

## **MEMORANDUM**

**To:** Jessica Manzi, City of Redwood City

**From:** Ben Huie, P.E., Kimley-Horn

**Date:** October 3, 2016

**Subject:** Farm Hill Boulevard Street Improvement Pilot Project: **FINAL** Project Evaluation

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## **Introduction**

The Farm Hill Boulevard Street Improvement Pilot Project started in September 2015. The pilot project reconfigured the travel lanes on Jefferson Avenue and Farm Hill Boulevard from Alameda de las Pulgas to Woodhill Drive. **Figure 1** shows the project limits and vicinity map. The overall goal of this pilot project is to increase safety for all roadway users by increasing driver compliance with the speed limit and by reducing exposure to multiple lanes of traffic. Prior to the pilot, there were two lanes of traffic in each direction. For most segments of the corridor, the pilot configuration has one lane of traffic in each direction and a two-way left-turn lane (TWLTL). As part of the pilot project, the City of Redwood City (City) committed to monitoring and reporting project results to the community and City Council specific to vehicle traffic, vehicle speed, and usage by people walking, riding bikes, and riding transit. Kimley-Horn was tasked to provide an independent review of the data and provide a summary of the results. Although the format of this report may be similar to the format of the Interim report, the data analysis and results were conducted independently.

An evaluation plan was created to assess the effectiveness of the pilot project. The evaluation plan was developed with input from the community and was adopted by the City Council, as discussed later. City staff collected input on the evaluation plan from a variety of sources, including comments from the January 2015 City Council meeting, emails and letters to City staff, feedback from the City's informal bicycle and pedestrian working group, and input via an online survey. The online survey determined that the top three priorities of the respondents were: improve safety, improve ease of crossing the street, and decrease traffic congestion. It should be noted that decreasing speeding was a close number four priority.

Figure 1 – Project Vicinity Map



## Data Collection

Baseline conditions for the project were collected prior to the initiation of the pilot project. All baseline traffic data, except travel times, were collected in May 2015 while Cañada College, Redwood City School District and Sequoia Union High School District schools were in session. Vehicular travel times conducted by TJKM Traffic Consultants, were collected in July 2015. Following the start of the pilot project, City staff monitored collisions and traffic operations on a regular basis through observations, data collected and provided by residents, and traffic counts and travel time runs. Per the direction of the City Council at its September 21, 2015 meeting, an extensive data set was collected at various time points throughout the pilot, including in May 2016 to assess Post-Pilot performance. May 2016 was selected because it is exactly one year following the Pre-Pilot data collection effort which should limit the influence of monthly variation. Travel times were conducted by TJKM in July 2016, one year after the Pre-Pilot data. Supplemental travel time surveys were collected in September 2016, when local schools were in session. It should be noted that the roadway improvements still remain in place subsequent to the Post-Pilot data collection in May and July 2016.

The City primarily used consultant firms to collect the data used in the evaluation. The exceptions to this were:

- **Transit ridership.** Data was provided directly from SamTrans, which uses automated passenger counters to count people as they get on and off their buses.
- **Collision data.** Data was provided by the Redwood City Police Department. City staff has received reports of near misses and unreported collisions before and during the pilot period. However, for consistency and verification, only reported collisions are reflected in this analysis.
- **Perception survey.** The in-person surveys at Stulsaft Park were conducted/collected by City staff.

In reviewing these data, it is important to note that traffic volumes and patterns vary by time of year and are influenced by broader regional characteristics. Recent economic growth has resulted in increased traffic throughout the Bay Area. The evaluation plan collects data on other roadways in an attempt to control for this – but it is impossible to completely separate the impacts of the project and broader economic growth.

The remainder of this memorandum outlines the pilot project objectives, the reason for each objective, the method of measurement, and the results.

## Evaluation Criteria

The evaluation criteria used for this project was determined by the City. **Table 1** lists the criteria set forth by the City to be evaluated using Pre-Pilot data and Post-Pilot data.

**Table 1: Evaluation Criteria**

Attribute and Performance Measures	Data Collection Locations
Air Quality	Calculated vehicle emissions along length of corridor
Congestion <ul style="list-style-type: none"> <li>• Average peak period travel time</li> <li>• Average off-peak travel time</li>   <li>• Peak hour traffic volume</li>   <li>• Average intersection vehicle delay</li> </ul>	<ul style="list-style-type: none"> <li>• Woodhill Drive to Alameda de las Pulgas</li> <li>• Woodhill Drive to Alameda de las Pulgas</li>   <li>• Between Eden Bower Ln and Lonesome Pine Rd</li> <li>• Between McGarvey Ave and Jefferson Ave</li> <li>• Between Highland Rd and Alameda de las Pulgas</li>   <li>• Farm Hill Blvd at Emerald Hill Road</li> <li>• Farm Hill Blvd at Glennan Dr</li> <li>• Farm Hill Blvd at Jefferson Ave</li> <li>• Farm Hill Blvd at McGarvey Ave</li> </ul>
Ease of crossing the street <ul style="list-style-type: none"> <li>• Percent of vehicles yielding to people crossing the street</li> <li>• How long people walking have to wait to cross the street</li> </ul>	(same locations for both measures) <ul style="list-style-type: none"> <li>• Farm Hill Blvd at Eden Bower Ln (PM peak)</li> <li>• Jefferson Ave at Dover Rd</li> </ul>
Ease of entering traffic <ul style="list-style-type: none"> <li>• Average vehicle delay for vehicles trying to make a left-turn from side street during the AM peak</li> </ul>	<ul style="list-style-type: none"> <li>• Lonesome Pine Road</li> <li>• Highland Ave</li> </ul>
Complete streets <ul style="list-style-type: none"> <li>• Number of passengers getting on and off SamTrans buses</li>   <li>• Number of people riding bikes</li> <li>• Number of people walking along the street</li> <li>• Number of people crossing the street</li>   <li>• Percent of people arriving without driving</li> </ul>	<ul style="list-style-type: none"> <li>• All bus stops along the corridor</li>   <li>(same locations for all measures)</li> <li>• Farm Hill Blvd at Glennan Dr</li> <li>• Farm Hill Blvd at Jefferson Ave</li> <li>• Farm Hill Blvd at McGarvey Ave</li>   <li>• Stulsaft Park</li> </ul>
Safety <ul style="list-style-type: none"> <li>• Number of conflict points at intersection and midblock locations</li>   <li>• Average number of monthly crashes</li> </ul>	<ul style="list-style-type: none"> <li>• Jefferson Ave at Altamont Way</li> <li>• Between Emerald Hill Rd and Brandy Rock Way</li>   <li>• Woodhill Drive to Alameda de las Pulgas</li> </ul>

Attribute and Performance Measures	Data Collection Locations
<p>Speeding</p> <ul style="list-style-type: none"> <li>• 85<sup>th</sup> Percentile Speed</li> <li>• 50<sup>th</sup> Percentile Speed</li> <li>• Percent of vehicles traveling above speed limit</li> <li>• Percent of vehicles traveling 10 mph over speed limit</li> </ul>	<p>(Same locations for all measures)</p> <ul style="list-style-type: none"> <li>• Between Eden Bower Ln and Lonesome Pine Rd</li> <li>• Between McGarvey Rd and Jefferson Ave</li> <li>• Between Highland Ave and Alameda de las Pulgas</li> </ul>
<p>Traffic Diversion</p> <ul style="list-style-type: none"> <li>• Average daily traffic volume</li> <li>• Traffic volume during peak hours (8 AM to 9 AM and 5 PM to 6 PM)</li> </ul>	<p>Along corridor:</p> <ul style="list-style-type: none"> <li>• Between Eden Bower Ln and Lonesome Pine Rd</li> <li>• Between McGarvey Ave and Jefferson Ave</li> <li>• Between Highland Rd and Alameda de las Pulgas</li> </ul> <p>Parallel routes:</p> <ul style="list-style-type: none"> <li>• Woodside Rd btw I-280 and Alameda de las Pulgas</li> <li>• Woodside Rd between Alameda de las Pulgas and El Camino Real</li> <li>• Edgewood Rd btw I-280 and Alameda de las Pulgas</li> <li>• Highland Rd between Laurel Way and Jefferson Ave</li> <li>• Jefferson Ave between Utah Way and Farm Hill Blvd</li> <li>• Dover Rd btw Lancaster Way and Alameda de las Pulgas</li> <li>• McGarvey Ave btw Farm Hill Blvd and Fernside St</li> <li>• Lancaster Way btw Jefferson Ave and Harding Ave</li> <li>• Bret Harte Dr btw Emerald Hill Rd and Glennan Dr</li> </ul>

**OBJECTIVE 1:**

**Reduce the vehicle crash rate by reducing the number of “conflict points”. A “conflict point” is a location at which traffic paths routinely cross, merge, or diverge and are generally more prone to near-misses or collisions between vehicles than other locations on the roadway network.**

*Why:* Historically, there have been a relatively high number of vehicle collisions along the corridor. By reducing the number of conflict points, the number of vehicles collisions should be reduced. **Figure 2** shows a comparison of crossing and through conflict points for a four-lane undivided roadway and a three-lane roadway with a TWLTL. As shown, the three-lane roadway significantly reduces the number of conflict points. It should be noted that this diagram does not show turning movement conflict points. **Figure 3** shows a comparison of mid-block conflict points for a four-lane undivided roadway and a three-lane roadway with a TWLTL. As shown, the three-lane roadway significantly reduces the number of conflict points. It should be noted that this diagram only shows the movements from the roadway onto a driveway, but not vice versa.

Figure 2: Crossing and Through Conflict Points at Intersection for a 4-lane Undivided Roadway & 3-lane Roadway

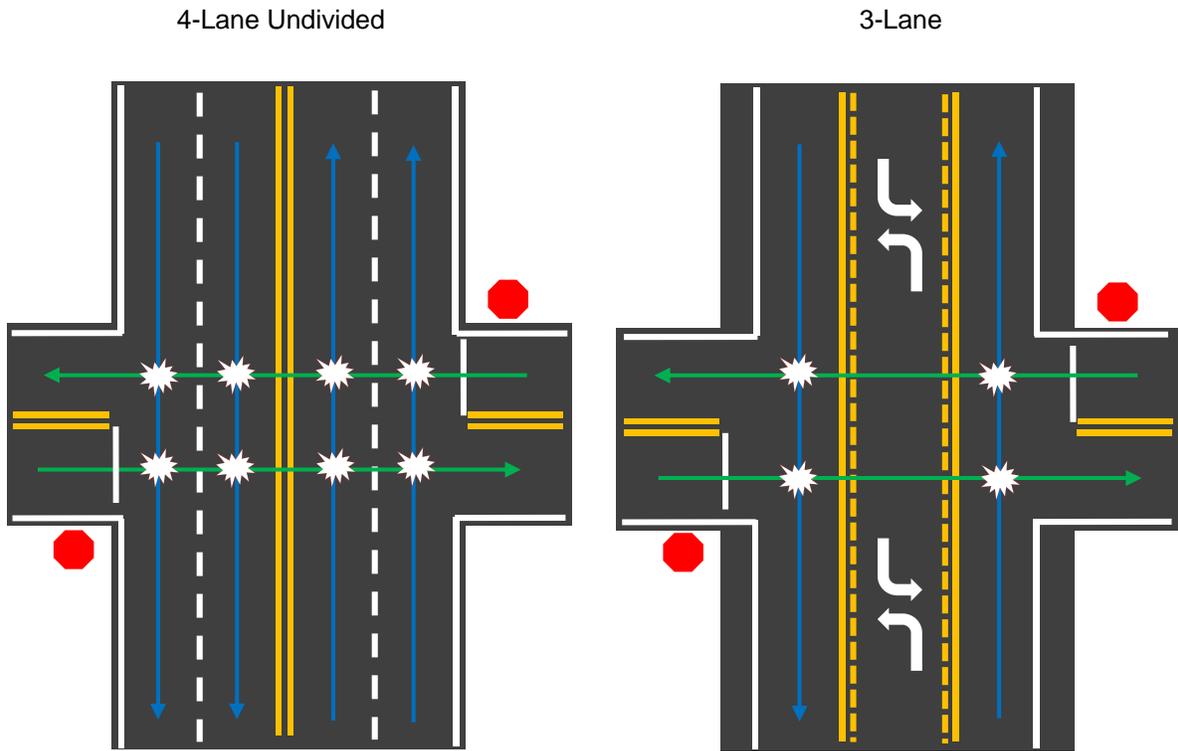
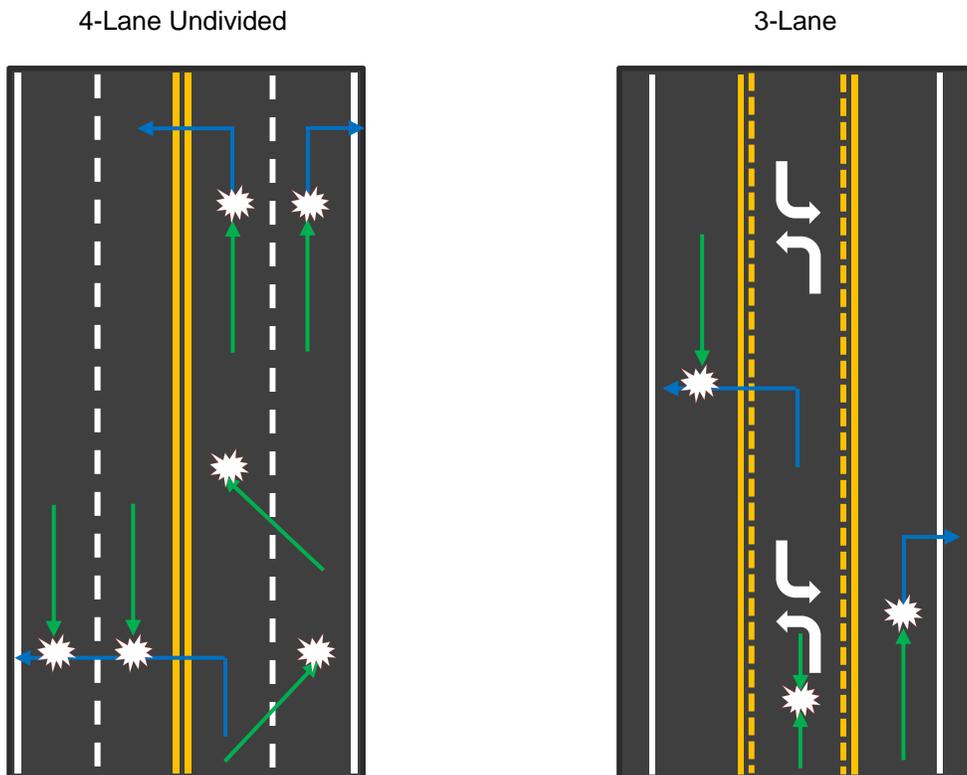


Figure 3: Mid-Block Conflict Points for a 4-lane Undivided Roadway & 3-lane Roadway



**Table 2** shows the number of potential conflict points at an example intersection (Altamont Way and Jefferson Avenue) and an example mid-block segment (Farm Hill Boulevard between Emerald Hill Road and Brandy Rock Way), before and during the pilot project. In both cases, the number of potential conflict points is reduced with the pilot project design. A similar reduction in conflict points happened throughout the corridor.

**Table 2: Number of Vehicle Conflict Points**

Number of intersections conflict points	Pre-Pilot	Post-Pilot
Jefferson Avenue at Altamont Way	10	8
Number of midblock conflict points	Pre-Pilot	Post-Pilot
Farm Hill Boulevard between Emerald Hill Road and Brandy Rock Way	12	8

Source: Redwood City

*Measurement:* Reported collisions were documented and summarized to determine if there was a reduction in the number of crashes along the study corridor (Alameda de las Pulgas to Woodhill Drive).

*Outcome:* The average number of Pre-Pilot crashes per month was based on total collisions during the five-year period from 2010 through 2014. Post-pilot crash data was collected from October 2015 through August 2016, since the majority of the roadway improvements were implemented in September 2015. **Table 3** provides a comparison of the Pre-Pilot and Post-Pilot crashes. It should be noted that this is a small sample size with 11 reported collisions during the Post-Pilot months from October 2015 through August 2016.

**Table 3: Monthly Average Number of Crashes**

Pre-Pilot	Post-Pilot	Absolute Change	Percent Change
1.28	1.00	-0.28	-22%

Source: Redwood City Police Department Collision Reports (Pre-Pilot: January 2010 – December 2014; Post-Pilot: October 2015 - August 2016)

## **OBJECTIVE 2:**

### **Make it safer and easier for people to walk across the street**

*Why:* For people walking, crossing Farm Hill Boulevard can be challenging due to the width of the street and the volume and speed of vehicular traffic. The ability to cross the street is affected by the number of travel lanes, gaps in traffic, and the rate at which drivers yield. By reducing the number of travel lanes and speed of vehicular traffic, drivers should more easily identify pedestrians and yield to crossing pedestrians at a higher rate. This should also reduce the number of multiple-threat collisions, or collisions involving a driver stopped in one lane of a multi-lane approach yielding to a pedestrian crossing the roadway and an oncoming vehicle in the same direction striking the pedestrian because the driver failed to see the pedestrian due to the first vehicle obstructing the view.

*Improvement:* At the intersection of Farm Hill Boulevard and Eden Bower Lane, the travel lanes were narrowed along Farm Hill Boulevard. At the intersection of Jefferson Avenue and Dover Road, the number of travel lanes was reduced and the travel lanes were narrowed along Jefferson Avenue.

*Measurement:* Data was collected on the number of cars that yielded to people walking across the street at two locations along Farm Hill Boulevard/Jefferson Avenue. To evaluate this, the traffic consultants videotaped the intersection of Eden Bower Lane and Farm Hill Boulevard from 4:00 PM to 6:00 PM and the intersection of Dover Road and Jefferson Avenue from 8:00 AM to 6:00 PM. The video footage was analyzed to determine the percentage of drivers yielding to people trying to walk across Farm Hill Boulevard/Jefferson Avenue. The yielding rate was calculated by taking the number of drivers who yielded and dividing by the total number of drivers.

*Outcome:* **Table 4** shows the results of the data collection and analysis. It should be noted that this performance measure has a small sample size as noted by the number of people crossing the street (n).

**Table 4: Percent of Vehicles Yielding to Pedestrians Crossing Farm Hill Boulevard or Jefferson Avenue**

Location and Time of Day	Pre-Pilot	Post-Pilot
Farm Hill Boulevard at Eden Bower Lane (4:00 PM – 6:00 PM)	4% (n=9)	10% (n=15)
Jefferson Avenue at Dover Road (8:00 AM – 6:00 PM)	19% (n=30)	25% (n=18)

Source: Quality Traffic Data (May 27, 2015 and May 31 - June 1, 2016).  
n= number of people crossing the street when vehicles present

After the pilot project, drivers yielded more often to people crossing the main street at both Eden Bower Lane and Dover Road. Although not part of the project evaluation metrics, the number of people crossing the street when vehicles were present increased at Eden Bower Lane.

The length of time a pedestrian waited to cross the main street at the same two intersections was measured and is summarized in **Table 5**. It should be noted that this performance measure has a small sample size as noted by the number of people crossing the street (n). Wait times went down at both Eden Bower Lane and Dover Road. These data were again based on analysis of the video footage.

**Table 5: Average Wait Time to Cross the Street (in seconds)**

Location and Time of Day	Pre-Pilot	Post-Pilot
Farm Hill Boulevard at Eden Bower Lane (4:00 PM – 6:00 PM)	6.0 s (n=9)	1.3 s (n=15)
Jefferson Avenue at Dover Road (8:00 AM – 6:00 PM)	1.0 s (n=30)	0.5 s (n=18)

Source: Quality Traffic Data (May 27, 2015 and May 31 - June 1, 2016)  
n= number of people crossing the street when vehicles present

### **OBJECTIVE 3:**

**Ensure there are not substantial increases to vehicle corridor travel times and/or significant intersection delays**

*Why:* Although increasing safety for everyone is the overarching goal, the Council was concerned that the vehicle travel times could increase substantially as a result of the pilot. Analysis before the pilot predicted that the longest average delays would occur during peak commute times, and could result in an increase in average delay of 1-2 minutes.

*Measurement:* Multiple criteria were used to assess delays along the corridor: average peak period travel time, average off-peak travel time, and average intersection vehicle delay.

#### Travel Times

TJKM Traffic Consultants conducted travel time surveys for the corridor, before, during and after the pilot project. The purpose of a travel time study is to evaluate the quality of traffic movement along a route and to determine the locations, types, and extent of traffic delays by using a moving test vehicle (a travel time “run”). This study method can be used to compare operational conditions before and after roadway or intersection changes. Travel time runs were performed on Farm Hill Boulevard/Jefferson Avenue between Woodhill Drive and Alameda de las Pulgas during the morning, midday and evening periods. TJKM used the *Tru-Traffic* software system with a GPS unit to collect the travel times. Travel times were initially collected for the Post-Pilot in July 2016, exactly one year after the Pre-Pilot data, but supplemental travel time surveys were collected in September 2016 to determine if the travel times increased once local schools were back in session.

Travel time data was collected from 7:00 AM - 9:00 AM, 1:00PM - 3:00 PM, and 5:00 PM - 7:00 PM for the AM, midday, and PM peak periods, respectively. It should be noted that a small sample size was collected with approximately 20 runs total (10 in each direction) being completed during each period and then averaged. **Table 6** summarizes the findings of the travel time study.

*Outcome:* The largest change in travel time from July 2015 to July 2016 was in the midday period, heading towards downtown, where the average run was 33 seconds less after the pilot. Generally, the average travel times decreased for all time periods in both directions, which was unexpected. The pilot project reduced the number of lanes along Farm Hill Boulevard/Jefferson Avenue which was anticipated to increase the travel time. However, the travel time surveys showed a decrease in the intersection delay, which is the main reason for the decrease in average travel time. This decrease in intersection delay was due to improvements in the signal timing operations at the signalized intersections.

Supplemental travel time surveys were collected in September 2016 to determine if travel times decreased once local schools were back in session. As shown in **Table 6**, the average travel time decreased for a majority of the time periods in both directions, with exception to the westbound direction in the AM peak. The average travel time increased by 42 seconds, which was due to the increased signal delay.

**Table 6: Average Travel Times during Peak & Off-Peak Periods**

Direction of Travel	Time Period	Average Travel Time (minutes)				
		Pre-Pilot <sup>1</sup>	Post-Pilot <sup>2</sup>	Change from Pre-Pilot	Post-Pilot <sup>3</sup>	Change from Pre-Pilot
Eastbound (towards downtown)	AM	4:42 (n=10)	4:11 (n=12)	-0:31	4:38 (n=11)	-0:04
	MID	4:39 (n=10)	4:06 (n=12)	-0:33	3:59 (n=13)	-0:40
	PM	4:43 (n=10)	4:32 (n=10)	-0:11	4:25 (n=10)	-0:18
Westbound (towards I-280)	AM	4:48 (n=10)	4:43 (n=11)	-0:05	5:30 (n=11)	+0:42
	MID	4:22 (n=11)	4:17 (n=11)	-0:05	4:07 (n=13)	-0:15
	PM	4:51 (n=10)	4:19 (n=10)	-0:32	4:39 (n=10)	-0:12

<sup>1</sup> Source: TJKM. Data collected July 15-16, 2015.

<sup>2</sup> Source: TJKM. Data collected: July 13, 2016.

<sup>3</sup> Source: TJKM. Data collected: September 20, 2016.

n = number of runs

Although average travel time was the adopted performance measure in the evaluation plan, maximum travel times were also evaluated during the travel time surveys, as shown in **Table 7**. The maximum travel time reflects the worst conditions that drivers are likely to experience on a typical day. In the morning commute, for example, this typically occurs in the 15 minutes when school-related traffic overlaps with commute traffic. The maximum travel time increased during the AM peak for both directions and during the midday peak heading towards I-280.

**Table 7: Maximum Travel Times during Peak & Off-Peak Periods**

Direction of Travel	Time Period	Maximum Travel Time (minutes)				
		Pre-Pilot <sup>1</sup>	Post-Pilot <sup>2</sup>	Change from Pre-Pilot	Post-Pilot <sup>3</sup>	Change from Pre-Pilot
Eastbound (towards downtown)	AM	5:13	5:29	0:16	6:46	1:17
	MID	5:23	5:00	-0:23	4:25	-0:58
	PM	5:52	5:13	-0:39	5:14	-0:38
Westbound (towards I-280)	AM	5:30	5:36	0:06	9:12	3:42
	MID	4:46	4:53	0:07	4:45	-0:01
	PM	5:26	5:11	-0:15	5:11	-0:15

<sup>1</sup> Source: TJKM. Data collected July 15-16, 2015.

<sup>2</sup> Source: TJKM. Data collected July 13, 2016.

<sup>3</sup> Source: TJKM. Data collected: September 20, 2016.

Average Vehicle Delay

Average vehicle delay was collected at four key intersections along the project corridor. The majority of the vehicle delay typically occurs at controlled intersections. Therefore, the average vehicle delay provides another way to represent travel time changes as a result of the pilot project and incorporates delays experienced by drivers entering the corridor. Average vehicle delay is the average time it takes vehicles on all intersection approaches (including cross-streets) to pass through the intersection. The morning peak hour was selected for the analysis because volumes are highest during the morning period and the results illustrate the highest anticipated levels of delay.

Average vehicle delay is a standard output from Synchro, a traffic analysis and modeling software program. Traffic volumes, lane configurations, and signal timing parameters before and after the pilot were inputs into Synchro.

*Outcome:* The calculated delays are summarized in **Table 8**.

**Table 8: Average Intersection Vehicle Delay during Morning Peak Hour**

Intersection	Average Vehicle Delay (seconds)		
	Pre-Pilot	Post-Pilot	Change
Farm Hill Boulevard at Emerald Hill Road <sup>1</sup>	36.6	36.5	-0.1
Farm Hill Boulevard at Glennan Drive	7.2	7.5	0.3
Farm Hill Boulevard at McGarvey Avenue	9.0	25.6	16.6
Farm Hill Boulevard at Jefferson Avenue	8.5	18.5	10.0

<sup>1</sup>The intersection of Farm Hill Boulevard and Emerald Hill road is an unsignalized intersection.

Sources: City of Redwood City, Synchro model (December 2015)  
Quality Traffic Data (May 27-28, 2015 and July 13, 2016).

Average vehicle delay increased for the three signalized intersections after the pilot project in May 2016 as compared to the Pre-Pilot in May 2015. Delay increases ranged from 0.3 to 16.6 seconds, with the largest increase at the intersection of Farm Hill Boulevard and McGarvey Avenue. Although the average intersection delay increased by 16.6 seconds, the intersection still averages only 25.6 seconds of delay, which is an acceptable level based on City guidelines.

Note that these results are different than the travel time results because average vehicle delay is: 1) only capturing intersection delays (as opposed to delay experienced between intersections), and 2) it accounts for delays to vehicles on side streets while the travel times studies only reflect conditions for vehicles traveling on the pilot corridor. It should also be noted that the volumes used in the intersection delay analysis were collected in May 2015 for the Pre-Pilot and in May 2016 for the Post-Pilot, while the travel time surveys by TJKM Traffic Consultants were collected in July 2015 for the Pre-Pilot and July and September 2016 for the Post-Pilot.

**OBJECTIVE 4:**

**Monitor the number of vehicles traveling along the pilot corridor during the peak hour to determine if drivers are shifting their travel patterns**

*Why:* Drivers may change the time of their travel or travel route to avoid congestion. There is concern that overall vehicle volumes would simply drop as drivers opted for alternative routes to avoid congestion. There is also concern within the community that the project would not accommodate traffic growth associated with downtown development.

*Measurement:* Traffic volumes were collected on three midweek days in May 2015 and in May 2016 at three locations within the pilot project corridor by a traffic data consultant using standard tube counters installed across the roadway. Data was collected at the following locations:

- Farm Hill Boulevard, between Eden Bower Lane and Lonesome Pine Road
- Farm Hill Boulevard, between McGarvey Avenue and Jefferson Avenue
- Jefferson Avenue, between Highland Avenue and Alameda de las Pulgas

The morning peak hour was identified as 8:00 AM – 9:00 AM and the afternoon peak hour was 5:00 PM – 6:00 PM.

*Outcome:* The three days of data were averaged and the results are summarized in **Table 9**. Volumes increased along the corridor by 4 to 17 percent during the morning and afternoon peak hour.

**Table 9: Average Peak Hour Traffic Volumes (Number of Vehicles)**

Location along Farm Hill Boulevard/ Jefferson Avenue	Morning Peak Hour (8:00 AM - 9:00 AM)				Afternoon Peak Hour (5:00 PM - 6:00 PM)			
	Pre-Pilot	Post-Pilot	Change	Percent Change	Pre-Pilot	Post-Pilot	Change	Percent Change
Eden Bower Lane to Lonesome Pine Road	1,277	1,327	50	4%	1,149	1,248	99	9%
McGarvey Avenue to Jefferson Avenue	1,027	1,159	132	13%	935	1,089	154	17%
Highland Avenue to Alameda de las Pulgas	1,208	1,405	197	16%	1,325	1,476	151	11%

Source: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016).

**OBJECTIVE 5:**

**Ensure that it is not more difficult to turn onto Farm Hill Boulevard from side streets.**

Why: One concern expressed about the pilot project was that it would be more difficult to turn onto Farm Hill Boulevard from side streets, due to vehicles being funneled down from two lanes into a single lane. The single lane of vehicles would have less frequent gaps for side street vehicles to turn into.

*Measurement:* To evaluate how long drivers have to wait to turn left, the traffic consultants videotaped the side streets of Lonesome Pine Road and Highland Avenue during the morning peak period (7:00 AM – 9:00 AM). The number of vehicles waiting to turn left was counted at five-minute intervals and divided by 12 to estimate their wait times.

Outcome: **Table 10** summarizes the results. It should be noted that there was a small sample size for this performance measure, as denoted by the number of vehicles counted (n). At both locations there was a 48 to 67 percent reduction in the wait time for vehicles to make a left turn from the side street during the morning peak hour. At Lonesome Pine Road, the typical wait times were less than a minute and the overall reduction was small as an absolute number. At Highland Avenue, the wait times were estimated at 4 minutes before the pilot and reduced to 2.1 minutes after the pilot. The decrease in average delay for vehicles on the side-street making a left turn can be attributed to the decrease in the number of lanes crossed to make the left turn, the storage space in the two-way left-turn lane, and the reduction in travel speed along the main street.

**Table 10: Average Delay for Vehicles Making a Left Turn, AM Peak Period (Seconds)**

Location	Pre-Pilot	Post-Pilot	Absolute Change	Percent Change
Lonesome Pine Road	54 (n=11)	20 (n=5)	-34	-63%
Highland Avenue	240 (n=48)	125 (n=40)	-115	-48%

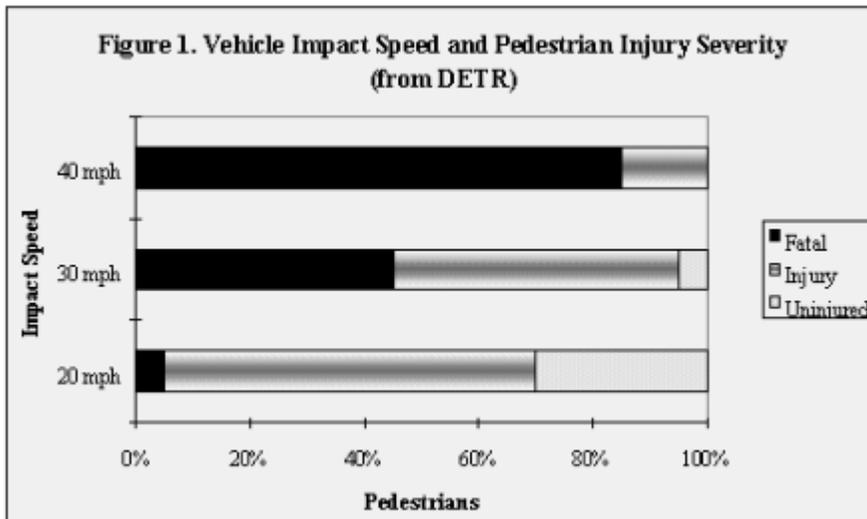
Source: Quality Traffic Data (May 27, 2015 and June 2, 2016).  
n = number of vehicles trying to turn left, counted at five-minute intervals

## OBJECTIVE 6:

**Make it safer for all roadway users by reducing vehicle speeds.**

Why: Reducing vehicle speeds provides several safety benefits. For example, reduced vehicle speeds provide more reaction time for drivers to avoid potential collisions. Furthermore, reducing speeds can substantially reduce the severity of collisions that may occur. Top-end speeders pose some of the greatest threats to pedestrians. A pedestrian hit at 30 miles per hour has an approximately 60 percent chance of survival. At 40 miles per hour, the chance of survival is only 20 percent.<sup>1</sup> **Figure 4** shows a comparison of the vehicle impact speed to pedestrian injury severity.

**Figure 4: Vehicle Impact Speed and Pedestrian Injury Severity**



Source: U.S. Department of Transportation, National Highway Traffic Safety Administration

Measurement: Traffic speed data was collected by a traffic data consultant in May 2015 before the pilot began, and then again in May 2016 during the pilot using standard tube counters over three consecutive midweek days. The collected data was analyzed to identify the following:

- 85th percentile speed, which is defined as the speed 85 percent of drivers are moving at or below,
- 50th percentile speed is the median speed – 50 percent of drivers are driving at or below that speed, and 50 percent of drivers are driving above that speed,

<sup>1</sup> U.S Department of Transportation, Literature Reviewed on Vehicle Travel Speeds and Pedestrian Injuries. March 2000.

<http://www.nhtsa.gov/About+NHTSA/Traffic+Techs/current/Literature+Reviewed+On+Vehicle+Travel+Speeds+And+Pedestrian+Injuries>

- Percent of vehicles traveling above the posted speed limit, and
- Percent of vehicles traveling 10 mph or more over the posted speed limit.

Outcomes:

85th Percentile Speed

**Table 11** shows the 85th percentile speeds on three segments of Farm Hill Boulevard, by direction. The data shows reductions in speed at each location and in both directions, with the reductions ranging from 7 percent to 12 percent. It should be noted that given the large sample size for each segment (over 15,000 samples) that the results are statistically significant. The data shows more than a 99.97 percent probability that the reduction in speeds is due to the improvements.

Farm Hill Boulevard between Eden Bower Lane and Lonesome Pine Road had the highest speeds with a pre-pilot 85th percentile speed of 45.9 mph in the westbound direction (going uphill towards I- 280) and 47.5 mph in the eastbound direction (going downhill towards downtown). After the pilot, these speeds decreased by seven percent – but are still well above the posted speed limit of 35 mph. Between McGarvey Avenue and Jefferson Avenue, 85th percentile speeds are either at the speed limit or slightly below the speed limit – at 35 mph going towards I-280 and 32.4 mph going towards downtown. On Jefferson Avenue, between Highland Avenue and Alameda de las Pulgas, the reductions were eight percent going towards I-280 and nine percent going towards downtown but speeds continued to be above the posted speed limit of 30 mph.

**Table 11: 85<sup>th</sup> Percentile Speed (in miles per hour)**

Segment	Speed Limit (mph)	85 <sup>th</sup> Percentile Speed							
		Towards I-280				Towards Downtown			
		Pre-Pilot	Post-Pilot	Absolute Change	Percent Change	Pre-Pilot	Post-Pilot	Absolute Change	Percent Change
Farm Hill Boulevard: Eden Bower Ln-Lonesome Pine Rd	35	45.9	42.7	-3.2	-7%	47.5	44.1	-3.4	-7%
Farm Hill Boulevard: McGarvey Ave-Jefferson Ave	35	38.7	35	-3.7	-10%	37	32.4	-4.6	-12%
Jefferson: Highland Ave to Alameda de las Pulgas	30	36.2	33.3	-2.8	-8%	36.4	33	-3.4	-9%

Source: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016). Speeds are based on data over the course of three full days (24-hour data).

50th Percentile Speed

As shown in **Table 12**, 50<sup>th</sup> percentile speeds decreased at all locations in each direction. Farm Hill Boulevard between Eden Bower Lane and Lonesome Pine Road had the highest 50th percentile speeds – 39.9 mph pre-pilot in the westbound direction (going uphill towards I-280) and 41.9 mph in the eastbound direction (going downhill towards downtown). After the pilot, these speeds went down by seven percent and five percent, respectively, but are roughly 5 mph above the posted speed limit of 35 mph. Between McGarvey Avenue and Jefferson Avenue, 50th percentile speeds for Post-Pilot are almost five to ten miles per hour below the speed limit – at 30.8 mph going towards I-280 and 26.9 mph going towards downtown. On Jefferson Avenue, between Highland Avenue and Alameda de las Pulgas, the reductions were 10 percent going towards I-280 and eight percent going towards downtown, with speeds close to the posted speed limit of 30 mph.

**Table 12: 50<sup>th</sup> Percentile Speed (in miles per hour)**

Segment	Speed Limit (mph)	Medium Speed (50 <sup>th</sup> )							
		Towards I-280				Towards Downtown			
		Pre-Pilot	Post-Pilot	Absolute Change	Percent Change	Pre-Pilot	Post-Pilot	Absolute Change	Percent Change
Farm Hill Boulevard: Eden Bower Ln-Lonesome Pine Rd	35	39.9	37.2	-2.7	-7%	41.9	39.8	-2.1	-5%
Farm Hill Boulevard: McGarvey Ave-Jefferson Ave	35	33.9	30.8	-3.1	-9%	32.2	26.9	-5.3	-17%
Jefferson: Highland Ave to Alameda de las Pulgas	30	31.3	28.1	-3.2	-10%	31.1	28.5	-2.6	-8%

Source: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016). Speeds are based on data over the course of three full days (24-hour data).

Percent of Vehicles Traveling above the Posted Speed Limit

As shown in **Table 13**, Farm Hill Boulevard between Eden Bower Lane and Lonesome Pine Road had over 88 percent of vehicles traveling over the speed limit in the westbound direction and 96 percent in the eastbound direction prior to the start of the pilot. After the pilot, the percentage of vehicles traveling over the speed limit in this section decreased by 11 percent in the westbound direction (going uphill towards I-280) and by three percent in the eastbound direction (going downhill towards downtown).

**Table 13: Percent of Vehicles Traveling Over the Speed Limit**

Segment	Speed Limit (mph)	% of vehicles traveling over speed limit					
		Towards I-280			Towards Downtown		
		Pre-Pilot	Post-Pilot	Change	Pre-Pilot	Post-Pilot	Change
Farm Hill Boulevard: Eden Bower Ln-Lonesome Pine Rd	35	88%	77%	-11%	96%	93%	-3%
Farm Hill Boulevard: McGarvey Ave-Jefferson Ave	35	49%	18%	-31%	32%	7%	-25%
Jefferson Ave: Highland Ave to Alameda de las Pulgas	30	72%	43%	-29%	68%	46%	-22%

Source: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016).

Farm Hill Boulevard, between McGarvey Avenue to Jefferson Avenue saw the largest reductions in the percentage of vehicles exceeding the speed limit. Going towards I-280, the percent of vehicles exceeding the speed limit decreased from 49 percent to 18 percent. There was a similar trend going towards downtown, with the percent of vehicles exceeding the speed limit decreasing from 32 percent to 7 percent.

On Jefferson Avenue, between Highland Avenue to Alameda de las Pulgas, high percentages of vehicles traveled above the speed limit before the start of the pilot – 72 percent towards I-280 and 68 percent towards downtown. After the pilot, the percentage of speeding decreased by 29 percent going towards I-280 and 22 percent going towards downtown.

These results are consistent with the roadway improvements implemented. Vehicle speeds in a single lane are set by the speed of the prudent driver. Narrower lanes force drivers to reduce travel speeds to stay within the lane markings, thereby reducing travel speeds.

Percent of Vehicles Traveling more than 10 mph over the Speed Limit

Top-end speeding is the percent of drivers traveling more than 10 miles per hour over the posted speed limit. The speed limit on Jefferson Avenue is 30 miles per hour and on Farm Hill Boulevard it is 35 miles per hour.

**Table 14** shows the comparison of the percent of vehicles traveling 10 or more miles per hour between the Pre-Pilot and Post-Pilot. Prior to the pilot project, between Eden Bower Lane and Lonesome Pine Road, 21 percent of drivers in the westbound (going uphill towards I-280) direction and 32 percent in the eastbound (going downhill towards downtown) direction exceeded the speed limit by at least 10 mph. After the pilot, these numbers decreased by 13 percent in the westbound direction and by 17 percent in the eastbound direction. The other segments of Farm Hill Boulevard slightly decreased in the share of vehicles exceeding the speed limit by greater than 10 mph.

**Table 14: Percent of Vehicles Exceeding the Speed Limit by 10 mph**

Segment	Speed Limit (mph)	Percent of vehicles traveling 10+ mph over the speed limit					
		Towards I-280			Towards Downtown		
		Pre-Pilot	Post-Pilot	Absolute Change	Pre-Pilot	Post-Pilot	Absolute Change
Farm Hill Boulevard: Eden Bower Ln- Lonesome Pine Rd	35	21%	8%	-13%	32%	15%	-17%
Farm Hill Boulevard: McGarvey Ave- Jefferson Ave	35	2%	0%	-2%	0%	0%	0%
Jefferson Ave: Highland Ave to Alameda de las Pulgas	30	4%	2%	-2%	5%	1%	-4%

Source: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016).

**ADDITIONAL OBJECTIVE 6A:**

**Reduce travel speeds during off-peak hours.**

*Why:* In addition to the travel speed analysis for the entire day, travel speeds were reviewed during the off-peak hours because the off-peak hours would not include a reduction in speed due to congestion. Therefore, speeds were evaluated during the middle of the day (MID) from 10:00 AM to 2:00 PM and during the nighttime (NIGHT) from 7:00 PM to 7:00 AM.

*Measurement:* The same traffic speed data from Objective 6 was used, except the data was trimmed to only include the MID (10:00 AM to 2:00 PM) and NIGHT (7:00 PM to 7:00 AM) hours. The Pre-Pilot data was collected in May 2015 and the Post-Pilot data was collected in May 2016.

The collected data was analyzed to identify the following:

- 85th percentile speed, which is defined as the speed 85 percent of drivers are moving at or below,
- 50th percentile speed is the median speed – 50 percent of drivers are driving at or below that speed, and 50 percent of drivers are driving above that speed,
- Percent of vehicles traveling above the posted speed limit, and
- Percent of vehicles traveling 10 mph or more over the posted speed limit.

*Outcomes:*

85th Percentile Speed

**Table 15** shows the comparison of daily versus off-peak 85th percentile speeds on Jefferson Avenue between Highland Avenue and Alameda de la Pulgas, by direction. The data shows that the reductions of 85<sup>th</sup> percentile speed are similar between the daily period and the off-peak hours. The decreases all

range from 8 to 10 percent, showing that the travel speed reductions are not solely a result of congestion during the peak period.

**Table 15: Daily versus Off-Peak 85<sup>th</sup> Percentile Speed on Jefferson Avenue (in miles per hour)**

Time Period	Speed Limit (mph)	85 <sup>th</sup> Percentile Speed							
		Towards I-280				Towards Downtown			
		Pre-Pilot	Post-Pilot	Absolute Change	Percent Change	Pre-Pilot	Post-Pilot	Absolute Change	Percent Change
DAILY	30	36.2	33.3	-2.8	-8%	36.4	33.0	-3.4	-9%
MID (10 AM – 2 PM)	30	36.3	33.4	-2.9	-8%	36.3	33.0	-3.3	-9%
NIGHT (7 PM – 7 AM)	30	36.4	33.3	-3.1	-9%	37.5	33.7	-3.8	-10%

Source: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016). Speeds are based on data over the course of three full days.

50th Percentile Speed

**Table 16** shows the comparison of daily versus off-peak 50th percentile speeds on Jefferson Avenue between Highland Avenue and Alameda de la Pulgas, by direction. The data shows that the reductions of 50<sup>th</sup> percentile speed are similar between the daily period and the off-peak hours. The decreases all range from 7 to 10 percent, showing that the travel speed reductions are not solely a result of congestion during the peak period.

**Table 16: Daily versus Off-Peak 50<sup>th</sup> Percentile Speed on Jefferson Avenue (in miles per hour)**

Time Period	Speed Limit (mph)	50 <sup>th</sup> Percentile Speed							
		Towards I-280				Towards Downtown			
		Pre-Pilot	Post-Pilot	Absolute Change	Percent Change	Pre-Pilot	Post-Pilot	Absolute Change	Percent Change
DAILY	30	31.3	28.1	-3.2	-10%	31.1	28.5	-2.6	-8%
MID (10 AM – 2 PM)	30	31.4	28.4	-3.0	-10%	31.3	28.9	-2.4	-8%
NIGHT (7 PM – 7 AM)	30	31.2	28.0	-3.2	-10%	32.1	29.8	-2.3	-7%

Source: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016). Speeds are based on data over the course of three full days.

Percent of Vehicles Traveling above the Posted Speed Limit

**Table 17** compares daily versus off-peak percent of vehicles traveling over the speed limit on Jefferson Avenue between Highland Avenue and Alameda de la Pulgas, by direction. The data shows that the reductions of the percent of vehicles traveling over the speed limit are similar between the daily period and the off-peak hours. The decreases towards I-280 all range from 28 to 29 percent and the decreases towards downtown all range from 20 to 23 percent, showing that the percent of vehicles traveling over the speed limit are not solely a result of congestion during the peak period.

**Table 17: Daily versus Off-Peak Percent of Vehicles Traveling Over the Speed Limit on Jefferson Avenue**

Time Period	Speed Limit (mph)	% of vehicles traveling over speed limit					
		Towards I-280			Towards Downtown		
		Pre-Pilot	Post-Pilot	Change	Pre-Pilot	Post-Pilot	Change
DAILY	30	72%	43%	-29%	68%	46%	-22%
MID (10 AM – 2 PM)	30	74%	45%	-29%	72%	49%	-23%
NIGHT (7 PM – 7 AM)	30	71%	42%	-28%	77%	57%	-20%

Source: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016).

Percent of Vehicles Traveling more than 10 mph over the Speed Limit

**Table 18** compares the daily versus off-peak percent of vehicles traveling 10+ mph over the speed limit on Jefferson Avenue between Highland Avenue and Alameda de la Pulgas, by direction. The data shows that the reductions of the percent of vehicles traveling 10+ mph over the speed limit are similar between the daily period and the off-peak hours. The decreases towards I-280 all range from 2 to 3 percent and the decreases towards downtown all range from 4 to 6 percent, showing that the percent of vehicles traveling 10+ mph over the speed limit are not solely a result of congestion during the peak period.

**Table 18: Daily versus Off-Peak Percent of Vehicles Exceeding the Speed Limit by 10 mph on Jefferson Avenue**

Time Period	Speed Limit (mph)	% of vehicles traveling 10+ mph over speed limit					
		Towards I-280			Towards Downtown		
		Pre-Pilot	Post-Pilot	Change	Pre-Pilot	Post-Pilot	Change
DAILY	30	4%	2%	-2%	5%	1%	-4%
MID (10 AM – 2 PM)	30	4%	2%	-2%	4%	0%	-4%
NIGHT (7 PM – 7 AM)	30	5%	2%	-3%	7%	1%	-6%

Source: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016).

## **OBJECTIVE 7:**

**Monitor the number of vehicles traveling on alternate routes to determine if drivers are diverting trips from the Farm Hill Boulevard corridor to alternate routes.**

*Why:* The purpose of the project was to modify the roadway design to increase safety and improve driver compliance with the speed limit, not to shift vehicles to other routes.

*Measurement:* Traffic volumes were collected on the corridor and on parallel routes to help evaluate whether drivers have shifted driving patterns in response to the pilot project. Locations for data collection were proposed by City staff and then refined by community input during development of the evaluation plan. The two metrics used to assess diversion are average daily traffic volumes (the number of vehicles travelled on a road over 24 hours) and peak hour traffic volumes (the number of vehicles travelled during the busiest hour in the morning and evening).

Peak hours typically occur between 7:00 AM and 9:00 AM in the morning and between 4:00 PM and 7:00 PM in the afternoon/evening. Each peak hour for the Farm Hill Boulevard/Jefferson Avenue corridor was identified by selecting the hour in which the traffic volumes for the three project count locations were highest. Peak hour volumes for all other streets are reported for the same hour to capture how traffic might have shifted routes.

Traffic volumes were collected by traffic data consultants using tube counters installed across each roadway for a period of three midweek days. The reported data is the average of those three days.

*Outcomes:*

### Average Daily Traffic Volume

**Table 19** shows the average daily traffic volumes on selected roadways in the study area. For trips to and from I-280, Edgewood Road and Woodside Road are the closest and most direct alternatives to driving on Farm Hill Boulevard. Traffic volumes along the pilot project corridor increased between May 2015 and May 2016 – ranging from 1 to 11 percent. Traffic on Woodside Road and Edgewood Road also increased, by 12 percent and 20 percent, respectively.

Other streets that were identified as potential cut-through routes saw increases in volume of 15 to 29 percent. The volume increases to all roadways, on the pilot project route and on potential diversion routes, is typical of the increase in traffic volumes observed along I-280. Volumes along I-280 at the SR-92 interchange in both directions, as reported from Caltrans Performance Measurement System (PeMS), showed an annual increase in volumes by approximately 20 percent over the past four years. More specifically, between May 2015 and May 2016, the volumes along I-280 increased by six percent, but it should be noted that between April 2015 and April 2016 the volumes increased by approximately 25 percent. This highlights the increase in volumes in the region, not necessarily due to the changes on Farm Hill Boulevard.

**Table 19: Average Daily Traffic Volumes on Selected Streets**

Segment	Average Daily Traffic Volume			
	Pre-Pilot	Post-Pilot	Absolute Change	Percent Change
<b>Locations Within Pilot Corridor</b>				
Farm Hill Blvd: Eden Bower Ln - Lonesome Pine Rd	12,609	12,788	179	1%
Farm Hill Blvd: McGarvey Ave - Jefferson Ave	10,334	11,288	954	9%
Jefferson Ave: Highland Ave to Alameda de las Pulgas	15,371	17,052	1,682	11%
<b>Parallel Routes</b>				
Woodside Road: I-280 to Alameda de las Pulgas	34,248	38,300	4,052	12%
Edgewood Road: I-280 to Alameda de las Pulgas	15,772	18,888	3,116	20%
<b>Other Potential Diversion Routes</b>				
Woodside Rd: Alameda de las Pulgas to El Camino Real	33,211	40,664	7,453	22%
Highland Ave: Laurel Way to Jefferson Avenue	755	892	137	18%
Jefferson Ave: Utah Way and Farm Hill Boulevard	4,447	5,731	1,284	29%
Dover Rd: Lancaster Way and Alameda de las Pulgas	432	497	65	15%
McGarvey Ave: Farm Hill Blvd and Fernside St	5240	6423	1,183	23%
Lancaster Way: Jefferson Ave and Harding Ave	288	348	60	21%
Bret Harte Dr: Emerald Hill Rd and Glennan Dr	518	595	77	15%

Sources: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016).

#### Average Peak Hour Traffic Volumes

Average peak hour volumes focus on the two hours of the day in which the traffic volumes are highest and when drivers would most likely experience congestion that might encourage a shift to their route – the morning peak hour and the evening peak hour. The same peak hours were used before and after the pilot – 8:00 AM to 9:00 AM and 5:00 PM to 6:00 PM. **Table 20** shows the average morning peak hour traffic volumes on selected roadways in the study area. **Table 21** shows the average evening peak hour traffic volumes on selected roadways in the study area.

Morning peak hour traffic volumes generally increased more than the increases in daily traffic volumes. Trips made on the pilot corridor increased by up to 197 vehicles or 16 percent in the morning peak hour (Jefferson Avenue between Highland Avenue and Alameda de las Pulgas). The largest increase on an alternate route was on Woodside Road, between Alameda de las Pulgas and El Camino Real (923 additional vehicles, a 42 percent increase). The largest increase on a parallel route was on Edgewood Road, between I-280 and Alameda de las Pulgas (690 additional vehicles, a 56 percent increase).

Evening peak hour traffic volumes generally increased more than the daily volumes increased. Trips made on the corridor increased by up to 154 vehicles or 16 percent in the evening peak hour (Farm Hill Boulevard between McGarvey Avenue and Jefferson Avenue). The largest increase on an alternate route was on Woodside Road between Alameda de las Pulgas to El Camino Real (468 additional vehicles, an 18 percent increase).

**Table 20: Average Morning Peak Hour (8:00 to 9:00 AM) Traffic Volumes on Selected Streets**

Segment	Average Peak Hour Traffic Volume			
	Pre-Pilot	Post Pilot	Absolute Change	Percent Change
<b>Locations Within Pilot Corridor</b>				
Farm Hill Blvd: Eden Bower Ln - Lonesome Pine Rd	1,277	1,327	50	4%
Farm Hill Blvd: McGarvey Ave - Jefferson Ave	1,027	1,159	132	13%
Jefferson Ave: Highland Ave to Alameda de las Pulgas	1,208	1,405	197	16%
<b>Parallel Routes</b>				
Woodside Road: I-280 to Alameda de las Pulgas	2,821	3,122	301	11%
Edgewood Road: I-280 to Alameda de las Pulgas	1,227	1,917	690	56%
<b>Other Potential Diversion Routes</b>				
Woodside Rd: Alameda de las Pulgas to El Camino Real	2,180	3,103	923	42%
Highland Ave: Laurel Way to Jefferson Avenue	94	107	13	14%
Jefferson Ave: Utah Way and Farm Hill Boulevard	433	514	81	19%
Dover Rd: Lancaster Way and Alameda de las Pulgas	43	54	11	26%
McGarvey Ave: Farm Hill Blvd and Fernside St	460	573	113	25%
Lancaster Way: Jefferson Ave and Harding Ave	30	39	9	30%
Bret Harte Dr: Emerald Hill Rd and Glennan Dr	95	96	1	1%

Sources: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016).

**Table 21: Average Evening Peak Hour (5:00 to 6:00 PM) Traffic Volumes on Selected Streets**

Segment	Average Peak Hour Traffic Volume			
	Pre-Pilot	Post Pilot	Absolute Change	Percent Change
<b>Locations Within pilot corridor</b>				
Farm Hill Blvd: Eden Bower Ln - Lonesome Pine Rd	1,149	1,248	99	9%
Farm Hill Blvd: McGarvey Ave - Jefferson Ave	935	1,089	154	16%
Jefferson Ave: Highland Ave to Alameda de las Pulgas	1,325	1,476	151	11%
<b>Parallel Routes</b>				
Woodside Road: I-280 to Alameda de las Pulgas	3,080	3,207	127	4%
Edgewood Road: I-280 to Alameda de las Pulgas	1,864	1,855	-9	-1%
<b>Other Potential Diversion Routes</b>				
Woodside Rd: Alameda de las Pulgas to El Camino Real	2,543	3,011	468	18%
Highland Ave: Laurel Way to Jefferson Avenue	61	84	23	38%
Jefferson Ave: Utah Way and Farm Hill Boulevard	365	468	103	28%
Dover Rd: Lancaster Way and Alameda de las Pulgas	45	46	1	2%
McGarvey Ave: Farm Hill Blvd and Fernside St	461	681	220	48%
Lancaster Way: Jefferson Ave and Harding Ave	30	24	-6	-20%
Bret Harte Dr: Emerald Hill Rd and Glennan Dr	42	40	-2	-5%

Sources: Quality Traffic Data (May 26-28, 2015 and May 31-June 2, 2016).

The change in traffic volumes between May 2015 and May 2016 suggest that there has been some growth in traffic to and from the I-280 corridor in Redwood City. As shown previously with the volumes along I-280, there has been an increase in volumes in the area, not necessarily due to the changes on Farm Hill Boulevard.

**OBJECTIVE 8:**

**Ensure that the project does not create air quality impacts.**

*Why:* Increased stopping and starting by vehicles can increase vehicle emissions and negatively impact air quality.

*Measurement:* Air quality changes were estimated by modeling vehicle emissions at the controlled intersections within the project limits. Data on traffic volumes, lane configurations, and signal timing before construction and after the pilot were input into *Synchro*, a traffic analysis and modeling software program. Emissions estimates are standard measures of effectiveness “MOE”s reported by the program. The morning peak hour was picked for the analysis because the volumes are highest in the morning for the corridor and it will result in a more conservative estimate of the air quality changes.

*Outcome:* The change in emissions during the morning peak hour (8 AM to 9 AM) is shown below in **Table 22** for carbon monoxide (CO), **Table 23** for nitrous oxides (NOX) and **Table 24** for volatile organic compounds (VOC). Emerald Hill Road had no changes in estimated emissions, while the other intersections experienced increases. The volume of emissions as a whole is very small, and does not exceed the Bay Area Air Quality Management District (BAAQMD) thresholds of significant impacts for air quality. These thresholds are shown in **Table 25**.

**Table 22: Change in CO Emissions (kg) in AM Peak Hour**

Intersection	Pre-Pilot	Post Pilot	Absolute Change	Percent Change
Farm Hill Blvd/ Emerald Hill Road	2.69	2.69	0.00	0%
Farm Hill Blvd/ Glennan Drive	1.67	1.92	0.25	15%
Farm Hill Blvd/ McGarvey Avenue	1.65	2.47	0.82	50%
Farm Hill Blvd/ Jefferson Avenue	2.03	2.99	0.96	47%

**Table 23: Change in NOx Emissions (kg) in AM Peak Hour**

Intersection	Pre-Pilot	Post Pilot	Absolute Change	Percent Change
Farm Hill Blvd/ Emerald Hill Road	0.52	0.52	0.00	0%
Farm Hill Blvd/ Glennan Drive	0.32	0.37	0.05	16%
Farm Hill Blvd/ McGarvey Avenue	0.32	0.48	0.16	50%
Farm Hill Blvd/ Jefferson Avenue	0.39	0.58	0.19	49%

**Table 24: Change in VOC Emissions (kg) in AM Peak Hour**

Intersection	Pre-Pilot	Post Pilot	Absolute Change	Percent Change
Farm Hill Blvd/ Emerald Hill Road	0.62	0.62	0.00	0%
Farm Hill Blvd/ Glennan Drive	0.39	0.45	0.06	15%
Farm Hill Blvd/ McGarvey Avenue	0.38	0.57	0.19	50%
Farm Hill Blvd/ Jefferson Avenue	0.47	0.69	0.22	47%

**Table 25: BAAQMD Thresholds of Significance for Operational-Related Projects<sup>1</sup>**

Pollutant	Tons/year	Pounds/day	Kilograms/day
CO <sup>2</sup>	None		
VOC	25	137	62
PM <sub>10</sub> <sup>3</sup>	15	82	37

<sup>1</sup> Source: BAAQMD CEQA Guidelines Assessing the Air Quality Impacts of Projects and Plans, May 2011

<sup>2</sup> CO- Carbon monoxide only has a threshold of 9.0 parts per million (8-hr average) and 20.0 parts per million (1-hr average)

<sup>3</sup> VOC- Volatile Organic Compounds

<sup>4</sup> PM<sub>10</sub>- Particulate Matter with diameter of 10 mm or less

**OBJECTIVE 9:**

**Design the street for all roadway users and increase the number of people using active forms of transportation.**

*Why:* A complete street design provides facilities for users of all ages and abilities – people walking (with strollers, wheelchairs, etc.), riding the bus, riding a bike, or driving a car. In the General Plan and Climate Action Plan, Redwood City has committed to making it safe and convenient to travel in Redwood City without driving.

*Measurement:* This objective is measured qualitatively by documenting the facilities provided for various roadway users and quantitatively by measuring whether the number of people walking, riding bikes, and riding transit has increased.

Data was also collected on the number of people riding bikes, walking along the street, and crossing the street during the morning (7:00 AM – 9:00 AM) and evening (4:00 PM – 6:00 PM) peak periods. One of the City’s traffic data consultants videotaped the intersections of Farm Hill Boulevard with Emerald Hill Road, Glennan Drive, Jefferson Avenue, and McGarvey Avenue and then reviewed the footage to count the number of people walking and biking at the study intersections.

SamTrans’ buses are equipped with automated passenger counters that track how many people get on an off a bus at each stop along the bus’s route. SamTrans provided on/off data for stops within the pilot corridor to the City for the months of May 2015 and May 2016.

*Outcomes:*

Complete Street Design

**Table 26** describes the facilities for different modes of transportation on Farm Hill Boulevard between Jefferson Avenue and McGarvey Avenue before and during the pilot. This location is representative of the corridor.

**Table 26: Description of Design by Mode**

Mode	Pre-Pilot	Post-Pilot
Walking	<ul style="list-style-type: none"> <li>Continuous sidewalks</li> <li>Buffer between moving traffic and sidewalk provided by parking and/or bicycle lanes</li> <li>Crossing the street requires crossing four lanes of vehicle traffic</li> <li>Yield symbols (“shark teeth”) in advance of uncontrolled crosswalks</li> </ul>	<ul style="list-style-type: none"> <li>Continuous sidewalks</li> <li>Buffer between moving traffic and sidewalk provided by parking and/or bicycle lanes</li> <li><b>Reduced the number of lanes crossing from four lanes to three lanes of vehicle travel way</b></li> <li>Yield symbols (“shark teeth”) in advance of uncontrolled crosswalks</li> <li><b>Painted pedestrian refuge island</b></li> </ul>
Transit	<ul style="list-style-type: none"> <li>Combination of red zones and pole stops</li> <li>Passengers going to a bus stop across the street requires crossing four lanes of vehicle traffic</li> </ul>	<ul style="list-style-type: none"> <li>Combination of red zones and pole stops</li> <li><b>Reduced the number of lanes crossed for passengers going to a bus stop across the street from four lanes to three lanes of vehicle traffic</b></li> </ul>
Bicycling	<ul style="list-style-type: none"> <li>Shared travel lane with “sharrow” roadway markings</li> <li>Striped shoulder used as de facto bike lane when vehicles aren’t parked on-street</li> </ul>	<ul style="list-style-type: none"> <li><b>Bicycle lane added throughout pilot project corridor</b></li> </ul>
Driving	<ul style="list-style-type: none"> <li>Two lanes in each direction</li> <li>Left-turns made from through-left lane</li> <li>Painted edge-line provided a small buffer between parked cars and moving traffic</li> </ul>	<ul style="list-style-type: none"> <li><b>One lane in each direction and a center two-way left-turn lane</b></li> <li><b>Left turns made from left turn pocket or center two-way left-turn lane</b></li> <li><b>Bicycle lane provides buffer between parked cars and moving traffic</b></li> <li><b>Eastbound right-turn pocket added at Farm Hill Blvd &amp; McGarvey Ave intersection</b></li> </ul>

Note: Additions/changes are **bolded**

Transit Ridership

In **Table 27**, average daily ridership data for SamTrans buses at all the stop locations along Farm Hill Boulevard and Jefferson Avenue (from Alameda de las Pulgas to Cañada College) is summarized. Over the evaluation period, ridership decreased by 15 percent. It should be noted that overall transit ridership for SamTrans in May 2016 has decreased (three percent) as well.

**Table 27: Transit Ridership (SamTrans)**

Route	Average Daily Boardings and Alightings			
	Pre-Pilot	Post-Pilot	Absolute Change	Percent Change
274 (weekday service)	392	335	-57	-15%
278 (Saturday service)	41	35	-6	-15%

Source: SamTrans (May 2015 and May 2016, stops between and including Cañada College and Jefferson Ave/Alameda de las Pulgas)

Bicycle Use

In **Table 28**, the number of bicycle riders is compared between the Pre-Pilot and Post-Pilot conditions. The number of people riding bicycles through the study intersections increased during the pilot, from four to seven additional people depending on the intersection, during the peak periods when the data was collected.

**Table 28: Bicycles Passing through the intersection during Peak Periods**

Location	Number of People Riding Bikes		
	Pre-Pilot	Post-Pilot	Absolute Change
Farm Hill Blvd at Glennan Drive	3	10	7
Farm Hill Blvd at Jefferson Ave	5	9	4
Farm Hill Blvd at McGarvey Ave	10	17	7
Farm Hill Blvd at Emerald Hill Road	2	9	7

Source: Quality Traffic Data, Turning Movement Counts (May 27-28, 2015 and May 31, 2016; 7-9 AM and 4-6 PM)

People Walking

In **Table 29**, the number of people walking through the study intersections increased or stayed the same in the Post-Pilot at all but one location. The exception to this was at Farm Hill Boulevard and Emerald Hill Road, where one less person walked along the street.

**Table 29: People Walking Along the Street during Peak Periods**

Location	Number of People Walking Along the Street		
	Pre-Pilot	Post Pilot	Absolute Change
Farm Hill at Glennan	10	19	9
Farm Hill at Jefferson	9	9	0
Farm Hill at McGarvey	0	14	14
Farm Hill Blvd at Emerald Hill Road	30	29	-1

Source: Quality Traffic Data, Turning Movement Counts (May 27-28, 2015 and May 31, 2016)

In **Table 30**, the number of people crossing the study intersections increased or stayed the same in the Post-Pilot data collection at all but one location. The exception to this was at Farm Hill Boulevard and Glennan Drive, where one less person crossed the street. The biggest changes occurred at the intersection with McGarvey Avenue where the number of people walking along the street increased by 14 people and the number of people crossing increased by 10 people.

**Table 30: People Crossing the Street during Peak Periods**

Location	Number of People Walking Along the Street		
	Pre-Pilot	Post Pilot	Absolute Change
Farm Hill at Glennan	9	8	-1
Farm Hill at Jefferson	2	7	5
Farm Hill at McGarvey	2	12	10
Farm Hill Blvd at Emerald Hill Road	12	12	0

Source: Quality Traffic Data, Turning Movement Counts (May 27-28, 2015 and May 31, 2016)

**OBJECTIVE 10:**

**Increase the share of people choosing active forms of transportation to access Stulsaft Park**

*Why:* Stulsaft Park is a unique feature of the neighborhood that attracts all types of visitors from various locations. Having more people access Stulsaft Park by walking, riding bikes, and taking the bus increases physical activity and increases access to the park by reducing the demand for the limited parking supply.

*Measurement:* An intercept survey was performed in July 2015 and July 2016 to collect information on how people got to Stulsaft Park and on their perceptions of comfort and safety using Farm Hill Boulevard. Intercept surveys are surveys that are conducted in-person, in a public setting.

Since the respondents in the Post-Pilot surveys were potentially different respondents than the Pre-Pilot, this data was not used for the evaluation, but it is provided in **Appendix A** for reference. In general, it is difficult to get an accurate representation of the public’s opinion on the Pre-Pilot and Post-Pilot changes given the different sample size of respondents, limited sample size of respondents, and

inability to capture respondents for each of the different transportation modes (i.e. pedestrians, bicyclists, transit users, and drivers).

## **OBJECTIVE 11:**

### **Increase feelings of comfort and safety for all roadway users**

*Why:* Farm Hill Boulevard and Jefferson Avenue serve important roles within the community and neighborhood – both connecting people to regional destinations (jobs outside the city, airports, etc.) and to local ones (park, places of worship, neighbors, etc.) – and people should feel safe using it.

*Measurement:* The intercept survey described above collected data on perceptions of comfort and safety of people using Farm Hill Boulevard and Jefferson Avenue.

Similar to Objective 11, an intercept survey was performed in July 2016 after the pilot to collect information on the change in feelings of comfort and safety for all roadway users. However, since the respondents in the Post-Pilot surveys were different respondents than the Pre-Pilot, this data was not used for the evaluation, but is provided in **Appendix A** for reference.

## **Summary of Evaluation**

Multiple performance measures set forth by the City were evaluated. **Table 31** summarizes the measures and key findings for each. Generally, the pilot project achieved the desired goals of the project, excluding the increase in emissions and congestion, as well as the reduction in transit ridership. It should be noted that the emissions and congestion are two measures that are correlated since the congestion and the emissions increased due to the increase in vehicle demand. The reduction in transit ridership is not necessarily due to the project itself since there is no direct correlation and the overall transit system ridership also decreased from May 2015 to May 2016.

It should also be noted that the amount of diversion of traffic to alternate routes is inconclusive because the number of vehicles on each corridor, including the project corridor increased. This increase in vehicle demand is typical of the increase in vehicle demand and traffic congestion in the general area, as shown by the increase in volumes along I-280.

**Table 31: Summary of Evaluation Measures and Findings**

Measure	Goal	Observed Result	Comments
Air Quality (Amount of Vehicle Emissions)			The vehicle emissions increased due to the increase in vehicle demand.
Congestion <ul style="list-style-type: none"> <li>• Intersection delay</li> <li>• Corridor travel times</li> </ul>	 	 	<ul style="list-style-type: none"> <li>• Intersection delay increased due to increase in vehicle demand.</li> <li>• Travel times went down.</li> </ul>
Ease of crossing the street			The % of vehicles yielding to pedestrians went up. The average wait time went down.
Ease of entering traffic (avg delay for side-street vehicles)			Average delay for vehicles making a left turn decreased.
Complete streets <ul style="list-style-type: none"> <li>• Number of passengers getting on and off SamTrans buses</li> <li>• Number of people riding bikes</li> <li>• Number of people walking along the street</li> <li>• Number of people crossing the street</li> </ul>	   	   	<ul style="list-style-type: none"> <li>• Transit boardings and alightings has decreased.</li> <li>• # of people riding bicycles increased</li> <li>• # of pedestrians increased walking along the street</li> <li>• # of pedestrians increased crossing the main roadway</li> </ul>
Safety (# of Crashes)			The number of average monthly crashes went down after project began.
Speeding			The 85 <sup>th</sup> and 50 <sup>th</sup> percentile speed, vehicles exceeding the speed limit and the speed limit by 10 mph all decreased.
Traffic Diversion			Inconclusive because vehicle traffic increased on the project corridor and on all other routes.
Improvement:                 Worsened:                 Inconclusive:			



**Appendix A – Survey Results (Physical Appeal and Comfort of Use)**

Questions	Pre-Pilot				
	Very Comfortable	Comfortable	Neutral	Not Comfortable	Very Uncomfortable
How comfortable to you feel traveling along Farm Hill and/or Jefferson?	13%	35%	40%	10%	2%
	<b>Very Safe</b>	<b>Safe</b>	<b>Neutral</b>	<b>Unsafe</b>	<b>Very Unsafe</b>
How safe do you feel traveling along Farm Hill and/or Jefferson?	27%	31%	26%	14%	2%
How safe do you feel crossing Farm Hill and/or Jefferson?	14%	30%	35%	13%	8%
Number of respondents	85				

Sources:

Intercept Surveys 7/18/15 and 7/23/15

Intercept Surveys 7/1/2016

Questions	Post-Pilot				
	Very Comfortable	Comfortable	Neutral	Not Comfortable	Very Uncomfortable
How comfortable to you feel traveling along Farm Hill and/or Jefferson?	17%	37%	29%	15%	2%
	<b>Very Safe</b>	<b>Safe</b>	<b>Neutral</b>	<b>Unsafe</b>	<b>Very Unsafe</b>
How safe do you feel traveling along Farm Hill and/or Jefferson?	18%	39%	34%	9%	0%
How safe do you feel crossing Farm Hill and/or Jefferson?	4%	35%	47%	14%	0%
Number of respondents	44				