. Other studies have indicated improvements in travel times but compared to the original systems that were of unknown efficiency.

The SCOOT System

Introduction: SCOOT is a fully adaptive traffic control system which uses data from vehicle detectors to optimize traffic signal settings so as to reduce vehicle delays and stops. It was developed in the United Kingdom by the Transport and Road Research laboratory together from three UK signal companies.

Range of Operation: SCOOT has been operational in the UK since 1980 in Coventry. There are now around forty implementations within the UK, with the largest controlling the central part of London and other parts of Greater London. There are also systems in Beijing, Hong Kong, Santiago, Durban and Port Elizabeth. Further systems are proposed in Madrid, Cyprus and Nijmegen (Netherlands). There are four systems in North America; these are Toronto, Red Deer and Halifax (Canada) and Oxnard, California in the USA. [A separate reference lists three installations: Arlington, VA, Minneapolis, MN, and Anaheim, CA.]

System Evaluation: The effectiveness of the SCOOT strategy has been assessed by major trials in five cities as shown in Table D-3. The trials in Glasgow and Coventry were conducted by TRL and those in Worcester, Southampton and London by consultants, a university, and the local traffic authority, respectively. In most cases, comparisons were made against a good standard of up to date fixed time plans, usually produced by TRANSYT. The following table shows that the largest benefits are achieved in comparison with isolated vehicle actuation but, of course, part or this benefit could be achieved by a good fixed time system. The relative effectiveness of SCOOT varies by area and time of day, but overall it is concluded that SCOOT achieved an average saving in delay of about 12 percent compared with good fixed time plans. Since SCOOT does not "age" in the way typical of fixed time plans, it follows that SCOOT should achieve savings in many practical situations of 20 percent or more depending on the quality and age of the previous fixed time plan and on the rapidity with which flows change. On the basis of the surveys and subsequent experience, SCOOT is likely to be of most benefit where vehicular flows are heavy, complex and vary unpredictably.

Review of the UTOPIA System

Introduction: UTOPIA was developed in Italy with the objective of improving private and public transport efficiency. Characteristics of the system are described in the sections which follow.

Range of Operation: UTOPIA was first used in 1985 in Turin. This is the only current operational system, but there are plans to implement UTOPIA in Gothenburg and Salerno. The Gothenburg system will be designed using its own central controller and UTOPIA SPOT units.
System Evaluation: It is believed that research to assess the benefits of UTOPIA have not been carried out against fixed time control. The improvements attributed to UTOPIA in Turin are believed to have been calculated against some other control strategy previously installed there. Trials on the Turin network were carried out over many months. After implementing UTOPIA, private traffic speeds were found to increase 9.5 percent in 1985 and 15.9 percent in 1986, following system tuning. In peak times the speed increases were 35 percent. Public transport vehicles, which were given absolute priority, showed a speed increase of 19.9 percent in 1985.
Appendix B

Peak Spreading

As commute traffic on highway facilities reaches congested levels, commuters begin to change their travel patterns by either finding less-congested routes or commuting during off-peak hours. This second phenomenon, known as peak spreading, has begun to occur on Bay Area area freeways. It is becoming especially pronounced on I-680, for which no uncongested reasonable alternative route exists. The graph at right illustrates peak spreading on I-680.

On I-680, the southbound a.m. peak period essentially lasted from 7:00 to sometime after 9:00 in 1991 and 1994. The 1996 data indicate the peak had extended well past 10:00, with traffic volumes also growing during the hours before 7:00. By 1997, the start of the a.m. peak period was close to 5:00. (TJKM’s 1997 counts ended at 8:00, so 1997 data for the end of the peak period are unavailable.) Between 1994 and 1997, the I-680 southbound volume between 5:00 and 9:00 a.m. increased from 15,854 to 21,698 (a 37 percent increase). Essentially all of this traffic growth occurred between 5:00 a.m. and 7:00 a.m. Note that in 1996 and 1997 the peak-hour volumes have decreased even while the total peak-period volumes have increased. Note also that I-680 was widened from 4 to 6 lanes between 1991 and 1994.
CITY OF PALO ALTO

Charleston Arastradero Corridor Plan

Preliminary Assessment of Funding Sources

November 2003
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Introduction

This memorandum investigates feasible funding sources for the implementation of the Charleston Arastradero Corridor Plan. Funding may come from a variety of programs, including federal, state and local transportation grants, formula funds, and potential fees and exactions that could be levied by the City of Palo Alto.

This list is an initial one, and therefore encyclopedically lists all potential sources. For each, this analysis summarizes the requirements, the amount of funding available, and assesses the likelihood that the funding could be available to implement the Charleston Arastradero Corridor Plan. Some sources of funding can quickly be judged as unlikely, due to lack of project competitiveness for discretionary grant sources, or local political barriers [rephrase?]. For these sources analysis is somewhat more cursory than for those that are more likely sources. A funding matrix summarizes all of the sources investigated.

This analysis builds upon Nelson\Nygaard’s ongoing work with the City of Palo Alto on the Transportation Improvement Program for the city. This work investigated many potential funding sources, and was a very helpful starting place to address the Charleston Arastradero Corridor in particular.

Our initial assessment is that several funding sources available to the City of Palo Alto are very appropriate candidates for funding the Charleston Arastradero Corridor Plan, and a funding strategy can be devised to build the improvements as planned. The timing of funding depends largely on Palo Alto’s prioritization of this project in the overall Transportation Improvement Program for the city as a whole. Because of the cost, the project will either have to be a very high priority for available funding, or it will need to be broken into smaller phases for gradual implementation.

Project Description

For the Charleston Arastradero Corridor Plan, the city proposes to calm traffic and increase pedestrian and bicycle safety by making substantial physical changes to the street environment along a 2.3-mile segment of Charleston and Arastradero Roads between Fabian Way and Miranda Avenue. The roadway improvements proposed in the Corridor Plan are contained within the existing 80-86’ right of way width (which includes the 60-foot curb-to-curb street width plus existing sidewalks and vegetation strip areas) along Charleston/Arastradero Road corridor and the existing rights of way at each of the ten signalized intersections.
Figure 1  Charleston Arastradero Corridor
Following designs prepared for the City of Palo Alto by Bottomley Design Group and TJKM Engineers, what is now a typical arterial would become a multi-use street with a tree-lined median along its full length. Bike lanes will be installed on both sides of the street, with their presence strongly signified by colored pavement. On the Charleston section, the number of lanes is decreased to one continuous lane in each direction, plus a left turn lane approaching all major intersections. Daytime parking is prohibited in much of the corridor, but overnight parking would be allowable in the bike lanes. The project also includes landscape treatments along the entire street frontage, including the addition of street trees.

Many of the improvements focus on making the street safer and more convenient for pedestrians. Bulbouts and half-bulbouts will be extended to make travel along the corridor easier. The planted median will incorporate pedestrian refuge islands at all crosswalks, allowing much greater safety in crossing from one side of the corridor to the other. Other improvements try to heighten the driver's awareness of pedestrians, with lighted and textured crosswalks prompting drivers to proceed cautiously through the neighborhood. Finally, landscaping and gateway treatments communicate that this stretch of roadway is different than a normal arterial, and also prompts drivers to be more vigilant.

**Project Costs**

The total costs for completing the Charleston Arastradero Corridor Plan have preliminarily been estimated by TJKM and Bottomley Design Group at approximately $7.4 million (in 2003 dollars). The costs of the basic project include the costs to install an irrigated, planted median, reorganize the travel lanes, add a painted or tinted bike lane in each direction, add pedestrian bulb-outs and median island refuges, install lighting, and add signage throughout the corridor. With contingencies, design, and management costs, the streetscape portion of the project totals $6.2 million. In addition to the streetscape portion, some additional improvements are proposed. These are part of the “Travel Smart, Travel Safe” Residential Arterial program approved by the Palo Alto City Council, and funding for them is being pursued already. These improvements primarily are comprised of a traffic adaptive system (which comprises both hardware and software) to coordinate signals along the corridor. This coordination can increase throughput by 20%, and is required to meet the city’s objective of no loss of capacity, even though traffic calming is projected to slow speeds somewhat through the corridor. This system adds another $1.2 million in costs, resulting in the $7.4 million grand total cost.
These costs suggest that the project may be installed in phases. Preliminarily, it is expected that a first phase will include the traffic adaptive signalization of the corridor, along with pedestrian controlled crossings at select locations, turning lanes and bike lanes. Temporary (trial) restriping of the street and installation of temporary medians and bulbouts could also be included. A second phase would make permanent the medians and corner bulbouts, and would include installation of the median landscaping. Finally, in a third phase frontage improvements, including installation of street trees and lighting, would complete the project.

**Funding**

Funds to provide the traffic calming benefits proposed in the Charleston Arastradero Corridor Plan will need to come from a variety of sources, and may also be phased in over several years in a sequence of products through full plan implementation.

This section identifies potential sources of funding for the Charleston Arastradero Corridor Plan implementation that will be reasonably available to the City of Palo Alto in coming years for these types of projects. In this section, we do not attempt to rank the importance of this project against others in Palo Alto that may also be competing for funds.

After a review of the broader funding environment and the regional transportation funding process, 13 possible funding sources are evaluated in detail. The emphasis is on the process of allocating the funds, the appropriateness of each source for projects in this plan, and strategies for successfully securing competitive sources. Funding sources are categorized by grant programs, formula allocations, and possible local sources (the latter are essential to winning competitive funds).
Funding Context

Transportation Funding in Transition – "SAFETEA" and State Deficits

For two major reasons, this is an uncertain time to evaluate funding sources and opportunities. First, the federal law that currently governs transportation spending, known as TEA-21, was set to expire in the fall of 2003. It was extended for five months in its current form into early 2004, but the replacement law, now referred to as "SAFETEA," has yet to be finalized and passed. Both the level of funding for and the ability to fund projects in the region’s Transportation Implementation Plan will be significantly impacted by the terms of SAFETEA. However, the two previous federal transportation bills have generally been considered popular successes and it is likely that most programs will not be radically changed. Therefore, this analysis is generally based on TEA-21 provisions.

A second uncertainty is the current State financial crisis, which not only makes new state funding programs for transportation projects unlikely, but also threatens existing sources. However, the fiscal picture will change over time and transportation is a sector that benefits from a number of "lock-boxed" sources that cannot easily be used for other purposes, such as filling general fund deficits.

Trends in Funding that Support the Charleston Arastradero Corridor Plan

Despite these reasons for concern regarding transportation funding, there are many trends and developments that bode well for the funding and implementation of the Charleston Arastradero Corridor Plan. These trends include growth in funding opportunities for projects focusing on bicyclists and pedestrians, as this one does. Examples of programs targeting funds towards bicycle/pedestrian projects include the federal Transportation Enhancement Activities Program (TEA), the state Safe Routes to School Local Assistance Program, and the regional Transportation for Livable Communities Program. In addition, these programs often emphasize community based planning processes, which fits well with Palo Alto’s planning philosophy and practice.

The Regional Process

The majority of federal and state funding sources are programmed at the regional level, overseen by the Metropolitan Transportation Commission (MTC). The two primary processes for funding that take place at MTC are the Transportation Improvement Program (TIP) and the Regional Transportation Plan (RTP). For Palo Alto, the county CMA – the Valley Transportation Authority (VTA) – is the key point of entry into the regional transportation planning process. For its preferred projects to receive outside funding, the City must impress their importance upon VTA.

\* Safe, Accountable, Flexible, Efficient Transportation Equity Act
Recommended Funding Sources

This section specifies the federal, state and local sources that are most applicable to funding the Charleston Arastradero Corridor Plan. Sources are considered in two broad categories: Federal and State funded grant programs, and local sources.

State and Federal Grant Programs

The most relevant grant sources are briefly discussed below and summarized in detail in Figure 7.

1. Transportation for Livable Communities

MTC created this innovative program to fund community-oriented transportation projects. Capital projects are funded using regional Transportation Enhancement Activities funding from the federal Surface Transportation Program (STP) of TEA-21 (and its eventual successor). Funding has also come from the Congestion Mitigation Air Quality program (CMAQ). MTC is revising the current project evaluation criteria and application process and the next call for projects is tentatively scheduled for February 2004. The planning grant cycle is expected to begin in spring 2004, and the next capital grant cycle for the Spring 2005. The intent of the program is to improve neighborhood livability and coordinate transportation and land use. Project sponsors are encouraged to submit proposals that improve bicycling, and walking, and encourage transit ridership through transit-oriented development. Current evaluation criteria for capital projects include community involvement, benefits to bicyclists and pedestrians, support for community redevelopment activities, and improved internal community mobility. The Charleston Arastradero Corridor Plan fits many of these criteria, placing the project in a very good position to receive this funding.

Examples of projects currently funded by the TLC program in the MTC 2003 TIP in Santa Clara County are presented in Figure 3. Grants awarded through this source range from several hundred thousand to well over one million dollars, and are often awarded on a multi-year, multi-phase basis which could be very appropriate for the Charleston Arastradero Corridor Plan.

Figure 3  Transportation for Livable Communities – Sample Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Funding Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruitdale Station Area Streetscape</td>
<td>$400,000</td>
</tr>
<tr>
<td>River Oaks Bike/Pedestrian Bridge</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>San Fernando Light-Rail Station Plaza</td>
<td>$885,000</td>
</tr>
</tbody>
</table>

2. Surface Transportation Program (STP)

The Surface Transportation Program is a funding program governed by the TEA-21 legislation and administered by the Federal Highway Administration (FHWA) and Caltrans. The funds can be used for a wide variety of capital purposes across all modes. The approximately $680 million in annual funding for California STP funds must be distributed as follows:

<table>
<thead>
<tr>
<th>Allocation</th>
<th>Category (Approx. Annual Statewide Funding)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>Safety Construction ($68 m)</td>
</tr>
<tr>
<td>10%</td>
<td>Transportation Enhancement Activities (STP-TEA) ($68 m)</td>
</tr>
<tr>
<td>50%</td>
<td>Regional STP and rural areas guaranteed return ($340 m)</td>
</tr>
<tr>
<td>30%</td>
<td>State Discretionary ($204 m)</td>
</tr>
</tbody>
</table>

The Safety Construction allocation and the State Discretionary allocation would generally not fund projects like the Charleston Arastradero Corridor Plan. However, the STP Transportation Enhancements and the Regional STP portions are potential sources for Charleston Arastradero.

*STP Transportation Enhancement Activities (STP-TEA) – 10%*

Of particular interest to the implementation of the Charleston Arastradero Corridor Plan is the STP Transportation Enhancement Activities programming. Examples of Bay Area projects funded from this program in the most recent TIP are listed in Figure 4.

**Figure 4  Transportation Enhancement Activities – Sample Projects**

<table>
<thead>
<tr>
<th>Project Description</th>
<th>2003 TIP Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oakland Bay Trail: Mandela Parkway</td>
<td>$836,000</td>
</tr>
<tr>
<td>Bay Trail (Baumberg Track Trail segment)</td>
<td>$293,000</td>
</tr>
<tr>
<td>San Pablo Ave Smart Corridor - Phase II</td>
<td>$31,000</td>
</tr>
</tbody>
</table>


Control over this funding source is divided between the region and the state. Regional agencies – MTC in the Bay Area – control the funding of 75% of the statewide funds for the STP-TEA program (i.e. 75% of the 10% allocated for this category), with the state controlling the remaining 25%. The state’s 25% share is further divided into three areas: the Caltrans Share (11%), the Statewide Environmental Enhancement Share (11%), and the Conservation Lands Share (3%). Only very high profile projects would be expected to attract the state share.
The regional enhancement's share is allocated during the regional Transportation Improvement Program process. In recent years, MTC has chosen to allocate the 75% regional share via the Transportation for Livable Communities program, discussed previously.

**STP Regional—50%**

Half of STP funds are allocated to regional entities that allocate these highly flexible funds during the regional Transportation Improvement Program process. In Santa Clara County, this source has helped fund a number bicycle and pedestrian oriented projects like the Charleston Arastradero Corridor Plan (Figure 5) in the range of $100,000-500,000.

**Figure 5 STP Regional 50% Share – Sample Projects**

<table>
<thead>
<tr>
<th>Project Description</th>
<th>2003 TIP Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evelyn Ave Class II bike Lane</td>
<td>$170,000</td>
</tr>
<tr>
<td>Sunnyvale North-South Bikeways</td>
<td>$150,000</td>
</tr>
<tr>
<td>Palo Alto Medical Foundation Bike/Ped Crossing</td>
<td>$500,000</td>
</tr>
</tbody>
</table>

3. **Congestion Mitigation and Air Quality Improvement Program (CMAQ)**

This flexible funding source for transportation is allocated primarily through the regional planning processes described earlier. Transit agencies and local governments both compete for these funds and in the short term these funds are oversubscribed. The Charleston Arastradero Corridor Plan seeks to calm traffic, but does not seek to remove SOV's from the roadways. However, by making it easy to bicycle or walk in the community (particularly to local schools) the overall impact of the plan could reduce vehicle congestion. To acquire funding for the Charleston Arastradero Corridor Plan, it will be important to articulate these benefits of the project to MTC and VTA. In recent years, MTC has chosen to allocate a portion of CMAQ funding via the Transportation for Livable Communities program, discussed previously.

4. **Safe Routes to School Local Assistance Program**

Caltrans uses federal funds from the Hazard Elimination/Safety program for this local grant program. Originally a pilot program, the Safe Routes to School Local Assistance Program was extended for three years until 2005. Each round of funding has distributed more than $20 million in funding to cities around the state, in grants ranging up to $500,000. Applications for the final scheduled round of funding are due in February, 2004.
While fiscal uncertainties may threaten this program, it has been highly popular and is likely to be continued in some form after its sunset. Its popularity, however, has also made it a highly competitive application process, and an oversubscribed funding source. The large number of schools in the Charleston Arastradero Corridor Plan area, combined with the street improvements and traffic calming concepts that Palo Alto wishes to implement would make this a strong candidate for funding under the Safe Routes To School Local Assistance Program.

Figure 6  Safe Routes to Schools – Sample Projects

<table>
<thead>
<tr>
<th>Project Description</th>
<th>2003 TIP Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belmont – in pavement crosswalk lights and radar signs</td>
<td>$372,700</td>
</tr>
<tr>
<td>Los Gatos – new sidewalks and sidewalk gap closures</td>
<td>$306,900</td>
</tr>
<tr>
<td>Mountain View – speed warning signs and countdown pedestrian signals</td>
<td>$232,000</td>
</tr>
</tbody>
</table>


5. Bicycle Transportation Account (BTA)

Through the Bicycle Transportation Account, Caltrans provided $7.2 million in 2003 to local communities for capital projects intended to improve and increase bicycle commuting, and despite the budget crisis that same amount will be distributed in upcoming 2004/5 funding cycle. This source is highly competitive, usually providing funding for bikeways of regional importance (generally Class 1 and Class 2 facilities), and providing grants from $100,000 to over $1,000,000 in rare instances. To be competitive for this source, the City of Palo Alto will need to articulate the regional and local benefits of the Charleston Arastradero Corridor Plan.

6. Transportation Fund for Clean Air (TFCA)

Using a regional surcharge on motor vehicles, the Bay Area Air Quality Management District provides grants to public agencies for a wide variety of transportation projects with a focus on projects that minimize or reduce single-occupant vehicle trips, such as bicycle projects, ride-sharing and transit shuttles. Bicycle projects have often scored well under the criteria for this source, which ranks project applications based on their projected cost-effectiveness in reducing air pollution: one project partially funded by a TFCA grant was the Alma Street Bicycle Bridge between Palo Alto and Menlo Park. However, because the project improves existing bicycle facilities, rather than creating entirely new ones, demonstrating that increased bicycling will result will be somewhat more difficult, though some evidence does demonstrate the link between traffic calming and increased levels of bicycling and walking.
7. Transportation Community and System Preservation Program (TCSP)

The federal TEA-21 legislation created TCSP as a pilot program. During the four-year program, federal agencies awarded grants totaling $120 million for smart growth projects intended to reduce the need for costly new infrastructure. Projects funded under the program ranged from bike paths to highway widening, with budgets from the tens of thousands to over $1 million. The administration's initial proposal under SAFETEA would incorporate the TCSP program into the Surface Transportation Program, delegating equal amounts of funding to each of the states, which would set up an allocation process including regional transportation planning agencies. Until the future direction of the program is established, it will not be clear whether this source will be available for the Charleston Arastradero Corridor.
<table>
<thead>
<tr>
<th>Grant Funding Source Matrix</th>
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<tbody>
<tr>
<td><strong>Capital projects and planning studies. Project sponsors are encouraged to submit proposals that improve bicycling, and walking, encourage transit ridership through transit-oriented development, and generally improve neighborhood livability.</strong></td>
</tr>
<tr>
<td><strong>Application / Approval Process</strong></td>
</tr>
<tr>
<td>Capital funding is programmed through MTC TIP process with county CMA's.</td>
</tr>
<tr>
<td>Approval process is competitive and currently oversubscribed, but viable funding option in the long-term.</td>
</tr>
<tr>
<td><strong>Fair. Popular flexible funds but competitive and currently over subscribed. Requires demonstration of vehicle trip reduction and air quality improvement. Since Plan focuses primarily on calming rather than trip reduction, it must make a good case that it will reduce auto trips to schools, etc.</strong></td>
</tr>
<tr>
<td><strong>Apply to Bay Area Air Quality Management District. 60% disburse by BAAQMD through competitive process. 40% through county CMA's</strong></td>
</tr>
<tr>
<td><strong>A capital grant program administered by Caltrans to support bikelaid safety projects linked to travel to and from schools with the inclusion of the school community. Two funding cycles remain in this program until it sunsets at 1/1/05</strong></td>
</tr>
<tr>
<td><strong>Apply to Bay Area Air Quality Management District. 60% disburse by BAAQMD through competitive process. 40% through county CMA's</strong></td>
</tr>
<tr>
<td><strong>1 Year. Cycle applications due 2/3/04</strong></td>
</tr>
<tr>
<td><strong>1 Year. Applications due in December</strong></td>
</tr>
<tr>
<td><strong>Local governments and MPO's eligible for discretionary grants to plan/Implement strategies to improve efficiency of transportation system; reduce environmental impacts of transportation; reduce the need for costly infrastructure; and ensure efficient access to jobs, services, and trade centers.</strong></td>
</tr>
<tr>
<td><strong>Fair. Charleston Araratrodo Corridor Plan tangentially fundable, although signal coordination could qualify as a transportation efficiency improvement. However, the small size of SA/T/LA program will require projects that 'stick-out'</strong></td>
</tr>
<tr>
<td><strong>Cupertino, In-pavement crosswalk lights, bicycle detectors, signage, and raised crosswalk, $405,000</strong></td>
</tr>
</tbody>
</table>
Formula-Based Sources

1. Transportation Development Act – Article 3 (Bicycle/Pedestrian)

The Transportation Development Act (TDA) levies a statewide 1/4-cent sales tax to generate revenue for transportation. TDA Article 3 funds are allocated to Santa Clara County by formula and generate about $1.4 million annually. The county uses the funds to implement the Bicycle Element of the Valley Transportation Plan 2020, which was adopted in 2002. The Bicycle Element consists of the Santa Clara Countywide Bicycle Plan and a $31 million Bicycle Expenditure Program (BEP). The California Avenue Undercrossing is allocated $1 million in the BEP and is the sole Palo Alto project on the list. The list of priority projects of the BEP (Tier 1 list), is reviewed and revised by the Valley Transportation Authority (VTA) Board of Directors every two years, at which time jurisdictions that do not currently have a project in Tier 1 receive priority consideration.

A number of other counties distribute a share of TDA Article 3 funds to cities. Palo Alto could work with other cities to press VTA to do the same for local bike/pedestrian projects, and the city should also be prepared to propose and advocate for projects during the BEP revision processes. In that scenario, the Charleston Arastradero Corridor Plan could receive some funding from this source, but otherwise, funding is currently unlikely.

2. Local Subventions of the State Gas Tax

Of California’s 18 cents per gallon fuel tax, 6.46 cents are allocated to cities and counties for local streets and roads. This important source provides revenue for Palo Alto to maintain and rehabilitate its streets. Local subventions are generally inadequate however, because the rate has not kept up with inflation. The current state fiscal crisis, and the stress it puts on Palo Alto’s general fund, makes this source very important to simply try to keep up with road maintenance, and it is therefore an unlikely source for funding capital improvements associated with the Charleston Arastradero Corridor Plan. In some cases, however, communities have built traffic calming improvements as part of rehabilitation, reconstruction and/or restriping projects: these range from narrowing traffic lanes (e.g. Stanford’s Campus Drive bicycle lanes, created by narrowing travel lanes to 10.5’ width as part of a resurfacing project) to major changes during full reconstruction. For example, the genesis of Mountain View’s Castro Street traffic calming improvements was the need to replace a major sewer line under the street. Savings can sometimes, but not always, be realized with this technique.
Other Local Sources

Finding outside funds for projects is naturally a more attractive option for any city, compared to raising revenue locally. However, not only are outside funds competitive, uncertain, and threatened by larger fiscal issues, but they also almost always call for a local “match.” Therefore, Palo Alto will best be able to fund the Charleston Arastradero Corridor Plan if it can maximize its own contribution. Below is a short list of sources that could be considered in order to advance project implementation and make the City more competitive for outside funding.

1. Assessment District

An Assessment District has been discussed as a potential mechanism to raise funds for the Charleston Arastradero Corridor Plan. Assessment districts delineate a defined geographic constituency and provide benefits to those residents, such as roads, water, parks, and recreational facilities. Assessment Districts are a common mechanism to pay for community infrastructure in California because they are not subject to Proposition 13 limits. The districts typically place a levy on a property in such a way that the benefit is comparable to the assessment.

Benefit assessment districts come in several different forms, and depending on their enabling legislation have a different set of requirement on what they may fund and how they are established. An assessment district created under the Improvement Act of 1911 or the Municipal Improvement Act of 1913, for instance, is normally initiated by petition by owners of property within the proposed district and then formed by a sponsoring local agency. Property owners can protest the district before it is formed. Other districts require a direct vote of property owners, such as a 1982 Act Benefit Assessment Districts (majority) and Mello Roos Community Facilities Districts (2/3rds). Once it is formed, assessments can be paid either in a lump sum or over a period of years (generally 15-20). Cities often bond against the income stream to pay for improvements.

2. Exactions on Development

It may be appropriate for the city to impose project-specific exactions on new development for certain elements of the Charleston Arastradero Corridor Plan, such as enhanced bus shelters, urban design improvements or intersection capacity improvements. In larger development projects, such exactions are often negotiated during the approvals process, often driven by the findings of an environmental analysis of the proposed project showing that the project will have impacts on local roadways and other infrastructure.

In the case of the Charleston Arastradero Corridor Plan, there are several large-scale developments in the pipeline, including those proposed for the Hyatt Rickey’s site, the Elks Club, the proposed Jewish Community Center, and Alma Plaza. It is expected that each of these projects will be required to undergo an impact analysis, and that the project proponents may be required to mitigate some of their impacts on the transportation infrastructure. Depending on the timing of both the projects and the implementation of
the Charleston Arastradero Corridor Plan, there may be some elements of the plan that could be directly funded as a part of the development process. More formal exactions on new development, in the form of impact fees, require study and legal clearance to determine that there is a rationale for the application of the fees. A traffic impact fee could be developed specifically for the Charleston Arastradero Corridor Plan area, as has been done for Stanford Research Park and the San Antonio/West Bayshore, but the proceeds of this fee would be limited by the amount of new development in the project area. As Palo Alto is currently considering the adoption of a citywide Transportation Impact Fee (described below), creation of an area-specific fee, which could be duplicative of the citywide fee and complicate its adoption, does not appear to be a fruitful path at this time.

3. Palo Alto Transportation Impact Fee

The City of Palo Alto is currently formulating a new development fee that will be used to fund citywide transportation improvements. It is broader than a typical traffic impact fee in that it recognizes that Palo Alto has a very high priority to enhance the ease of transportation for pedestrians, bicyclists and transit as well automobiles, and therefore focuses on bicycling, walking and transit projects. Transportation impact fees are commonly used by local jurisdictions in California to account for the impact of new growth on transportation resources. The proposed projects in the Charleston Arastradero Corridor area would all pay into this citywide fund, if it were approved, based on their projected generation of peak hour automobile trips.

Use of the Transportation Impact Fee will be limited to improvements specified in the fee ordinance. Revenues will be dependent on the rate of new development, which tends to fluctuate markedly from year to year. At the current proposed rate of $2,458 per PM peak hour vehicle trip, the Traffic Impact Fee is predicted to generate $7.2 million (in 2003 dollars) over its 22-year life. Generating about $330,000 per year for Palo Alto projects, it will provide a good source of local match for implementing the Charleston Arastradero Corridor Plan.

The advantages of the use of this source for the Charleston Arastradero Corridor Plan over a more narrowly drawn neighborhood traffic impact fee is that the project will be able to draw on fees generated in the entire city, smoothing year to year variations in local development cycles. More importantly, under the proposed Transportation Impact Fee, major aspects of the Charleston Arastradero Corridor project are fundable, including computerized traffic management, bike routes, and pedestrian improvements. The Charleston Arastradero Corridor bike lanes and ped/bike intersection improvements are specifically named in the draft expenditure plan for the fees.
4. Palo Alto General Fund

The General Fund is a flexible, yet over-committed resource that is critical to supporting community services, police, fire, public works and other core governmental functions in the City of Palo Alto. In recent years, the General Fund has totaled over 100 million dollars, but less than $1 million of that, on average, has been committed to transportation capital projects. Currently, given the severe recession, General Fund revenues are down dramatically and the City has had to significantly decrease budgets across the board, and has put off capital expenditures whenever possible. At this point, the city conservatively does not expect receipts to return to their 2000 levels for another five years. Governor Schwarzenegger’s first act in office, to repeal the Vehicle License Fee, presents another immediate crisis to the city’s General Fund, which stands to lose another $2.4 million from this source. Given the great demands on the General Fund, and the prospect of a slow turn-around in tax receipts flowing into Palo Alto, this source of funding is not a likely one for the Charleston Arastradero Corridor Plan.

Conclusions

Our initial assessment is that there are several funding sources available to the City of Palo Alto which are very appropriate candidates for funding the Charleston Arastradero Corridor Plan, and a funding strategy can be devised to build the improvements as planned, even in the current difficult funding environment.

The nature of the Corridor Plan makes it highly fundable from a number of competitive grant pools that focus on pedestrian and bike improvements, school safety, and smart growth. It is likely that these programs will continue under a reauthorized federal transportation bill (“SAFETEA”), which should be passed by Congress in the coming months. Importantly, there are feasible sources of local match money, particularly if the Transportation Impact Fee is adopted. A firm source of local match will be important to attract competitive grants.

The timing of funding depends largely on Palo Alto’s prioritization of this project in the overall Transportation Improvement Program for the city as a whole. Because of the cost the project will either have to be a very high priority for available funding, or, more likely it will need to be broken into smaller phases for gradual implementation as funding is obtained.
Street Layout

Gunn High School

Arastradero / West Charleston

- Reduce from 4-Lane to 3-Lane Cross Section
- Install 16' Median Islands w/ Pedestrian Crossing Refuges
- Stripe Auto Lanes 11/10/11'
- Maintain Curbside Parking on West Side
- Widen Bike Lanes to 6' on West and 8' on East
- Sign Bike Lane on East Side for Programmed Curbside Parking (e.g. 7pm to 7am)
- Paint/Tint Bike Lanes
- Install Lights / Signs, e.g., "Bike Boulevard"
- Construct Regular Curb East Side
- Install Street Trees in ROW / PUE Area

Street Design Concept

CHARLESTON / ARASTRADERO CORRIDOR STUDY
CITY OF PALO ALTO
Street Layout

Arastradero/West Charleston

- Maintain 4-Lane Cross Section
- Install 6' Median Islands* w/ Pedestrian Crossing Refuges
- Stripe Auto Lanes 10'/10/10/10'
- Remove Curbside Parking Lane West Side

- Widen Bike Lanes to 7' *
- Sign Bike Lanes Both Sides for Programmed Curbside Parking (e.g. 7pm to 7am)
- Paint/Tint Bike Lanes
- Construct Regular Curb East Side

- Install Lights / Signs, e.g., "Bike Boulevard"
- Install Street Trees in ROW / PUE Area

* Islands widened to 10' at Local Streets to Create Left Turn Pockets; Requires Narrowing Bike Lanes to 5' and Eliminating Curbside Parking

Street Design Concept - 4-Lane Option

CHARLESTON / ARASTRADERO CORRIDOR STUDY
CITY OF PALO ALTO
Street Design Concept - 3-Lane Plan

CHARLESTON / ARASTRADERO CORRIDOR STUDY
CITY OF PALO ALTO
- Reduce from 4-Lane to 3-Lane Cross Section
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Arastradero / West Charleston
CHARLESTON / ARASTRADERO CORRIDOR STUDY
CITY OF PALO ALTO
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