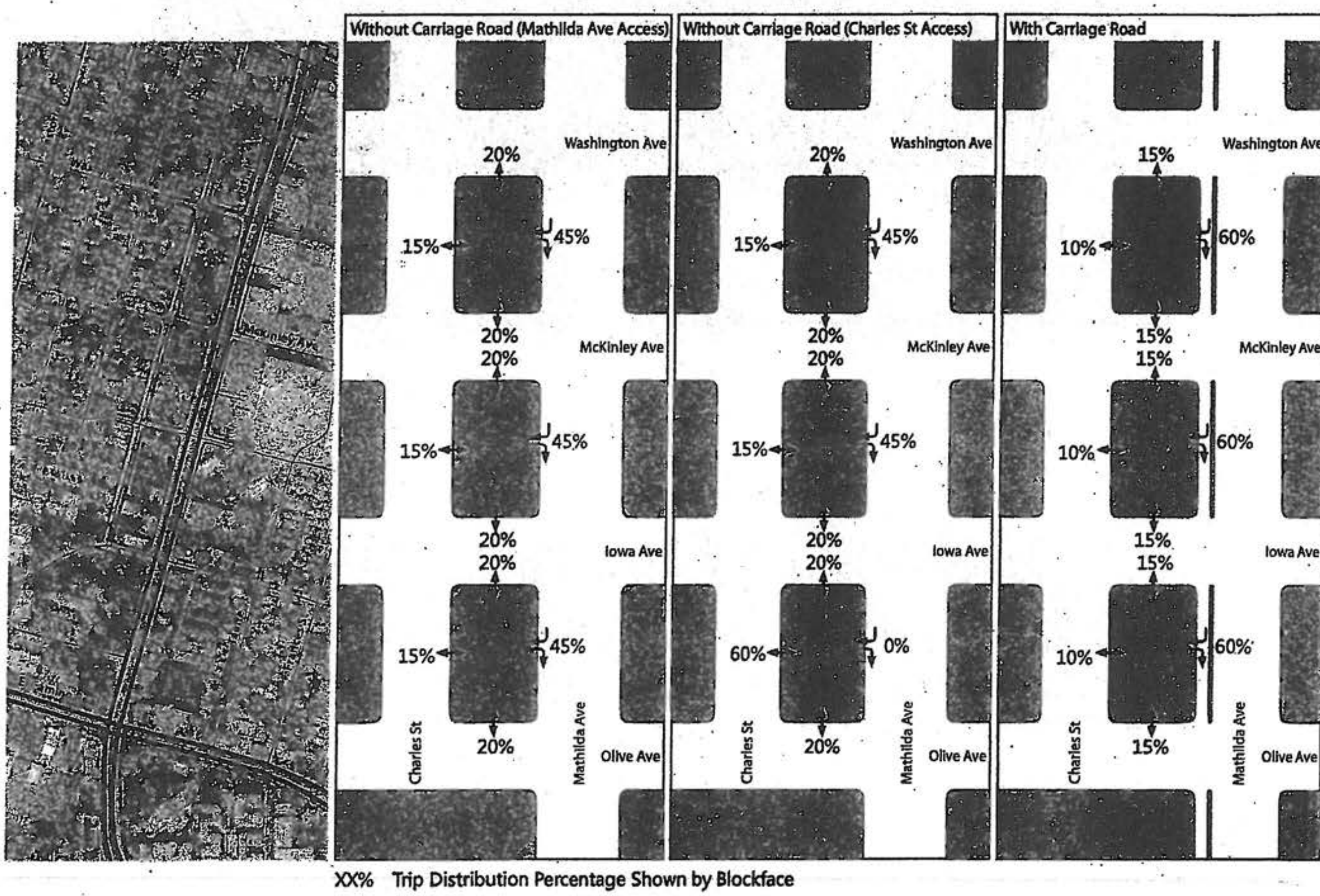


**Figure 7**

**Mathilda Carriage Road**
**Trip Distribution by Scenario (Percentage Shown by Blockface)**

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Date: July, 2013

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**Downtown Specific Plan Carriage Road Design**

The *Downtown Specific Plan* recommends the development of a carriage road on the west side of Mathilda Avenue. The goal of the carriage road is to provide access and circulation improvements for properties along the west side of Mathilda Avenue while limiting driveways and access points off the arterial corridor of Mathilda Avenue.

The Downtown Specific Plan calls for a one-way carriage road to west side of Mathilda Avenue, with an 8 foot wide parking lane, a 15 foot wide travel lane and a 7 foot wide landscaped median separating the carriage road from through travel lanes. The Specific Plan does not provide a detailed description of how the carriage road would operate.

The carriage road dimensions described in the *Downtown Specific Plan* require a dedication of 33 feet on the west side of Mathilda Avenue to construct the carriage road. On the east side of Mathilda Avenue, 27 foot wide sidewalks would be constructed using a 10 foot dedication along with the fourth northbound travel lane and existing right-of-way. The existing center median would be narrowed to accommodate wider travel lanes. The conceptual design of the Specific Plan carriage road is summarized in **Table 7** and in **Figure 8.**

Wider sidewalks reduce the need for building setbacks from the public right-of-way. As a result, the *Downtown Specific Plan* does not require minimum setbacks for developments that dedicate public right-of-way. Parcels developed since 2003 along the east side of Mathilda Avenue have included narrower sidewalks (between 10' and 15' wide including setbacks) than are called for in the Specific Plan.

The *Downtown Specific Plan's* carriage road concept would add parking spaces to the west side of Mathilda Avenue, where on-street parking is currently prohibited. Currently, parking is only present on the east side of Mathilda Avenue between El Camino Real and Olive Avenue.

**TABLE 7**
**DOWNTOWN SPECIFIC PLAN CARRIAGE ROAD CONCEPT CONFIGURATION**
*(Dimensions in feet)*

| Sidewalk (west) | Parking | Carriage Road | Planted Median | Southbound Travel Lanes | Landscaped Median (left turn lane) | Northbound Travel Lanes | Sidewalk (east) |
|---|---|---|---|---|---|---|---|
| 10.0 | 8.0 | 15.0 | 7.0 | 12.0 12.0 12.0 | 24.0 | 12.0 12.0 12.0 | 27.0 |
| Total right-of-way: 163<br>ROW is reduced to approximately 145-150 feet if sidewalks on east side are reduced to 10-15 feet in width consistent with recent office development along the corridor. | | | | | | | |
| Dedication: 33' | | | | | | | Dedication: 10' |

Sources: Fehr & Peers, 2013; City of Sunnyvale Downtown Specific Plan, 2002.

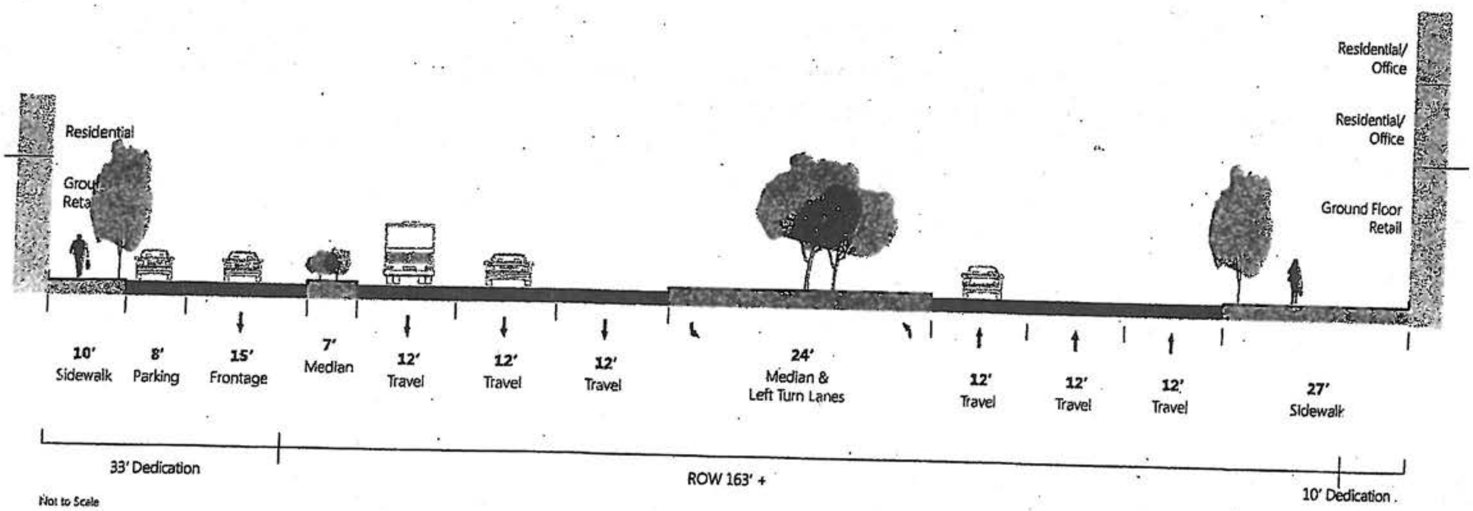


**Figure 8**

**Specific Plan Carriage Road**

**(Mid-block, Facing North)**



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**Level of Service Methodology**

The operations of roadway facilities are described with the term *level of service*. Level of Service (LOS) is a qualitative description of traffic from the driver's perspective based on such factors as speed, travel time, delay, and freedom to maneuver. Six levels are defined from LOS A, the least congested operating conditions, to LOS F, the most congested operating conditions. LOS E represents "at-capacity" operations. When traffic volumes exceed the capacity, stop-and-go conditions result, and operations are designated as LOS F.

Signalized intersections are analyzed using the method described in Chapter 16 of the 2000 Highway Capacity Manual (HCM) (Special Report 209, Transportation Research Board). This method evaluates signalized intersection operations on the average control vehicular delay.

Control delay includes initial deceleration delay, queue move-up time, stopped delay, and acceleration delay. The average control delay for signalized intersection is calculated using the Synchro 7.0 analysis software and is correlated to a LOS designation as shown in **Table 8.**

**TABLE 8**
**SIGNALIZED INTERSECTION LOS CRITERIA**

| Level of Service | Description | Delay in Seconds |
| --- | --- | --- |
| A | Progression is extremely favorable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay. | < 10.0 |
| B | Progression is good, cycle lengths are short, or both. More vehicle stop than with LOS A, causing higher levels of average delay. | 10.0 to 20.0 |
| C | Higher congestion may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level, though many still pass through the intersection without stopping. | > 20.0 to 35.0 |
| D | The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high V/C ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable. | > 35.0 to 55.0 |
| E | This level is considered by many agencies to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high V/C ratios. Individual cycle failures are frequent occurrences. | > 55.0 to 80.0 |
| F | This level is considered unacceptable with oversaturation, which is when arrival flow rates exceed the capacity of the intersection. This level may also occur at high V/C ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be contributing factors to such delay levels. | > 80.0 |

Source: Fehr & Peers, 2013.

**Level of Service Analysis**

Level of service analysis was conducted using the Synchro traffic operations modeling software package. A weekday peak hour Synchro model was developed for the length of Mathilda Avenue from El Camino Real to Washington Avenue and for the block between Iowa Avenue and Olive Avenue on the west side of Mathilda Avenue. Synchro traffic simulation software is based on procedures outlined in the Transportation Research Board's 2000 *Highway Capacity Manual* (HCM). The Synchro models were coded with existing peak hour volumes, posted speed limit, vehicle mix, and current traffic signal timings. Traffic signal-related information such as phasing and initial timings (minimum green, maximum green, gap, etc.) for the five study intersections was input based on Synchro files provided by the City of Sunnyvale and adjusted to replicate field conditions. Additional detail such as turn pocket lengths and intersection spacing was coded based on field measurements.

The Synchro model was converted to SimTraffic to verify that the model accurately reflects conditions observed in the field. SimTraffic captures the random nature of driver behavior and models the interaction between vehicles in a study network. Traffic simulation better accounts for delays under congested conditions including pedestrian crossings, queue blocking, and queue interactions between adjacent intersections when compared to traditional analysis methods. SimTraffic models reflecting existing field conditions require calibration to ensure that traffic volumes, queue lengths, and other operational observations are satisfactorily replicated.

SimTraffic is a stochastic model where different seed numbers generate different driver behaviors (i.e., accepting available gaps for turns, changing lanes, etc.) and system results. The *Guidelines for Applying Traffic Microsimulation Modeling Software* recommends multiple runs to account for this stochastic nature of the model and to achieve confidence in the simulated results.

*Existing*

To model Existing conditions, turning volumes from driveways counted in February 2013 were added to intersection turning volumes counted in December 2013. Intersection volumes were then balanced upwards. While this method is likely to slightly overestimate total volumes traveling on Mathilda Avenue, we preferred to present a conservative analysis of operations at study intersections rather than potentially undercount vehicles entering and exiting driveways within the study area. Turning volumes from intersection counts on Charles Avenue were likewise added to Mathilda Avenue intersections in order to present a conservative analysis. This resulted in an average delay at the Mathilda Avenue/Olive Avenue intersection of 25.4 seconds, which is slightly higher than what was calculated in our previous study.

All intersections operate at LOS D or better under Existing conditions, except the intersection of Mathilda Avenue/El Camino Real, which operates at LOS E during the PM peak hour, with an average delay of 58.7 seconds.

*Year 2035 No Carriage Road (Mathilda Access)*

Level of service analysis was conducted for No Carriage Road (Mathilda Access) conditions, with signal cycle lengths and offsets optimized. Under this scenario, the intersection of Mathilda Avenue and El Camino Real is forecasted to operate at LOS E during the AM peak hour, with an average vehicle delay of 76.3 seconds, and at LOS D during the PM peak hour, with an average vehicle delay of 54.8 seconds. The remaining study intersections would operate at LOS D or above during both AM and PM peak hours.

*Year 2035 No Carriage Road (Charles Access)*
Level of service analysis was conducted for Year 2035 No Carriage Road (Charles Access) conditions, with signal cycle lengths and offsets optimized. Under this scenario, the intersection of Mathilda Avenue and El Camino Real is forecasted to operate at LOS E during the AM peak period, with an average vehicle delay of 73.8 seconds, and at LOS D during the PM peak hour, with an average vehicle delay of 51.2 seconds. The remaining study intersections would operate at LOS D or above during both AM and PM peak hours.

*Year 2035 Carriage Road*
Level of service analysis was conducted for Year 2035 Carriage Road conditions, with signal cycle lengths and offsets optimized. All intersections are forecasted to operate at LOS D or better, with the exception of Mathilda Avenue/El Camino Real, which is forecasted to operate at LOS E during the AM peak period, with an average vehicle delay of 73.9 seconds, and at LOS D during the PM peak hour, with an average vehicle delay of 50.6 seconds.

Trips into driveways on Mathilda Avenue were modeled as through trips at the upstream intersection, assuming they would enter the carriage road mid-block instead of turning in directly from a side street Average vehicle delay is generally consistent across all three scenarios. However, compared to the other two Year 2035 scenarios the Charles Access scenario shows slightly higher level of service at the Mathilda Avenue/Olive Avenue intersection and slightly lower level of service at the Mathilda Avenue/Iowa Avenue intersection. The Charles Access scenario assumes that there will be no access to Block 14 via Mathilda Avenue. This eliminates the need for vehicles to make U-turns from the northbound or southbound left turn lanes at Mathilda/Olive in order to access driveways on the west side of Mathilda, thereby reducing delay at this intersection. At the Mathilda/Iowa intersection, however, more vehicles make eastbound left turns under the Charles Access scenario than under either of the other two study scenarios, which slightly increases average delay.

Depending on the ultimate layout of the frontage road intersections, reported delay may differ from what would actually occur under field conditions. Further analysis, using a more detailed traffic operations simulation software (such as VISSIM) and development of more detailed alternatives for carriage road operations and traffic control, would be needed to accurately assess level of service and plan carriage road operations.

Average delay and level of service during the AM and PM peak hours for all scenarios are reported in **Table 9.** Turning movement volumes for the three future scenarios are shown in **Figures 9, 10 and 11.**

**TABLE 9**
**EXISTING VERSUS YEAR 2035 CONDITIONS LEVEL OF SERVICE**

| Intersection | Peak Hour | Existing | | 2035 Charles Road | | 2035 No Charles Road | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Mathilda Access | | Charles Access | |
| | | Delay | LOS | Delay | LOS | Delay¹ | LOS² | Delay¹ | LOS² |
| 1. Mathilda Ave & Washington Ave | AM<br>PM | 20.1<br>30.6 | C<br>C | 33.1<br>52.8 | C<br>D | 30.3<br>52.3 | C<br>D | 32.1<br>48.2 | C<br>D |
| 2. Mathilda Ave & McKinley Ave | AM<br>PM | 8.3<br>15.4 | A<br>B | 9.2<br>22.1 | A<br>C | 14.0<br>21.5 | B<br>C | 8.3<br>22.7 | A<br>C |
| 3. Mathilda Ave & Iowa Ave | AM<br>PM | 16.1<br>15.2 | B<br>C | 8.4<br>36.8 | A<br>D | 10.3<br>35.2 | B<br>D | 9.5<br>46.4 | A<br>D |
| 4. Mathilda Ave & Olive Ave | AM<br>PM | 8.6<br>25.4 | A<br>C | 22.9<br>47.9 | C<br>D | 20.1<br>44.9 | C<br>D | 18.8<br>39.9 | B<br>D |
| 5. Mathilda Ave & El Camino Real | AM<br>PM | 48.9<br>58.7 | D<br>E | 73.9<br>50.6 | E<br>D | 76.3<br>54.8 | E<br>D | 73.8<br>51.2 | E<br>D |
| 6. Charles St & Iowa Ave* | AM<br>PM | 12.9<br>10.8 | A<br>A | | | | | 17.3<br>16.6 | A<br>A |
| 7. Charles St & Olive Ave* | AM<br>PM | 9.9<br>10.9 | A<br>A | | | | | 12.1<br>14.2 | A<br>A |

Source: Fehr & Peers, 2013.
Asterisk (*) indicates unsignalized intersection.
1. Whole intersection weighted average control delay expressed in seconds per vehicle calculated using methods described in the 2000 Highway Capacity Manual. For intersections #6 and #7, which are side-street stop controlled, intersection delay is reported for the worst approach, and LOS is reported for the entire intersection.
2. LOS = Level of service. LOS calculations conducted using the Synchro corridor analysis software package. Signal cycle lengths, phasing and offsets were optimized for 2035 General Plan conditions to align with City of Sunnyvale current practice.

**Corridor Speeds**

SimTraffic was used to calculate average travel speeds and times during the AM and PM peak hours for the Mathilda Avenue corridor between Washington Avenue and El Camino Real. Southbound travel speeds, which reflect delay resulting from driveway traffic along the west side of Mathilda Avenue, showed little variation between Year 2035 scenarios. Southbound vehicles are forecasted to have an average speed of 18-20 miles per hour during the PM peak hour under all Year 2035 scenarios. During the AM peak hour, southbound travel speeds are forecasted at 21-22 miles per hour in Year 2035. Travel speeds for all Year 2035 scenarios are summarized in **Table 10**.

**TABLE 10**
**CORRIDOR ARTERIAL SPEEDS**
*(Average peak hour vehicle speed in miles per hour, including intersection delay)*

| Corridor | Peak Hour | No Carriage Road (Mathilda Access) | | No Carriage Road ([illegible] Access) | | Carriage Road | |
|---|---|---|---|---|---|---|---|
| | | NB | SB | NB | SB | NB | SB |
| Mathilda Avenue (Washington-El Camino Real) | AM<br>PM | 18<br>19 | [illegible]<br>20 | 17<br>21 | 22<br>18 | 18<br>19 | [illegible]<br>20 |

Source: Fehr & Peers, 2013.
Results reflect signal phasing optimized for SimTraffic evaluation.

Travel times on the corridor under future year scenarios are shown in **Table 11.** Travel times vary no more than 20 seconds between the three Year 2035 scenarios.

Further analysis, using a more detailed traffic operations simulation software (such as VISSIM) and development of more detailed alternatives for carriage road operations and traffic control, would be needed to accurately assess level of service and plan carriage road operations.

**TABLE 11**
**CORRIDOR ARTERIAL TRAVEL TIMES**
*(Average peak hour vehicle travel time in seconds, including intersection delay)*

| Corridor | Peak Hour | No Carriage Road (Mathilda Access) | | No Carriage Road ([illegible] Access) | | Carriage Road | |
|---|---|---|---|---|---|---|---|
| | | NB | SB | NB | SB | NB | SB |
| Mathilda Avenue (Washington-El Camino Real) | AM<br>PM | [illegible]<br>137.9 | [illegible]<br>[illegible] | [illegible]<br>[illegible] | 132.8<br>[illegible] | [illegible]<br>[illegible] | [illegible]<br>126.2 |

Source: Fehr & Peers, 2013.
Results reflect signal phasing optimized for SimTraffic evaluation.

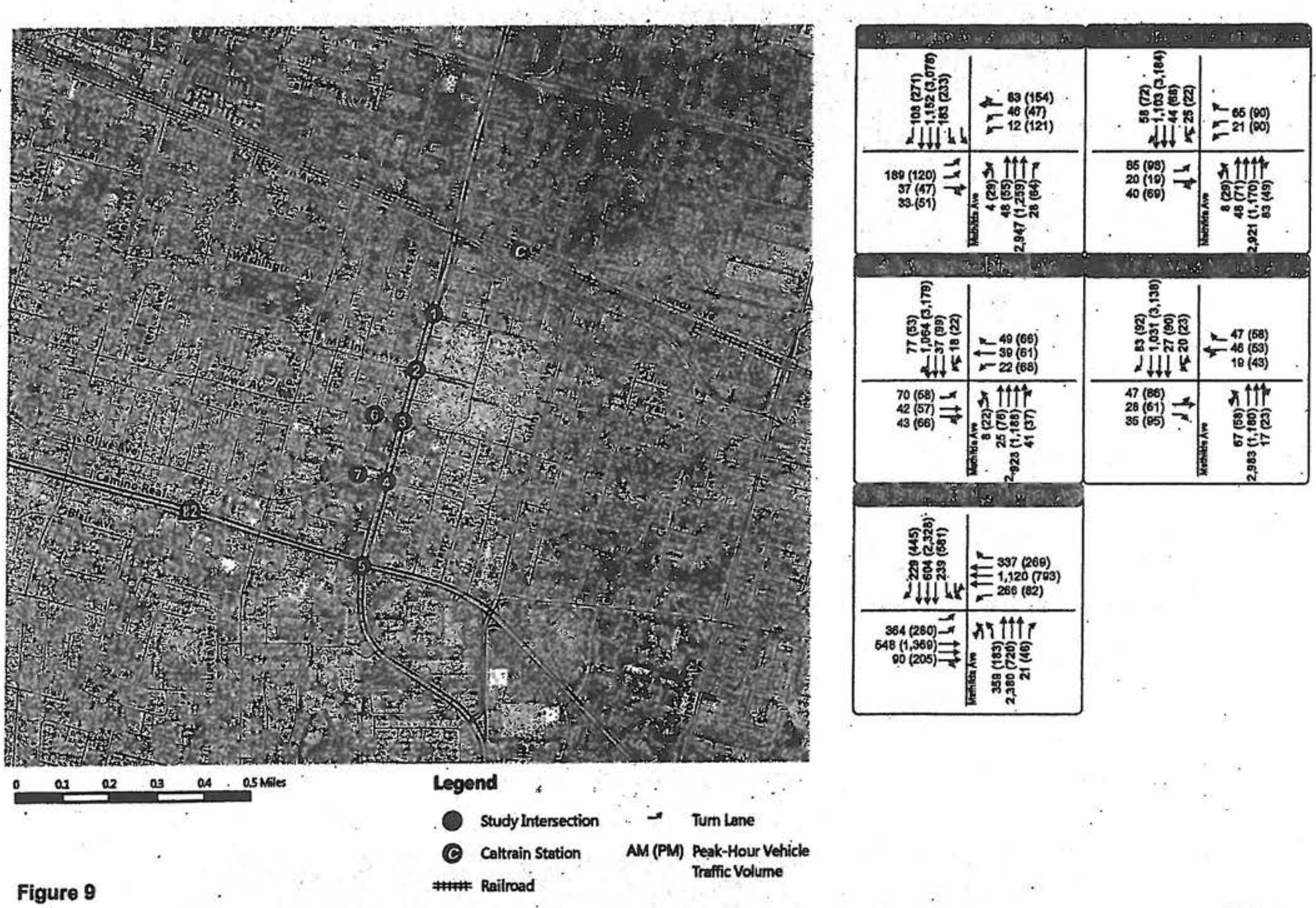


**Figure 9**

**Mathilda Carriage Road**
**Year 2035: No Carriage Road - Mathilda Access Scenario Vehicle Volumes**

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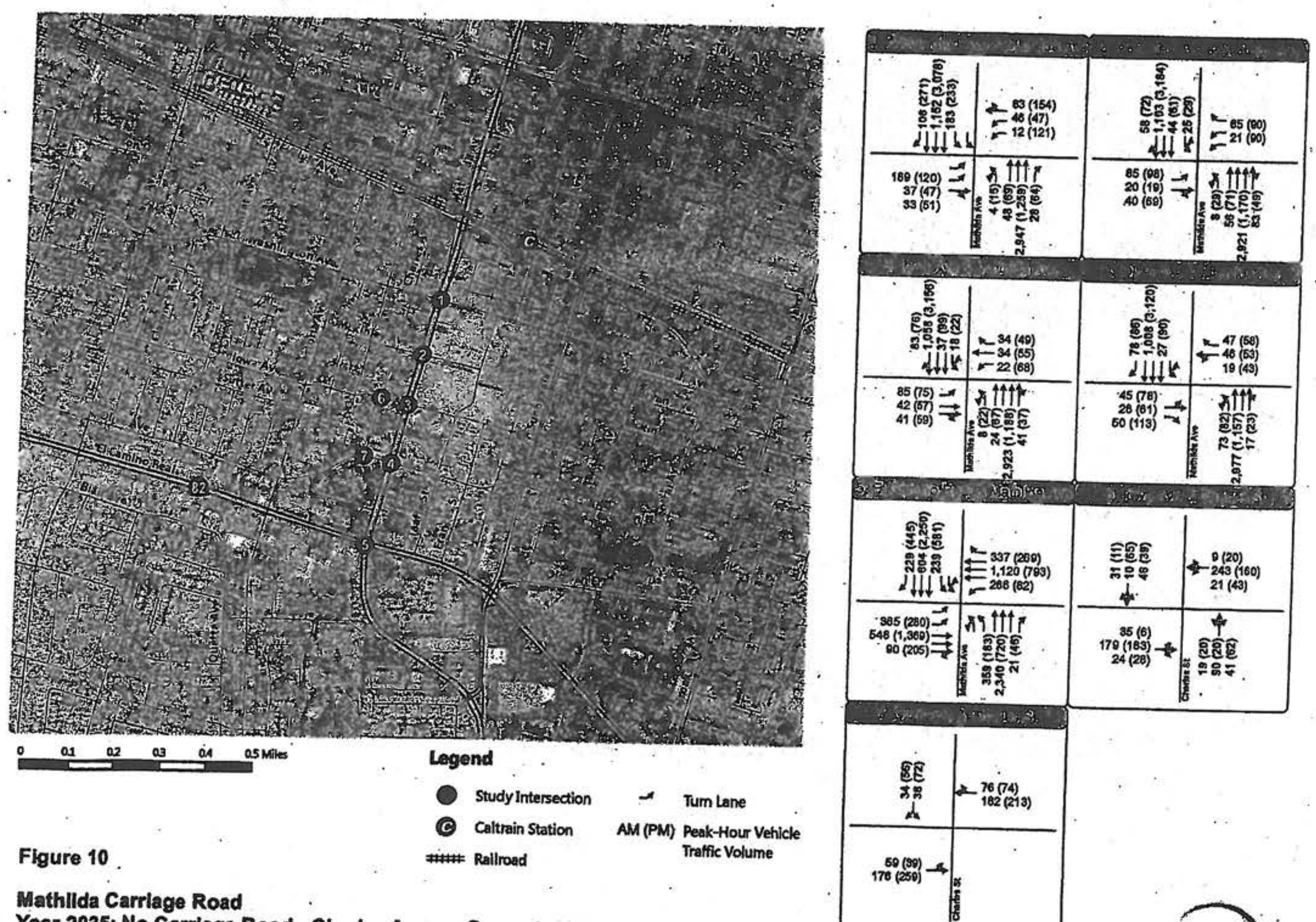


**Figure 10**

**Mathilda Carriage Road**
**Year 2035: No Carriage Road - Charles Access Scenario Vehicle Volumes**

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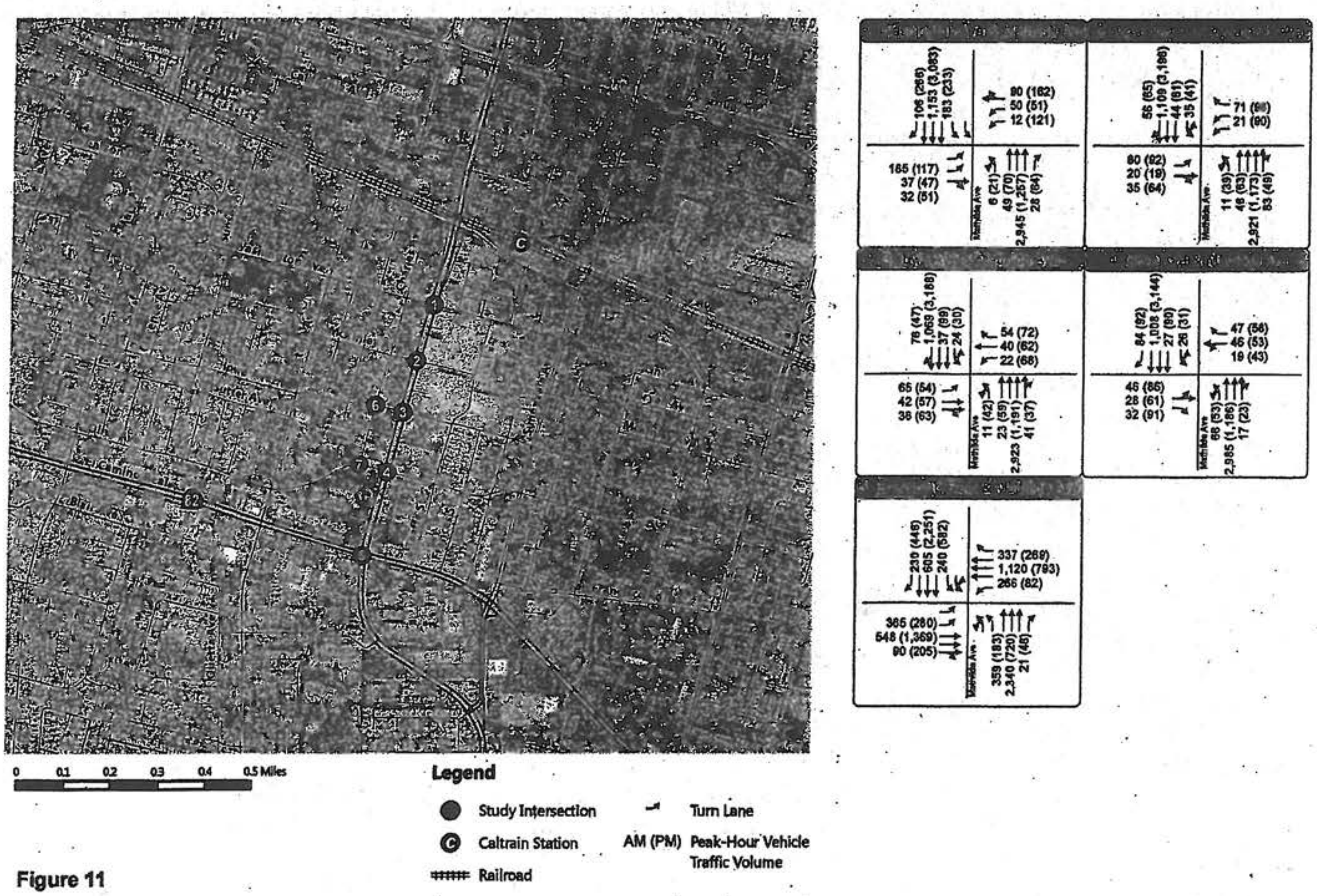


**Figure 11**

**Mathilda Carriage Road**
**Year 2035: Carriage Road Scenario Vehicle Volumes**

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Date: July, 2013

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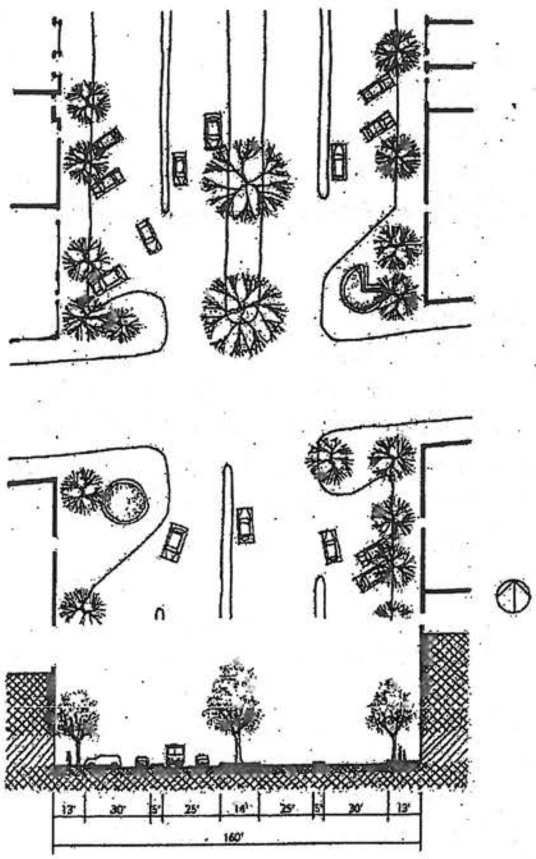
**Access and Traffic Circulation Effects of Carriage Road**

Based on the results presented above, the addition of a carriage road would not substantially affect vehicle capacity on Mathilda Avenue and would therefore have no substantial effect on vehicle level of service. However, the presence or absence of a carriage road may have other effects on vehicle, pedestrian and bicycle circulation. Access and traffic circulation effects are discussed below.

While vehicle capacity would not be substantially affected, a carriage road may slightly reduce travel speeds for through-moving vehicles by reducing the number of access points on the main thoroughfare. As a result, it would slightly increase the delay caused by vehicles entering the carriage road from the southbound right turn lane of Mathilda Avenue. Forecasts of corridor travel speeds and times indicate that intersection travel times on the corridor could be slightly longer with a carriage road than without one. During the PM peak hour, southbound travel times on Mathilda Avenue in Year 2035 are forecasted at 240 seconds under Carriage Road conditions, 237 seconds under No Carriage Road (Charles Access) conditions and 230 seconds under No Carriage Road (Mathilda Access) conditions. It is therefore unlikely that adding a carriage road would substantially improve travel speeds and vehicle throughput in Year 2035.

One of the frequently-cited benefits of a street with frontage or carriage roads (also referred to as a multi-way boulevard) is that they separate local traffic from through traffic. With a carriage road, vehicles would enter and exit the main roadway at intersections, reducing the number of mid-block conflicts between through traffic and vehicles entering and exiting driveways.




Plan view of Shattuck Avenue carriage road in Berkeley
Source: Jacobs, MacDonald, & Rofe, *The Boulevard Book*, 2003.

However, additional conflicts could arise at intersections as vehicles enter the through-traffic stream from the carriage road. If a carriage road remains under consideration, we recommend that further study of carriage road operations and traffic control be conducted before construction.

The addition of a carriage road has the potential to improve conditions for bicyclists and pedestrians traveling on the west side of Mathilda Avenue. New development anticipated in the *Downtown Specific Plan* is likely to bring more pedestrians to the downtown area, which could increase the potential for conflict between vehicles and pedestrians. Because vehicles traveling on the carriage road would typically move more slowly than vehicles traveling on the main roadway, adding a carriage road would tend to improve pedestrian comfort and reduce conflicts between pedestrians and vehicles. Lower speeds and volumes of vehicle traffic on the carriage road would also improve perceived safety for bicyclists.

As a result, the main benefits of adding a carriage road are separation of local and through traffic, improved conditions for bicycle and pedestrian travel, and the addition of on-street parking to serve local businesses and new residential developments.

**Year 2035 Scenario Comparison**

The addition of a carriage road would generally lead to a slight reduction in intersection delay. The carriage road is forecasted to reduce average vehicle delay at study intersections by up to 2.3 seconds under Year 2035 conditions, although it is anticipated to increase delay at the Mathilda Avenue/El Camino Real intersection by up to 3 seconds when compared to No Carriage Road scenarios. The carriage road would also add on-street parking, which could meet short-term parking and delivery needs for retail customers and residents.

Constructing a carriage road would provide a buffer from southbound through traffic for pedestrians and bicyclists on the west side of Mathilda Avenue. However, the addition of a carriage road would create a longer crossing distance for pedestrians on Mathilda (though increased pedestrian crossing distance is partially addressed by the fact that pedestrians can cross the street in multiple sections, and carriage road crossings are sometimes only stop-controlled – which reduces the effective crossing distance). It would also reduce the space available to transit riders waiting at bus stops. Pedestrian and transit issues could be mitigated by adding curb bulbs to the carriage road median strip at bus stops and crosswalks. Targeted pedestrian and bicycle improvements that could be implemented along with the addition of a carriage road are outlined in the section on Alternative Cross Sections Designs, under Option 3.

In order to properly understand the benefits and drawbacks of the three access alternatives, measures of effectiveness were developed for vehicle operations, transit, bicycle and pedestrian modes, and parking. Operations on Mathilda Avenue under the three future year scenarios were then compared to each other using these measures. **Table 12** presents a comparative chart of the results.

**TABLE 12**
**OPERATIONAL COMPARISON: YEAR 2035 SCENARIOS**

| Year 2035 Scenario | Pedestrian, Bicyclist and Transit User Conditions | | | | Traffic Operations and Parking | |
|---|---|---|---|---|---|---|
| | Bus Waiting/ Boarding | Bicyclist Comfort | Pedestrian Crossing Experience | Pedestrian Comfort | Traffic Circulation | Parking Capacity |
| No Carriage Road (Mathilda Access) | — | — | — | — | — | — |
| No Carriage Road (Charles Access) *Block 14 results* | — | — | — | — | — | — |
| Carriage Road | ↓ | ↑ | — | ↑ | — | ↑ |

Source: Fehr & Peers, 2013.

## ALTERNATIVE CROSS SECTION DESIGNS

Redevelopment on the west side of Mathilda Avenue provides the opportunity to address the transportation needs of all travel modes consistent with the goals of the existing General Plan, the Administrative Draft Land Use and Transportation Element/Climate Action Plan (LUTE/CAP) and the *Downtown Specific Plan*. Currently, Mathilda Avenue through downtown Sunnyvale lacks dedicated bicycle facilities. In addition, pedestrian access is limited by narrow sidewalks, large curb radii and long crossing distances at intersections. While the frontage road concept outlined in the *Downtown Specific Plan* improves pedestrian facilities by providing wider sidewalks on both sides of the street and slightly reducing crossing distances, it does not identify specific improvements for bicycle travel. Mathilda Avenue is an important north–south bicycle connection in Sunnyvale as it is one of a limited number of streets that crosses the Caltrain railroad tracks.

We developed several cross section designs for Mathilda Avenue that improve pedestrian and bicycle conditions and maintain or improve existing conditions for transit riders. The following criteria were used in developing the cross sections:

- Provide a north-south bicycle connection on Mathilda Avenue;
- Reduce pedestrian crossing distance across Mathilda avenue (both for pedestrian accessibility to and from downtown but also to reduce the amount of signal green time devoted to cross streets when a pedestrians are crossing the street);
- Where possible, maintain local access to existing and proposed land uses along the corridor;
- Maintain or improve bus stop layouts and access on the corridor;
- Reduce required right of way dedication (if possible).

The three cross section designs require either no dedications or a smaller right-of-way dedication than the Specific Plan frontage road concept. Options 1 and 2 would be compatible with the two "No Carriage Road" scenarios; Option 3 would be feasible with the construction of the carriage road on Mathilda Avenue.

Parcels developed since 2003 along the east side of Mathilda Avenue have included narrower sidewalks (between 10 and 15 feet wide including setbacks) than are called for in the *Downtown Specific Plan*. A fourth northbound lane on Mathilda, which operates as parking lane south of Olive Avenue and a travel lane north of Olive Avenue, is currently underutilized as a travel lane. In our proposed designs we recommend repurposing it for bicycle travel, as a reduction in the number of northbound lanes does not substantially affect traffic conditions along the corridor.

The landscaped center median would need to be modified to accommodate most of these modifications. In addition to landscaping, the existing median includes streetlights, signage and other utilities. As a result, implementing any of these options may require relocating some utilities and removing trees from the median.

There may be opportunities to implement these alternatives at lower cost if double left-turn lanes in the southbound direction were reduced or eliminated,[1] or if dedications to accommodate bicycle facilities and wider sidewalks were required from new development along Mathilda Avenue.

*Option 1: Restriping with Minimal Median Reduction*
This option would add 8 foot wide buffered bicycle lanes (Class II bicycle facility) to Mathilda Avenue by eliminating the underutilized fourth northbound travel lane, realigning the center median and reducing the center median width. Providing the desired sidewalk widths of 14 to 20 feet described in the *Downtown Specific Plan* would require additional dedications from adjacent property owners. **Figure 12** shows the street configuration proposed for Option 1.

Buffered bicycle lanes would consist of a 5 foot bicycle lane (adjacent to sidewalk) and a 3 foot diagonally striped buffer (adjacent to travel lane). At bus stops and intersections, the striped buffer would be replaced with a dashed line to show. Class II bicycle facilities typically share space with buses at transit stops, so this configuration would be relatively easy for both bicyclists and transit vehicle operators to negotiate.

Some design variations may be possible with Option 1 as well, including:

- Narrowing travel lanes to 10.5 feet would allow for a 30 foot wide median, reducing the need to relocate utilities from the median area.
- 7 foot buffered bike lanes (with a 5 foot lane and 2 foot buffer) would likewise allow for slightly wider planted median.
- Dedications on west side could allow for wider sidewalks.

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[1] Under existing conditions, peak-hour southbound left turn volumes are under 300 vehicles at all study intersections except for the intersection of Mathilda Avenue and El Camino, making this a feasible treatment for most of the study corridor.

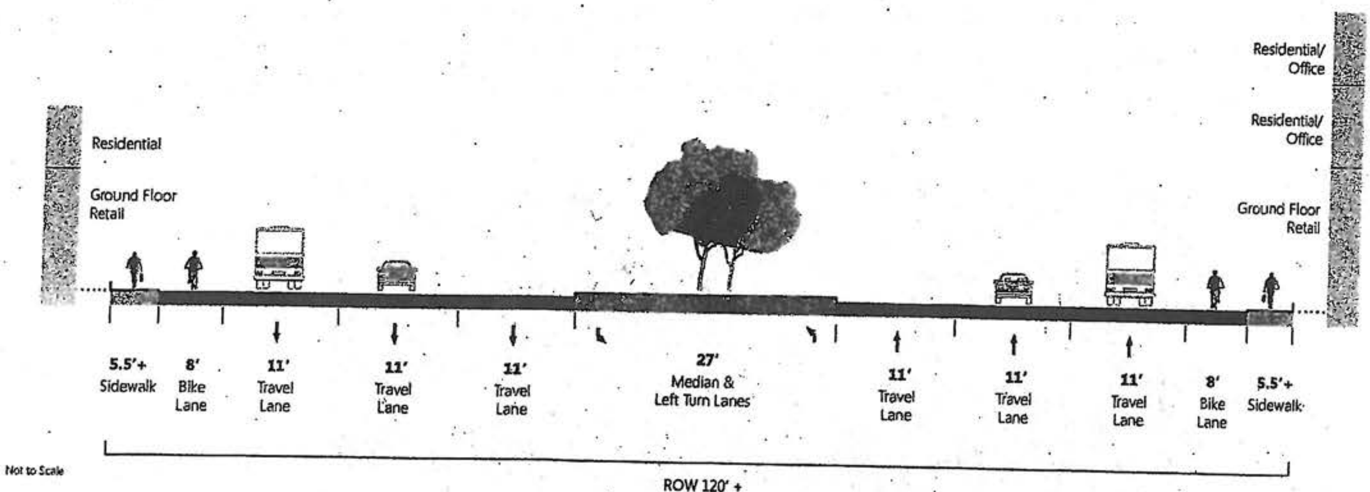


**Figure 12**

**Cross Section Option One**

**(Mid-block, Facing North)**

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Date: March, 2013

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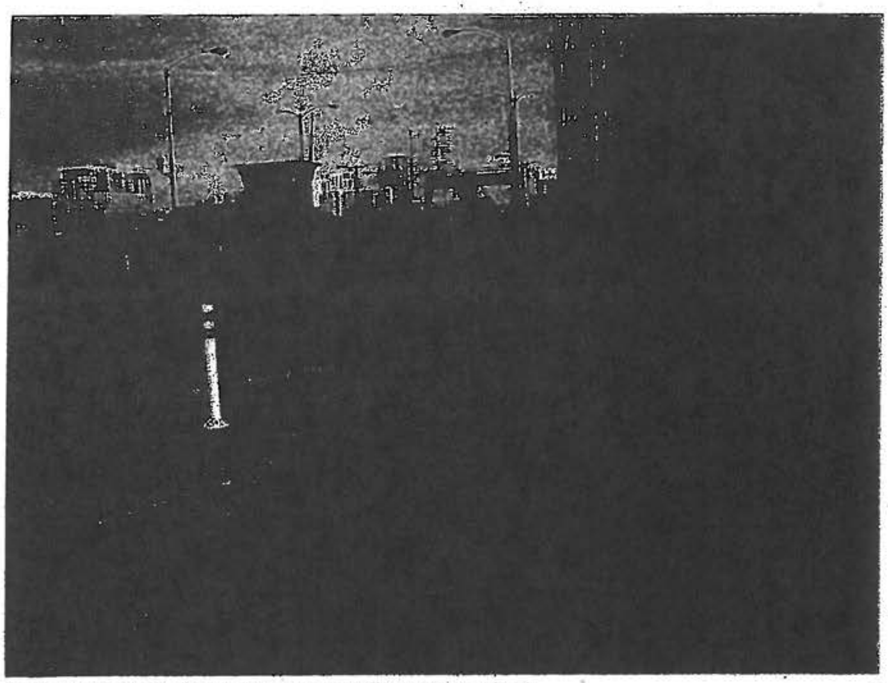
*Option 2: Cycle Tracks and Widened Sidewalks*

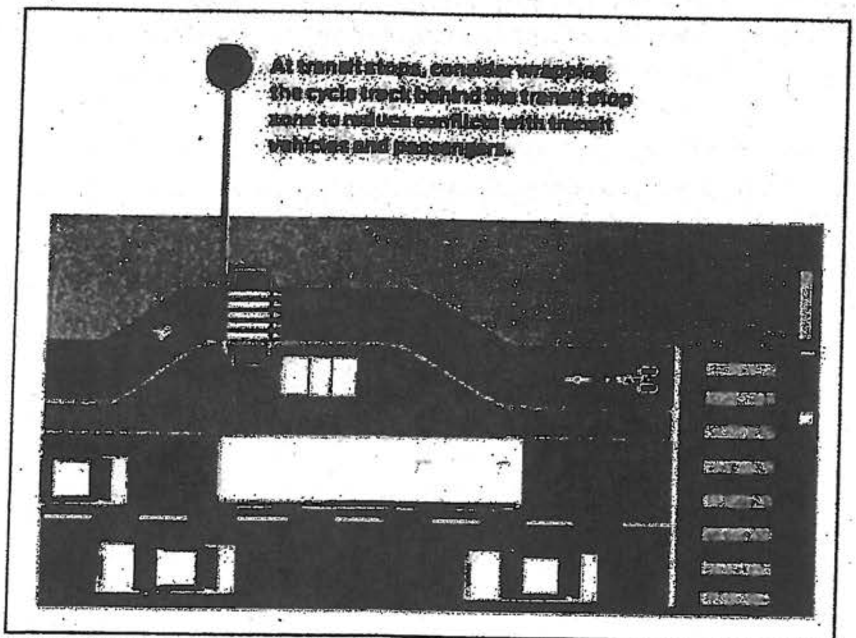
The option reduces median width more than Option 1 and narrows travel lanes slightly in order to provide 8' wide sidewalks on both sides of Mathilda Avenue. It provides cycle tracks (physically-separated bicycle facilities) to improve bicyclist comfort and access on both sides of the street. Providing the desired sidewalk widths of 14 to 20 feet described in the Downtown Specific Plan would require additional dedications. **Figure 13** shows the street configuration proposed for Option 2.

A cycle track is a physically-separated bicycle facility implemented on a city street. Cycle tracks are typically separated from vehicle traffic by a parking lane, raised curbs or a buffer that incorporates tubular markers, bollards or movable planters. At driveways and other locations with unsignalized right turns, bicycle lanes with pavement markings to indicate bicyclist right-of-way replace cycle tracks.



Cycle track with flexible delineators in buffer, Chicago, Illinois.

At transit stops, the cycle track would shift behind the bus loading zone to prevent conflicts with transit vehicles and passengers. Pedestrians would cross the cycle track from the sidewalk to access the transit stop. Safety features include a raised crossing area and truncated dome paving material, to slow cyclists and alert pedestrians that they are crossing a bicycle path.




Design guidance for cycle tracks at transit stops.
Source: NACTO Bikeway Design Guide, 2012.

Several intersection treatments are available to reduce conflict between through-moving bicycles conflict and left- and right-turning vehicles. These treatments include:

- Moving stop lines in adjacent mixed-flow lanes backwards to increase cyclist visibility. In San Francisco this has been combined with an experimental "bike box" treatment, in which bicycles wait in a designated space ahead of cars and proceed first through intersections.
- Adding warning signs and pavement markings to show bicycle paths through intersections, (see Appendix for examples).
- Adding bicycle signal heads or signage directing bicyclists to obey pedestrian signals (see Appendix for examples).

Maintenance costs for cycle tracks can be slightly higher than for Class II bicycle lanes for a few reasons. First, vertical separators require maintenance and periodic replacement. Second, debris can accumulate in cycle tracks, presenting a safety concern if they are not cleared regularly.

Design variations possible under Option 2 include:

- Dedications of 2 feet (west side) and 6 to 12 feet (east side) would allow desired sidewalk widths of 10 feet (west side) and 14 to 20 feet (east side).
- A raised cycle track could be used instead of vertical barriers. If a raised cycle track were considered, sidewalks with a continuous furniture/planting zone (minimum 8' wide) are recommended to reduce the risk of cyclists intruding into pedestrian walkways and vice versa.
- Eliminating southbound double left turn lanes would reduce the need to realign the center median, potentially providing cost savings to the project.

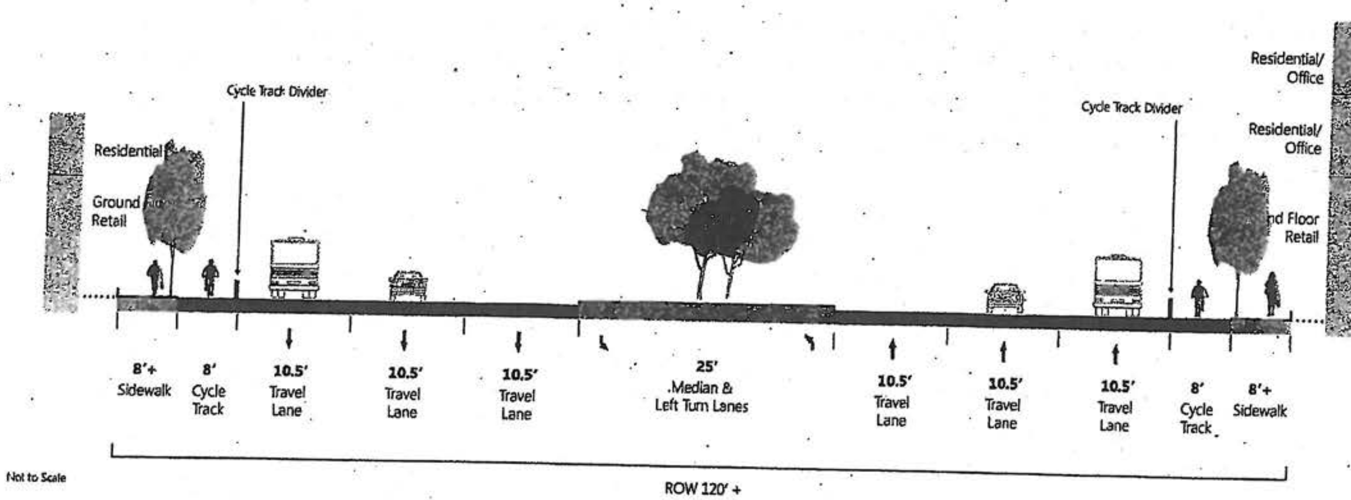



**Figure 13**

**Cross Section Option Two**

**(Mid-block, Facing North)**

*Option 3: Narrower Carriage Road and Added Northbound Bicycle Lanes*

This option provides a narrower carriage road than described in the Downtown Specific Plan, a shared (Class III) bicycle facility in the frontage road and a buffered bicycle lane in the existing fourth northbound travel lane, and widens sidewalks on both sides of Mathilda Avenue.

The west side carriage road proposed in Option 3 would provide an 8 foot parking lane, a 10 foot' shared-use travel lane with center shared lane markings ("sharrows") and a 3 foot' landscaped median separating the carriage road from through travel lanes. A 10 foot shared-use travel lane is similar to the configurations of recently-constructed boulevards, such as Octavia Boulevard in San Francisco. It would require dedications of 15 feet from development on the west side of Mathilda Avenue. A dedication of 8' from development on the east side of Mathilda Avenue would allow for wider sidewalks consistent with the goals of the Downtown Specific Plan. **Figure 14** shows the street configuration proposed for Option 3.

In addition to wider sidewalks, this option presents several advantages for pedestrians. The frontage road would separate pedestrians on the west side of Mathilda Avenue from fast-moving through traffic. It would also allow for the implementation of curb extensions, which we recommend at intersections to provide a shorter pedestrian crossing distance on Mathilda Avenue. Reduced pedestrian crossing distance would also reduce delay for northbound and southbound vehicles by reducing the amount of signal "green time" needed to facilitate pedestrian crossings.

Because a 3 foot wide median does not provide an adequate accessible boarding area for transit riders, we recommend special treatments at transit stops under this alternative. Parking should be removed and the frontage road median widened to accommodate transit riders boarding and exiting buses.

Design variations possible under Option 3 include:

- Larger dedications from developers would allow for wider sidewalks.
- *Double carriage road:* An additional 13 foot dedication on the east side of Mathilda Avenue would allow for a true boulevard-style road configuration similar to that along the west side of the street. This would have the advantage of further reducing pedestrian crossing distances and adding street parking.
- Eliminating southbound double left turn lanes would reduce the need to realign the center median, providing cost savings to the project.

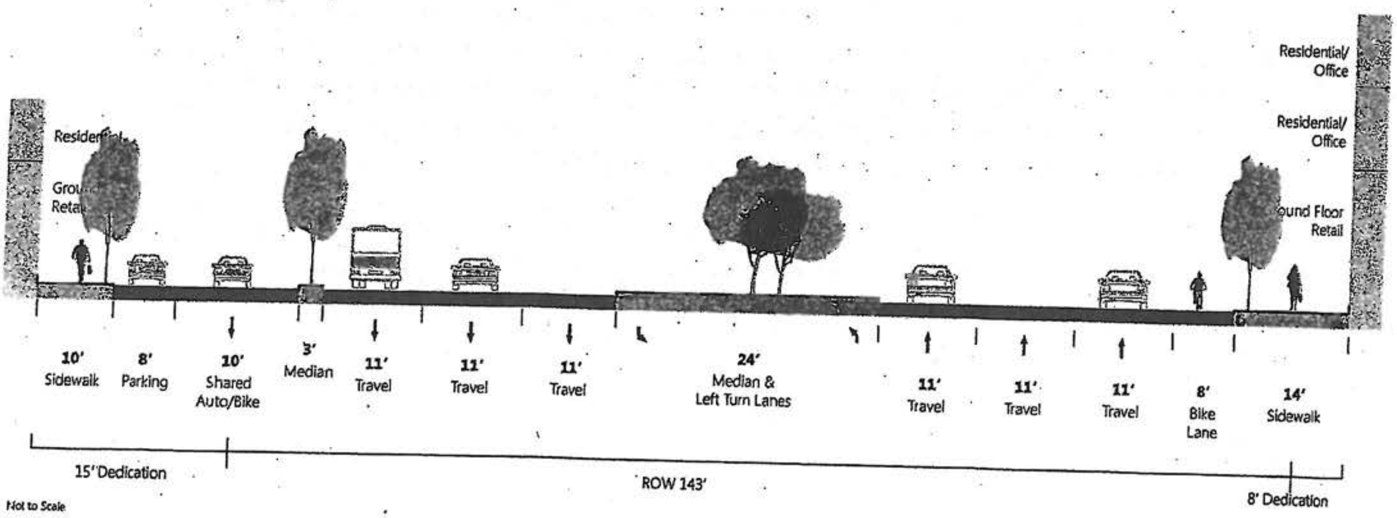



**Figure 14**

**Cross Section Option Three**

**(Mid-block, Facing North)**

*Evaluation of Project Benefits*

Measures of effectiveness were developed for transit, bicycle and pedestrian modes, parking and cost and constructability. The *Downtown Specific Plan* frontage road concept and the three options outlined above were then compared to existing conditions on Mathilda Avenue using these measures. **Figure 15** presents a comparative chart of the results.

Options 1-3 provide clear benefits for bicyclists by providing dedicated bicycle facilities, which are not included in the *Downtown Specific Plan* frontage road concept. Option 2 and Option 3, as well as the Specific Plan frontage road concept, provide improvements to pedestrian access and safety as well as enhancing the streetscape. Both Option 3 and the Specific Plan carriage road concept would add on-street parking (approximately 30 to 80 spaces given current driveway locations), while Options 1 and 2 would remove approximately 15 parking spaces from the east side of Mathilda Avenue between Olive Avenue and El Camino Real.

Both carriage road options would have greater and longer-term construction impacts than Options 1 and 2, and would entail approximately the same costs. Additional evaluation of potential project costs is described below.

**Figure 15: Measures of Effectiveness Comparison Chart**

| Improvements | Transit Rider Access & Experience | | Bicyclist Access and Experience | | | Accessibility & Pedestrian Safety | | | Streetscape Environment (neighborhood character) | | Traffic Circulation and Parking | | Cost | | | Constructability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Waiting/ Boarding Experience | Accessibility | Bicycle Access | Bicyclist Safety | Bicyclist Comfort | Crossing Experience | Pedestrian Comfort | Accessibility | Street Identity | Landscaping Opportunities | Traffic circulation | Parking capacity* | Capital | Operating/ Maintenance | Land Dedication Required | Time to Complete | Construction Impacts |
| | *Alternatives compared to Existing Conditions* | | | | | | | | | | | | | | | | |
| Downtown Specific Plan Frontage Road | – | ↓ | – | – | ↑ | – | ↑ | ↑ | ↑ | ↑ | – | ↑ | $$$ | $ | $$$ | ⚒⚒⚒ | ⚒⚒⚒ |
| Option 1: Add Bicycle Lanes | – | – | ↑ | ↑ | ↑ | – | – | – | – | – | – | ↓ | $ | $ | – | ⚒⚒ | ⚒ |
| Option 2: Cycle Track & Wider Sidewalks | ↑ | – | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | – | ↓ | $$ | $$ | – | ⚒⚒ | ⚒⚒ |
| Option 3: Frontage Road, Cycle Track & Wider Sidewalks | ↑ | – | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | – | ↑ | $$$ | $$ | $$ | ⚒⚒⚒ | ⚒⚒⚒ |

* The addition of bicycle lanes or cycletracks on Mathilda Avenue NB between El Camino Real and Olive Avenue would result in the removal of approximately 15 parking spaces. The frontage road concepts described in the Downtown Specific Plan and Option 3 would both add approximately 8-15 parking spaces on the west side of each block.

*Order of Magnitude Cost Estimates*

While precise estimates of relative costs for each of the three options outlined above are beyond the scope of this study, planning-level cost estimates, which are shown in **Table 13,** provide a general understanding of the relative costs of each option. Information about land prices and the full relocation costs of utilities along the Mathilda Avenue corridor were not available at the time of this study. These estimates should therefore be taken as providing an order of magnitude estimate for construction costs and are not intended as a substitute for more detailed construction cost estimates.

These planning-level estimates are based on recent project cost information provided by the City of Sunnyvale and additional project cost information gathered by Fehr & Peers. Based on this information, the lowest-cost option is Option 1, which provides Class II bicycle facilities but no other improvements and totals approximately $600,000 to $900,000. However, Option 1 does not provide a substantial benefit to bicycle and pedestrian circulation in the area. Option 2, which provides a physically-separated bicycle facility and widened sidewalks, would cost approximately $1.5 to $1.9 million. Option 3, which adds a carriage road, parking, bicycle facilities and sidewalks, would cost approximately $2.3 to $2.7 million.

The center median would have to be realigned to accommodate all of the options outlined above, except for those variations in which bicycle facilities and sidewalks are constructed using dedications from development on the west side of Mathilda Avenue or roadway width previously allocated to double left turn lanes. In addition to landscaping, the existing median includes streetlights, signage and other utilities. The cost of implementing any of these options would include relocating these utilities.