Ralston Avenue Corridor Study Issues and Analysis Report

Prepared for the

City of Belmont

Submitted by

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Executive Summary

The goals of the Ralston Avenue Corridor Study and Improvement Project are two-fold: first to determine the adequacy of the corridor for multi-modal use by evaluating the ability to accommodate pedestrians, bicyclists, transit riders and motorists under existing and projected future conditions, and secondly to develop context sensitive transportation alternatives to improve multi-modal use along the corridor. This report presents an analysis of the existing multi-modal transportation facilities along the Ralston Avenue Corridor and their operations. The study segment in the City of Belmont is located between US Route (US) 101 and State Route (SR) 92. This report is the second in the series of three building-block documents that will be produced as part of this effort. The first document summarized data collected for the project and has been submitted to City staff. The third building-block report will present context sensitive alternatives for improving multi-modal connectivity along the corridor and will be prepared later in 2013.

This report includes chapters on corridor operations, alternative modes of travel, and a traffic signal system evaluation. Corridor operations include intersection and pedestrian levels of service, travel times, collision history analysis, and parking. The alternative modes of travel chapter provides a detailed discussion of pedestrian and bicycle conditions, opportunities and constraints, access issues, and transit operations. In the traffic signal system evaluation, the performance of signalized and unsignalized intersections is evaluated, with an emphasis on the hardware and software that controls the City of Belmont's traffic signal system.

As a next step in the Ralston Avenue Corridor Study, a series of corridor alternatives will be developed that take into consideration the data collection (submitted as a separate report) and this analysis of transportation facilities and operations.

Corridor Operations

Study Area and Periods

The study area consists of the Ralston Avenue corridor between US 101 and SR 92 in the City of Belmont. Within the corridor, the following signalized intersections were analyzed, which are shown on Figure 1:

1. Ralston Avenue/US 101 Northbound Ramps
2. Ralston Avenue/US 101 Southbound Ramps
3. Ralston Avenue/Hiller Street
4. Ralston Avenue/Old County Road
5. Ralston Avenue/El Camino Real
6. Ralston Avenue/Sixth Avenue
7. Ralston Avenue/South Road
8. Ralston Avenue/Notre Dame University Road
9. Ralston Avenue/Chula Vista Drive
10. Ralston Avenue/Notre Dame Avenue
11. Ralston Avenue/Alameda de las Pulgas
12. Ralston Avenue/Cipriani Boulevard
13. Ralston Avenue/Davis Drive
14. Ralston Avenue/Tahoe Drive
15. Ralston Avenue/Belmont Canyon Road
16. Ralston Avenue/Hallmark Drive
17. Ralston Avenue/SR 92 Eastbound Ramps
18. Ralston Avenue/SR 92 Westbound Ramps

Operating conditions during the weekday a.m. and p.m. peak periods were evaluated to capture the highest level of congestion along the corridor. The morning peak hour occurs between 7:00 and 9:00 a.m. and reflects conditions during the home to work or school commute, while the p.m. peak hour occurs between 4:00 and 6:00 p.m. and typically reflects the highest level of congestion during the homeward bound commute.

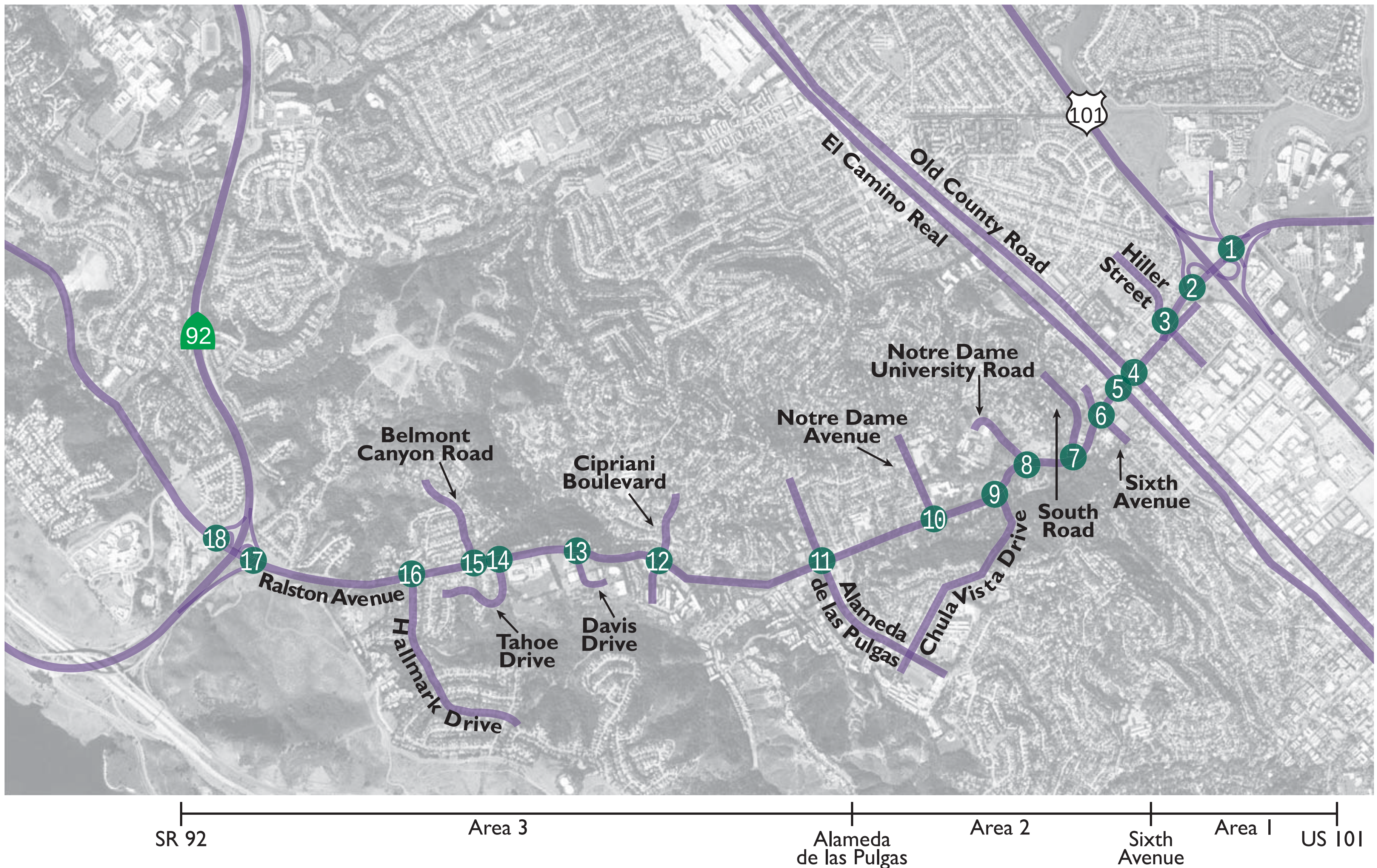
Level of Service Methodologies

In transportation/traffic studies, Level of Service (LOS) has traditionally been determined for vehicular traffic at intersections and on roadway segments based on vehicle delay; however, for the purpose of the Ralston Avenue Corridor Study a more holistic approach was applied to account for all transportation users, not just motorists.

Automobile LOS

Level of Service (LOS) is used to rank traffic operation on various types of facilities based on traffic volumes and roadway capacity using a series of letter designations ranging from A to F. Generally, Level of Service A represents free flow conditions and Level of Service F represents forced flow or breakdown conditions. A unit of measure that indicates a level of delay generally accompanies the LOS designation.

The study intersections were analyzed using methodologies published in the *Highway Capacity Manual* (HCM), Transportation Research Board, 2000. This source contains methodologies for various types of intersection control, all of which are related to a measurement of delay in average number of seconds per vehicle.



LEGEND
● Study Intersection

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Ralston Avenue Corridor Study – Issues and Analysis Report

Figure 1 – Study Area

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The Levels of Service for the intersections with side-street stop controls, or those which are unsignalized and have one or two approaches stop controlled, were analyzed using the "Two-Way Stop-Controlled" intersection capacity method from the HCM. This methodology determines a level of service for each minor turning movement by estimating the level of average delay in seconds per vehicle. Results are presented for individual movements together with the weighted overall average delay for the intersection.

The study intersections with stop signs on all approaches were analyzed using the "All-Way Stop-Controlled" Intersection methodology from the HCM. This methodology evaluates delay for each approach based on turning movements, opposing and conflicting traffic volumes, and the number of lanes. Average vehicle delay is computed for the intersection as a whole, and is then related to a Level of Service.

The study intersections that are currently controlled by a traffic signal, or may be in the future, were evaluated using the signalized methodology from the HCM. This methodology is based on factors including traffic volumes, green time for each movement, phasing, whether or not the signals are coordinated, truck traffic, and pedestrian activity. Average stopped delay per vehicle in seconds is used as the basis for evaluation in this LOS methodology. For purposes of this study, delays were calculated using optimized signal timing.

The ranges of delay associated with the various levels of service are indicated in Table 1.

Table 1
Intersection Level of Service Criteria

LOS	Two-Way Stop-Controlled	All-Way Stop-Controlled	Signalized
A	Delay of 0 to 10 seconds. Gaps in traffic are readily available for drivers exiting the minor street.	Delay of 0 to 10 seconds. Upon stopping, drivers are immediately able to proceed.	Delay of 0 to 10 seconds. Most vehicles arrive during the green phase, so do not stop at all.
B	Delay of 10 to 15 seconds. Gaps in traffic are somewhat less readily available than with LOS A, but no queuing occurs on the minor street.	Delay of 10 to 15 seconds. Drivers may wait for one or two vehicles to clear the intersection before proceeding from a stop.	Delay of 10 to 20 seconds. More vehicles stop than with LOS A, but many drivers still do not have to stop.
C	Delay of 15 to 25 seconds. Acceptable gaps in traffic are less frequent, and drivers may approach while another vehicle is already waiting to exit the side street.	Delay of 15 to 25 seconds. Drivers will enter a queue of one or two vehicles on the same approach, and wait for vehicle to clear from one or more approaches prior to entering the intersection.	Delay of 20 to 35 seconds. The number of vehicles stopping is significant, although many still pass through without stopping.
D	Delay of 25 to 35 seconds. There are fewer acceptable gaps in traffic, and drivers may enter a queue of one or two vehicles on the side street.	Delay of 25 to 35 seconds. Queues of more than two vehicles are encountered on one or more approaches.	Delay of 35 to 55 seconds. The influence of congestion is noticeable, and most vehicles have to stop.
E	Delay of 35 to 50 seconds. Few acceptable gaps in traffic are available, and longer queues may form on the side street.	Delay of 35 to 50 seconds. Longer queues are encountered on more than one approach to the intersection.	Delay of 55 to 80 seconds. Most, if not all, vehicles must stop and drivers consider the delay excessive.
F	Delay of more than 50 seconds. Drivers may wait for long periods before there is an acceptable gap in traffic for exiting the side streets, creating long queues.	Delay of more than 50 seconds. Drivers enter long queues on all approaches.	Delay of more than 80 seconds. Vehicles may wait through more than one cycle to clear the intersection.

Reference: *Highway Capacity Manual,* Transportation Research Board, 2000

Pedestrian LOS

The *Highway Capacity Manual 2010* (HCM) includes methodologies to determine pedestrian LOS. The methodology used to evaluate adequacy of pedestrian facilities considers the presence of pedestrian facilities, lateral separation between pedestrians and vehicular traffic, width of sidewalk, speed and makeup of vehicle traffic, and number of vehicle traffic lanes. Pedestrian LOS is determined for both segments and signalized intersections. Additionally, a pedestrian midblock crossing factor is calculated, which is considered in tandem with the segment and intersection levels of service to develop an overall pedestrian LOS. All of the pedestrian factors are combined to produce an overall segment LOS score, which is then assigned a ranking of LOS A to F. In general, LOS A represents ideal pedestrian conditions and LOS F represents a segment with little or no pedestrian facilities. A summary of the LOS score range and the respective LOS is shown in Table 2.

Table 2
Pedestrian Level of Service Criteria

LOS	Pedestrian LOS Score
A	≤ 2.00
B	> 2.00 – 2.75
C	> 2.75 – 3.50
D	> 3.50 – 4.25
E	> 4.25 – 5.00
F	> 5.00

Reference: *Highway Capacity Manual*, Transportation Research Board, 2010
Note: Pedestrian LOS score for average pedestrian space of 60 square feet per pedestrian or more

Data Collection

In an effort to document existing conditions on the corridor, transportation data was collected in spring 2013 along the Ralston Avenue corridor. The data collected are summarized and provided in the *Ralston Avenue Corridor Study – Data Collection Report*, June 24, 2013.

Existing Conditions

The Existing Conditions scenario provides an evaluation of current corridor operation based on existing traffic volumes during the a.m. and p.m. peak periods.

Vehicle Intersection Levels of Service

A summary of the intersection level of service calculations is contained in Table 3. Copies of the Level of Service calculations are provided in Appendix A. Also provided with these calculations are the anticipated queue lengths for each of the study intersections.

Table 3
Existing Peak Hour Intersection Levels of Service

Study Intersection *Approach*	**Existing Conditions**			
	AM Peak		**PM Peak**	
	Delay	**LOS**	**Delay**	**LOS**
1. Ralston Ave/US 101 NB Ramps	26.4	C	28.2	C
2. Ralston Ave/US 101 SB Ramps	17.9	B	16.0	B
3. Ralston Ave/Hiller St	22.9	C	21.6	C
4. Ralston Ave/Old County Rd	30.8	C	32.6	C
5. Ralston Ave/El Camino Real	43.9	D	67.9	E
6. Ralston Ave/Sixth Ave	26.1	C	26.0	C
7. Ralston Ave/South Rd	**	F	**	F
8. Ralston Ave/Notre Dame University Rd	2.6	A	3.4	A
Southbound Approach	*46.1*	*E*	*40.5*	*E*
9. Ralston Ave/Chula Vista Dr	7.9	A	1.9	A
Northbound Approach	*60.9*	*F*	*24.7*	*C*
10. Ralston Ave/Notre Dame Ave	2.5	A	1.2	A
Southbound Approach	*42.5*	*E*	*28.3*	*D*
11. Ralston Ave/Alameda de las Pulgas	45.4	D	43.1	D
12. Ralston Ave/Cipriani Blvd	59.9	E	26.0	C
13. Ralston Ave/Davis Dr	10.2	B	7.6	A
14. Ralston Ave/Tahoe Dr	0.8	A	0.1	A
Northbound Approach	*21.1*	*C*	*13.9*	*B*
15. Ralston Ave/Belmont Canyon Rd	10.1	B	7.3	A
16. Ralston Ave/Hallmark Dr	30.8	C	16.1	B
17. Ralston Ave/SR 92 EB Ramps	22.7	C	19.2	B
18. Ralston Ave/SR 92 WB Ramps	21.9	C	12.1	B

Notes: Delay is measured in average seconds per vehicle; LOS = Level of Service; Results for minor approaches to two-way stop-controlled intersections are indicated in *italics;* ** = delay greater than 120 seconds

Vehicular Travel Times and Speeds

Corridor travel times were collected along Ralston Avenue between SR 92 and US 101 on Wednesday, April 17 and Thursday, April 18, 2013. These data were collected during the weekday morning peak period between 7:00 and 9:00 a.m. as well as the weekday evening peak period between 4:00 and 6:00 p.m. A minimum of three runs was completed in each direction for each study period. The average travel times and speeds are summarized in Table 4, and copies of the data collection are provided in Appendix B.

Table 4
Average Corridor Speeds and Travel Time

Study Segment Direction	Existing Conditions			
	AM Peak		PM Peak	
	Speed	Travel Time	Speed	Travel Time
Ralston Ave				
Eastbound – SR 92 to US 101	17.0 mph	13:53	27.8 mph	8:28
Westbound – US 101 to SR 92	18.1 mph	13:01	22.0 mph	10:41

Notes: Travel Time is reported in minutes:seconds

Cut-Through Traffic

Through the public out-reach efforts it was noted that some community members believe that some drivers use Ralston Avenue as a cut-through route to connect between SR 92 and US 101, contributing to congestion in Belmont. An origin-destination survey was conducted to determine the portion of vehicular traffic passing through Belmont compared to local community traffic. This was be done by setting up Bluetooth readers at four locations along the corridor between SR 92 and US 101.

As summarized in Figure 2, it was determined that during the morning peak period approximately 5.5 percent of westbound traffic surveyed traveled through the Ralston Avenue corridor without stopping in Belmont, increasing to 8.7 percent of traffic during the p.m. peak period. In the eastbound direction, it was found that approximately 9.2 percent of traffic during the a.m. peak period and 7.1 percent of traffic during the p.m. peak period passed through the City of Belmont on Ralston Avenue without stopping.

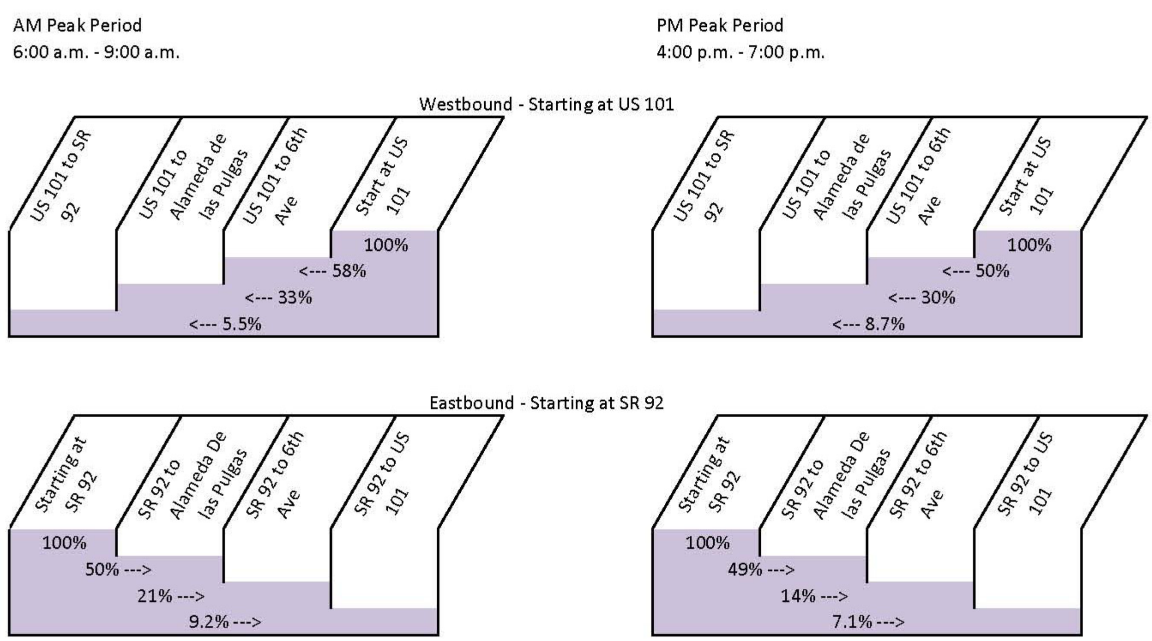

Figure 2 – Origin-Destination Survey Results Summary

Pedestrian Level of Service

The pedestrian level of service was calculated for core pedestrian areas along the Ralston Avenue Corridor. The results are summarized for the westbound and eastbound directions of travel, respectively, in Table 5 and Table 6 and calculations are provided in Appendix C.

Table 5
Existing Pedestrian Levels of Service – Westbound Ralston Ave

Segment	Existing Conditions			
	AM Peak		PM Peak	
	Score	LOS	Score	LOS
US 101 NB to US 101 SB	3.96	D	3.70	D
US 101 SB to Hiller St	3.50	D	3.62	D
Hiller St to Old County Rd	3.46	C	3.17	C
Old County Rd to El Camino Real	3.25	C	3.60	D
El Camino Real to Sixth Ave	3.52	D	3.96	D
Sixth Ave to South Rd	3.05	C	4.11	D
Alameda de las Pulgas to Cipriani Blvd	3.98	D	3.96	D
Cipriani Blvd to Davis Dr	3.41	C	3.40	C
Davis Dr to Tahoe Dr	3.42	C	3.42	C
Tahoe Dr to Belmont Canyon Rd	3.77	D	3.75	D
Belmont Canyon Rd to Hallmark Dr	3.82	D	3.82	D

Notes: LOS = Level of Service

Table 6
Existing Pedestrian Levels of Service – Eastbound Ralston Ave

Segment	Existing Conditions			
	AM Peak		PM Peak	
	Score	LOS	Score	LOS
Hallmark Dr to Belmont Canyon Rd	3.30	C	3.30	C
Belmont Canyon Rd to Tahoe Dr	2.81	C	2.81	C
Tahoe Dr to Davis Dr	3.47	C	3.46	C
Davis Dr to Cipiani Blvd	3.53	D	3.54	D
Cipriani Blvd to Alameda de las Pulgas	3.60	D	3.59	D
South Rd to Sixth Ave	3.70	D	3.67	D
Sixth Ave to El Camino Real	3.62	D	3.70	D
El Camino Real to Old County Rd	3.17	D	3.16	C
Old County Rd to Hiller St	3.60	D	3.47	C
Hiller St to US 101 SB	3.96	D	3.58	D
US 101 SB to US 101 NB	4.11	D	3.86	D

Notes: LOS = Level of Service

Collision History

Three-year collision histories between January 2010 and May 2013 were provided by the City. Collision history summaries provided general data for each collision reported. The data included the collision date and time, the general area where the collision occurred, the general cause of the collision, and the type of damage and/or injury (property damage only, injury, or fatality).

Appendix D summarizes the collision histories by primary collision factor for each study intersection. It is important to note that some locations include collisions occurring at nearby unsignalized intersections. For example, there were 60 reported collisions referenced to the intersection of Ralston Avenue at Alameda de las Pulgas (24 percent of all collisions along the corridor). Of those, 73 percent of the incidents were attributed to the unsignalized intersections of Pullman Avenue/Lyall Way, Coronet Boulevard, Villa Avenue, Academy Avenue, and Maywood Drive which are within 1,000 feet east or west of Alameda de las Pulgas.

During the period for which collision data were provided, a total of 262 incidents were reported along Ralston Avenue. On average, this equates to about six reported collisions per month along the corridor. The majority of these incidents, nearly 37 percent, or about two to three collisions per month, as shown in Figure 3, were attributed to unsafe speeds. The second primary collision factor (14 percent of incidents) involved following too closely, and about 13 percent of incidents involved unsafe turns or a failure to signal. There were two incidents along the corridor that resulted in fatalities: in 2011 a pedestrian at El Camino Real was outside the crosswalk and in 2010 speeding was indicated as the cause of a fatality on Old County Road.

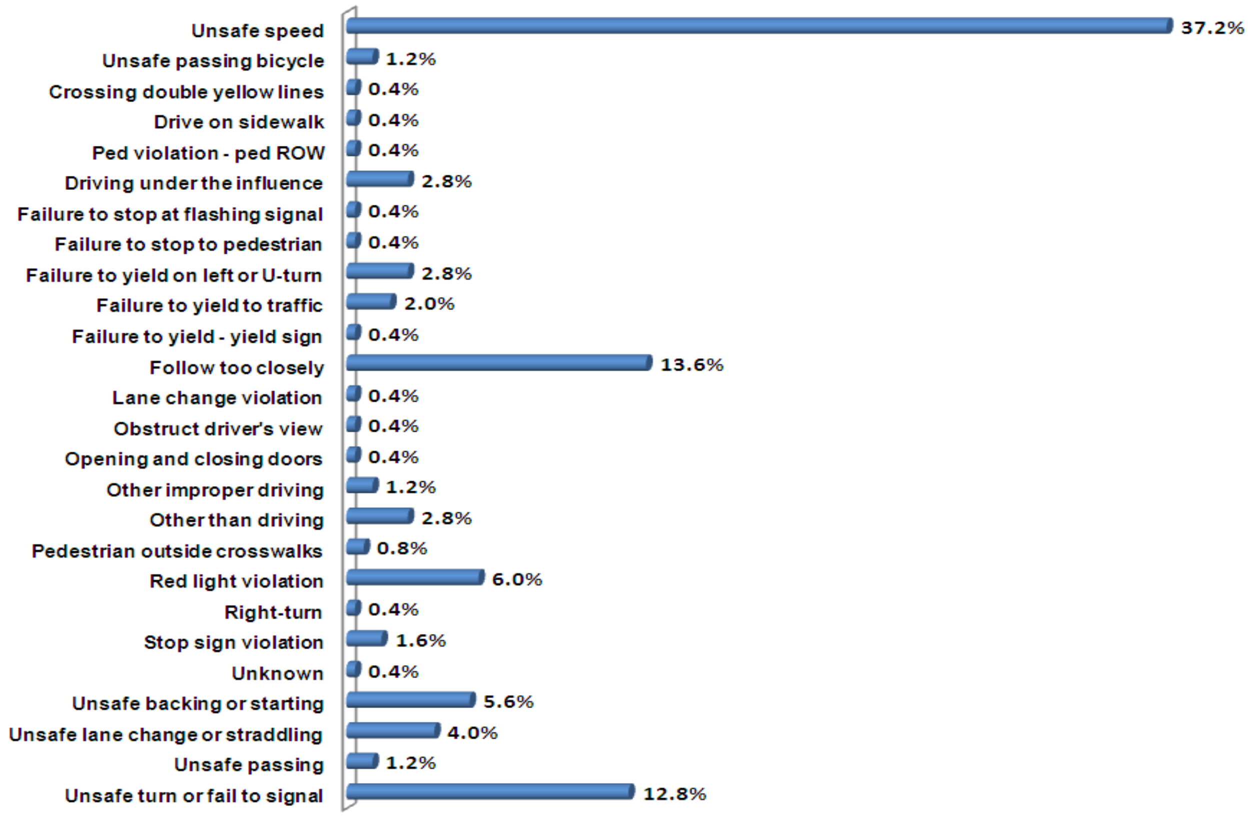

Figure 3 – Ralston Avenue Collision Summary

Based on the collision history there are a few items worth noting. Speeding, following too closely and unsafe turns are issues that affect motorists, pedestrians and bicyclists. As corridor alternatives are developed, opportunities for physical and operational improvements will be explored that address these issues.

As presented in Table 7, the calculated collision rates for the Ralston Avenue corridor was compared to average collision rates for similar facilities statewide, as indicated in *2009 Collision Data on California State Highways*, California Department of Transportation. The collision rates were calculated for the three study segments, and also further divided into two sub-segments between US 101 and South Road, with Old County Road as the dividing point, because the roadway and collision characteristics vary within the larger segment. It was determined that Ralston Avenue east of Alameda de las Pulgas experienced collision rates that were higher than the statewide average for similar facilities. The segment of Ralston Avenue between Old County Road and South Road experienced the highest calculated collision rate overall, where it was noted that 45 percent of the collisions reported within this segment occurred at the intersection of Ralston Avenue and El Camino Real. However, between Alameda de las Pulgas and SR 92, Ralston Avenue experienced a collision rate that was significantly lower than the statewide average.

Table 7
Collision Rates for the Study Segments

Ralston Avenue Segments	Number of Collisions	Calculated Collision Rate (c/mvm)[1]	Statewide Average Collision Rate (c/mvm)[2]
between US 101 and Old County Road	58	2.99	2.45
between Old County Road and South Road	62	5.67	2.45
between South Road and Alameda de las Pulgas	82	3.51	2.80
between Alameda de las Pulgas and SR 92	60	0.95	2.45

Note: [1] c/mvm = collisions per million vehicles miles
[2] Statewide average collision rate is for urban arterials

Future Conditions

Future traffic forecasts for the horizon year of 2035 were obtained from the San Mateo Countywide gravity demand model, which is maintained by the City/County Association of Governments of San Mateo County (C/CAG). The C/CAG model is built off of a regional model developed by the Santa Clara Valley Transportation Authority (VTA). The VTA model includes a focused traffic analysis zone (TAZ) system that is consistent with the TAZ structure used by the San Mateo Countywide models developed by C/CAG. The VTA model is based on socioeconomic data sets including population, households, income and jobs.

A comparison of the socioeconomic data between VTA's 2010 base model and 2035 build-out model indicates projected growth in both households and jobs for the City of Belmont as well as for the Village District TAZ's. The VTA traffic model is assumed to be based on the currently adopted City of Belmont General Plan. The City is in the midst of developing the Village District Element and 2035 General Plan.

Roadway segment volumes were obtained from the model and translated to turning movement volumes at each of the study intersections using a combination of the "Furness" method and factoring. At key intersections, where side-street traffic volumes are expected to increase substantially in the future, the "Furness" method was used. The Furness method is an iterative process that employs existing turn movement data, existing link volumes and future link volumes to project likely future turning movement volumes at intersections. At all other intersections, where the majority of traffic growth is expected, growth rates between 1.09 and 1.72 were used on Ralston Avenue through traffic. For the purpose of analyzing base future conditions, it was assumed that there would be no physical improvements to Ralston Avenue that would increase the route's capacity; however, traffic signal timings were optimized for the intersections (optimized traffic signal timing reflects changes in signal timing based on traffic volumes, but does not assume coordination of traffic signals).

Automobile Level of Service

Future intersection operating conditions are summarized in Table 8.

Table 8
Existing and Future Peak Hour Intersection Levels of Service

Study Intersection *Approach*	**Existing Conditions**				**Future Conditions**			
	AM Peak		**PM Peak**		**AM Peak**		**PM Peak**	
	Delay	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**	**Delay**	**LOS**
1. Ralston Ave/US 101 NB Ramps	26.4	C	28.2	C	36.3	D	30.2	C
2. Ralston Ave/US 101 SB Ramps	17.9	B	16.0	B	18.5	B	14.5	B
3. Ralston Ave/Hiller St	22.9	C	21.6	C	20.5	C	19.6	B
4. Ralston Ave/Old County Rd	30.8	C	32.6	C	53.1	D	75.0	E
5. Ralston Ave/El Camino Real	43.9	D	67.9	E	**	F	**	F
6. Ralston Ave/Sixth Ave	26.1	C	26.0	C	50.5	D	29.5	C
7. Ralston Ave/South Rd	**	F	**	F	**	F	**	F
8. Ralston Ave/Notre Dame University Rd	2.6	A	3.4	A	19.9	B	9.2	A
Southbound Approach	*46.1*	*E*	*40.5*	*E*	**	*F*	**	*F*
9. Ralston Ave/Chula Vista Dr	7.9	A	1.9	A	35.9	D	2.4	A
Northbound Approach	*60.9*	*F*	*24.7*	*C*	**	*F*	*39.6*	*E*
10. Ralston Ave/Notre Dame Ave	2.5	A	1.2	A	5.7	A	1.4	A
Southbound Approach	*42.5*	*E*	*28.3*	*D*	**	*F*	*41.6*	*E*
11. Ralston Ave/Alameda de las Pulgas	45.4	D	43.1	D	79.7	E	82.0	F
12. Ralston Ave/Cipriani Blvd	59.9	E	26.0	C	108.5	F	33.7	C
13. Ralston Ave/Davis Dr	10.2	B	7.6	A	13.5	B	9.1	A
14. Ralston Ave/Tahoe Dr	0.8	A	0.1	A	0.7	A	0.1	A
Northbound Approach	*21.1*	*C*	*13.9*	*B*	*26.2*	*D*	*15.7*	*C*
15. Ralston Ave/Belmont Canyon Rd	10.1	B	7.3	A	12.5	B	8.0	A
16. Ralston Ave/Hallmark Dr	30.8	C	16.1	B	33.4	C	19.1	B
17. Ralston Ave/SR 92 EB Ramps	22.7	C	19.2	B	31.1	C	28.0	C
18. Ralston Ave/SR 92 WB Ramps	21.9	C	12.1	B	35.7	D	16.9	B

Notes: Delay is measured in average seconds per vehicle; LOS = Level of Service; Results for minor approaches to two-way stop-controlled intersections are indicated in *italics;* ** = delay greater than 120 seconds

Parking

Parking is currently provided along the Ralston Avenue corridor by a mix of both on-street and off-street parking facilities. The majority of off-street parking facilities are provided by private landowners for the use of their customers and employees; however, there are three off-street parking lots owned and operated by the City Belmont for public parking. In general, both on-street and off-street public parking areas along Ralston Avenue are restricted to two to four hours of parking during the day, but there are no time limits on weekday evenings or Sundays.

As future development occurs along Ralston Avenue in accordance with the Village District Plan, new development would generally be required to provide adequate off-street parking to satisfy the City's parking requirement. However, if on-street parking is available immediately adjacent to the frontage of a development, this parking may be considered to count towards the development's parking supply (Village District Zoning § 27.6 (1) iii).

Generally, on-street parking is utilized by patrons accessing a business that has access directly on Ralston Avenue. There are also a handful of spaces on Ralston Avenue that provide access to Twin Pines Park. When evaluating possible geometric changes to the corridor, consideration will be given to the use of on-street parking spaces.

Alternative Modes of Transportation

This section summarizes the pedestrian, bicycle and transit related improvements for the study area based on a review of the following documents:

- *City of Belmont General Plan*, City of Belmont, 1982
- *Belmont Village District Zoning Draft*, City of Belmont, 2012
- *Draft Belmont Village Element – 2035 General Plan Update*, City of Belmont, 2013
- *Grand Boulevard Multimodal Transportation Corridor Plan*, San Mateo County Transit District, 2010

City of Belmont General Plan

The transportation policies contained in the *City of Belmont General Plan*, August 1982, that pertain to alternative modes of transportation are summarized below.

- Pedestrians and bicycle crossings should be designated at appropriate locations with adequate sight distance and clearly distinguished signs and lane markings.
- The City should continue discussions with the State to encourage improvements along El Camino Real including the addition of landscaped median strips and left-turn stacking lanes. Widening of El Camino Real should be supported only when absolutely necessary based on traffic volumes and adequate plans to protect the properties along the roadway.
- The City should encourage the development of the El Camino Real and Southern Pacific rights-of-way as a major intercity transportation corridor to accommodate mass transit as well as automobile, bus and bicycle movement.
- Public transit on a regular schedule should be provided along El Camino Real, arterial streets and, as possible, major collectors. Services to increase mobility of the aged and handicapped that depend on public transportation should be provided.
- Commuter buses, vanpools and other forms of private transit should be encouraged or required where appropriate, especially in conjunction with major new industrial or commercial development.
- The establishment of commuter park–and-ride stations should be encouraged. Such stations should be located and improved to have minimum impact on adjoining uses.
- The City shall encourage improvement of bus routes and schedules to provide transportation to commuter trains, local school and recreational facilities without infringing on quiet neighborhoods.
- Special design and landscaping features should be established for visually important entrances to the City including the Ralston Avenue, Alameda de las Pulgas and El Camino Real entrances.
- Public sidewalks shall be required in conjunction with all new non-residential development. Sidewalks in the CBD shall be of special design.
- Public sidewalks shall be installed in all new residential developments except in areas where construction of sidewalks would be incompatible with existing development and/or require excessive grading or tree removal. In such cases, adequate roadway shoulders, or alternative trails and pathways shall be provided to ensure the safety of pedestrian and bikers.
- The City shall maintain and encourage use of the existing system of main and neighborhood bike routes. Bike lanes or pathways shall be incorporated into the circulation system of any new subdivision.
- Bicycle and pedestrian paths should be provided within scenic corridors wherever possible.

Belmont Village District Zoning Draft

The *Belmont Village District Zoning Draft*, December 2012, emphasizes a connected network of pedestrian sidewalks and walkways, which are defined by high quality amenities and pedestrian oriented uses as follows:

- Provide wider sidewalks and pedestrian amenities such as seating, pedestrian-scale lighting, trash receptacles, planters, pots, and other street furniture on primary pedestrian routes.
- Add routes through blocks to facilitate shorter walking distances between destinations and points of interest.
- Provide active ground floor uses, such as retail and restaurants, on block frontages designated as active pedestrian frontages.
- Incorporate pocket parks and plazas that are fully accessible to the public.

Draft Belmont Village Element-2035 General Plan Update

The *Draft Belmont Village Element-2035 General Plan Update*, May 21, 2013, has established goals and polices to implement the specific vision for the Village District. The policies that relate to alternative modes of transportation are summarized as follows:

Policy 1.2: Create a 1,000-linear-foot retail/pedestrian corridor that facilitates north-south pedestrian connectivity across and between the Pedestrian Core district, and that features a continuous frontage of retail and restaurants, facing attractive and welcoming sidewalks with pedestrian amenities.

Policy 3.4: Develop a connected network of sidewalks/paseos and bicycle routes, with appropriate amenities and connections to adjacent residential neighborhoods, to facilitate safe, convenient pedestrian access into and within the Village, and across El Camino Real, Caltrain, and Ralston Avenue.

Policy 3.7: Provide a comfortable and attractive central transit hub, with park–and-ride facilities, passenger amenities, and pedestrian/bicycle connections, to facilitate easy use of public transit. Encourage residents, visitors and workers to avail themselves of such alternative modes of transportation to access and circulate within the Village area.

Policy 3.8: Create pedestrian routes through the Caltrain right-of way to enable east-west pedestrian connectivity at O'Neill Street.

Grand Boulevard Multimodal Transportation Corridor Plan

The *Grand Boulevard Multimodal Transportation Corridor Plan* focuses on transforming the El Camino Real Corridor from Daly City to San Jose's Diridon Station into a pedestrian and transit friendly, high-performing multimodal arterial. The plan recommends the following pedestrian, bicycle and transit related improvements within one-quarter mile of the El Camino Real Corridor:

- Better pedestrian connectivity and wider sidewalks with amenities including seating, planters, pedestrian-oriented lighting, transit shelters, bike racks, outdoor cafes, and vendors
- Short distances between protected crossings and safe crossings at unsignalized intersections
- Physically separated Class I bike path
- Dedicated Class II bike lanes along frontages that do not contain storefront commercial space
- Real-time transit information
- Bus Rapid Transit (BRT) service
- Special BRT stations and bus stop/waiting area facilities
- Infrastructure improvements such as queue-jump lanes, signal prioritization, etc. to decrease travel time along the corridor
- Improved pedestrian environment through traffic calming, landscaping, building design guidelines, land use and sidewalk improvements; and an integrated shuttle access program

The goals and policies in the City's General Plan and the Village District Element are consistent with the goals and objects of the *Grand Boulevard Multimodal Transportation Corridor Plan* as each of these supports more pedestrian, bicycle and transit-friendly elements along the El Camino Real Corridor. Therefore, it is important that pedestrian, bicycle and transit related improvements along the Ralston Avenue Corridor, particularly where it meets El Camino Real and downtown Belmont, are consistent with the recommendations included in the Belmont Village District Element and the Grand Boulevard Plan.

Pedestrian and Bicycle Facilities

One of the goals for the Ralston Avenue Corridor Study is to determine the adequacy of existing facilities along the corridor to serve multi-modal demands, including pedestrians, bicyclists, transit, and vehicles under existing and future traffic volumes, and to develop context sensitive transportation alternatives to improve multi-modal use along the corridor.

This chapter outlines issues identified related to bicycle and pedestrian travel through and across the corridor. The findings in this chapter were informed by:

- Community input gathered from:
    - A community workshop held on April 18, 2013
    - Comments submitted through the project website: www.ralstonavenuecorridorstudy.org
    - Comments provided through stakeholder interviews

- Professional judgment based on:
    - April 29, 2013 project team walking audit
    - Vehicle, bicycle, and pedestrian counts conducted as part of this project on April 11, 2013

The physical character, conditions and travel patterns within the corridor vary, but generally pedestrian and bicycle needs are the same for each of the following three sub-segments, or areas:

- Area 1 (Downtown) – US 101 to South Road
- Area 2 (Middle Segment) – South Road to Alameda de las Pulgas
- Area 3 (Western Segment) – Alameda de las Pulgas to SR 92

Pedestrian Transportation Needs

Several challenge points were identified relative to the goal of a 'complete street' corridor that provides for safe and functional pedestrian travel. Some of the specific challenges relate to the compliance with the Americans with Disabilities Act (ADA) while others are associated with pedestrian safety and mobility.

Challenge Areas:

- *Incomplete pedestrian network along the corridor:* There are gaps in the sidewalk network on both the north and south sides of Ralston Avenue.

- *Narrow sidewalks:* Sidewalks along Ralston Avenue vary in width; however most range from 4 to 5 feet wide. In high demand areas the sidewalks are not wide enough to meet pedestrian needs.

- *Hill erosion impacted sidewalks:* Sidewalks adjacent to hillsides are often covered with dirt and vegetation.

- *Inadequate pedestrian crossing times:* Community members noted they do not have sufficient time to cross at signalized intersections.

- *Reported low yield rates at uncontrolled pedestrian crossings:* Community members noted that drivers do not always yield for pedestrians at uncontrolled marked crossings.

- *Vehicular travel speeds make the corridor uncomfortable for walking:* Community members shared that walking along the corridor is uncomfortable because of the vehicular travel speeds, particularly where there is no on-street parking.

As corridor alternatives are developed there are several opportunities for pedestrian facility improvements that will be considered.

Opportunities for Improvement:

- Complete the sidewalk network along corridor.
- Widen sidewalks where available right-of-way exists.
- Examine opportunities for retaining walls and erosion/drainage control measures.
- Study opportunities for longer pedestrian crossing times and lead pedestrian traffic signal intervals where the pedestrian phase begins while all vehicle indicators show red. This would allow pedestrians to establish their presence in the crosswalk before drivers start to travel through the intersection.
- Improve uncontrolled crossings with enhanced treatments.
- Study opportunities to calm traffic and enhance the pedestrian experience along the corridor.
- Implement a traffic safety campaign.

Area 1: It was reported that drivers do not comply with this illuminated sign at Hiller Street

Area 1: It was reported that drivers do not always yield to pedestrians at this uncontrolled crossing at Elmer Street

<u>Area 1 Pedestrian Needs and Opportunities</u>

Area 1 includes Ralston Avenue from US 101 to South Road. This Area has the highest density of pedestrian attractors and generations, the most recorded pedestrian activity, and the most complete pedestrian network of all three segments.

Attractors include:

- US 101 bicycle and pedestrian overcrossing
- Nesbit Elementary School
- Post Office
- Belmont Caltrain Station
- Downtown retail
- Twin Pines Park
- Twin Pines Senior and Community Center
- Central Elementary School

Pedestrian counts conducted for this project and annual activity estimates are presented in Table 9. The intersection with the highest recorded pedestrian activity was El Camino Real followed by Hiller Street and Old County Road.

Table 9
Area 1 Pedestrian Counts

Ralston Ave Intersection	AM Counts (7-9 am)	PM Counts (3-5pm)	PM Counts (5-7pm)
NB US 101 Ramps	52	19	60
SB US 101 Ramps	108	12	59
Hiller St	123	118	117
Old County Rd	73	111	82
El Camino Real	195	279	255
Sixth Ave	58	98	62
South Rd	28	75	41

Table 10 presents existing pedestrian crossing times and recommended minimum crossing times based on 2012 CA MUTCD standards and City standards.

Table 10
Area 1 Pedestrian Crossing Times

Signalized Intersection Cross Street	Intersection Leg	Existing Crossing Time (Seconds)	Recommended Crossing Time (Seconds)
SB US 101 Ramps	East	18	Currently meets CA MUTCD
Hiller St	West	12	11
	North/South	17	23
	East	12	11
Old Country Rd	South	17	23
	West	11	13
	East	10	13
	North	17	27
El Camino Real	North	14	18
	South	21	25
	East	17	19
	West	17	19
Sixth Ave	West	12	14
	North	16	18
	South	16	17
	East	12	Currently meets CA MUTCD

Area 1 has the most complete pedestrian network within the study area, however there are challenges. Identified pedestrian related challenges in Area 1 include:

- Pedestrians using unmarked crossings.
- Missing curb ramps.
- Narrow sidewalks that are inadequate to serve the high pedestrian volumes.
- Insufficient pedestrian crossing times at signalized intersections.
- South Road intersection requires pedestrians to cross four travel lanes at a high-volume stop-controlled intersection.
- Indirect access to Twin Pines Park from the north side of Ralston Avenue.
- Reported driver non-compliance with the "No Right Turn" illuminated sign at Hiller Street.
- Reported low driver yielding rates at the Elmer Street pedestrian beacon.

Opportunities for pedestrian improvement in Area 1 include:

- Mark crosswalks across intersecting streets.
- Install curb ramps.
- Install Curb extensions.
- Re-time pedestrian crossings using a minimum walking speed of 3.5 feet per second.
- Provide "Lead Pedestrian Intervals" (will require traffic analysis).
- Improve uncontrolled marked crossing treatments.
- Implement a traffic safety campaign.

Figure 4 presents these challenges and opportunities.

Area 2: Narrow sidewalks with hill erosion

Area 2: Shared facility is not standard

<u>Area 2 Pedestrian Needs and Opportunities</u>

Area 2 includes Ralston Avenue from South Road to Alameda de las Pulgas. This area has key community attractors including:

- Notre Dame de Namur University
- Notre Dame High School
- Barrett Park and Community Center
- Carlmont Village District

Area 2: Poor driver compliance at Chula Vista Drive

Pedestrian counts conducted for this project and annual activity estimates are presented in Table 11. The intersection of Ralston Avenue at Alameda de las Pulgas had the third highest recording of pedestrian activity along the corridor.

Source: Alta Planning + Design

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Ralston Avenue Corridor Study – Issues and Analysis Report

Figure 4 – Pedestrian Needs and Opportunities – Area 1 – US 101 to South Road

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Table 11
Area 2 Pedestrian Counts

Ralston Ave Intersection	AM Counts (7-9am)	PM Counts (3-5pm)	PM Counts (5-7pm)
Notre Dame University	8	16	11
Chula Vista Dr	16	38	24
Notre Dame Ave	22	25	25
Alameda de las Pulgas	102	91	74

Table 12 presents existing pedestrian crossing times and recommended crossing times based on 2012 CA MUTCD standards and agency preferences.

Table 12
Area 2 Pedestrian Crossing Times

Signalized Intersection Cross Street	Intersection Leg	Existing Crossing Time (Seconds)	Recommended Crossing Time (Seconds)
Alameda De Las Pulgas	West	12	17
	East	12	15
	South	16	20
	North	16	21

Area 2 has a relatively complete pedestrian network; however there are challenges. Identified pedestrian related challenges in Area 2 include:

- Missing curb ramps.
- Narrow sidewalks on the north side of Ralston Avenue between South Road and Notre Dame De Namur University; hill erosion further narrows the usable width of the sidewalk.
- Narrow sidewalks in Carlmont Village District despite having the third highest pedestrian activity recorded.
- Reported blocked sidewalks near Notre Dame De Namur University during University events.
- Shared bicycle and pedestrian path on the north side of Ralston Avenue in front of Notre Dame High School does not meet Caltrans design standards or NACTO best practices. Stencils indicating travel direction appear to be reversed from typical travel on the right.
- Reported high vehicular speeds between Notre Dame Avenue and South Road make crossing at uncontrolled marked crossings challenging.
- Reported low driver yielding rates at the Chula Vista uncontrolled marked crossing.
- Missing signage warning eastbound drivers of Chula Vista crosswalk.
- Low visibility of Chula Vista crosswalk.
- Reported low driver yielding rates at the Villa Avenue and Maywood Drive pedestrian beacons.
- Wide crossing at Maywood Drive.
- Northeast corner of Alameda de las Pulgas at Ralston Avenue has a wide turning radius and traffic signal pole in the pedestrian path.
- Insufficient pedestrian crossing times at Alameda De Las Pulgas

Opportunities for pedestrian improvement in Area 2 include:

- Widen sidewalks where adequate right-of-way is available.
- Improve retaining walls to minimize erosion's impact on sidewalk width.
- Consider dedicating pathway in front of Notre Dame High School for pedestrian use only.
- Improve Chula Vista Drive uncontrolled crossing with high visibility crosswalks and rapid rectangular flashing beacons (RRFB); consider need for additional stop signs.
- Implement traffic calming elements between Notre Dame Avenue and South Road.
- Improve uncontrolled marked crossing treatments with high visibility crosswalks and curb extensions where available right-of-way.
- Reduce curb radius on north east corner at Alameda De Las Pulgas and move traffic signal pole so that it is out of the pedestrian walking path.
- Re-time pedestrian crossing at Alameda De Las Pulgas to accommodate a 2.8 feet per second walking speed due to its proximity to the senior living facility (Sunrise Assisted Living).
- Implement "Lead Pedestrian Interval" at Alameda De Las Pulgas (will require traffic analysis).
- Install curb ramps.
- Implement a traffic safety campaign.

Area 3: Gaps in the sidewalk network

Area 3: The Cipriani Boulevard intersection is wide with free right turn lanes and no curb ramps

Figure 5 presents these challenges and opportunities.

Area 3 Pedestrian Needs and Opportunities

Area 3 includes Ralston Avenue from Alameda de las Pulgas to SR 92. While this area is primarily residential and hilly, there are a number of attractors both along and off the corridor, including:

- Fox Elementary School
- Ralston Middle School
- Cipriani Elementary School
- Immaculate Heart of Mary School

Pedestrian counts conducted for this project and annual activity estimates are presented in Table 13. While this area has lower pedestrian activity than the others, Davis Drive, which is adjacent to Ralston Middle School, had the seventh highest recorded pedestrian activity along the corridor.

Area 3: Medians in crosswalks

Source: Alta Planning + Design

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Ralston Avenue Corridor Study – Issues and Analysis Report

Figure 5 – Pedestrian Needs and Opportunities – Area 2 – South Road to Alameda de las Pulgas

Table 13
Area 3 Pedestrian Counts

Ralston Ave Intersection	AM Counts (7-9am)	PM Counts (3-5pm)	PM Counts (5-7pm)
Cipriani Blvd	11	63	10
Davis Dr	25	135	7
Tahoe Dr	59	42	4
Belmont Canyon Rd	40	0	0
Hallmark Dr	57	6	13
SR 92 EB Off-Ramp	0	0	4
SR 92 WB Off-Ramp	0	0	0

Table 14 presents existing pedestrian crossing times and recommended crossing times based on 2012 CA MUTCD standards and agency preferences.

Table 14
Area 3 Pedestrian Crossing Times

Signalized Intersection Cross Street	Intersection Leg	Existing Crossing Time (Seconds)	Recommended Crossing Time (Seconds)
Cipriani Blvd	East	10	Currently meets CA MUTCD
	South	20	22
	West	10	Currently meets CA MUTCD
Davis Dr	West	12	15
	South	16	Currently meets CA MUTCD
Belmont Canyon Rd	North	14	18
Hallmark Dr	South	16	20
	West	16	19

Area 3 has the least complete pedestrian network within the study area. Identified pedestrian related challenges in Area 3 include:

- Missing sidewalks:
  - 300 feet west of Davis Drive to Lodge Drive connector path (north side)
  - 500 feet west of Pullman Avenue to Cipriani Boulevard (north side)
  - In front of Ralston Middle School parking loop (south side)
  - In front of SR 92 Park and Ride lot (south side)
- Wide intersection with free right turn lanes at Cipriani Boulevard; no marked crossing on west leg.
- Narrow sidewalks with no buffer between traveling cars and pedestrians.
- Vegetation encroaching on narrow sidewalks.
- Missing curb ramps.

- Raised medians that encroach in crosswalk area.
- Reported high vehicular speeds.
- Poor sight lines at intersecting streets require drivers to encroach in crosswalk.
- Community concern that drivers do not look for pedestrians in crosswalks.
- Few marked crossings across Ralston Avenue.
- Insufficient pedestrian crossing times at signalized intersections.

Opportunities for pedestrian improvements in Area 3 include:

- Install sidewalk where adequate right-of-way is available.
- Widen Sidewalks where adequate right-of-way is available.
- Remove free right-turn lanes at Cipriani Boulevard and add marked crossing on west leg.
- Trim vegetation.
- Install curb ramps.
- Remove raised medians in crosswalks.
- Improve marked crossing treatments including high visibility crosswalks near schools.
- Install crosswalks on all east-west crossings.
- Re-time pedestrian crossings to accommodate a minimum 3.5 feet per second walking speed.
- Install traffic calming elements.
- Implement a traffic safety campaign.

Figure 6 presents these challenges and opportunities.

Bicycle Transportation Needs and Opportunities

Several challenge points in the project study area were identified related to the goal of a complete streets corridor that provides for safe and functional bicycle travel.

Challenge Areas:

- *Incomplete bicycle network along the corridor:* There are gaps in the bicycle network on both the north and south sides of Ralston Avenue.

- *Narrow bike lanes:* Bike lanes along Ralston Avenue vary in width, but many are narrow and include the gutter pan and seam. Typical bike lane width along the corridor ranges from 4 to 6 feet.

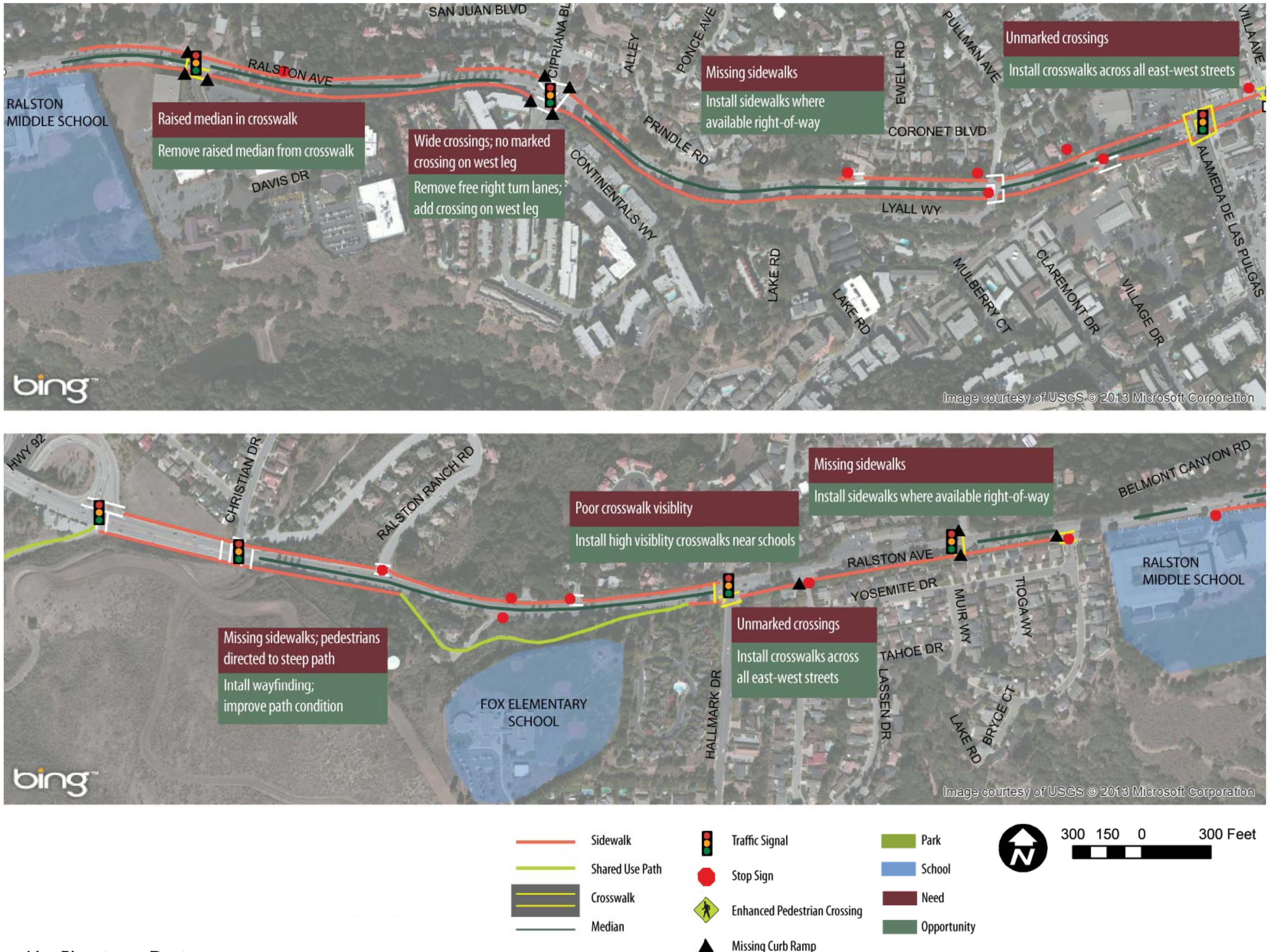
- *Vehicular travel speeds make the corridor uncomfortable for bicycling:* Community members shared the view that bicycling along the corridor is uncomfortable because of vehicular travel speeds and narrow vehicular and bicycle travel lanes.

- *Bicycle detection at traffic signals:* Bicycles are not always detected at actuated traffic signals.

Opportunities for bicycle facility improvements will be a key part of the alternatives development phase of the *Ralston Avenue Corridor Study*.

Opportunities for Improvement include the following:

- Complete the bicycle network along corridor.
- Widen bike lanes where available right-of-way exists.
- Improve bicycle detection at actuated traffic signals.
- Study opportunities to calm traffic along the corridor.
- Implement a traffic safety campaign.



Source: Alta Planning + Design

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Ralston Avenue Corridor Study – Issues and Analysis Report

Figure 6 – Pedestrian Needs and Opportunities – Area 3 – Alameda de las Pulgas to SR 92

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Area I Bicycle Needs and Opportunities

Area I includes Ralston Avenue from US 101 to South Road. This area has the highest density of bicyclist attractors and generators and recorded the most bicycle activity.

Attractors include:

- US 101 bicycle and pedestrian overcrossing
- Nesbit Elementary School
- Post Office
- Belmont Caltrain Station
- Downtown retail
- Twin Pines Park
- Twin Pines Senior and Community Center
- Central Elementary School

Bicycle counts conducted for this project and annual activity estimates are presented in Table 15. This area includes the five intersections with the highest bicycle activity along the corridor, listed below in order from highest to lowest:

1. El Camino Real
2. US 101 Southbound ramps
3. Hiller Street
4. Old County Road
5. South Road

Area 1: The corridor is well traveled by bicyclists

Area 1: Many bicyclists are not comfortable sharing the road

Table 15
Area I Bicycle Counts

Ralston Ave Intersection	AM Counts (7-9am)	PM Counts (3-5pm)	PM Counts (5-7pm)
NB US 101 Ramps	16	16	15
SB US 101 Ramps	0	50	90
Hiller St	56	19	58
Old County Rd	52	31	27
El Camino Real	73	52	126
Sixth Avenue	15	7	13
South Rd	27	34	31

Table 16 presents bicycle signal detection for traffic within the study corridor. A review of detection findings with City staff will be required to develop specific improvement recommendations.

Table 16
Area 1 Bicycle Detection

Signalized Intersection	Direction of Travel	Type of Bicycle Signal Detection[1]
NB US 101 Ramps	--	Not present or unknown
SB US 101 Ramps	--	Not present or unknown
Hiller St	Eastbound	Loop – D in left-turn lane
Old Country Rd	Westbound	Loop – D (near crosswalk) and A
El Camino Real	Eastbound and Westbound	Loop – Eastbound: D (near crosswalk), E, and A Westbound: D (near crosswalk) and A
Sixth Ave	--	Not present or unknown

Note: [1] Types of bicycle signal detection within Area 1 include: Type A (Square or Rectangular), Type D (Diagonal Quadrupole), and Type E (Circular)

While Area 1 has the most recorded bicycle activity, many attractors, and the bicycle and pedestrian US 101 overcrossing, it does not include a complete network.

Identified bicycle related challenges in Area 1 include:

- No on-street dedicated bicycle space.
- Bicycles are not always detected at actuated traffic signals.
- The US 101 overcrossing does not have bicycle facilities.
- Reported driver non-compliance with the "No Right Turn" illuminated sign at Hiller Street.
- Way-finding from the westbound US 101 bicycle and pedestrian overcrossing does not continue past the intersection of Hiller Street and Ralston Avenue.
- It is difficult to access US 101 bicycle and pedestrian overcrossing for eastbound bicyclists.
- Crossing El Camino Real and the Caltrain undercrossing is challenging because of the high vehicle volume and limited roadway space.
- Some bicyclists may not know where to stand to best trigger a bicycle loop for detection or may not be aware of the function of inductive sensors.

Opportunities for bicycle improvements in Area 1 include:

- Install Shared Lane markings and share the road signage.
- Identify low stress alternate routes for bicyclists not comfortable using this area of Ralston Avenue.
- Develop and install bicycle way-finding guiding bicyclists at least to Caltrain and the US 101 bicycle and pedestrian overpass.
- Install bike lanes and green conflict zone markings on the US 101 overpass.
- Ensure bicycles are detected at all actuated traffic signals.
- Type D bicycle signal detectors are recommended if in-pavement detectors are used. Include pavement markings to identify the where bicyclists should position themselves at bicycle detection loops be detected.
- Consider reducing travel lane width on the US 101 overpass and install bike lanes with enhanced freeway ramp crossing treatments. Encourage Police Department enforcement of "No Right Turn" illuminated sign at Hiller Street.

Figure 7 presents these challenges and opportunities.

Source: Alta Planning + Design

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Ralston Avenue Corridor Study – Issues and Analysis Report

Figure 7 – Bicycle Needs and Opportunities – Area 1 – US 101 to South Road

Area 2 Bicycle Needs and Opportunities

Area 2 includes Ralston Avenue from South Road to Alameda de las Pulgas. This area has key community attractors including:

- Notre Dame de Namur University
- Notre Dame High School
- Barrett Park and Community Center
- Carlmont Village District

Area 2: Bike lane ends just west of South Road

Bicycle counts conducted for this project and annual activity estimates are presented in Table 17. This area includes locations with high bicycle activity.

Table 17
Area 2 Bicycle Counts

Ralston Ave Intersection	AM Counts (7-9am)	PM Counts (3-5pm)	PM Counts (5-7pm)
Notre Dame University	8	13	21
Chula Vista Dr	17	11	9
Notre Dame Ave	23	11	15
Alameda de las Pulgas	25	18	17

Area 2: The bike lane network is incomplete

No bicycle detection was identified at Alameda de las Pulgas, the only signalized intersection within Area 2. A review of detection findings with City staff will be required to develop specific improvement recommendations.

Area 2: The lane merge east of Alameda de las Pulgas is challenging for bicyclists

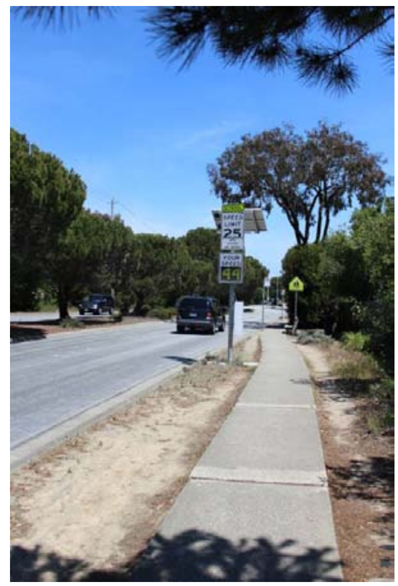
Area 2 has the most complete bicycle network; however, there are identified needs, including:

- No on-street bike lanes between:
  - Notre Dame de Namur entrance and Notre Dame Avenue (north side)
  - Barrett Park and Maywood Drive (north side)
  - Villa Avenue and Alameda de las Pulgas (north side)
  - Alameda de las Pulgas and 460 feet west of Alameda de las Pulgas (south side)
- Bi-directional shared bicycle and pedestrian path on the north side of Ralston Avenue in front of Notre Dame High School does not meet Caltrans design standards or NACTO best practices. Stencils indicating travel direction appear to be reversed from typical travel on the right
- Reported vehicular travel speeds make the corridor uncomfortable for bicycling except for the most experience bicyclists.
- The eastbound vehicular travel lane merge just west of Alameda de las Pulgas poses positioning challenges for bicyclists.
- No bike parking is provided in the Carlmont Village District.

Opportunities for bicycle improvements in Area 2 include:

- Install bike lanes in network gaps. Consider travel lane width reduction to accommodate bicycle lanes.
- The purpose of the bi-directional shared use path in front of Notre Dame High School is unclear because there are not enhanced treatments to facilitate transition to on-street travel at either end. Consider making this facility pedestrian only or providing enhanced crossing treatments.
- Study feasibility of moving eastbound lane merge to west of Alameda De Las Pulgas.
- Provide traffic calming elements.
- Establish a traffic safety campaign.
- Ensure that bicycles are detected at all actuated traffic signals. Type D bicycle signal detectors are recommended if in-pavement detectors are used. Include pavement markings to identify the where bicyclists should position themselves at bicycle detection loops be detected.
- Work with landowners to install bike parking in retail areas.

Area 3: Bicyclist use Area 3 despite lack of bike lanes



Area 3: High vehicular speeds make bicycle travel uncomfortable

Figure 8 presents these challenges and opportunities.

<u>Area 3 Bicycle Needs and Opportunities</u>

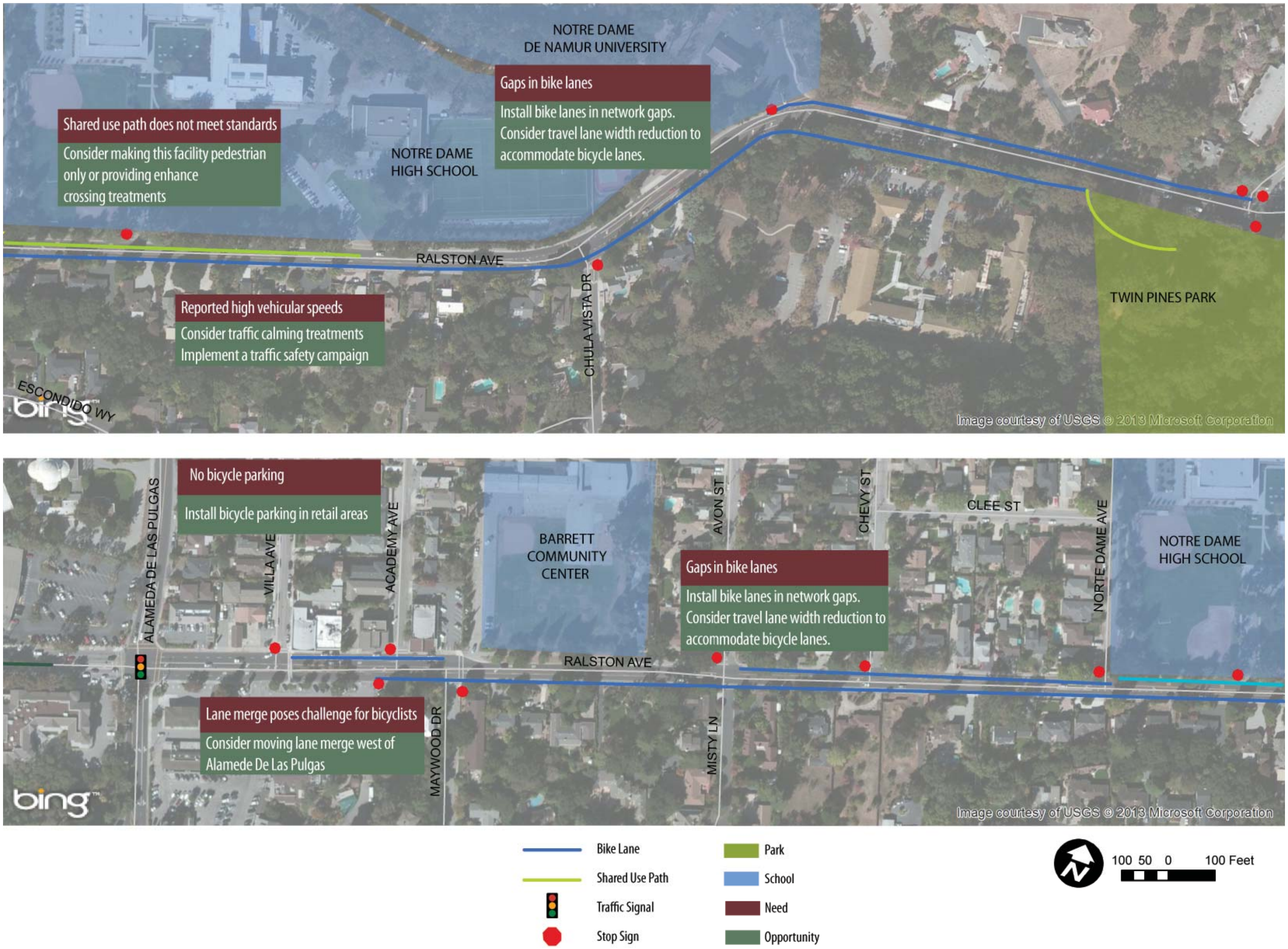
Area 3 includes Ralston Avenue from Alameda de las Pulgas to SR 92. While this area is primarily residential and hilly, there are a number of attractors both along and off the corridor including:

- Fox Elementary School
- Ralston Middle School
- Cipriani Elementary School
- Immaculate Heart of Mary School

Bicycle counts conducted for this project and annual activity estimates are presented in . While Area 3 is the least bicycle friendly because of the topography and few bike lanes or paths, the number of recorded bicyclists is notable.

Table 18
Area 3 Bicycle Counts

Ralston Ave Intersection	AM Counts (7-9am)	PM Counts (3-5pm)	PM Counts (5-7pm)
Cipriani Blvd	10	33	10
Davis Dr	4	12	1
Tahoe Dr	1	6	2
Belmont Canyon Rd	0	1	1
Hallmark Dr	24	10	8
SR 92 EB Off-Ramp	8	22	6
SR 92 WB Off-Ramp	4	7	21



Source: Alta Planning + Design

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Ralston Avenue Corridor Study – Issues and Analysis Report

Figure 8 – Bicycle Needs and Opportunities – Area 2 – South Road to Alameda de las Pulgas

Table 19 presents bicycle signal detection within the study corridor. A review of detection findings with City staff will be required to develop specific improvement recommendations.

Table 19
Area 3 Bicycle Signal Detection

Signalized Intersection	Direction of Travel	Type of Bicycle Signal Detection
Cipriani Blvd	Eastbound	Type A Loop
Davis Dr	Eastbound and westbound	Type A Loop
Belmont Canyon Rd	Eastbound	Type A Loop
Hallmark Dr	Eastbound	Type A Loop
SR 92 EB Off-Ramp	--	Not present or unknown
SR 92 WB Off-Ramp	Eastbound	Type A Loop

Note: [1] Types of bicycle signal detection within the Area 3 include Type A (Square or Rectangular). Signal detection is generally located 200 to 300 feet back from the crosswalk.

Constraints identified for Area 3 include:

- No on-street bike lanes between:
  - SR 92 and 400 feet east of Cipriani Boulevard (north side).
  - 500 feet west of Pullman Avenue and Alameda de las Pulgas (north side).
  - Hwy 92 and Alameda de las Pulgas (south side).
- Signed bike lane on north side between Pullman Avenue and 500 feet west of Pullman Avenue. There is no bike lane, only an asphalt sidewalk that is obstructed with poles.
- Bike lane begins 500 feet west of Pullman Avenue (north side) but it is not signed or stenciled at its beginning.
- Signed bike lane at Ralston Ranch Road (south side) directs bicyclists up steep path that is not consistent with Caltrans standards. There is no ramp to take bicyclists from on-street to the path.
- Narrow roadway and landscaped median leave no room for bicycle lanes.
- Poor pavement quality between SR 92 and Cipriani Boulevard.
- Pavement curves around drainage grate about 200 feet east of Christian Drive. The asphalt pavement lip may be a hazard to bicyclists.
- Reported vehicular travel speeds make the corridor uncomfortable for bicycling except for the most experience bicyclists.
- No bike parking at Ralston Middle School.
- Some bicyclists may not know where to stand to best trigger a bicycle loop for detection or may not be aware of the function of inductive sensors.

Opportunities for bicycle improvements in Area 3 include:

- Prioritize Ralston Avenue between SR 92 and Cipriani Boulevard for repaving.
- Investigate community desire for retaining the existing landscaped median verses possible removal of the landscaped medians to allow for the installation of bike lanes.
- Install traffic calming elements.
- Implement a traffic safety campaign.
- Ensure that bicycles are detected at all actuated traffic signals. Type D bicycle signal detectors are recommended if in-pavement detectors are used. Include pavement markings to identify the where bicyclists should position themselves at bicycle detection loops be detected. Install bike parking.

Figure 9 presents these challenges and opportunities.

Source: Alta Planning + Design

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Ralston Avenue Corridor Study – Issues and Analysis Report

Figure 9 – Bicycle Needs and Opportunities – Area 3 – Alameda de las Pulgas to SR 92

Estimated Bike Lane Use – Existing and Future Activity

Existing Bicycle Activity

Bicycle counts conducted as part of this project demonstrate bicyclists are using the Ralston Avenue corridor. Table 20 presents bicycle counts by location.

Table 20
Bicycle Counts

Ralston Ave Intersection	AM Counts (7-9am)	PM Counts (3-5pm)	PM Counts (5-7pm)
NB US 101 Ramps	16	16	15
SB US 101 Ramps	0	50	90
Hiller St	56	19	58
Old Country Rd	52	31	27
El Camino Real	73	52	126
Sixth Ave	15	7	13
South Rd	27	34	31
Notre Dame University	8	13	21
Chula Vista Dr	17	11	9
Notre Dame Ave	23	11	15
Alameda De Las Pulgas	25	18	17
Cipriani Blvd	10	33	10
Davis Dr	4	12	1
Tahoe Dr	1	6	2
Belmont Canyon Rd	0	1	1
Hallmark Dr	24	10	8
SR 92 EB Off-Ramp	8	22	6
SR 92 WB Off-Ramp	4	7	21

Distribution of Bicycle Activity

Figure 10 presents a distribution of bicycle activity along the corridor. The highest concentration of bicycle activity is in Area 1.

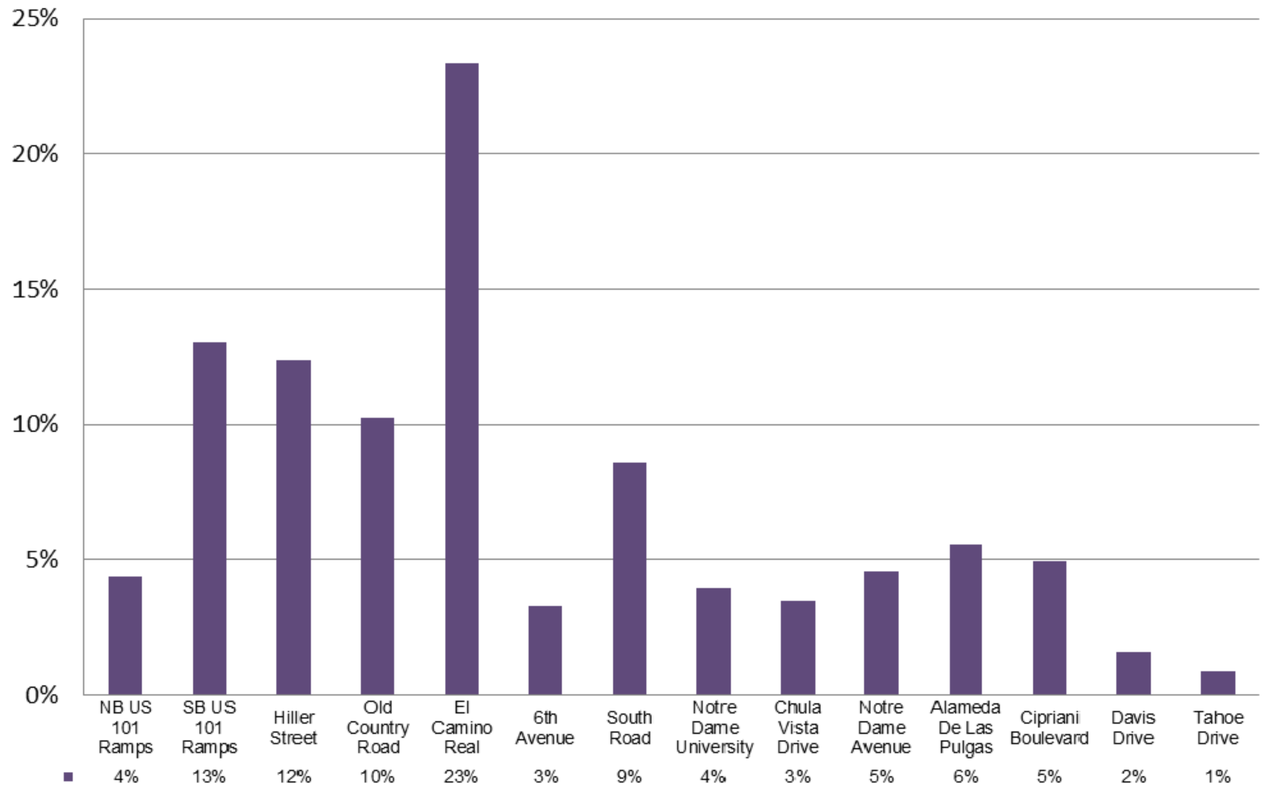


Figure 10 – Distribution of Bicycle Activity

Future Bicycle Activity

It is difficult to determine how much bicycling activity there would be along the corridor if continuous facilities were provided. The factors that influence current demand and future activity include (but are not limited to):

- Community perceptions regarding safety
- Presence of dedicated bicycle roadway space
- Presence of dedicated bicycle roadway space at intersections (no bike lane drop for dedicated turn lanes)
- Width of dedicated bicycle roadway space
- Traffic volumes
- Traffic speed
- Topography

Given the unique qualities of the Ralston Avenue corridor and the inability to determine which factors above will be addressed in the design, it is not possible to quantitatively determine future demand.

However, the bicycle counts shown in Figure 10 illustrate that the corridor is already well used by bicyclists. Community input has revealed there is a strong latent demand for dedicated bicycle facilities along the corridor and because of that, it can be assumed that if continuous facilities were provided, more bicyclists would use the corridor.

Transit Facilities

There are two local and regional transit services providers in the City of Belmont: SamTrans and Caltrain. Below is a summary of the transit services provided along Ralston Avenue.

SamTrans

The San Mateo County Transit District operates SamTrans, a fixed-route bus service within San Mateo County. SamTrans primarily serves as a local transit provider within San Mateo County, but also provides connecting regional services to neighboring Santa Clara and San Francisco Counties. All SamTrans buses are equipped with bike racks, which hold two bikes. Two additional bikes are allowed inside the bus, depending on passenger loads.

The following routes currently serve the Ralston Avenue corridor and are shown in Figure 11:

- Route 260 provides service along Ralston Avenue, terminating at the College of San Mateo to the west and connecting to Redwood Shores and the San Carlos Caltrain station to the east. There are stops at both the Belmont and San Carlos Caltrain stations. The route runs on weekdays on an approximately one-half hour headways with extra service on school days.

- Route 262 traverses the portions of the Ralston Avenue corridor between Hiller Street and El Camino Real, and again west of Alameda de las Pulgas. The route terminates at the Hillsdale Caltrain station to the north and the Carlmont Village Shopping Center to the south. On school days, the route is extended to stop at the Ralston Middle School and Carlmont High School. Service is provided on approximately one-hour headways on weekdays.

Additionally, SamTrans routes KX, 390, 391, 397 and ECR run along El Camino Real, crossing Ralston Avenue. Riders waiting along Ralston Avenue can use either route 260 or 262 to connect to these regional routes. While weekend service is provided along some of the El Camino Real Routes, Routes 260 and 262 only operate on weekdays. Therefore, if a rider along Ralston Avenue wanted to utilize one of the El Camino Real routes on the weekend, they would have to use a different mode of transportation to reach El Camino Real.

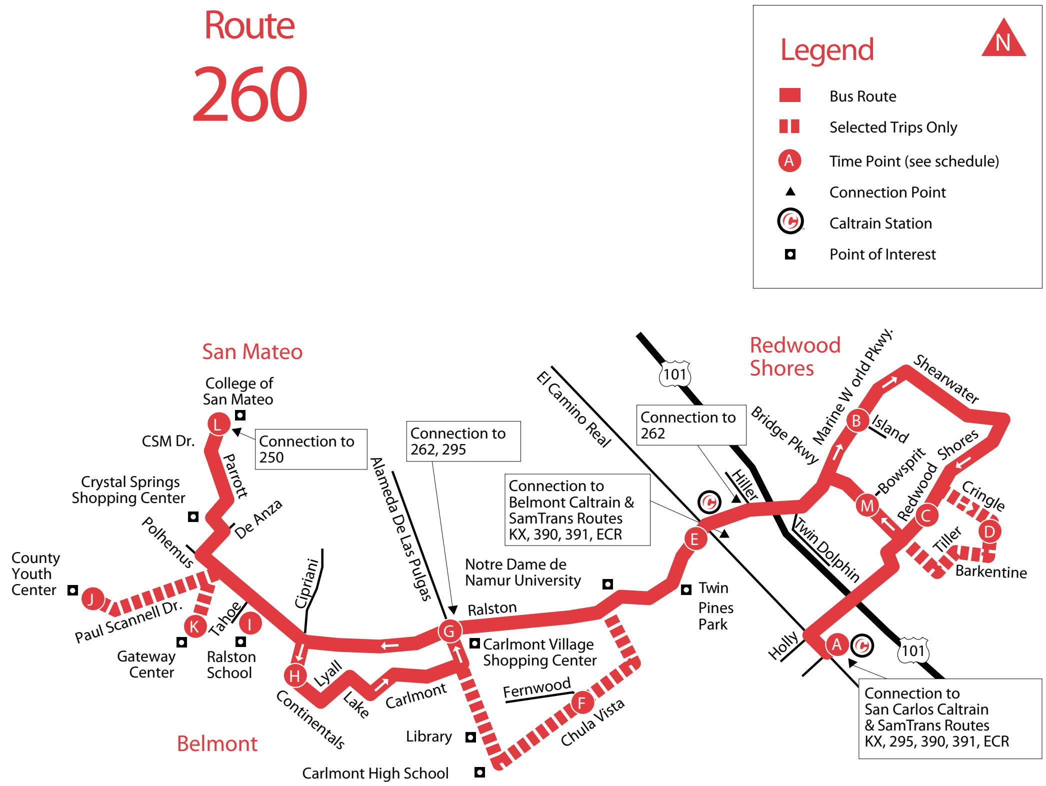
Paratransit, also known as dial-a-ride or door-to-door service, is available for those who are unable to independently use the transit system due to a physical or mental disability. SamTrans provides paratransit services through the affiliated Redi-Wheels and RediCoast providers. Paratransit service is designed to serve the needs of individuals with disabilities within South San Francisco and the greater San Mateo County.

Caltrain

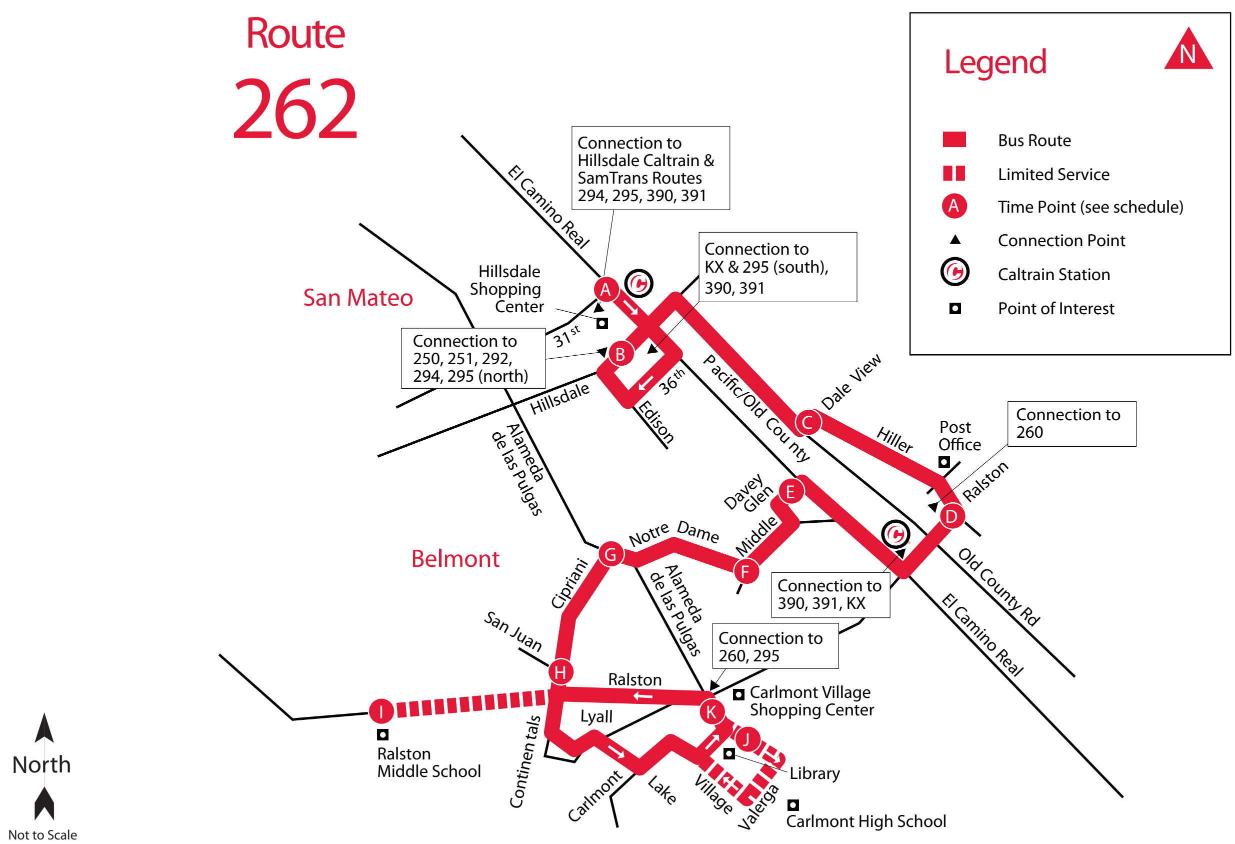
Caltrain is a regional, intercity commuter rail service between San Francisco and Santa Clara Counties. On weekdays, service extends between San Francisco and Gilroy, and on weekends, San Jose is the service's southern terminus. The Belmont station is located along El Camino Real at Ralston Avenue. Currently, there are 23 northbound and 23 southbound trains that stop at the Belmont Station, of which nine in each direction are limited-stop, express trains. On Saturdays, the Belmont Station serves 16 trains in both the northbound and southbound directions and 14 trains in each direction on Sundays. The Belmont Station is not served by the weekend express trains.

On weekdays a shuttle service is provided between the Belmont Caltrain Station and Hillsdale Caltrain Station during the morning and evening commute periods. These free shuttles provide connections with

Route 260



Route 262



Source: SamTrans

001blm.ai 8/13

Ralston Avenue Corridor Study – Issues and Analysis Report

Figure 11 – Transit Routes

the employer shuttles at the Hillsdale station, as well as connections to "Baby Bullet" express trains that stop at the Hillsdale station, but do not stop at the Belmont station.

Parking facilities are available at the Belmont Caltrain station for riders. Currently there is no charge for passenger parking at the Belmont Station; however, the free parking program is scheduled to end in December 2013, at which time a fee for parking may be instated. Passengers are allowed to transport bicycles on designated bicycle train cars. As discussed in the previous section, SamTrans lines provide connections along Ralston Avenue to the Belmont Caltrain station.

Introduction

Ralston Avenue is an east/west divided arterial that extends from SR 92 in the west to US 101 in the east. The speed limit ranges from 30 mph to 40 mph with segments at 25 mph when children are present. The Corridor currently has twelve signalized intersections, as shown in Figure 12, some of which operate with an LOS F during the peak hours creating significant back-ups, decreasing air quality and impacting traffic and pedestrian safety. There are a number of schools along the Corridor with some accessible only from Ralston Avenue.

Figure 12 – Ralston Avenue Study Area

Evaluation of Unsignalized Intersections

There are five unsignalized intersections identified within the study area which may require upgrades such as a new traffic signal, in pavement flashing crosswalks, flashing beacons, geometric modifications and/or other traffic control devices. With the exception of the intersections of Ralston Avenue/Tahoe Drive and Ralston Avenue/Notre Dame University Road, all intersections have an existing pedestrian crosswalk across Ralston Avenue. Four of the unsignalized intersections are located between the signalized intersections at Alameda de las Pulgas and Sixth Avenue, a distance of without a controlled crossing of 3,900 feet.

Prior to making any recommendations, a signal warrant analysis was performed for each intersection to determine if there is justification to consider a new signal. The 2012 *California Manual on Uniform Traffic Control Devices* (CA MUTCD) establishes nine warrants to determine potential need for intersection signalization:

1. Eight-Hour Vehicular Volume
2. Four-Hour Vehicular Volume
3. Peak Hour
4. Pedestrian Volume
5. School Crossing
6. Coordinated Signal System
7. Crash Experience
8. Roadway Network
9. Intersection Near a Grade Crossing

For planning purposes, the Peak Hour Volume Warrant (Warrant Number 3) was used to evaluate potential need for signalization. The results of this analysis are summarized in Table 21. Detailed worksheets are provided in Appendix E.

Table 21
Signal Warrant Analysis Summary

Intersection	Warrant Satisfied? (Yes or No)
Ralston Ave/Tahoe Dr	Yes
Ralston Ave/Notre Dame Dr	Yes
Ralston Ave/Chula Vista Dr	Yes
Ralston Ave/Notre Dame University Rd	Yes
Ralston Ave/South St	Yes

Volumes at all five of these intersections currently satisfy the peak hour volume traffic signal warrant. It should be noted that, as stated in the CA MUTCD, the "satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal." Prior to installing a signal "adequate trial of other alternatives that could cause less delay and inconvenience to traffic" should be implemented and observed.

Ralston Avenue/Tahoe Drive

The only warrant that is satisfied for this intersection is Warrant 3 – Peak Hour Volume, which indicates that during the peak of the peak, side street traffic will experience a significant delay when trying to cross or enter Ralston Avenue. Because this is the only warrant met and no existing crosswalk exists crossing Ralston Avenue, other alternatives should be considered before installing a signal. Potential modifications that will be evaluated during the alternatives development phase include:

- Updating the coordination plans at Belmont Canyon Road and Davis Drive to ensure that there is a gap during the peak of the peak for vehicles on Tahoe Drive to turn into Ralston Avenue.
- Removing the raised median on the west leg and striping a two-way left-turn median, which will give the northbound left-turn vehicles room to wait for a gap and enter the westbound Ralston Avenue traffic.

Ralston Avenue/Notre Dame Avenue

In addition to the peak hour warrants that was satisfied for this intersection, Warrant 7 – Crash Experience, may be met if other mitigation measures fail to reduce the crash frequency, which currently ranks as one of the highest amongst all the intersections along the Ralston Avenue corridor. Due to the number of warrants that were met, a new traffic signal or other traffic control at this location may be considered as corridor alternatives are developed.

Ralston Avenue/Chula Vista Drive and Ralston Avenue/Notre Dame University Road

These two intersections are in the middle of the unsignalized locations experiencing delays on the side street. Though both intersections satisfy the peak hour warrants, improvement measures other than signalization may help alleviate congestion at these intersections. If the City elects to signalize these two locations at some point, it is recommended that the possibility of running both with one controller be explored to ensure there are no back-ups between the intersections.

Ralston Avenue/South Road

The only warrant that is satisfied for this intersection is Warrant 3 – Peak Hour Volume, which indicates that during the peak of the peak, drivers on the side street will experience significant delay when trying to cross or enter Ralston Avenue. It was noted that this intersection has an existing crosswalk that crosses Ralston Avenue which experiences a high volume of pedestrian and bicycle traffic during the various peaks of the day. Because of these high pedestrian crossing volumes and the fact that South Road is the first intersection west of Sixth Avenue with a marked crosswalk, consideration of other pedestrian amenities will be explored along with traffic control options. These may include:

- Flashing beacon scheduled to go on during certain times of the day
- In-pavement flashing lights to improve the visibility of pedestrians and bicyclists crossing Ralston Avenue
- Enhanced advance warning signs and/or pavement markings

Basic Timing Parameters

This section provides information on the existing timing parameters for all the intersections in the study area. The signal timing parameters and the phasing configuration were reviewed for the safe operation of the intersections and to check whether they meet the minimum times recommended. The following timing parameters were used for reviewing the operation of each phase at the intersection.

- Yellow Time
- All-Red Clearance Time
- Walk Time
- Flashing Don't Walk Time
- Minimum Green Time
- Vehicle Extension
- Extension Reduction
- Recall Operation

Some of the settings (i.e. vehicle and pedestrian clearance intervals) are important for the safe operation of the intersection and can provide significant liability if they do not meet the minimums recommended. Other settings such as the actuated settings (minimum green, vehicle extension, and recall operation) assist in providing a more efficient operation of the intersection during coordinated and non-coordinated times.

As of January 2012, the CA MUTCD incorporated the Federal Highway Administration's (FHWA's) 2009 MUTCD, which had already been adopted nationally. Any proposed values based on the new guidelines will be submitted to all the agencies for review prior to conducting any optimization analysis.

Review of Vehicle and Pedestrian Clearance Intervals

The general guideline, per the CA MUTCD and experience from similar projects, used to calculate the standard values are listed below.

- Yellow times were calculated based on the requirements of the CA MUTCD using the higher of either the posted speed limits or the 85th percentile speed (if available) rounded to the nearest 5 mph. In addition, it is recommended that the CA MUTCD yellow times be rounded to the nearest 0.5 second, as shown below.

Speed (mph)	Yellow Time (CA MUTCD) (sec)	Yellow Time (ROUNDED) (sec)
< 25	3.0	3.0
30	3.2	3.5
35	3.6	4.0
40	3.9	4.0
45	4.3	4.5
50	4.7	5.0
55	5.0	5.0
60	5.4	5.5
65	5.8	6.0

Furthermore, the yellow time for all left-turn phases are recommended to be 3.5 seconds to ensure a conservative clearance interval, especially at locations with red light cameras.

- Red clearance intervals, as per the CA MUTCD, should normally range from 0.1 to 2 seconds and should never exceed 6 seconds.
  - o Bicycle clearance interval calculated per the CA MUTCD guidelines:

  $G_m \geq 6 + (W + 6) / 14.7 – Y – AR$, where

    G_m = Minimum green time (sec)
    W = Distance from limit line to far side of last conflicting lane (ft)
    Y = Yellow time (sec)
    AR = All red time (sec)

- The CA MUTCD recommends a walk time of between 4 and 7 seconds. Based on previous projects and existing values, the following is recommended:
  - o Walk time for Caltrans locations = 5 seconds
  - o Walk time for City locations = 7 seconds
  - o Walk time for locations with school crossing = 8 seconds

- Flashing Don't Walk (FDW) values were calculated using a crossing distance measured from the center of the curb ramp to the center of the opposing curb ramp and a walking speed of 3.5 feet per second (ft/sec), per the CA MUTCD. In addition to walking speeds and crossing distances, as shown in Figure13, the pedestrian clearance interval can also include the yellow and/or all red clearance intervals, which will reduce the total FDW value.

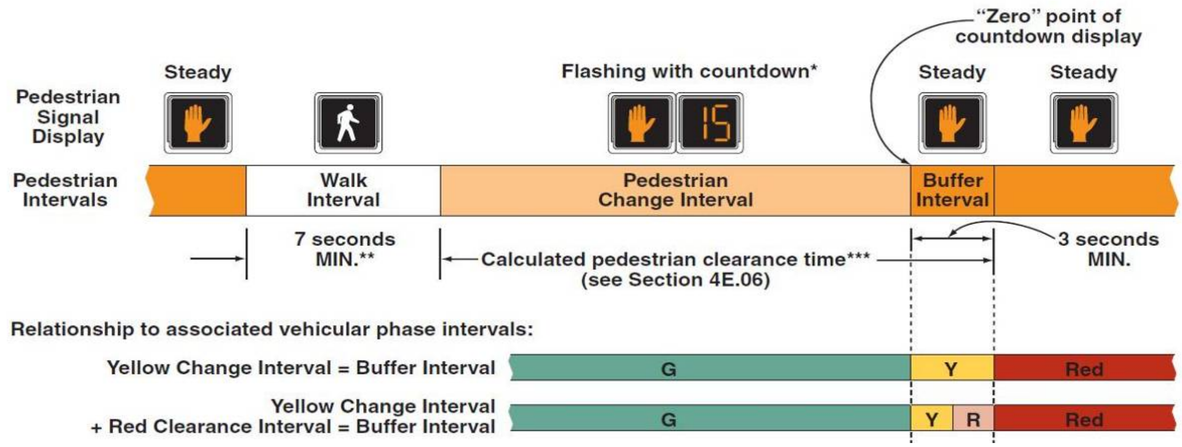


Figure 13 – Pedestrian Interval Options (CA MUTCD Figure 4E-2)

All Caltrans locations will include the yellow and all red, per Iteris' previous experience. It is recommended that only the yellow interval be included for the City locations, however. This will ensure that no pedestrians are in the intersection during the red interval. Therefore, the following calculations were used for the FDW interval.

- Caltrans FDW = Distance / 3.5 – Yellow – All Red
- City FDW = Distance / 3.5 – Yellow

It should be noted that the above recommendations are based on engineering experience from similar projects. Should the agencies determine that a different approach is preferred, modifications will be made prior to any additional analysis or timing implementation.

Review of Additional Basic Timing Parameters

There are no guidelines in the FHWA MUTCD or the CA MUTCD regarding the actuated settings (vehicle extensions, density features, recall options, etc.). However, Table 22 summarizes general guidelines proposed for all basic timing parameters at the City locations assuming they are operating with BI Tran 233 firmware. These guidelines were generated through similar previous projects and engineering judgment.

Table 22
General Guideline for Basic Timing Parameters

Parameter	Value	Application
Phase Timing Data [C+0+F=1] <F+Col+Row> (Phases are in Columns 1-8)		
0 PED WALK	4 – 7 sec	Use seven (7) seconds at typical locations. In unusual situations where the overall signal cycle length is critical, the duration can be reduced to a minimum of four (4) seconds.
	8 sec	Locations with school crossing or high student traffic
1 PED FDW (Pedestrian Flashing Don't Walk)	Variable	FDW = D/3.9 – Y, D = Distance of the crosswalk from the center of ADA ramp to center of ADA ramp Y = Yellow time defined below
2 MIN GREEN (Minimum Green)	Variable	Ensure that the minimum green is long enough to meet the minimum bicycle clearance interval: G_{min} = 6 + (D+6)/14.7 – Y – AR G_{min} = length of minimum green interval (sec) D = distance from limit line to far side of last conflicting lane (ft) Y = Yellow time defined below AR = All Red clearance time defined below
3 TYPE 3 DISCONNECT	0 sec	Approaches that do not have stop bar detectors or the stop bar detectors are not set-up as Calling (Type 3).
	Variable	This is only used if the stop bar detectors of the approaches are set-up as Calling (Type 3) and there is existing advance detectors. (D/25)*2 D = distance from advance loops to stop bar (ft) 25 = average vehicle length (ft) 2 = headway between vehicles (sec)
4 ADDED PER VEHICLE (Seconds per actuation – Added Initial)	0 sec	Typically used in conjunction with Max Initial and when there are no stop bar detectors. Added per Vehicle represents the time by which the variable initial time period is increased from zero with each actuation receiving during associated phase yellow and red intervals. If used, use a value of 2 seconds.
5 VEHICLE EXTENSION	Variable	Distance/Speed; where Speed = posted speed and Distance = distance from advance loop detector to stop line.
	2 sec	All exclusive left-turn movements, minor and major thru movement with only stop bar detectors.
6 MAX GAP (Maximum Gap)	Same as MIN GREEN	Major thru and shared movements – use in conjunction with Reduce Ever and Minimum Gap.
7 MIN GAP (Minimum Gap)	2 sec	Minimum time between vehicle actuations before gap out. Used in conjunction with Reduce Every.
	½ of VEH EXT	For approaches with advanced inductive loop detectors.
8 MAX LIMIT (Maximum Green 1)	40 sec	Major thru movement, depends on use – use larger values for higher volume intersections.
	30 sec	Minor thru movement, depends on use – use larger values for higher volume intersections.
	20 sec	Major left movement, depends on use – use larger values for higher volume intersections.

Table 22
General Guideline for Basic Timing Parameters

<table>
<tr><th colspan="2">Parameter</th><th>Value</th><th>Application</th></tr>
<tr><td></td><td></td><td>15 sec</td><td>Minor left movement, depends on use – use larger values for higher volume intersections.</td></tr>
<tr><td>9</td><td>MAX LIMIT 2
(Maximum Green 2)</td><td>Variable</td><td>Depends on use. If used, typically set to be larger than Maximum Green 1.</td></tr>
<tr><td>A</td><td>ADV/DELAY WALK
(Advance/Delay Walk)</td><td>0 sec</td><td>The Walk interval can be programmed to start prior to the beginning of its associated vehicle phase, which must be set to have an advance or delayed walk phase.</td></tr>
<tr><td>B</td><td>RR MIN PED FDW
(Rail Road Minimum Pedestrian Flashing Don't Walk)</td><td>0 sec</td><td>Not used under normal operation. This value is used to give quicker response for preempts which issue a Force Off. It allows preempt to shorten a phase's Flashing Don't Walk.</td></tr>
<tr><td>C</td><td>COND SERV CHECK
(Conditional Service Check)</td><td>0 sec</td><td>Not used under normal operation. If used, must be in conjunction with Conditional Service. This number is checked against the time remaining in the Max Timer of the non-terminating lag phase (in the other ring) to see if there is enough time left to allow a Conditional Service. If the intersection is in coordination, the "time before T_0" (Local Cycle Timer = Zero) is used in place of the remaining Max Time.</td></tr>
<tr><td>D</td><td>REDUCE EVERY</td><td>0 sec
2 sec</td><td>Not typically used for left turn movements.
Major Thru and shared movements. Each interval will be reduced by 0.1 seconds.</td></tr>
<tr><td>E</td><td>YELLOW CHANGE</td><td>3.5 sec
3.0 – 6.0 sec</td><td>Protected left or right turn movements.
Per the California MUTCD, rounded up to nearest 0.5 seconds:
Table 4D-102 (CA)
Minimum Yellow Light Change Interval Timing
<table>
<tr><th colspan="2">85% Speed or Posted Speed</th><th>Min. Yellow Interval</th><th>Yellow Interval (PR)</th></tr>
<tr><th>mph</th><th>Km/h</th><th>Seconds</th><th>Seconds</th></tr>
<tr><td>25 or less</td><td>40 or less</td><td>3.0</td><td>3.0</td></tr>
<tr><td>30</td><td>48</td><td>3.2</td><td>3.5</td></tr>
<tr><td>35</td><td>56</td><td>3.6</td><td>4.0</td></tr>
<tr><td>40</td><td>64</td><td>3.9</td><td>4.0</td></tr>
<tr><td>45</td><td>72</td><td>4.3</td><td>4.5</td></tr>
<tr><td>50</td><td>80</td><td>4.7</td><td>5.0</td></tr>
<tr><td>55</td><td>89</td><td>5.0</td><td>5.0</td></tr>
<tr><td>60</td><td>97</td><td>5.4</td><td>5.5</td></tr>
<tr><td>65</td><td>105</td><td>5.8</td><td>6.0</td></tr>
</table>
Any timing for yellow less than 3.0 seconds and more than 6.0 seconds will be ignored by the controller.</td></tr>
<tr><td>F</td><td>RED CLEAR
(All Red Clearance)</td><td>0.5 sec
up to 0.5/1.0 sec</td><td>Protected left turn movements
All thru movements depending on the yellow interval. Yellow + All Red should equal a whole number.</td></tr>
</table>

Table 22
General Guideline for Basic Timing Parameters

Parameter		Value	Application
Phase Function [C+0+F=1] <F+F+Row>			
0	PERMIT	Yes	Allows only the assigned phases to be answered under the normal operations.
1	RED LOCK	No	Vehicle calls may be locked into each phase when the phase is red. Not used under normal operation.
2	YELLOW LOCK	No	Vehicle calls may be locked into each phase at the beginning of the yellow change interval. Not used under normal operation.
3	MIN RECALL	No	Not used under normal operation.
		Yes	Parallel thru phases at major/major crossing arterials. Will cause a phase to time a Minimum Green.
4	PED RECALL	No	Avoid using PED recall if pedestrian detection is functional.
5	VIEW SET PEDS	View ONLY	Displays the assigned pedestrian phases as programmed in the Configuration Data.
6	REST IN WALK	No	This phase function flag, when set with PED RECALL, causes the phase to rest at the end of the pedestrian walk interval.
7	RED REST	No	Not used under normal operation. If enabled, will cause a phase to terminate even in the absence of a conflicting call. If any recall is selected or Hold is set, the phase will not rest in RED.
8	DUAL ENTRY	Yes	Turns on two separate signal indications at the same time. Typically used for all thru phases.
9	MAX RECALL	No	Avoid using MAX recall if all detectors are functional.
A	SOFT RECALL	Yes	For all major coordinated phases Soft Recall will cause the controller to recall and rest in the selected phase.
B	MAX 2 (Maximum Green 2)	No	Not used under normal operation.
		Yes	If Max Limit 2 is being used, especially during coordination when assigned split time is greater than Max Limit and less than Max Limit 2.
C	COND SERVICE (Conditional Service)	No	Lead phases, which are allowed to be conditionally served for a second time in a given cycle. Not typically used under normal operation.
D	MAX COND CALLS (Maximum Conditional Calls)	No	Used in conjunction with Conditional Service. A maximum call is placed on the selected phase so that if the phase is reserviced, the phase will not Gap Out.
E	YELLOW START	Yes	These will be the phases to start in yellow after a restart (power-up or flash exit), typically the side street through phases.
F	FIRST PHASES	Yes	These will be the first green phases serviced in the restart sequence, typically the through movements along the major arterial/corridor.

Notes: These guidelines are just general settings and would need to be modified if a particular intersection requires special attention. The City will have an opportunity to provide preferences on actuated settings for optimum operation for its signals.
Source: Iteris 2013

Proposed Timing Parameters

The existing vehicle and pedestrian clearance intervals obtained from the City were compared to the calculated values described above. Appendix F summarizes the comparison, which includes the existing, calculated, and proposed values for each interval: Minimum Green, Bicycle Green, Yellow All Red, Walk, and FDW. Following is a summary of the recommendations:

- *Minimum Green:* Because there may be external reason for a longer existing minimum green time, it is proposed that the minimum green value be the higher of the existing versus the bicycle minimum calculated.
- *Yellow:* It is recommended that all yellow clearance intervals match the calculated values, especially since the guidelines are more conservative.
- *All Red:* To ensure that the yellow + all red intervals equals a whole number, it is recommended that the all red interval match the calculated values.
- *Walk:* In order to have a consistent starting point, it is recommended that the walk time match the calculated values.
- *FDW:* Due to the new walking speed and the conservative measurement of the crosswalk distances, it is recommended that the FDW match the calculated values.

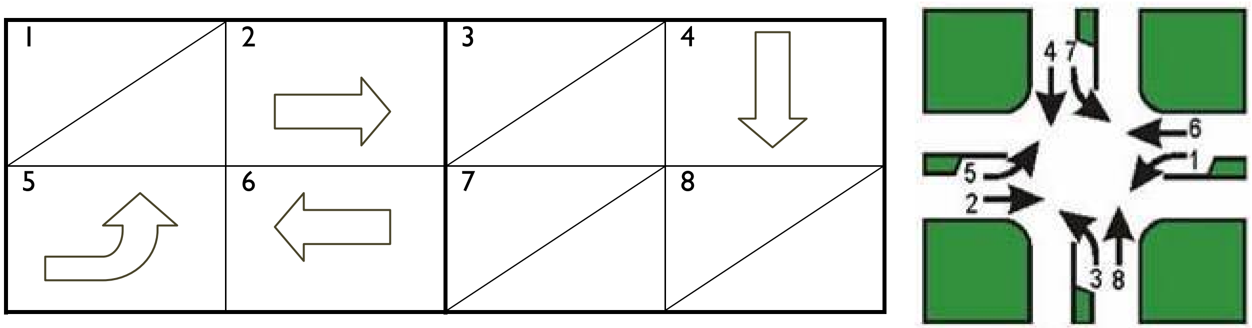
As summarized in Appendix F, most existing yellow time values were lower than the calculated values, which are mainly attributed to the rounding used per the recommended guidelines. Existing all-red clearance intervals were between 0.0 and 1.0 seconds. Proposed all-red clearance intervals are either 0.5 or 1.0 second, which is a mix of higher and lower values versus the existing.

Existing walk times were between 5 and 9 seconds. Walk times can be lowered to 4 seconds if the agency desires and there can be further discussions regarding locations where 9 seconds is used to determine if such a long walk time is necessary. As for the FDW times, the existing values were typically lower when compared to calculated values, which was mainly due to the change in pedestrian walking speed (to 3.5 feet/second) and potentially due to the measurement of the crosswalk distances.

If there is a need to reduce the pedestrian clearance times in order to provide better vehicular coordination without violating the pedestrian clearance intervals, recommendations will be made to agency staff. Changes to walk and FDW times will not be made unless approved by agency staff.

The agency controller software does not currently have bicycle timing parameters and/or separate bicycle detection. Therefore, the suggested vehicle minimum green times are long enough to meet the minimum bicycle green times. Based on the analysis, bicycle minimum green time is significantly higher for the left-turn and side street through movements. The major through movements, however, have longer existing minimum green values than the calculated, which will remain as is unless otherwise requested by the City.

Preliminary timing (minimum green, yellow, all red, walk, and FDW) values are also included for the five unsignalized intersections should the City wish to signalize them. The phasing used follows the scheme to the right in the diagram below. For example, at Ralston Avenue and South, the only movements are the eastbound through and left-turn, westbound through, and southbound right-turn and left-turn. The proposed phasing for this particular location is shown on the left side of the following diagram.



Signal System Evaluation

The City of Belmont currently operates a Bi-Trans QuicNet central traffic control system (TCS) with Model 170, 170A and 170E controller hardware and 233 firmware. During field investigations it was reported that the QuicNet system is currently out of date and QuicNet expertise among City staff is minimal resulting in the system falling into disrepair.

As a stakeholder in the San Mateo Smart Corridor Program, the City of Belmont will receive a new central TCS (KITS by Kimley-Horn and Associates, Inc.) and traffic controller hardware for intersections located in the Smart Corridor project area.

San Mateo Smart Corridor KITS Deployment

The San Mateo Smart Corridor Program was initiated by the City/County Association of Governments of San Mateo (C/CAG) in association with Caltrans District 4, the San Mateo County Transportation Authority (SMCTA), and the participating local agencies, to address the operation of the US 101 corridor that includes both freeway and local arterials, with the intent of benefiting a variety of users. The overall goal is to improve operations along the US 101 corridor, including the local arterials, to better accommodate the influx of traffic that diverts off of US 101 onto the local arterials during times of recurring and non-recurring congestion on US 101.

Early in the Smart Corridor Program it was understood that deploying Intelligent Transportation Systems (ITS) strategies along key arterial corridors was essential to achieving the overall goal of the Smart Corridor Program. The program will implement the ITS strategies listed below (all quantities are preliminary).

- *Traffic Signal System:* The Program includes 250 traffic signals in San Mateo County, with nearly half of the total traffic signals belonging to Caltrans; most are located along El Camino Real. The traffic signals included in the San Mateo Program will receive new traffic signal controllers installed in a combination of 332 and NEMA cabinets. A new central system, KITS, will be implemented at Caltrans and each of the Project Stakeholders' TMCs (City Hall), for central monitoring and control of the new traffic signal controllers.

- *Trailblazer Signs (TBS):* The Program includes 111 TBS installed primarily along the local arterials, as well as at selected US 101 and SR 92 off ramps.

- *Arterial Dynamic Message Signs (ADMS):* The Program includes eight ADMS installed primarily along El Camino Real at locations where more information is necessary than can be displayed on the TBS, such as in advance of key diversion points (El Camino Real north and south of SR 92).

- *CCTV Cameras:* The Program includes 80 Closed Circuit Television (CCTV) camera locations that use a combination of mostly fixed view CCTV cameras and a few full pan, tilt, and zoom (PTZ) cameras.

- *Microwave Vehicle Detection Systems (MVDS):* The Program will deploy 43 MVDS locations that provide mid-block vehicle detection along select arterial links.

- *Communications Network:* The Program will implement single mode fiber optic cable to support an Ethernet-based communication network comprised of Edge Ethernet switches, Aggregation Hub switches, and Layer 3 Routers. The Edge switches are installed at each traffic signal (most Edge switches at traffic signals also support the CCTV camera, MVDS and TBS), select CCTV camera locations, select TBS locations and the ADMS locations. Along El Camino Real, Gigabit Ethernet Aggregation switches (inset is Hub switch from Demonstration Project at Iteris' lab) will be installed within Type 334 communication hub cabinets that in turn will provide backbone communication to either the San Mateo Police Station or BART station, for backbone communications to the Caltrans District 4 TMC.

<u>KITS Deployment Overview</u>

The KITS central management system for this project will be a commercial-off-the-shelf (COTS) KITS 12.5A with the following enhancements:

- Integration of the newest version of traffic signal control program (TSCP) firmware as available from Caltrans Headquarters on date of notice to proceed:
  - Update of timing editing pages
  - Update of upload/download process
  - Daily batch compare
  - Integration on Laptop application (D4+TSCP) for serial and internet protocol communications

The central management system software license will include unlimited users within San Mateo County and Caltrans District 4. The features of the COTS system that meet the functional requirements set forth by the Smart Corridor Program are identified in Kimley-Horn's Scope of Work, which is available in Appendix G.

KITS servers and workstations will be deployed throughout the County as shown in Table 23. The City of Belmont will receive a Communications Server that will carry out communications from the Distributed Database Server and Application Servers located at the City of San Mateo Communications Hub. For agencies such as the City of Belmont that will receive a Communications Server, intersections on the Smart Corridor in the agency will be integrated with the communications server and local database. Database replication services will be available for failover operation in the event that the connection between the San Mateo Hub and the agency is severed. In the event of loss of communications with the San Mateo Hub, the agency will be able to continue to operate the signals in their jurisdiction. Other signals, such as those under "Monitoring Workstation Only" on the Smart Corridor will not be available.

Table 23
Workstation and Server Deployment Summary

Agency	Monitoring Workstation Only	Communications Server	Distributed Database and Communications Server
San Bruno	X		
Millbrae	X		
Burlingame		X	
San Mateo	X		
San Mateo County	X		
Belmont		X	
San Carlos	X		
Redwood City			X
Atherton	X		
Menlo Park			X
East Palo Alto		X	
Caltrans District 4			X

The City of Belmont will receive a workstation and client applications software and a communications server. All of the City of Belmont Smart Corridor will be connected to their communications server. Communications servers will have the following minimum specifications:

- 16GB RAM
- 2TB Hard Drive Space
- Windows Server 2008 OS
- Quad core processor

In addition to the server, the City will receive a rack-mounted KVM switch and integrated monitor, keyboard, and mouse.

Traffic Signal Controllers

For signals within the Smart Corridor project area, the City of Belmont will receive fully configured Model 2070 (E, L or N) controllers and Fourth Dimension D4 controller firmware with serial card for locations with serial communications for their Smart Corridor intersections. The Smart Corridor consultant will convert existing timing parameters to the D4 format and assist City staff in change-out of the existing controller to the new controller.

Smart Corridor Deployment and Support

As part of the Smart Corridor project, C/CAG and its consultants will provide the City of Belmont with the necessary base maps, configuration files, and intersection graphics required for KITS. In addition to configuring and integrating the system, on-site training for the technical skills needed to effectively operate and maintain all system features and components will be provided to every participating agency. Sessions will also include "hands on" training, such as basic and advanced sections for field firmware and central management system.

The Smart Corridor consultant will provide five years of warranty support. This will consist of 24 hours, seven days a week warranty support for critical issues when necessary to cover all central system software, firmware, and field controller elements of this project. At the conclusion of the initial five-year warranty period KITS maintenance will be the responsibility of Caltrans for the signals within the Smart Corridor project area. The City of Belmont will be responsible for maintaining the signals outside the Smart Corridor project area.

Central Server and Workstation Hardware warranties will be transferred to C/CAG or designated agencies, as appropriate. Hardware warranties will match the five years of warranty support provided by the Smart Corridor consultant.

Traffic Control System Options

KITS will be deployed as described previously at twelve of the eighteen traffic signals located within the City of Belmont. Therefore, the only traffic signals not included in the San Mateo Smart Corridor are those on Ralston Avenue between Alameda de las Pulgas and Hallmark Drive. These intersections include:

- Ralston Avenue/Alameda de las Pulgas
- Ralston Avenue/Cipriani Boulevard
- Ralston Avenue/Davis Drive
- Ralston Avenue/Hillcrest Drive
- Ralston Avenue/Hallmark Drive

The City of Belmont has the following options with regards to the five intersections listed above that are not part of the Smart Corridor project area and will not receive new controller hardware:

Option #1 – Maintain the current QuicNet system: In reality, this option equates to maintaining the status quo. The QuicNet system would remain out of maintenance and nearing obsolescence resulting in the City operating two separate traffic control systems.

Option #2 – Migrate to the current version of QuicNet: This option would require the City to purchase new central software and server hardware at a minimum. Annual software maintenance is strongly recommended as well. In effect, the City would maintain two traffic control systems that have very similar functionality. The KITS system will be provided at no cost to the City while the QuicNet upgrade would be paid for with City funds.

Option #3 – Migrate to KITS: This option would require the City to upgrade their controller firmware from McCain 233 to McCain 233-CC which is a version customized to operate with KITS. The firmware license costs approximately $1,000 per intersection and is sold by McCain. Integration services from Kimley-Horn would also be required. This option would result in a single, well-maintained traffic control system operating all signalized intersections in the City of Belmont.

<u>Signal System Recommendations</u>

It is recommended that the City of Belmont pursue Option #3, which would be to migrate all its signalized intersections to KITS. For minimal upfront costs the City will consolidate all traffic signals onto a single central system that is purchased and maintained by C/CAG. The only costs incurred by the City will be a firmware upgrade to their existing Model 170 controllers. It will allow the City the flexibility to implement traffic signal timing plans in a coordinated fashion with Caltrans District 4 and the San Mateo Smart Corridor program.

As a next step, the City of Belmont should contact the appropriate vendors to obtain quotes on the firmware upgrade and associated integration services.

Study Participants and References

Study Participants

W-Trans

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