6-9-2016

Redesign of Lawrence Expressway and Pruneridge Avenue

Matthew Wong
Santa Clara Univeristy

Tyler Isaac
Santa Clara Univeristy

SANTA CLARA UNIVERSITY

Department of Civil Engineering

I HEREBY RECOMMEND THAT THE THESIS PREPARED
UNDER MY SUPERVISION BY

Matthew Wong, Tyler Isaac

ENTITLED

REDESIGN OF LAWRENCE EXPRESSWAY AND PRUNERIDGE AVENUE

BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

BACHELOR OF SCIENCE
IN
CIVIL ENGINEERING

06/09/2016

Thesis Advisor(s) (use separate line for each advisor) date

6/9/16

Department Chair(s) (use separate line for each chair) date

REDESIGN OF LAWRENCE EXPRESSWAY AND PRUNERIDGE AVENUE

By

Matthew Wong, Tyler Isaac

SENIOR DESIGN PROJECT REPORT

Submitted to
the Department of Civil Engineering

of

SANTA CLARA UNIVERSITY

in Partial Fulfillment of the Requirements
for the degree of
Bachelor of Science in Civil Engineering

Santa Clara, California

Spring 2016

Acknowledgements

A special thank you to

Santa Clara University, Department of Civil Engineering
Dr. Rachel He
Dr. Jacquelyn Hendricks
Professor Ziad Dweiri
Byron Tang, PE - Associate Civil Engineer, SCC Roads & Airports
Benison Tran - Senior Civil Engineer, City of Santa Clara

for their assistance, sharing of technical knowledge and documents, and support throughout the project.

Abstract

In 2012, the segment of Pruneridge Avenue from Lawrence Expressway to Pomeroy Avenue saw a project called a Road Diet. A Road Diet refers to the replacement of vehicle lanes with bicycle lanes and a center turning lane, in order to create safe zones for cyclists and drivers on the same street. While the Road Diet sufficiently addressed the safety issues of the corridor, it severely worsened its traffic capacity, creating long queues along Pruneridge and on Lawrence Expressway during peak traffic hours as residents around the area commute to and from work. The queues are so long that many drivers decide to run red lights to avoid waiting additional cycles, introducing a new set of safety concerns. Pedestrians also had to deal with cars speeding through right-hand turns between Pruneridge and Lawrence, because the visibility on the curb is very low at night. Finally, the center turn lane that was implemented on Pruneridge is very under-utilized during peak hours, and that space could be used for something more efficient or useful than a suicide lane. This project aims to address the problems that the Road Diet introduced and some pre-existing issues while maintaining the bike lanes to provide safety and encourage cycling in the area.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

1.1 Choosing a Project

With the help of Dr. Rachel He, we were able to find a local traffic project that we could study up close and understand on an intimate level. We were looking for a project that would introduce us to the mindset of an engineer designing an area to meet high traffic demands. Dr. He mentioned that a segment of a local street, Pruneridge Avenue, recently underwent a road project to make space for driving and cycling safety, and as a result was faced with terrible traffic delays. This project is what is commonly becoming known as a Road Diet. This project proposes a solution that alleviates the high traffic on Pruneridge and Lawrence while maintaining a complete street that is safe for all users including drivers, cyclists, pedestrians, residents, and Emergency Vehicles.

1.2 Project History: A Brief Introduction to Road Diets

The concept of “Road Diet” programs gained momentum nearly eight years ago as a result of the state of California pushing for “complete streets” - or, streets that can be safely accessed and used by non-drivers. Road Diets specifically target 4-lane streets and convert them into 2-lane streets with bike lanes and a center turn lane. Although they almost always successfully achieve their goals of providing accessibility to non-drivers, Road Diet projects quickly grew a reputation for worsening vehicle traffic because of the reduction of lanes.

Many Road Diets, such as Lincoln Avenue in Willow Glen of San Jose, or in this project’s case, Pruneridge Avenue of Santa Clara, often get strong push-back from drivers usually trying to use the street for daily work commutes. The tenants of the streets also often have issues with Road Diets. If the project is on a residential street, residents have to deal with irritating traffic just to get to and from home on weekdays. If it is a commercial street, many businesses will face sharp losses in revenue as customers begin to avoid travelling through the area.

In many cases, Road Diets are justified, and project managers would point out that as consumers become more accustomed to the changes, driver complaints will start to die down within several months. In the case of this project, Pruneridge has had its Road Diet for nearly four years, and daily commuter traffic is still unbearably bad. This project aims to find a different, more efficient way to execute a complete street.

1.3 General Site Description

Pruneridge Avenue is a residential street located in Santa Clara, California close to the western City limits. The project focuses on the section of Pruneridge Avenue between Lawrence Expressway and Pomeroy Avenue, which is just less than one half mile long. Figure 1 portrays a Google Maps screenshot of the scope.

Figure 1: Pruneridge Avenue layout. The blue line depicts the section the team will focus on.

As noted in Figure 1, several high occupancy buildings surround the concentrated scope. Sutter Elementary School and Eisenhower Elementary School are east of Pomeroy Avenue. Kaiser Permanente is northbound along Lawrence Expressway at the intersection with Homestead Road. The new Apple Campus, set to open in 2017, is about one half mile west of the scope.

1.4 Demonstrated Need

High Traffic Density. The elementary schools cause high traffic density problems in the mornings and afternoons when classes are dismissed. The close proximities of these schools force the speed limit to be decreased which in turn creates even more congestion. The looming opening of the new Apple Campus will only add more cars to this busy area. The County of Santa Clara Roads and Airports Department (RDA) conducted a vehicle count on the intersection of Lawrence Expressway and Pruneridge Avenue on November 30, 2015. RDA counted 3,306 cars traveling northbound along Lawrence during the morning peak hour, and 2,995 cars traveling southbound along Lawrence during the evening peak hour. Additionally, since 2005, there has been a 3.7% increase in traffic demand each year along Pruneridge[8]. These numbers along with the fact that one through lane is being taken away in each direction from the Road Diet project lead to an extremely high traffic density road. The congestion along Pruneridge Avenue is shown in Figure 2 below.

Figure 2: Photograph of vehicles waiting in a queue on Pruneridge Avenue heading westbound during the morning peak hours.

Bicycle & Pedestrian Safety Measures. The safety of bicyclists and pedestrians is a greater issue on the intersection of Lawrence Expressway and Pruneridge Avenue than the safety of vehicles. When the team visited the project site to count cars one day, a cyclist approached the team and wondered what they were doing. When told about the Senior Design project, the cyclist expressed his concern about the dangers of the intersection. Due to the long queues and lengthy delay times, drivers frequently sped through the red lights because they did not want to waste time and became impatient. The intersection was also dimly lit, which increased the dangers during the evening peak hours. The safety of non-motorized commuters was a serious matter that the team took into account when creating the redesign of the street. Figure 3 portrays the aforementioned dimly lit intersection.

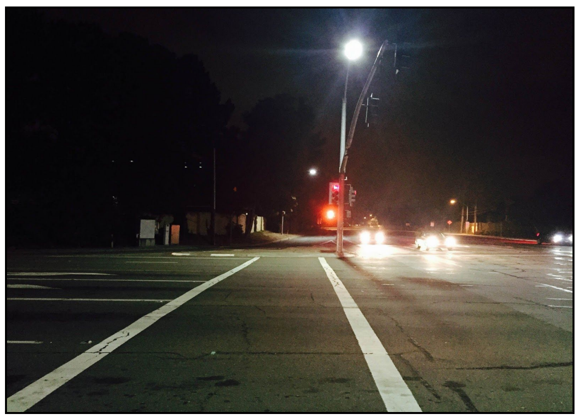


Figure 3: Intersection of Lawrence Expressway and Pruneridge Avenue. Dimly lit intersection creates a dangerous place for bicyclists.

CHAPTER TWO: ALTERNATIVES AND POSSIBLE SOLUTIONS

Given the scope of our project, we figured we would have three specific areas to focus on: the street layout of Pruneridge Avenue, the signal timing of the traffic lights at the intersection of Pruneridge and Lawrence, and the physical features of the intersection itself. The most significant in terms of addressing vehicle traffic flow and capacity is by far the layout of the lanes and the space allocated for vehicles, as the beginnings of the traffic problems stemmed from the reduction of lanes in the Road Diet. The signal timing of the Pruneridge and Lawrence intersection needed to be addressed, as nearly all of the traffic stemmed from cars waiting to use that intersection. Finally, any other design implementations to increase the overall safety throughout the scope that do not negatively affect traffic will be considered.

2.1 Alternative Pruneridge Avenue Layouts

When considering how to alleviate traffic on Pruneridge, three goals were considered. The most important is the safety of cyclists, drivers, street residents, pedestrians, and emergency vehicles. A complete street is one that allows all users to naturally have a safe experience, meaning that they will not have to adjust their behavior to feel and be safe. For example, if a cyclist feels the need to ride on the sidewalk to avoid vehicle traffic, the first goal is not met.

Another goal almost as important as safety is alleviating traffic - this is directly reflected by reducing queue times and queue lengths, and indirectly reflected by increasing the average driver speed through the corridor. The option with the highest speeds would not necessarily be the best option, as it could interfere with the first goal of safety. The biggest criticism of the Road Diet was the resulting traffic it caused, so this goal is integral to the entire project.

The third goal is to find a solution that is versatile enough to meet the changing demands of the corridor throughout a standard work day. Pruneridge Avenue is slightly different from other streets in that it faces heavy single-direction traffic only in the morning and evening commute hours, each going at different directions at different times. Also, the street is residential with cars coming in and out of driveways throughout the day. After considering these goals, the amount of solutions considered was narrowed down to four that could be simulated and easily compared.

2.1.1 Design Constraints

All solutions are limited by several constraints that add another level of complexity to this project. These constraints limit the amount of feasible solutions, and leaves the remaining ones with their advantages and disadvantages.

Because it is a residential street, Pruneridge cannot be widened to make more space for its users. This limits the amount of lanes available and gives things like on-street parking and bike lanes a larger impact on vehicle traffic. It also limits the hours a construction crew can work on this project, as night construction would be strongly opposed by the residents trying to sleep.

This street project incorporates Pruneridge Avenue, which is a city street, and Lawrence Expressway, which is a county expressway. This means that this project would have to be approved by both the County of Santa Clara and the City of Santa Clara, and would have to meet each of their respective design standards.

Table 1 below shows the advantages and disadvantages of the four proposed design alternatives. Each design was carefully planned while taking into account both technical and nontechnical aspects.

Table 1: Summary of design features for Pruneridge Avenue.

Proposal	Advantages	Disadvantages
4 lanes, 2 lanes in each direction, with on-street parking	● High vehicle capacity ● On-street parking	● No bike lane ● No center turn lane
3 lanes, 1 lane in each direction, with reversible center lane	● High vehicle capacity ● On-street parking ● Bike lanes	● Requires signs ● Possibly confusing ● Center turn lane is not always available
4 lanes, 2 lanes in each direction, with bike lane	● High vehicle capacity ● Bike lanes	● No center turn lane ● No on-street parking
2 lanes, 1 lane in each direction, with center turn lane	● On-street parking ● Bike lanes ● No construction cost	● Low vehicle capacity ● Inefficient use of roadway

2.1.2 Four Lane Street With On-Street Parking

A four lane street with on-street parking is what Pruneridge Avenue looked like before the Road Diet. There are two lanes in both the west- and eastbound directions, similar to the street depicted in Figure 4. Two lanes in each direction gives this option plenty of flexibility in terms of shortening queue lengths and minimizing the amount of time cars are waiting at red lights when leaving the scope. The street parking is convenient to residents that may have more cars than their driveway can handle, or if they are expecting visitors. However, the lack of a bike lane makes the corridor appear unwelcome to cyclists. Reverting the street back to its pre-2012 look may seem like backtracking, and would make the Road Diet seem like a waste of time and money - something that many users may already think of to some degree.

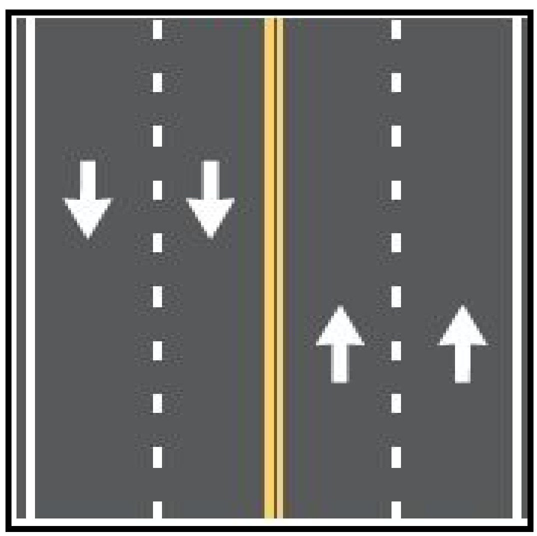


Figure 4: Original Pruneridge layout before Road Diet in 2012.

2.1.3 Reverse Lane With Bike Lane and Street Parking

Inspired by Lafayette Street by Santa Clara University, a reverse lane is the most flexible and efficient option. In terms of re-purposing the street and the pavement markings, the only thing that would change from the Road Diet to this would be that the center turn lane would be converted into a reverse lane. This means that traffic would be able to use the center lane as a thru lane during peak hours; drivers can use it going westbound in the morning peak hours

(7am-9am) and going eastbound in the evening peak hours (4pm-7pm). During all other hours, the center lane would be used as a turning lane. This allows there to be two lanes going in the direction of heavy traffic when they need it, and it also leaves enough room for bike lanes and street parking. In order to keep all drivers aware of how the reverse lane is used, signs and signals are essential throughout the corridor. A depiction of this can be seen in Figure 5.

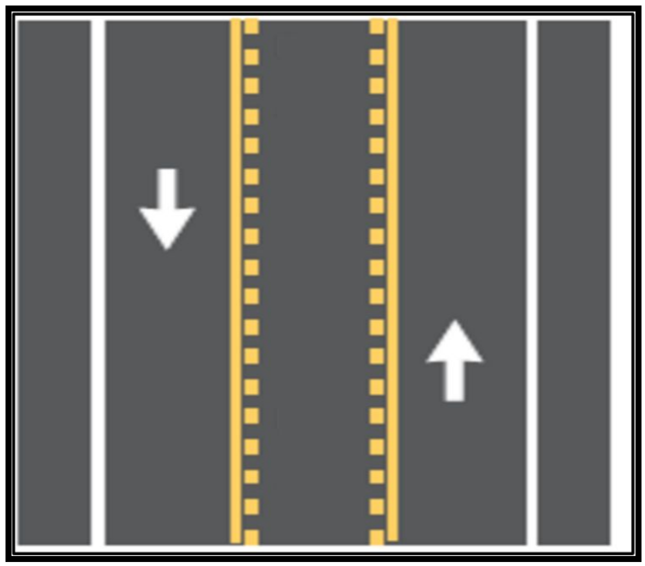


Figure 5: Reverse lane alternative for Pruneridge Ave.

2.1.4 Four Lane Street with Bike Lane

A four lane street with two bike lanes faces many similar issues to a four lane street with on-street parking in that it would be back-tracking some of the progress the Road Diet made. Choosing between on-street parking and a bike lane is difficult because the needs of two different groups are being compared - that of residents and that of bicyclists. Removing the on-street parking puts immense pressure on the residents that only have enough space for a couple cars in their driveway. It could potentially harm how the homeowners value their property. However, this is a very strong candidate for driver safety, cyclist safety, and traffic alleviation.

2.1.5 Maintain Road Diet Layout

There is a possibility that none of the above solutions can significantly address the high demand for vehicle traffic while maintaining a safe environment for all of the users of the corridor. If no solution can show promise in meeting the three goals, the best solution would be to keep the street the way it is and use that money elsewhere. This solution is the right choice if the negatives of construction cost, diverting traffic, and intruding on the residents' community outway the benefits of changing Pruneridge Avenue. The Road Diet has a low traffic capacity, and cars will be queuing for long periods of time for red lights. During peak hours the center turn lane is seldom, if ever, used, and is an inefficient use of space. The team observed that during the peak hours, residents were very seldomly entering or leaving their homes at peak hour and using the center lane. They were either travelling at different times or making right turns into their driveways as opposed to making left turns across oncoming traffic.The extra 13 feet of roadway could be used more effectively. For comparison, Figure 6 depicts what the Road Diet looks like currently.

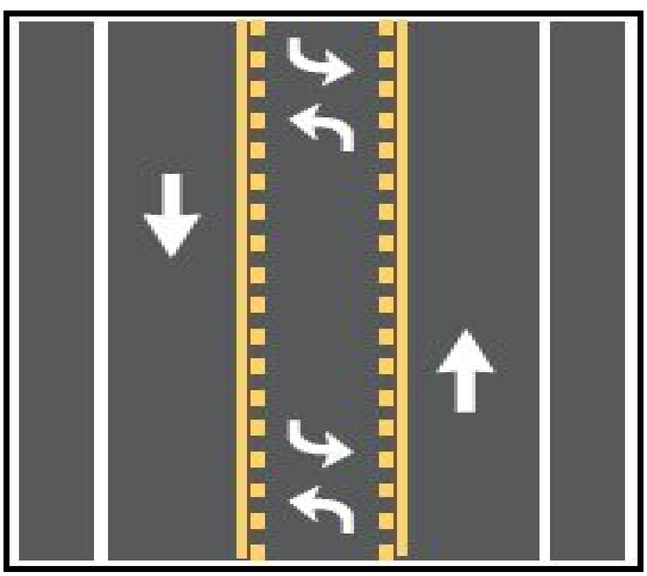


Figure 6: Current Road Diet layout on Pruneridge Ave.

2.1.6 Final Design

The solution that meets the project goals the most effectively is the implementation of a reverse lane. It is able to meet the needs of all of the users of the corridor by making minor sacrifices to drivers and residents. By having only 3 lanes, there is plenty of space for on-street parking and a bike lane, giving the cyclists and residents the space they need as well as keeping moving vehicles a safe distance away from pedestrians walking on the sidewalk. The reverse lane allows there to be two thru lanes during peak hours, which significantly improves the vehicle capacity of the corridor. The accompanied research for this project suggests that the reverse lane has virtually the same effect on peak hour traffic as the 4-lane alternatives.

A reverse lane on Pruneridge requires minimal changes done to the street markings, reducing the impact of street construction and traffic diversion. However, there will be some additional spending on the construction and maintenance of overhead signs. In addition to the tax dollars being spent, these overhead signs can have a varying impact on how the surrounding homeowners value their homes and property.

This option also allows for a center turn lane for the majority of the day, which is good for the safety of residents trying to pull into their driveways from the opposite side of the street and vise versa. Although it isn't as dependable as the 24/7 center turn lane of the Road Diet, it is a reasonable sacrifice in order to reduce the amount of time drivers spend on the road. From an environmental perspective, reducing the amount of time people are in their cars also reduces the amount of greenhouse gasses they emit every day. A reverse lane is much more environmentally conscious than the Road Diet, especially since they have equal capacity for cyclists.

2.2 Signal Light Changes

2.2.1 Optimize Signal Timing

In order to keep cars waiting at a red light for as little time as possible, work has to be done to make sure that the signal lights are properly programmed to match the demand of a given intersection. When it was discovered that the County of Santa Clara grossly underestimated the number of cars that used the intersection of Lawrence and Pruneridge, the group determined that a change would have to be made to the signal lights to better reflect how drivers were using the intersection.

With the help of the computer program Synchro 6, it was determined that the amount of time cars were waiting at red lights could be reduced significantly. The cycle length was reduced from 200 seconds to 150 seconds in order to allow more green lights to be shown across all approaches more frequently. This was especially helpful for southbound cars trying to turn left onto Pruneridge in the evening peak hours. They were able to see green lights more often so that the queue length wouldn't be backed up as far back as Kaiser Hospital.

Although our scope included two intersections, one at Lawrence and one at Pomeroy, it was determined that an adjustment to the Pomeroy sign cycle was not necessary for alleviating traffic in the area. The switch to a reverse lane as well as the signal changes at Lawrence is enough for the entire corridor.

2.2.2 Increase Red Light Duration

While recording the traffic flow through the intersection of Lawrence and Pruneridge, the team noticed that many cars trying to use the intersection would be waiting multiple light cycles in a queue. In the morning, this was seen in cars approaching going westbound, and in the evening this was seen in cars approaching going southbound and trying to turn left onto Pruneridge. As the impatience grew in the drivers, many would decide to run red lights as the green phase ended so that they would not have to wait another cycle. This is not only dangerous for those impatient drivers and any oncoming drivers, it is unsafe for any pedestrians or cyclists also using the intersection. In response, this project increases the red light time in each direction from 0.5 TO 2 seconds in order ensure none of the green phases began when cars were still using the intersection.

2.3 Intersection Changes

After talking to the cyclist during one of the team's data recording sessions, it was determined that this project should address some of the concerns of the people using our streets. Although not all of the possible solutions were implemented, they can still be considered for future projects

2.3.1 Additional Lighting

A simple fix to the problem of driver visibility of crossing pedestrians is the installation of street lights. Street lights are inexpensive and are not intrusive to traffic. Pedestrians will be able to feel safer from turning cars, and they will also be able to see any other approaching pedestrians or cyclists at night. People will feel safer when they know they can be seen, and when they can see all of their surroundings as well.

2.3.2 Bulb-outs

A more drastic solution to visibility would be to introduce bulb-outs to the corners of the intersection. They bring the crossing pedestrians out into the sight lines of the drivers, and also they force drivers to slow down to turn around them. For this project, bulb-outs were determined to be excessive and out of the scope. While safety is the highest priority, the group had no reason to believe that bulb-outs would be significantly more preferable to additional lighting, and they were determined to be too much cost for not enough guaranteed benefit.

2.3.4 Lengthen Left Turn Storage Lane

In the evening, southbound cars turning left onto Pruneridge would regularly be backed up to the Kaiser Hospital to the north and affect the intersection there. This is not only inconvenient for drivers, it is potentially dangerous for EMT vehicles trying to travel to or from the hospital. A possible solution would be to lengthen the left turn lanes at the Lawrence and Pruneridge intersection. This was determined to be out of the scope of our project, as it would have to involve research and design of additional traffic and intersections away from the original Road Diet that this project addresses.

CHAPTER THREE: DATA RECORDING AND RESEARCH

3.1 Finding Existing Information

Finding current traffic information on Pruneridge Avenue and Lawrence Expressway proved difficult. Contacting the City of Santa Clara and the County of Santa Clara to obtain their data was an agonizing process, as each person seemed to direct the search to another department or a co-worker. After several weeks of searching, Byron Tang P.E., an Associate Civil Engineer for the County of Santa Clara Roads and Airports Department, was able to provide several pages of traffic data for the intersection of Pruneridge and Lawrence. This included vehicle counts through the intersection and the signal timing for the lights. To get any more information of Pruneridge Avenue, however, such as vehicles per hour and queue delays, the City of Santa Clara would have to be contacted. The City was unresponsive to any attempt at finding any existing data.

3.2 Field Work

To gain more data and insight to the project, the team visited the site 8 different times between November 2015 and April 2016 to collect data, 4 times during the morning peak hours and 4 times during the evening peak hours. Attempting to be efficient, the team split up each intersection by standing on opposite corners. One person would count cars traveling westbound and southbound, while the other person would count cars traveling eastbound and northbound. Jamar counters were used to keep count of the vehicles, and each count lasted for 15 minutes. This number was multiplied by 4 to calculate the peak hour factor volume. These values were inputted into Synchro 6 to find the best solution to lessen the traffic density on Lawrence and Pruneridge.

3.3 Additional Research

3.3.1 Scope of Work

The team objective to design a complete street design that would greatly lessen the traffic density required extensive research and time spent observing and analyzing traffic and street conditions. Table 2 shows the dates and times that the team visited the site.

Table 2: Site visits From November 2015 through April 2016.

Date	Time	Condition
November 17, 2015	8AM - 9AM	Cold
January 13, 2016	5PM - 6PM	Cold
January 19, 2016	8AM - 9AM	Raining
January 26, 2016	8AM - 9AM	Windy
January 27, 2016	5PM - 6PM	Windy
February 9, 2016	8AM - 9AM	Warm
February 10, 2016	5PM - 6PM	Warm
April 25, 2016	5PM - 6PM	Cold

3.3.2 Post-Construction Traffic Study (Collisions)

Although the City of Santa Clara did not provide any useful data, they did, however, provide a link to their website where the "Pruneridge Avenue Bicycle Lane Improvements Post-Construction Traffic Study" was found. This traffic study conducted by Kimley-Horn & Associates in 2012 provided useful information about the Road Diet project[8]. Table 3 on the following page shows the collision statistics from Pruneridge Avenue over a 7 year period.

Table 3: Pruneridge Avenue collision summary from August 2005 through October 2012.

Pruneridge Avenue Segment				Segment Length (Miles)	No. of Collisions Before Project			No. of Collisions After Project		
					Total	Injury	Fatality	Total	Injury	Fatality
Pomeroy/ Cronin	To	Lawrence	WB	0.5	8	2	0	3	0	0
Lawrence	To	Giannini	WB	0.3	8	2	0	1	0	0
Giannini	To	N Tantau	WB	0.3	2	0	0	0	0	0
N Tantau	To	Giannini	EB	0.3	3	4	0	0	0	0
Giannini	To	Lawrence	EB	0.3	7	2	0	0	0	0
Lawrence	To	Pomeroy/ Cronin	EB	0.5	17	8	0	2	0	0
		Totals		**1.1**	**45**	**18**	**0**	**6**	**0**	**0**

Table 3 shows that during the 76 month period before the Road Diet project from August 2005 to January 2012, a total of 45 collisions were reported along Pruneridge Avenue. This resulted in 1.22 collisions/1,000,000 vehicle miles. During the 8 month period after the road the project, a total of 6 collisions were reported. This came out to be 1.20 collisions/1,000,000 vehicle miles. Both these statistics are significantly under the national average of 1.86 collisions/1,000,000 vehicle miles. None of these collisions reported injuries or fatalities (Kimley-Horn & Associates).

The slight decrease in collisions on Pruneridge after the Road Diet project was promising. Since there was only one lane of traffic in each direction, the chances of sideswipe collisions inevitably went down. The center turn lane allowed vehicles turning left to wait for gaps in the traffic without blocking the through traffic lane; this would reduce the number of rear-end collisions. This study helped prove that Pruneridge is not a dangerous street for drivers.

3.3.3 Post-Construction Traffic Study (Bicyclists)

Kimley-Horn & Associates also conducted bicycle counts before and after the Pruneridge Road Diet project. The ‘before’ counts were collected in May 2010, and the ‘after’ counts were collected in June 2012 at the same morning and evening peak hours. Table 4 on the following page summarizes the results of those bicycle counts.

Table 4: Pruneridge Avenue and Pomeroy Avenue 'before' and 'after' bicycle counts.

		AM	PM	*Total*
Weekday Bicycle Counts	Before	5	3	*8*
	After	19	17	*36*
	Difference	+14	+14	+28
	% Change	*280%*	*467%*	*350%*

The bicycle counts in Table 4 show an increase of 350% in weekday usage. This significant increase could be attributed to the addition of the bicycle lanes from the Road Diet project. The study also anticipated even more cyclists to use the roadway once the presence of the bicycle lanes became more well-known (Kimley-Horn & Associates). The increase of bicyclists along Pruneridge also led to a decrease in CO_2 emissions and less vehicular congestion, which is shown in Table 8.

CHAPTER FOUR: SIMULATION

4.1 Software

The simulation software used in this project is a combination of Synchro 6 and SimTraffic from Trafficware. Synchro 6 is a platform for creating the conditions for the simulation, including the lane layout, signal timing, and traffic density. It allows for the customization of any traffic project, from a single street to an entire downtown area. After the inputs are finished, it can provide estimations for a variety of conditions, including queue length, queue time, fuel consumption, and the qualitative measure of Level of Service (LOS). It can also optimize the signal timing of an intersection to provide the best possible balance of green times in a traffic cycle. Once all of the data is input to Synchro 6, a SimTraffic can run a video simulation to better visualize the situation. The visual simulation can help identify problem areas and brings the numbers in the Synchro pages to life.

4.2 Simulation Procedure

In order to begin the simulation process, the scope had to be drawn in the Synchro 6 Map Page to accurately portray the street geometry. Information about the lanes on Pruneridge would be specific to the different proposals being simulated. Traffic volume would be input from the data recorded with the Jamar Counters on the volume window. Finally, the intersection type and signal timing could be customized in the timing window. These windows can be found in Appendix A.

4.3 Assumptions Made

Synchro 6 is a simulation program, and just like any other simulation model, some assumptions had to be made because of limitations and also in order to produce comparable results.

The first assumption was made in the map window, with the physical geometry of Pruneridge and Lawrence. The actual length and spacing between streets was taken from Google Maps and estimated to within around 50 feet. Also, the streets are all assumed to be straight and at 90 degree right angles to each other, except for the right-hand turns between Pruneridge and Lawrence. Those, too, were of estimated radii from Google Maps. The lane widths are all assumed to be at 12 feet wide.

Another assumption that was made that was alluded to in Chapter 3 was the fact that the traffic volume in Synchro 6 must be hourly traffic, yet the recorded data was taken over 15 minute intervals. The resulting numbers were multiplied by 4 to represent hourly volumes. Moreover, the values used in the simulation were only single-time recordings, and not averages over time. Although these are standard practices, they still leave a slight margin of error in the simulation. For this project, the differences between simulations is so significant that it was determined that this assumption could be ignored.

In Synchro 6, no option was found for either a center turning lane nor a reverse lane. To work around the lack of a center turn lane, a left-turn lane was used. Cars in the simulation could not use this as a thru lane, but they could merge into it if they were turning onto Pruneridge. For the reverse lane, two different simulations were made for the morning and afternoon peak hours with two different street layouts. In the morning, a second thru lane was present going west, and in the evening, the thru lane was present in the eastbound direction. The opposing traffic would only have one thru lane.

CHAPTER FIVE: DATA ANALYSIS AND COMPARING SOLUTIONS

5.1 Level of Service

Using Synchro 6, a Level of Service (LOS) analysis was conducted. LOS is a qualitative measure used to relate the quality of traffic service based on performance measures such as speed and density[5]. Table 5 shows the various LOS qualities that were applied to the intersection of Lawrence and Pruneridge to evaluate the different approaches.

Table 5: Level of Service for signalized intersection lane groups and approaches.

Level of Service	Delay (s/veh)
A	≤ 10
B	> 10 - 20
C	> 20 - 35
D	> 35 - 55
E	> 55 - 80
F	> 80

As Table 5 shows, LOS A is the best rating because the delay is less than or equal to 10 seconds per vehicle. LOS F is the worst because the road is in a constant traffic jam. This means the intersection is failing, and the delay is greater than 80 seconds per vehicle. The team's goal was to improve each approach towards the intersection of Lawrence and Pruneridge from LOS F to at least LOS E. Anything higher would be an added bonus.

To find the different approach LOS's at the intersection, the team used their own vehicle counts from the project site, not the data that was given to them by the County of Santa Clara Roads and Airports Department. The team inputted their peak hour volumes into Synchro 6 and used the same numbers for three different alternatives: the original four lane layout, the current Road Diet layout, and the reverse lane alternative. The Lane Window from Synchro 6 for the existing conditions at the intersection is shown in Figure 7 on the following page.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰↰	↑↑	↱	↰↰	↑↑	↱	↰↰	↑↑↑↑	↱	↰↰	↑↑↑↑	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	200		80	120		100	250		40	250		50
Storage Lanes	2		1	2		1	2		1	2		1

Figure 7: Synchro 6 analysis for exiting lane conditions at Lawrence intersection.

The lane configurations shown in Figure 7 accurately represent the number of lanes going in each direction. For example, there are four northbound through lanes (NBT), two northbound left turn lanes (NBL), and one northbound right turn lane (NBR). The storage lengths are representative of the actual dimensions on the intersection of Lawrence and Pruneridge, and the lane widths are each 12 feet. The Volume Window for the existing conditions at the intersection is shown in Figure 8.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	172	96	112	392	400	392	152	3012	124	96	1276	52

Figure 8: Synchro 6 analysis for existing volume conditions at Lawrence intersection.

The team inputted their manually collected vehicle counts into the volume row. The northbound through lane had the highest volume: 3,012 vehicles per hour. Table 6 on the following page shows the various approach LOS's that were found using Synchro 6.

Table 6: Comparison of approach Level of Service at intersection of Lawrence and Pruneridge during morning and evening peak hours.

Pruneridge & Lawrence Approach LOS				
AM				
	Eastbound	Westbound	Northbound	Southbound
Original	D	D	E	C
Road Diet	F	F	D	C
Reverse Lane	D	D	E	C
PM				
	Eastbound	Westbound	Northbound	Southbound
Original	D	D	C	C
Road Diet	F	F	B	F
Reverse Lane	D	D	C	C

The current Road Diet layout had the worst overall Level of Service from each approach besides the northbound direction. It had LOS Fs from the eastbound and westbound approaches during both peak hours. It also had LOS C from the southbound approach during the morning peak hour, and LOS F from the southbound approach during the evening peak hour. When the same peak hour volumes were inputted into the Synchro 6 map of the proposed reverse lane alternative, each approach LOS either improved or remained the same besides the northbound approach.

5.2 Queue Delay

The team was also able to quantify the queue delay times for each approach to the intersection of Lawrence Expressway and Pruneridge Avenue. Delay at a signalized intersection is calculated as the difference in the departure time and the arrival time of a vehicle. Table 7 on the following page shows the approach delay times for the same three alternatives at the intersection.

Table 7: Comparison of approach delays at intersection of Lawrence and Pruneridge during morning and evening peak hours.

Approach Delay (sec)				
AM				
	Eastbound	Westbound	Northbound	Southbound
Original	51.9	43.3	58.7	30.2
Road Diet	101.6	136.0	41.3	34.9
Reverse Lane	54.2	44.1	60.3	29.1
PM				
	Eastbound	Westbound	Northbound	Southbound
Original	48.8	50.2	29.3	29.6
Road Diet	103.4	80.1	18.2	132.0
Reverse Lane	49.2	54.6	30.9	30.0

The current Road Diet layout consistently had the longest approach delays, aside from the northbound approach when compared to the original layout and the reverse lane alternative. During the morning peak hour, the eastbound approach for the Road Diet layout had a delay time that was approximately twice the duration of the other two alternatives. Its westbound approach delay time was approximately three times the duration of the other two alternatives. These increased delay times on the Road Diet layout further supported the need for a redesign of Lawrence Expressway and Pruneridge Avenue.

5.3 Signal Timing Changes

In addition to designing the reverse lane to alleviate traffic on Pruneridge Avenue, the team changed the durations of the traffic signals on the intersection of Lawrence Expressway and Pruneridge. The team decided the duration of the green light signal for vehicles traveling northbound along Lawrence was too long, thus explaining the high Level of Service and short delay times for only the northbound approach on the current Road Diet layout. This excessively long green light for only the northbound approach played a role in causing the traffic density. Figure 9 on the following page shows the current morning peak hour timing plan that the team recorded on the intersection of Lawrence and Pruneridge.

Figure 9: The current AM peak hour signal timing plan for Lawrence and Pruneridge. The northbound green light duration is 120 seconds.

After changing the street design to include the reverse lane in Synchro 6, the team created a new optimized timing plan. The new plan would have a shortened green light cycle for northbound vehicles and increased red light durations for all approaches. Figure 10 shows the optimized timing plan that would lead to lessened traffic density.

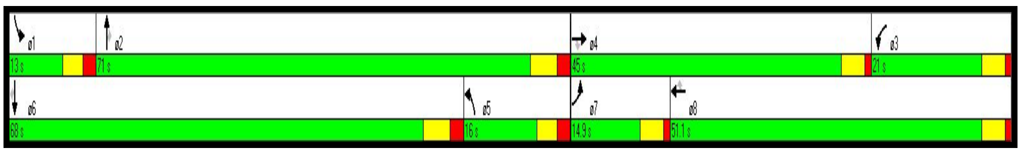


Figure 10: The optimized AM peak hour signal timing plan for Lawrence and Pruneridge. The northbound green light duration is 71 seconds.

The green light duration for vehicles traveling northbound along Lawrence was decreased by 49 seconds. Since heavy traffic density existed for vehicles traveling westbound along Pruneridge in the morning, their queue lengths and delay times were decreased because the new timing plan created more frequent westbound green light cycles. The red light durations were increased as a response to the frequent red light running to improve the safety of the intersection for drivers, bicyclists, and pedestrians. The entire cycle length was decreased by 50 seconds.

5.4 Fuel Consumption

The combination of improved LOS's, shortened queue delays, and optimized timing plans led to a decrease in the amount of fuel consumption for vehicles on the intersection of Lawrence Expressway and Pruneridge Avenue. Table 8 on the following page shows the fuel consumption for vehicles from all approaches on the intersection for the team's three design alternatives.

Table 8: Comparison of fuel consumption at intersection of Lawrence and Pruneridge during morning and evening peak hours.

Fuel Consumed (gal/hr)					
AM					
	Eastbound	Westbound	Northbound	Southbound	Total
Original	8	20	74	22	124
Road Diet	10	41	59	23	133
Reverse Lane	7	18	72	22	119
PM					
	Eastbound	Westbound	Northbound	Southbound	Total
Original	13	10	37	64	124
Road Diet	19	10	25	137	191
Reverse Lane	12	9	35	62	118

The fuel consumption quantified in Synchro 6 highlighted significant differences between the Road Diet layout and the team's reverse lane alternative. The fuel consumption for the Road Diet layout during the evening peak hour was 191 gallons per hour, while the fuel consumption for the reverse lane alternative was 118 gallons per hour. In total, there was a 36.7% reduction in fuel consumption for the entire intersection during both peak hours combined. Since vehicles are the primary cause of air pollution in the United States, the reduction in fuel consumption attributed to reducing CO_2 emissions.

CHAPTER SIX: SOLUTION DESIGN

6.1 Design Standards

6.1.1 Manual on Uniform Traffic Control Devices (MUTCD)

The following chapters of the MUTCD[6] were used in the Redesign of Lawrence Expressway and Pruneridge Avenue:

- Section R3-9: Center Turn Lane and Reverse Lane Signs.
- Section R3-17: Bike Lane Signs.

6.1.2 2010 Highway Capacity Manual (HCM)

The following sections of the HCM[5] were used in the Redesign of Lawrence Expressway and Pruneridge Avenue:

- Part 2: Signs. The signs used to identify the reverse lane were taken from this section.
- Part 3: Markings. This section was used to reference proper line types and markings to use on the road, particularly in the reverse lane.

6.2 Design Criteria

AutoCAD from AutoDesk was used to provide CAD drawings for the redesign of Lawrence Expressway and Pruneridge Avenue. These drawings included the entire street markings, the dimensions of a segment of Pruneridge Avenue, and the reverse lane street signs.

6.2.1 Design Details

- Lane Widths
    - Total street width: 60’ 0”
    - Street parking: 7’ 6”
    - Bike lane: 4’ 0”
    - Thru lane: 12’ 0”
    - Reverse lane: 13’ 0”

- Signal Timing
    - 150 second cycle length
    - 8 phase cycle (different cycles for AM and PM peak hours)
- 2 Signs
    - Westbound and eastbound reverse lane signs (108 x 48 mm)
- 4 street lights
- 4 overhead reverse lane signal lights

6.2.2 Design Implementation

There is only one thru lane in the westbound approach to the intersection of Pomeroy and Pruneridge. During non-peak hours (center lane is not a thru lane), cars will proceed normally with one lane. During AM peak hours, westbound cars will have the option to stay in their lane or to change lanes into the center lane after they have crossed the intersection. During PM peak hours, westbound cars will remain in their lane similar to during non-peak hours. This is shown in Figure 18 of Appendix B.

In the eastbound direction, the reverse/turn lane does not begin until after Harvard Avenue. There are two lanes available for cars to enter Pruneridge Avenue; however, during non-peak hours, all cars must quickly merge into one single eastbound thru lane. During PM peak hours, cars are not required to merge, and are allowed to continue straight thru, as the center lane will become open to thru traffic. During AM peak hours, drivers will have to merge into the single thru lane similar to during non-peak hours. This is shown Figure 14 of Appendix B.

Overhead signal lights will be over each intersection along the reverse lane, above Harvard, Geneva, Rosemont, and Tracy. They will be programmed to change at the beginning and end of each peak hour.

CHAPTER SEVEN: NON-TECHNICAL ISSUES

7.1 Safety

The safety of all users of the Pruneridge corridor is of highest priority. This includes drivers, cyclists, pedestrians, residents, and EMT vehicles. Cyclists and pedestrians should not have to worry about being hit by cars going through the intersection at high speed, and cars should not have to speed through red lights to avoid waiting extended time at red lights.

When we visited the project site, an interested cyclist informed us of a problem that was very common at the intersection - cars turning right would speed through the crosswalk connecting the curb to the pedestrian island, putting anyone trying to cross in serious danger. The reason for this is because the drivers would merge much further into the turn than the crosswalk, as indicated in the figure below. In addition, the curb was positioned in a way that cars have difficulty seeing any pedestrians, and the curb is very dark making any visibility of people near impossible. Although there are street lights on the island, they are absent on the curb. The street lights are marked by yellow circles. This issue is worst in the highlighted corner in Figure 11, but is present on all four corners.

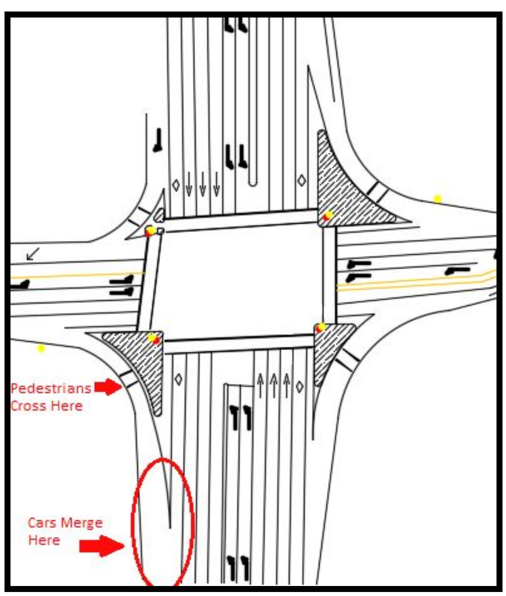


Figure 11: AutoCAD drawing of intersection of Lawrence and Pruneridge. The red marks highlight the dangerous conditions for pedestrians.

In addition to safety at the intersection, safety on Pruneridge Avenue is of utmost importance. Bike lanes are essential in giving cyclists the space they need to travel without the fear of cars clipping them. A four foot wide bike lane will be sufficient. The bike lane also keeps moving vehicles further away from any parked vehicles and any pedestrians, as well as away from the houses that line the street.

The reverse lane is a potential area of concern, as the direction of traffic will be different at different points of the day. Signs like the ones in Figure 12 are essential for making drivers aware of their surroundings, as well as overhanging signals also depicted below. When the center lane is not being used for through traffic, the turning lane will give drivers a safe space to either merge into the opposing lane from their driveway or side street, or turn left into their driveway or into a side street. The turn lane allows cars to stop on the street without hindering the traffic behind them.

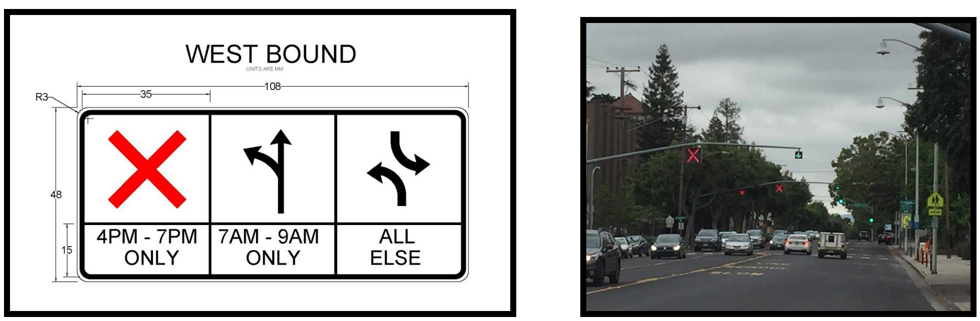


Figure 12: AutoCAD drawing of proposed reverse lane signs (left image). Overhead reverse lane signals on Lafayette Street (right image).

Our project should not cause safety and health risks for those who live, work, or pass by the proposed project site. During construction, the appropriate lanes will be closed and traffic will be diverted accordingly. Lighted signs should be used to notify drivers of construction in the days preceding construction, so they can plan accordingly and find a different route to use on those days. All relevant ADA and OSHA requirements will be satisfied for people who visit or work within the project site during its long-term operation, including construction signs and detour signs.

7.2 Political

Because transportation projects are government projects, our project would be funded by taxpayer dollars. This means that there has to be some level of public support of the project, and if any groups strongly oppose it (residents, local businesses) then we would have to seriously consider any arguments, especially since they will be the ones paying for the job, and they will be the ones directly affected by it.

Conversely, if the project is something the public is strongly in favor for, and there is resistance by the government, we will take action to push for what the public wants.

Finally, we must keep in mind that while Lawrence Expressway is county property, and Pruneridge is city property. This would mean that any permits would need to be taken from both county and city governments, and permission would be needed from both parties.

7.3 Environmental

The Santa Clara County Department of Environmental Health is the governmental agency that will exert jurisdiction over the requirements for assessing environmental impacts for our project. Our project will not cause significant environmental impacts. Our goal is to reduce traffic, which will cause fewer cars to sit idly in traffic, which will lead to less pollution and toxic fumes in the air. This will lead to a more sustainable intersection. Also when paving the roads, we will aim to use asphalt and concrete sparingly.

7.4 Economic

The chosen alternative is the most cost-effective solution for a life-cycle cost perspective. There will be economic benefits associated with the project because people will not have to sit in traffic as long and will be able to get to work to increase productivity. Commuters and bicyclists will not have to waste valuable time in their cars when they can be at work faster. We would consider our project a high priority infrastructure investment because the new Apple Campus (which is two blocks from the scope of our project) is almost complete. This may cause traffic to be even worse, so our project deserves high priority in order to prevent mass traffic during rush hours. We believe our project is affordable. Our project will be financed by the city of Santa Clara, and funds should be currently available.

7.5 Aesthetics

Our project will need to be approved by the city and people of Santa Clara based on its aesthetics. We want people to be aesthetically pleased with our street and intersection, so they do not mind utilizing it every day. The aesthetics of our project does have the potential to have an impact on the willingness of individuals to use the street; however, because it is a busy intersection and thousands of commuters have to use it every day, aesthetics probably will not have too great of an impact on its usability. The aesthetic impact will affect the residents more than the drivers. Anything too drastic could potentially affect the value of the homes, or at least how the residents perceive the value of their homes. As designers, we want to make sure our final product doesn't draw any extra negative attention. The area of concern here is the overhanging signal lights needed to indicate which direction traffic is moving in the center lane. They will be hanging on large metal posts, which is not a welcoming thing to see on a residential street. It is important to use just enough signs to convey meaning without obscuring the image of the surrounding community.

7.6 Ethics

Regarding a conflict of interest, if an individual with some degree of project oversight has a personal stake in the alternative that is ultimately selected, we will make sure our proposed solution adheres to the city of Santa Clara's best interest. We will not adhere to one individual's needs. Regarding social justice, we will ensure there is an equitable distribution of benefits associated with our project. We are not looking to cause any unnecessary issues and are just looking to provide a faster, less hectic commute for drivers and bicyclists. In terms of the development versus environment debate where ethical decisions often need to be made when the need for development potentially comes at the potential expense of biological diversity and environmental quality, we definitely do not want to upset any biodiversity or natural habitats. We do not want to needlessly cut down any trees or plants. We are just redesigning the roads that are already there, so there should not be a problem with the environmental ethics. If such issues arise, California's regulations will govern. Lastly, regarding long-term sustainability issues, we do not believe using sustainable materials will be a problem for our project. We are simply changing the amount of lanes going in each direction and possibly changing the traffic signal durations, so sustainable materials will not really be relevant.

CHAPTER EIGHT: COST ESTIMATE

After designing the preliminary design of intersection of Lawrence Expressway and Pruneridge Avenue, the 2015 Caltrans Cost Data Document was used to find the probable cost that would be needed to construct the vast majority of the elements proposed above. To find each cost, the team divided the total amount by the number of projects in the district. Santa Clara is in district No. 4. Table 9 below summarizes the costs for each category. For a more detailed list of the estimated cost and how we calculated each cost, refer to Appendix C.

Table 9: Displays the cost for each category of construction.

Items	Total Cost
Project Schedule	$7,150
Construction Area Signs	$18,940
Traffic Control System	$160,960
Portable Changeable Message Sign	$9,180
Job Site Management	$19,820
Noise Monitoring	$1,735
Thermoplastic Traffic Stripe	$5,400
Thermoplastic Pavement Marking	$7,320
Signal Timing & Lighting	$4,290
Total Cost =	**$234,800**

The traffic control system would be the most expensive item at around $160,000. This includes the overhead traffic signals along Pruneridge for the reverse lanes and the signal timing changes on the intersection of Lawrence and Pruneridge. Thermoplastics were chosen for the traffic stripes and pavement markings because they have proven to have a long service life and a high retro-reflectivity level that increases nighttime visibility. These important aspects would lessen the maintenance costs of our street many years down the road and provide an aesthetically pleasing appearance. The thermoplastics along with the improvements to the signal timing and sighting will make Pruneridge safer for cyclists. The total cost estimate came out to about $235,000.

CHAPTER NINE: CONCLUDING REMARKS

9.1 Down the Road

As a two-member team, we were limited to the amount of research we could perform on Lawrence Expressway and Pruneridge Avenue in one academic year. We hope that our work can open the door for future projects and research.

9.1.1 Expanding the Reverse Lane

Our project spans the length of the previous Road Diet project, from Lawrence Expressway to Pomeroy Avenue, which is only about a quarter mile. We realize that the majority of traffic is bottlenecked in this small corridor because many cars enter and exit through Pomeroy. However, we believe that a Reverse Lane with Bike Lanes can be implemented as far east as San Tomas Expressway. Chances are, if cyclists are using the bike lane from Pomeroy to Lawrence, they will be on Pruneridge for much longer than that small stretch of land.

9.1.2 Investigation of Apple Campus Impact on Local Traffic

Although we can predict that the introduction of Apple to the area will increase vehicle traffic, we aren't sure how severe of an impact it will be. From which direction will these new commuters be coming from? How many Apple Employees will be biking to work? Will extra space need to be made for busses, shuttles, or carpooling? How long will delays be extended during the peak morning and evening hours after the Campus becomes online?

9.1.3 Investigation of Safety Impacts of Reverse Lane

Although we were able to find a small amount of research done on Reverse Lanes in America, it was not enough to definitively say that a Reverse Lane on Pruneridge will be safer for drivers than the current Road Diet, or even maintain the same safety. Each corridor is different, and the street would have to be monitored very closely to see if the benefit of adding another lane during peak hours is worth the potential risk of new drivers using the street incorrectly. Even if the drivers are using it correctly, Reverse Lanes are rare enough for some people to hesitate switching lanes or merging while they figure out what is going on.

9.1.4 Detailed Construction Timeline and Gantt Chart

One thing we really wanted to do with our project was to look at the Construction Management side, in terms of the logistics of implementing a street project in real time, and how traffic would have to be diverted during the months of construction. Unfortunately, this was too far outside of the scope of our project to be feasible, and we decided to focus on other aspects of our project. Some questions we would have liked to answer are, "would the traffic impact of construction be so bad that any improvements we make would be insignificant?", and "if construction should be avoided during peak hours for commuter traffic, and avoided at night so as not to disturb the residents, is the available window for construction big enough to have a feasible project?".

9.1.5 Potential Bus Route

A common practice in terms of trying to take more cars off of the road is to introduce a Bus Route through an area, especially if the majority of the traffic is commuter traffic. Depending on where the residents around Pruneridge Avenue work, a Bus Route could potentially be an option for them - especially if they will be working nearby in the Kaiser Hospital, the Apple Campus, or in the neighboring towns of Sunnyvale or Cupertino. Pruneridge may be a bit narrow to try to fit in a bus stop, but we believe that it is possible.

After a bit of research, we discovered that before the Road Diet, a bus route did exist on Pruneridge Avenue but was removed. We were not able to find out if the removal was because of the Road Diet, because of the Kaiser Hospital (it appears the route may have been moved north onto Homestead), or other political or logistical reasons.

9.1.6 Expand Pruneridge and Lawrence Signaling Scope

From a Traffic Engineering perspective, the impact of the Lawrence and Pruneridge intersection extends much further to the north and south. In fact, the light signals are most likely actuated and synched with other intersection lights along Lawrence Expressway. A future Traffic Engineering project could try and incorporate any changes at Pruneridge with the entire system of traffic lights on Lawrence, as far north as El Camino Real and as far south as Stevens Creek Boulevard. The majority of traffic in the area is traveling north and south along the Expressway, and even a small change in signal timing could ripple and affect the street for miles, impacting thousands of cars per day.

9.1.7 Impact of Construction Project on Saratoga Creek

A bit east to Pomeroy Avenue runs Saratoga Creek - a small waterway that flows north into the South Bay. The impact of a small construction project on Pruneridge in terms of water runoff or construction debris getting into the water is something that we were aware of, but didn't want to include in our scope. We wanted to keep our project a Traffic and Transportation project, and not introduce another layer of Water Resources and Environmental Engineering. If the Reverse Lane was implemented in the future, this would be a very interesting project for a group looking to research the impact of industrial projects on water systems in an area very close to SCU.

9.2 Conclusion

Lawrence Expressway and Pruneridge Avenue are two of the most congested and busy streets in the city of Santa Clara. The daily traffic during the peak hours prevent commuters from spending more time at work or school which leads to lost productivity and money. The current street and intersection design cause many traffic flow and safety issues. This project aims to delay the average time along Pruneridge avenue without having to tear any houses down or remove any sidewalks or parallel street parking. The main focus of the design will be implementing the reverse lane, maintaining the bicycle and on-street parking, improving the signal timing on Lawrence Expressway, and overall creating a space that is safe and accommodates all modes of transportation. More bicyclists utilizing Pruneridge will lead to fewer cars on the road and less CO_2 emissions. Sustainability has become more popular in recent days; therefore, the project aims to create an environmentally sound design that will last for decades and protect future generations.

REFERENCES

1. ASCE. "Code of Ethics." ASCE. ASCE: American Society of Civil Engineers, 23 July 2006. Web. 14 Feb. 2016.

2. Baum, Julia. September 30, 2015. "San Jose: Committee votes to keep Lincoln Avenue Road Diet intact until next spring". *San Jose Mercury News*. <http://www.mercurynews.com/san-jose-neighborhoods/ci_28903090/san-jose-committee-votes-keep-lincoln-avenue-road>.

3. Contract Cost Data. (2015). State of California, Business, Transportation and Housing Agency, Dept. of Transportation, Sacramento, CA. Web. 21 Apr. 2016. <http://www.dot.ca.gov/hq/esc/oe/awards/2015CCDB/2015ccdb.pdf>.

4. Giwargis, Ramona. September 25, 2015. "San Jose: Willow Glen Road Diet's fate to be determined by city council". *San Jose Mercury News*. <www.mercurynews.com/bay-area-news/ci_28873055/san-jose-lincoln-road-diet-willow-glen>.

5. Highway Capacity Manual. (2010). Transportation Research Board. Washington, DC.

6. Manual on Uniform Traffic Control Devices (MUTCD). 2014. State of California, Business, Transportation and Housing Agency, Dept. of Transportation, Sacramento, CA. Web. 15 Jan. 2016. <http://www.dot.ca.gov/hq/traffops/engineering/mutcd/ca_mutcd2014.htm>.

7. NACTO Urban Street Design Guide: Overview. (2012). National Association of City Transportation Officials, New York.

8. "Pruneridge Avenue Bicycle Lane Improvements Post-Construction Traffic Study." Kimley-Horn and Associates, Inc. City of Santa Clara, Jun. 2013. Web. 11 Feb. 2016. <http://www.santaclaraca.gov/home/showdocument?id=9075>.

9. Richards, Gary. April 4, 2015. "Lincoln Avenue 'Road Diet' gets mixed reviews". *San Jose Mercury News*. <http://www.mercurynews.com/bay-area-news/ci_27850119/lincoln-avenue-road-diet-gets-mixed -reviews>.

10. Urban Bikeway Design Guide. (2014). National Association of City Transportation Officials, New York.

APPENDIX A

Synchro Data Plans

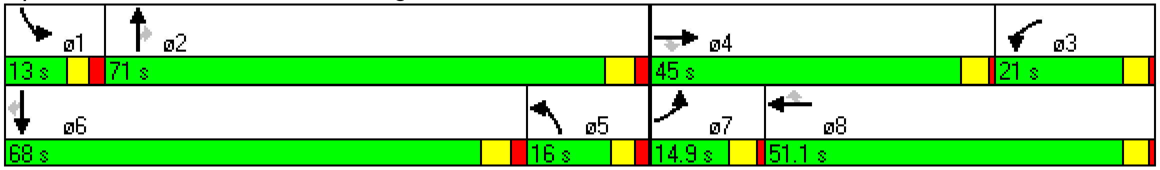
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	200		80	120		100	250		150	250		55
Storage Lanes	2		1	2		1	2		1	2		1
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.86	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Flt Permitted	0.950			0.950			0.950			0.950		
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			122			117			43			19
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		347			335			654			774	
Travel Time (s)		7.9			7.6			14.9			17.6	

Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	172	96	112	392	400	392	152	3012	124	96	1276	52
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			6
Detector Phases	7	4	4	3	8	8	5	2	2	1	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.5	45.0	45.0	9.5	22.0	22.0	10.0	22.0	22.0	10.0	22.0	22.0
Total Split (s)	14.9	45.0	45.0	21.0	51.1	51.1	16.0	71.0	71.0	13.0	68.0	68.0
Total Split (%)	9.9%	30.0%	30.0%	14.0%	34.1%	34.1%	10.7%	47.3%	47.3%	8.7%	45.3%	45.3%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.0	4.0	4.0	3.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag	Lead	Lead	Lead	Lag	Lag	Lag	Lag	Lag	Lag	Lead	Lead	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	None	Max	Max	None	Max	Max
Act Effct Green (s)	10.6	9.6	9.6	35.2	34.2	34.2	11.7	67.5	67.5	8.7	64.5	64.5
Actuated g/C Ratio	0.08	0.07	0.07	0.26	0.25	0.25	0.09	0.49	0.49	0.06	0.47	0.47
v/c Ratio	0.70	0.42	0.54	0.48	0.49	0.88	0.56	1.04	0.17	0.48	0.46	0.08
Control Delay	76.5	63.5	12.1	44.7	44.3	43.4	69.5	61.7	15.5	71.3	26.4	17.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	76.5	63.5	12.1	44.7	44.3	43.4	69.5	61.7	15.5	71.3	26.4	17.0
LOS	E	E	B	D	D	D	E	E	B	E	C	B
Approach Delay		54.2			44.1			60.3			29.1	
Approach LOS		D			D			E			C	

Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 137.1	
Natural Cycle: 150	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 1.04	
Intersection Signal Delay: 49.8	Intersection LOS: D
Intersection Capacity Utilization 82.8%	ICU Level of Service E
Analysis Period (min) 15	

Splits and Phases: 1: Pruneridge & Lawrence



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	172	96	112	392	400	392	152	3012	124	96	1276	52
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	187	104	122	426	435	426	165	3274	135	104	1387	57
Lane Group Flow (vph)	187	104	122	426	435	426	165	3274	135	104	1387	57

Intersection Summary

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	180			0	0	0
Storage Lanes	0			1	2	0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	
Trailing Detector (ft)	0	0	0	0	0	
Turning Speed (mph)	15			9	15	9
Lane Util. Factor	0.95	0.95	1.00	1.00	0.97	0.95
Ped Bike Factor						
Frt				0.850	0.904	
Flt Protected		0.996			0.982	
Satd. Flow (prot)	0	3525	1863	1583	3208	0
Flt Permitted		0.753			0.982	
Satd. Flow (perm)	0	2665	1863	1583	3208	0
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				417	117	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30	30		30	
Link Distance (ft)		180	478		570	
Travel Time (s)		4.1	10.9		13.0	

Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	WBT	WBR	SBL	ø2
Lane Configurations						
Volume (vph)	28	340	960	384	96	
Turn Type	Perm			Perm		
Protected Phases		4	8		6	2
Permitted Phases	4			8	2	
Detector Phases	4	4	8	8	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.5	21.5	21.5	21.5	21.5	21.5
Total Split (s)	45.0	45.0	45.0	45.0	21.5	21.5
Total Split (%)	67.7%	67.7%	67.7%	67.7%	32.3%	32%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Max	Max	Max	Max	Max	Max
Act Effct Green (s)		41.0	41.0	41.0	17.5	
Actuated g/C Ratio		0.62	0.62	0.62	0.26	
v/c Ratio		0.24	0.91	0.37	0.31	
Control Delay		6.2	25.2	1.7	12.6	
Queue Delay		0.0	0.0	0.0	0.0	
Total Delay		6.2	25.2	1.7	12.6	
LOS		A	C	A	B	
Approach Delay		6.2	18.4		12.6	
Approach LOS		A	B		B	

Intersection Summary

Cycle Length: 66.5

Actuated Cycle Length: 66.5

Offset: 0 (0%), Referenced to phase 2:SBL and 6:SBL, Start of Green

Natural Cycle: 70

Control Type: Pretimed

Maximum v/c Ratio: 0.91

Intersection Signal Delay: 15.4 Intersection LOS: B

Intersection Capacity Utilization 65.4% ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 13: Pruneridge & Pomeroy

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	28	340	960	384	96	172
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Adj. Flow (vph)	30	370	1043	417	104	187
Lane Group Flow (vph)	0	400	1043	417	291	0

Intersection Summary

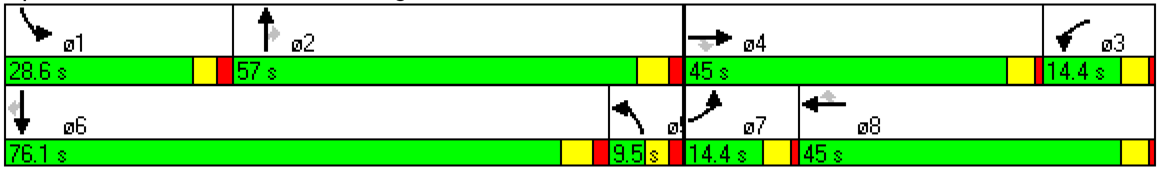
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	200		80	120		50	400		200	500		200
Storage Lanes	2		1	2		1	2		1	2		1
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.86	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Flt Permitted	0.950			0.950			0.950			0.950		
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			50			130			146			91
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		347			335			654			774	
Travel Time (s)		7.9			7.6			14.9			17.6	

Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	124	360	188	228	112	120	84	1928	232	452	3076	184
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			6
Detector Phases	7	4	4	3	8	8	5	2	2	1	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	8.5	45.0	45.0	8.5	22.0	22.0	9.5	22.0	22.0	9.5	22.0	22.0
Total Split (s)	14.4	45.0	45.0	14.4	45.0	45.0	9.5	57.0	57.0	28.6	76.1	76.1
Total Split (%)	9.9%	31.0%	31.0%	9.9%	31.0%	31.0%	6.6%	39.3%	39.3%	19.7%	52.5%	52.5%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.0	4.0	4.0	3.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag	Lead	Lead	Lead	Lag	Lag	Lag	Lag	Lag	Lag	Lead	Lead	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	None	Max	Max	None	Max	Max
Act Effct Green (s)	9.6	20.0	20.0	10.4	20.8	20.8	5.5	55.2	55.2	22.4	72.2	72.2
Actuated g/C Ratio	0.08	0.16	0.16	0.08	0.17	0.17	0.04	0.44	0.44	0.18	0.58	0.58
v/c Ratio	0.51	0.69	0.69	0.86	0.21	0.35	0.60	0.73	0.32	0.79	0.90	0.21
Control Delay	61.4	50.0	39.4	83.9	44.6	8.3	75.8	31.3	11.3	56.0	27.5	7.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	61.4	50.0	39.4	83.9	44.6	8.3	75.8	31.3	11.3	56.0	27.5	7.7
LOS	E	D	D	F	D	A	E	C	B	E	C	A
Approach Delay		49.2			54.6			30.9			30.0	
Approach LOS		D			D			C			C	

Intersection Summary	
Cycle Length: 145	
Actuated Cycle Length: 124.1	
Natural Cycle: 145	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.90	
Intersection Signal Delay: 33.7	Intersection LOS: C
Intersection Capacity Utilization 77.7%	ICU Level of Service D
Analysis Period (min) 15	

Splits and Phases: 1: Pruneridge & Lawrence



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	124	360	188	228	112	120	84	1928	232	452	3076	184
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	135	391	204	248	122	130	91	2096	252	491	3343	200
Lane Group Flow (vph)	135	391	204	248	122	130	91	2096	252	491	3343	200

Intersection Summary

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	180			0	0	0
Storage Lanes	0			0	2	0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50		50	
Trailing Detector (ft)	0	0	0		0	
Turning Speed (mph)	15			9	15	9
Lane Util. Factor	0.95	0.95	0.95	0.95	0.97	0.95
Ped Bike Factor						
Frt			0.968		0.964	
Flt Protected		0.997			0.964	
Satd. Flow (prot)	0	3529	3426	0	3358	0
Flt Permitted		0.894			0.964	
Satd. Flow (perm)	0	3164	3426	0	3358	0
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)			101		54	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30	30		30	
Link Distance (ft)		180	478		570	
Travel Time (s)		4.1	10.9		13.0	

Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	WBT	SBL	ø2
Lane Configurations					
Volume (vph)	52	984	432	276	
Turn Type	Perm				
Protected Phases		4	8	6	2
Permitted Phases	4			2	
Detector Phases	4	4	8	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0
Total Split (s)	55.0	55.0	55.0	20.0	20.0
Total Split (%)	73.3%	73.3%	73.3%	26.7%	27%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Max	Max	Max	Max	Max
Act Effct Green (s)		51.0	51.0	16.0	
Actuated g/C Ratio		0.68	0.68	0.21	
v/c Ratio		0.52	0.25	0.52	
Control Delay		7.0	4.1	25.3	
Queue Delay		0.0	0.0	0.0	
Total Delay		7.0	4.1	25.3	
LOS		A	A	C	
Approach Delay		7.0	4.1	25.3	
Approach LOS		A	A	C	

Intersection Summary	
Cycle Length: 75	
Actuated Cycle Length: 75	
Offset: 0 (0%), Referenced to phase 2:SBL and 6:SBL, Start of Green	
Natural Cycle: 45	
Control Type: Pretimed	
Maximum v/c Ratio: 0.52	
Intersection Signal Delay: 9.6	Intersection LOS: A
Intersection Capacity Utilization 65.0%	ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 13: Pruneridge & Pomeroy

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	52	984	432	116	276	88
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Adj. Flow (vph)	57	1070	470	126	300	96
Lane Group Flow (vph)	0	1127	596	0	396	0

Intersection Summary

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	200		80	120		100	250		80	250		200
Storage Lanes	2		1	2		1	2		1	2		1
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.86	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Flt Permitted	0.950			0.950			0.950			0.950		
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			122			76			26			25
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		347			335			654			774	
Travel Time (s)		7.9			7.6			14.9			17.6	

Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	172	96	112	392	400	392	152	3012	124	96	1276	52
Turn Type	Prot		custom	Prot		Perm	Prot		Perm	Prot		custom
Protected Phases	7	3		4	8		6	2		1	5	
Permitted Phases			4			8			2			6
Detector Phases	7	3	4	4	8	8	6	2	2	1	5	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	8.0	45.0	20.0	20.0	22.0	22.0	20.0	20.0	20.0	8.0	20.0	20.0
Total Split (s)	14.0	45.0	22.0	22.0	53.0	53.0	22.0	120.0	120.0	13.0	111.0	22.0
Total Split (%)	7.0%	22.5%	11.0%	11.0%	26.5%	26.5%	11.0%	60.0%	60.0%	6.5%	55.5%	11.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag	Lead	Lag	Lead	Lead	Lag	Lag	Lead	Lag	Lag	Lead	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effct Green (s)	10.0	41.0	18.0	18.0	49.0	49.0	18.0	116.0	116.0	9.0	107.0	18.0
Actuated g/C Ratio	0.05	0.20	0.09	0.09	0.24	0.24	0.09	0.58	0.58	0.04	0.54	0.09
v/c Ratio	1.09	0.14	0.48	1.38	0.50	0.96	0.53	0.88	0.15	0.68	0.40	0.35
Control Delay	175.8	65.8	18.4	249.3	67.4	92.7	93.8	39.8	15.8	115.3	28.0	56.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	175.8	65.8	18.4	249.3	67.4	92.7	93.8	39.8	15.8	115.3	28.0	56.5
LOS	F	E	B	F	E	F	F	D	B	F	C	E
Approach Delay		101.6			136.0			41.3			34.9	
Approach LOS		F			F			D			C	

Intersection Summary

Cycle Length: 200
Actuated Cycle Length: 200
Offset: 0 (0%), Referenced to phase 2:NBT and 6:NBL, Start of Green
Natural Cycle: 145
Control Type: Pretimed
Maximum v/c Ratio: 1.38
Intersection Signal Delay: 61.4 Intersection LOS: E
Intersection Capacity Utilization 82.8% ICU Level of Service E

Analysis Period (min) 15

Splits and Phases: 1: Pruneridge & Lawrence

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	172	96	112	392	400	392	152	3012	124	96	1276	52
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	187	104	122	426	435	426	165	3274	135	104	1387	57
Lane Group Flow (vph)	187	104	122	426	435	426	165	3274	135	104	1387	57

Intersection Summary

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	180			0	0	0
Storage Lanes	1			1	2	0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	
Trailing Detector (ft)	0	0	0	0	0	
Turning Speed (mph)	15			9	15	9
Lane Util. Factor	1.00	1.00	1.00	1.00	0.97	0.95
Ped Bike Factor						
Frt				0.850	0.904	
Flt Protected	0.950				0.982	
Satd. Flow (prot)	1770	1863	1863	1583	3208	0
Flt Permitted	0.124				0.982	
Satd. Flow (perm)	231	1863	1863	1583	3208	0
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				417	145	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30	30		30	
Link Distance (ft)		180	478		570	
Travel Time (s)		4.1	10.9		13.0	

Intersection Summary

Area Type: Other

Lane Group	EBL	EBT	WBT	WBR	SBL	ø2
Lane Configurations						
Volume (vph)	28	340	960	384	96	
Turn Type	Perm			Perm		
Protected Phases		4	8		6	2
Permitted Phases	4			8	2	
Detector Phases	4	4	8	8	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	55.0	55.0	55.0	55.0	20.0	20.0
Total Split (%)	73.3%	73.3%	73.3%	73.3%	26.7%	27%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Max	Max	Max	Max	Max	Max
Act Effct Green (s)	51.0	51.0	51.0	51.0	16.0	
Actuated g/C Ratio	0.68	0.68	0.68	0.68	0.21	
v/c Ratio	0.19	0.29	0.82	0.34	0.36	
Control Delay	7.9	5.5	16.1	1.3	13.9	
Queue Delay	0.0	0.0	0.0	0.0	0.0	
Total Delay	7.9	5.5	16.1	1.3	13.9	
LOS	A	A	B	A	B	
Approach Delay		5.7	11.9		13.9	
Approach LOS		A	B		B	

Intersection Summary	
Cycle Length: 75	
Actuated Cycle Length: 75	
Offset: 0 (0%), Referenced to phase 2:SBL and 6:SBL, Start of Green	
Natural Cycle: 65	
Control Type: Pretimed	
Maximum v/c Ratio: 0.82	
Intersection Signal Delay: 11.0	Intersection LOS: B
Intersection Capacity Utilization 65.4%	ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 13: Pruneridge & Pomeroy

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	28	340	960	384	96	172
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Adj. Flow (vph)	30	370	1043	417	104	187
Lane Group Flow (vph)	30	370	1043	417	291	0

Intersection Summary

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	200		80	120		80	300		75	400		200
Storage Lanes	2		1	2		1	2		1	2		1
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.86	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Flt Permitted	0.950			0.950			0.950			0.950		
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			89			130			93			39
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		347			335			654			774	
Travel Time (s)		7.9			7.6			14.9			17.6	

Intersection Summary

Area Type: Other

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	124	360	188	228	112	120	84	1928	232	452	3076	184
Turn Type	Prot		Perm	Prot		custom	Prot		Perm	Prot		custom
Protected Phases	8	4		3	7		6	2		1	5	
Permitted Phases			4			8			2			6
Detector Phases	8	4	4	3	7	8	6	2	2	1	5	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	22.0	45.0	45.0	45.0	8.0	22.0	20.0	20.0	20.0	8.0	8.0	20.0
Total Split (s)	13.0	26.0	26.0	20.0	33.0	13.0	21.0	130.0	130.0	14.0	123.0	21.0
Total Split (%)	6.8%	13.7%	13.7%	10.5%	17.4%	6.8%	11.1%	68.4%	68.4%	7.4%	64.7%	11.1%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag	Lag	Lead	Lead	Lag	Lead	Lag	Lead	Lag	Lag	Lead	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effct Green (s)	9.0	22.0	22.0	16.0	29.0	9.0	17.0	126.0	126.0	10.0	119.0	17.0
Actuated g/C Ratio	0.05	0.12	0.12	0.08	0.15	0.05	0.09	0.66	0.66	0.05	0.63	0.09
v/c Ratio	0.83	0.95	0.78	0.86	0.23	0.65	0.30	0.49	0.23	2.71	0.83	1.13
Control Delay	124.4	115.9	65.6	111.5	71.9	27.9	83.7	16.5	8.3	812.4	30.2	163.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	124.4	115.9	65.6	111.5	71.9	27.9	83.7	16.5	8.3	812.4	30.2	163.9
LOS	F	F	E	F	E	C	F	B	A	F	C	F
Approach Delay		103.4			80.1			18.2			132.0	
Approach LOS		F			F			B			F	

Intersection Summary

Cycle Length: 190

Actuated Cycle Length: 190

Offset: 0 (0%), Referenced to phase 2:NBT and 6:NBL, Start of Green

Natural Cycle: 150

Control Type: Pretimed

Maximum v/c Ratio: 2.71

Intersection Signal Delay: 89.9 Intersection LOS: F

Intersection Capacity Utilization 77.7% ICU Level of Service D

Analysis Period (min) 15

Splits and Phases: 1: Pruneridge & Lawrence

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	124	360	188	228	112	120	84	1928	232	452	3076	184
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	135	391	204	248	122	130	91	2096	252	491	3343	200
Lane Group Flow (vph)	135	391	204	248	122	130	91	2096	252	491	3343	200

Intersection Summary

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	180			0	0	0
Storage Lanes	1			1	2	0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	
Trailing Detector (ft)	0	0	0	0	0	
Turning Speed (mph)	15			9	15	9
Lane Util. Factor	1.00	1.00	1.00	1.00	0.97	0.95
Ped Bike Factor						
Frt				0.850	0.964	
Flt Protected	0.950				0.964	
Satd. Flow (prot)	1770	1863	1863	1583	3358	0
Flt Permitted	0.450				0.964	
Satd. Flow (perm)	838	1863	1863	1583	3358	0
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				126	54	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30	30		30	
Link Distance (ft)		180	478		570	
Travel Time (s)		4.1	10.9		13.0	

Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	WBT	WBR	SBL	ø2
Lane Configurations						
Volume (vph)	52	984	432	116	276	
Turn Type	Perm			Perm		
Protected Phases		4	8		6	2
Permitted Phases	4			8	2	
Detector Phases	4	4	8	8	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	55.0	55.0	55.0	55.0	20.0	20.0
Total Split (%)	73.3%	73.3%	73.3%	73.3%	26.7%	27%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Max	Max	Max	Max	Max	Max
Act Effct Green (s)	51.0	51.0	51.0	51.0	16.0	
Actuated g/C Ratio	0.68	0.68	0.68	0.68	0.21	
v/c Ratio	0.10	0.84	0.37	0.11	0.52	
Control Delay	4.7	17.4	6.1	1.1	25.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	
Total Delay	4.7	17.4	6.1	1.1	25.3	
LOS	A	B	A	A	C	
Approach Delay		16.8	5.1		25.3	
Approach LOS		B	A		C	

Intersection Summary

Cycle Length: 75
Actuated Cycle Length: 75
Offset: 0 (0%), Referenced to phase 2:SBL and 6:SBL, Start of Green
Natural Cycle: 65
Control Type: Pretimed
Maximum v/c Ratio: 0.84
Intersection Signal Delay: 15.1 Intersection LOS: B
Intersection Capacity Utilization 69.1% ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 13: Pruneridge & Pomeroy

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	52	984	432	116	276	88
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Adj. Flow (vph)	57	1070	470	126	300	96
Lane Group Flow (vph)	57	1070	470	126	396	0
Intersection Summary						

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	200		80	120		100	250		150	250		55
Storage Lanes	2		1	2		1	2		1	2		1
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.86	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Flt Permitted	0.950			0.950			0.950			0.950		
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			122			117			43			19
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		347			335			654			774	
Travel Time (s)		7.9			7.6			14.9			17.6	

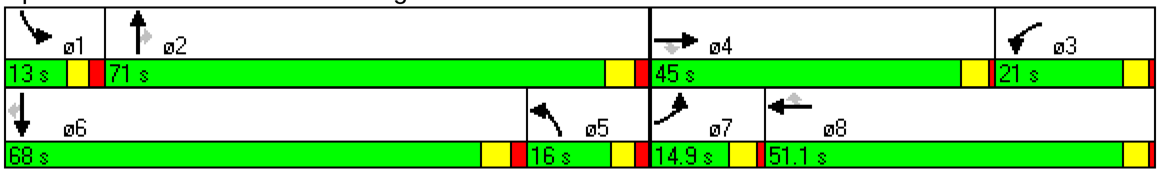
Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	172	96	112	392	400	392	152	3012	124	96	1276	52
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			6
Detector Phases	7	4	4	3	8	8	5	2	2	1	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.5	45.0	45.0	9.5	22.0	22.0	10.0	22.0	22.0	10.0	22.0	22.0
Total Split (s)	14.9	45.0	45.0	21.0	51.1	51.1	16.0	71.0	71.0	13.0	68.0	68.0
Total Split (%)	9.9%	30.0%	30.0%	14.0%	34.1%	34.1%	10.7%	47.3%	47.3%	8.7%	45.3%	45.3%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.0	4.0	4.0	3.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag	Lead	Lead	Lead	Lag	Lag	Lag	Lag	Lag	Lag	Lead	Lead	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	None	Max	Max	None	Max	Max
Act Effct Green (s)	10.6	9.6	9.6	35.2	34.2	34.2	11.7	67.5	67.5	8.7	64.5	64.5
Actuated g/C Ratio	0.08	0.07	0.07	0.26	0.25	0.25	0.09	0.49	0.49	0.06	0.47	0.47
v/c Ratio	0.70	0.42	0.54	0.48	0.49	0.88	0.56	1.04	0.17	0.48	0.46	0.08
Control Delay	76.5	63.5	12.1	44.7	44.3	43.4	69.5	61.7	15.5	71.3	26.4	17.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	76.5	63.5	12.1	44.7	44.3	43.4	69.5	61.7	15.5	71.3	26.4	17.0
LOS	E	E	B	D	D	D	E	E	B	E	C	B
Approach Delay		54.2			44.1			60.3			29.1	
Approach LOS		D			D			E			C	

Intersection Summary

Cycle Length: 150
Actuated Cycle Length: 137.1
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.04
Intersection Signal Delay: 49.8 Intersection LOS: D
Intersection Capacity Utilization 82.8% ICU Level of Service E
Analysis Period (min) 15

Splits and Phases: 1: Pruneridge & Lawrence



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	172	96	112	392	400	392	152	3012	124	96	1276	52
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	187	104	122	426	435	426	165	3274	135	104	1387	57
Lane Group Flow (vph)	187	104	122	426	435	426	165	3274	135	104	1387	57

Intersection Summary

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	180			0	0	0
Storage Lanes	1			1	2	0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	
Trailing Detector (ft)	0	0	0	0	0	
Turning Speed (mph)	15			9	15	9
Lane Util. Factor	1.00	1.00	1.00	1.00	0.97	0.95
Ped Bike Factor						
Frt				0.850	0.904	
Flt Protected	0.950				0.982	
Satd. Flow (prot)	1770	1863	1863	1583	3208	0
Flt Permitted	0.098				0.982	
Satd. Flow (perm)	183	1863	1863	1583	3208	0
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				417	117	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30	30		30	
Link Distance (ft)		180	478		570	
Travel Time (s)		4.1	10.9		13.0	

Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	WBT	WBR	SBL	ø2
Lane Configurations						
Volume (vph)	28	340	960	384	96	
Turn Type	Perm			Perm		
Protected Phases		4	8		6	2
Permitted Phases	4			8	2	
Detector Phases	4	4	8	8	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	21.5	21.5	21.5	21.5	21.5	21.5
Total Split (s)	45.0	45.0	45.0	45.0	21.5	21.5
Total Split (%)	67.7%	67.7%	67.7%	67.7%	32.3%	32%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Max	Max	Max	Max	Max	Max
Act Effct Green (s)	41.0	41.0	41.0	41.0	17.5	
Actuated g/C Ratio	0.62	0.62	0.62	0.62	0.26	
v/c Ratio	0.27	0.32	0.91	0.37	0.31	
Control Delay	13.2	7.0	25.2	1.7	12.6	
Queue Delay	0.0	0.0	0.0	0.0	0.0	
Total Delay	13.2	7.0	25.2	1.7	12.6	
LOS	B	A	C	A	B	
Approach Delay		7.5	18.4		12.6	
Approach LOS		A	B		B	

Intersection Summary

Cycle Length: 66.5
Actuated Cycle Length: 66.5
Offset: 0 (0%), Referenced to phase 2:SBL and 6:SBL, Start of Green
Natural Cycle: 70
Control Type: Pretimed
Maximum v/c Ratio: 0.91
Intersection Signal Delay: 15.6 Intersection LOS: B
Intersection Capacity Utilization 65.4% ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 13: Pruneridge & Pomeroy

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	28	340	960	384	96	172
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Adj. Flow (vph)	30	370	1043	417	104	187
Lane Group Flow (vph)	30	370	1043	417	291	0

Intersection Summary

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%			0%	
Storage Length (ft)	200		80	120		50	400		200	500		200
Storage Lanes	2		1	2		1	2		1	2		1
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	50	50	50	50	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.86	1.00
Ped Bike Factor												
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Flt Permitted	0.950			0.950			0.950			0.950		
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	6408	1583
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			50			130			146			91
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		347			335			654			774	
Travel Time (s)		7.9			7.6			14.9			17.6	

Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	124	360	188	228	112	120	84	1928	232	452	3076	184
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			6
Detector Phases	7	4	4	3	8	8	5	2	2	1	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	8.5	45.0	45.0	8.5	22.0	22.0	9.5	22.0	22.0	9.5	22.0	22.0
Total Split (s)	14.4	45.0	45.0	14.4	45.0	45.0	9.5	57.0	57.0	28.6	76.1	76.1
Total Split (%)	9.9%	31.0%	31.0%	9.9%	31.0%	31.0%	6.6%	39.3%	39.3%	19.7%	52.5%	52.5%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.0	4.0	4.0	3.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0
Lead/Lag	Lead	Lead	Lead	Lag	Lag	Lag	Lag	Lag	Lag	Lead	Lead	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	None	Max	Max	None	Max	Max
Act Effct Green (s)	9.6	20.0	20.0	10.4	20.8	20.8	5.5	55.2	55.2	22.4	72.2	72.2
Actuated g/C Ratio	0.08	0.16	0.16	0.08	0.17	0.17	0.04	0.44	0.44	0.18	0.58	0.58
v/c Ratio	0.51	0.69	0.69	0.86	0.21	0.35	0.60	0.73	0.32	0.79	0.90	0.21
Control Delay	61.4	50.0	39.4	83.9	44.6	8.3	75.8	31.3	11.3	56.0	27.5	7.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	61.4	50.0	39.4	83.9	44.6	8.3	75.8	31.3	11.3	56.0	27.5	7.7
LOS	E	D	D	F	D	A	E	C	B	E	C	A
Approach Delay		49.2			54.6			30.9			30.0	
Approach LOS		D			D			C			C	

Intersection Summary

Cycle Length: 145

Actuated Cycle Length: 124.1

Natural Cycle: 145

Control Type: Actuated-Uncoordinated

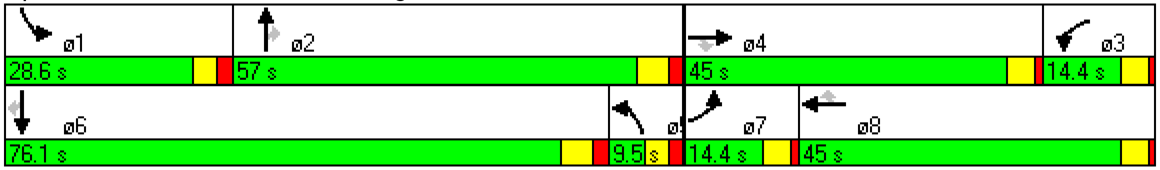
Maximum v/c Ratio: 0.90

Intersection Signal Delay: 33.7 — Intersection LOS: C

Intersection Capacity Utilization 77.7% — ICU Level of Service D

Analysis Period (min) 15

Splits and Phases: 1: Pruneridge & Lawrence



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	124	360	188	228	112	120	84	1928	232	452	3076	184
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	135	391	204	248	122	130	91	2096	252	491	3343	200
Lane Group Flow (vph)	135	391	204	248	122	130	91	2096	252	491	3343	200

Intersection Summary

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12
Grade (%)		0%	0%		0%	
Storage Length (ft)	180			0	0	0
Storage Lanes	0			1	2	0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50	50	50	50	
Trailing Detector (ft)	0	0	0	0	0	
Turning Speed (mph)	15			9	15	9
Lane Util. Factor	0.95	0.95	1.00	1.00	0.97	0.95
Ped Bike Factor						
Frt				0.850	0.964	
Flt Protected		0.997			0.964	
Satd. Flow (prot)	0	3529	1863	1583	3358	0
Flt Permitted		0.908			0.964	
Satd. Flow (perm)	0	3214	1863	1583	3358	0
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				126	54	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		30	30		30	
Link Distance (ft)		180	478		570	
Travel Time (s)		4.1	10.9		13.0	

Intersection Summary	
Area Type:	Other

Lane Group	EBL	EBT	WBT	WBR	SBL	ø2
Lane Configurations						
Volume (vph)	52	984	432	116	276	
Turn Type	Perm			Perm		
Protected Phases		4	8		6	2
Permitted Phases	4			8	2	
Detector Phases	4	4	8	8	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0	20.0
Total Split (s)	55.0	55.0	55.0	55.0	20.0	20.0
Total Split (%)	73.3%	73.3%	73.3%	73.3%	26.7%	27%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Max	Max	Max	Max	Max	Max
Act Effct Green (s)		51.0	51.0	51.0	16.0	
Actuated g/C Ratio		0.68	0.68	0.68	0.21	
v/c Ratio		0.52	0.37	0.11	0.52	
Control Delay		6.9	6.1	1.1	25.3	
Queue Delay		0.0	0.0	0.0	0.0	
Total Delay		6.9	6.1	1.1	25.3	
LOS		A	A	A	C	
Approach Delay		6.9	5.1		25.3	
Approach LOS		A	A		C	

Intersection Summary	
Cycle Length: 75	
Actuated Cycle Length: 75	
Offset: 0 (0%), Referenced to phase 2:SBL and 6:SBL, Start of Green	
Natural Cycle: 45	
Control Type: Pretimed	
Maximum v/c Ratio: 0.52	
Intersection Signal Delay: 9.8	Intersection LOS: A
Intersection Capacity Utilization 72.1%	ICU Level of Service C

Analysis Period (min) 15

Splits and Phases: 13: Pruneridge & Pomeroy

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Volume (vph)	52	984	432	116	276	88
Confl. Peds. (#/hr)						
Confl. Bikes (#/hr)						
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0
Parking (#/hr)						
Mid-Block Traffic (%)		0%	0%		0%	
Adj. Flow (vph)	57	1070	470	126	300	96
Lane Group Flow (vph)	0	1127	470	126	396	0

Intersection Summary

APPENDIX B

Detailed AutoCAD Drawings

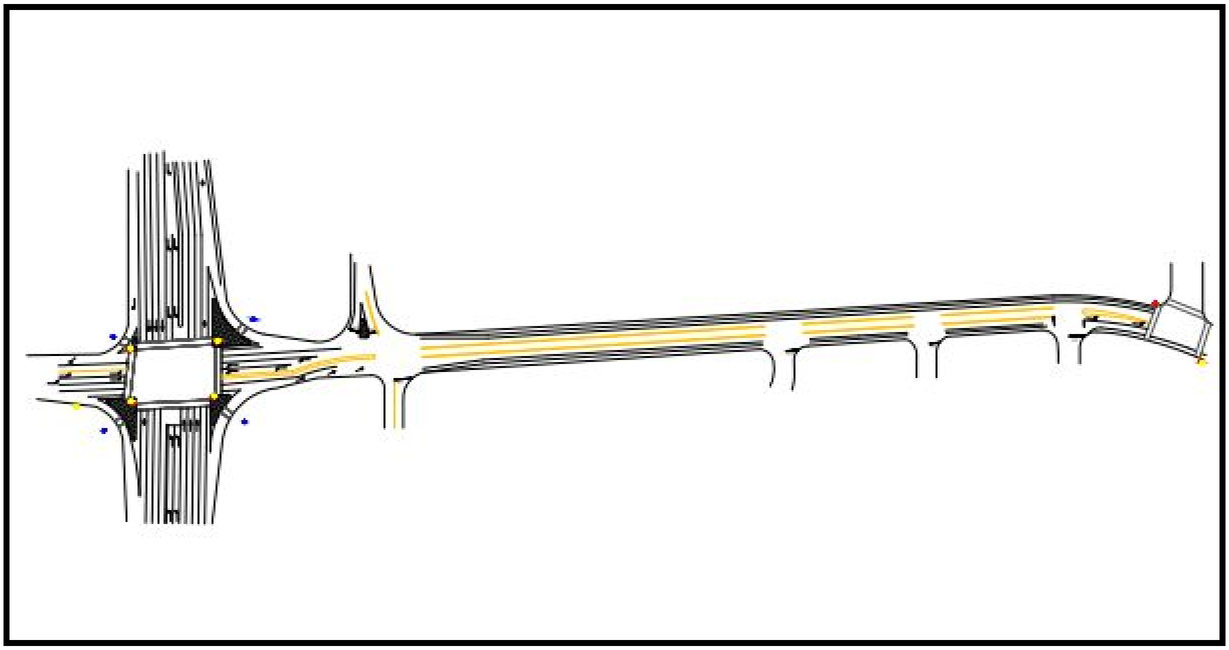


Figure 13: AutoCAD drawing of Pruneridge Ave. The project scope is between Lawrence Expy and Pomeroy Ave.

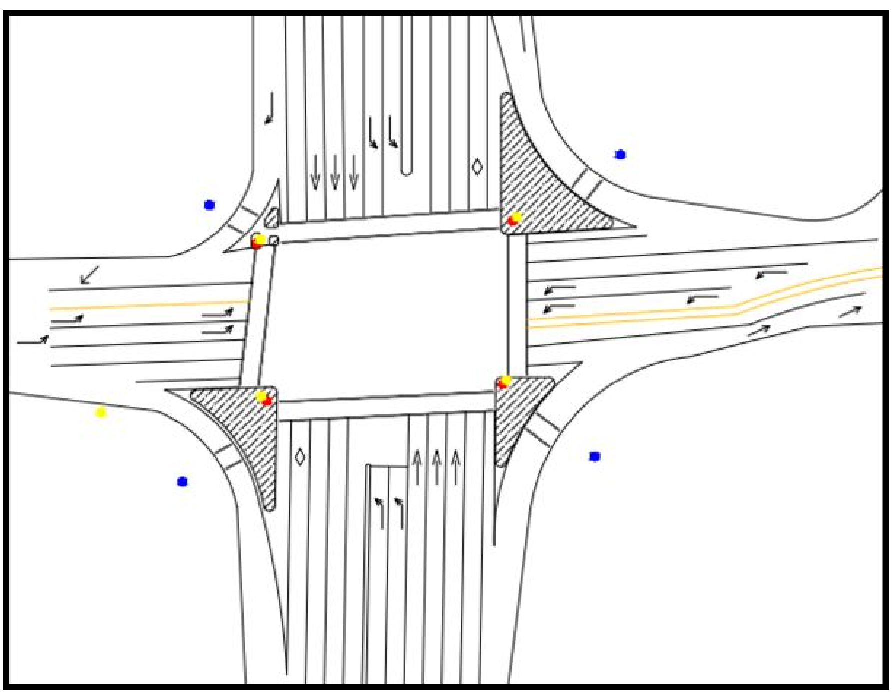


Figure 14: AutoCAD drawing of the intersection of Pruneridge Ave and Lawrence Expy. The red dots signify traffic signals, while the yellow dots signify light posts. The blue dots signify

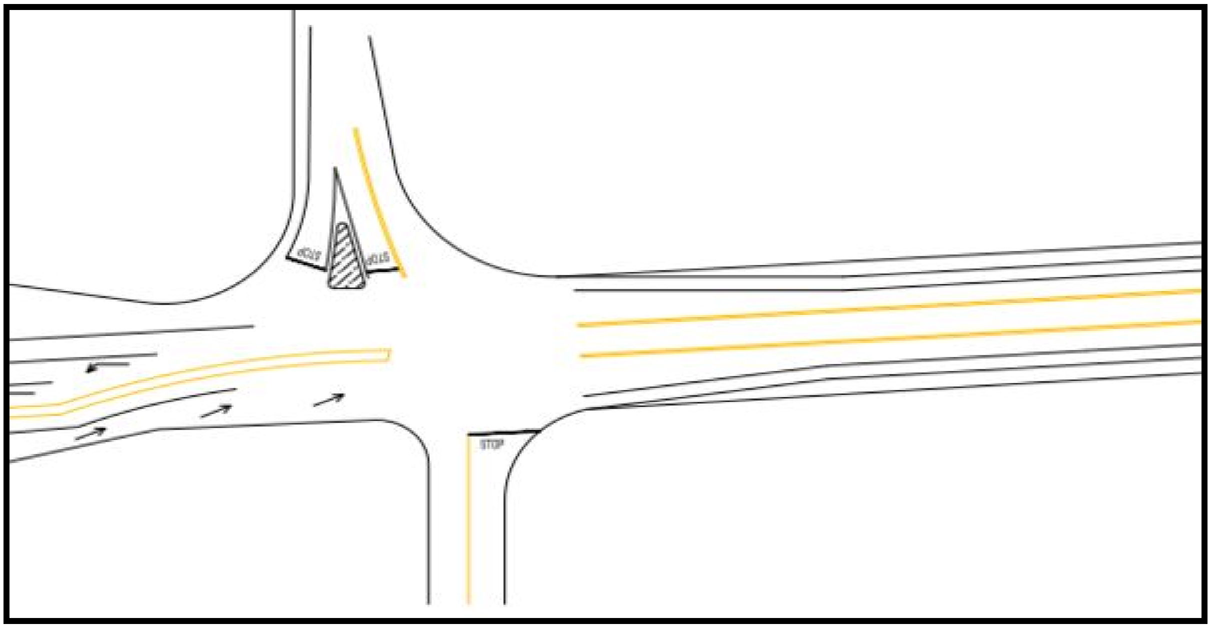


Figure 15: AutoCAD drawing of the intersection of Pruneridge Ave and Harvard Ave.

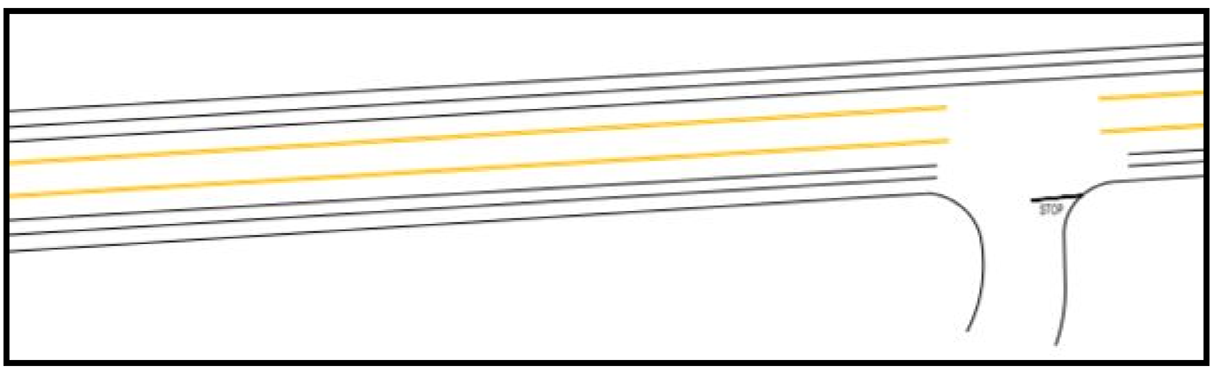


Figure 16: AutoCAD drawing of the intersection of Pruneridge Ave and Rosemont Dr.

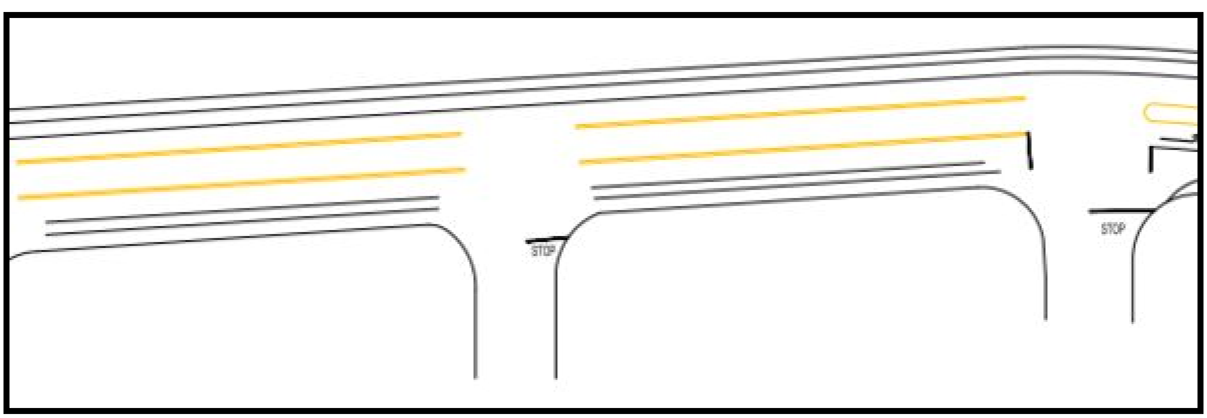


Figure 17: AutoCAD drawing of Geneva Dr and Tracy Dr.

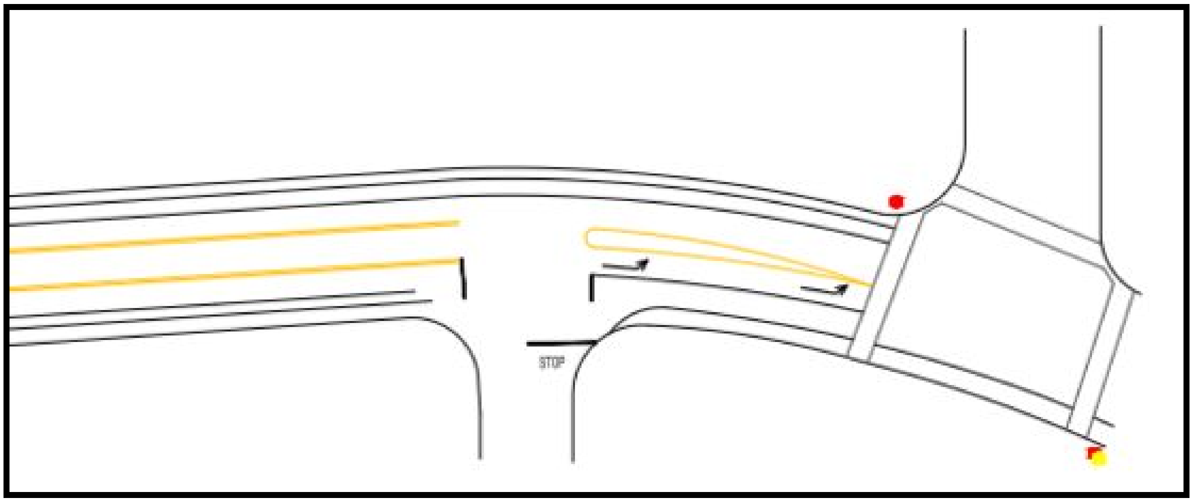


Figure 18: AutoCAD drawing of the intersection of Pruneridge Ave and Pomeroy Ave.

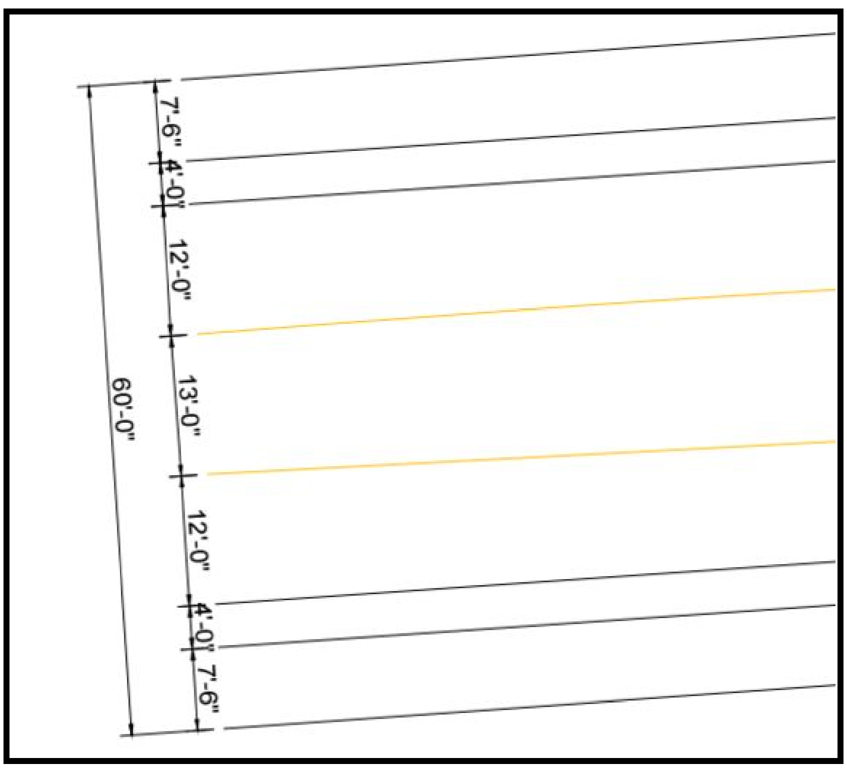


Figure 19: AutoCAD drawing showing the dimensions of proposed reverse lane design for Pruneridge Ave.

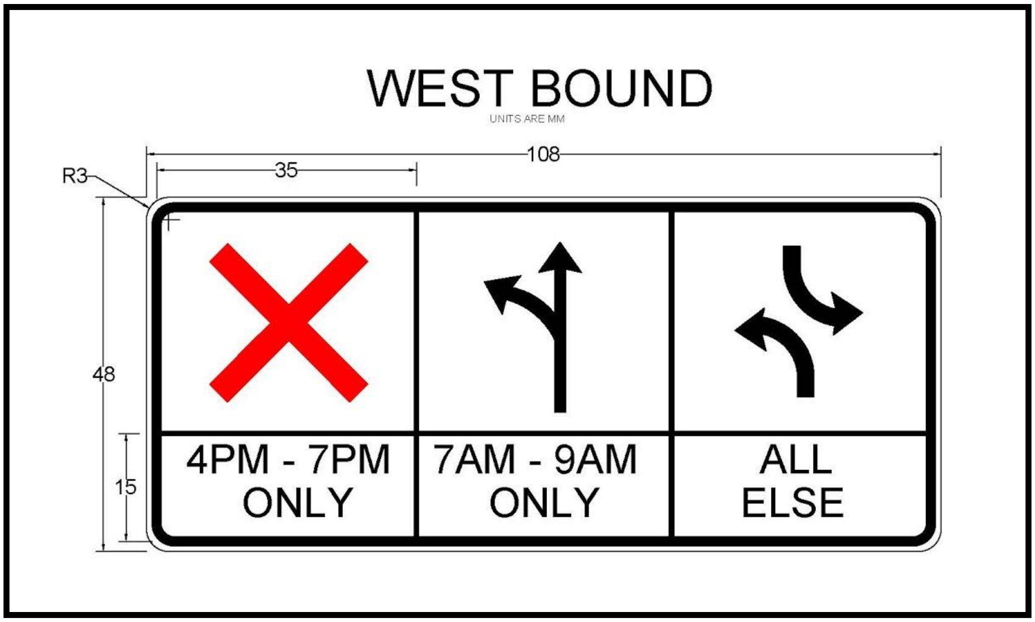


Figure 20: AutoCAD drawing of proposed reverse lane signs for Pruneridge Ave.

APPENDIX C

Cost Estimate

	UNIT TOTAL	LS	455	1,378,609.74
	ITEM CODE 070030 TOTAL		455	1,378,609.74*

080050 PROGRESS SCHEDULE (CRITICAL PATH METHOD)

LS	01	4	65,421.37
LS	02	5	33,338.04
LS	03	7	70,259.00
LS	04	25	178,776.23
LS	05	7	40,250.00
LS	06	4	19,200.00
LS	07	15	142,188.00
LS	08	4	28,300.00
LS	09	1	7,250.00
LS	10	3	25,000.00
LS	11	9	43,275.00
LS	12	6	32,250.00

Figure 21: Cost estimate for progress schedule (critical path method).

120090 CONSTRUCTION AREA SIGNS

LS	01	34	229,797.00
LS	02	31	197,344.83
LS	03	45	315,422.40
LS	04	95	1,799,275.62
LS	05	35	464,362.00
LS	06	47	405,243.45
LS	07	59	1,031,724.68
LS	08	36	393,523.50
LS	09	12	140,295.00

Figure 22: Cost estimate for construction area signs.

120100 TRAFFIC CONTROL SYSTEM

LS	01	38	4,586,959.44
LS	02	32	4,564,044.69
LS	03	50	7,342,040.20
LS	04	93	14,969,500.54
LS	05	35	5,458,545.57
LS	06	47	5,927,148.13
LS	07	59	17,313,748.20
LS	08	34	4,808,444.80
LS	09	12	1,616,963.00
LS	10	45	10,568,740.92
LS	11	27	4,253,416.01
LS	12	18	2,615,018.56

Figure 23: Cost estimate for traffic control system.

128651 PORTABLE CHANGEABLE MESSAGE SIGN (EA)

EA	01	7	18.0	4,050.0000	72,900.00
EA	03	1	2.0	1,200.0000	2,400.00
EA	04	11	40.0	2,524.0000	100,960.00
EA	07	2	6.0	5,000.0000	30,000.00
EA	08	33	144.0	2,913.3681	419,525.00
EA	11	25	150.0	4,769.8200	715,473.00
EA	12	8	66.0	3,372.0182	222,553.20

Figure 24: Cost estimate for portable changeable message sign.

130100 JOB SITE MANAGEMENT

LS	01	39	1,794,040.00
LS	02	32	284,616.94
LS	03	50	473,156.00
LS	04	98	1,942,199.60
LS	05	37	653,650.64
LS	06	48	273,483.80
LS	07	61	2,108,020.71
LS	08	36	531,420.55
LS	09	14	166,355.20
LS	10	45	597,916.00
LS	11	27	842,509.56
LS	12	20	208,071.52

Figure 25: Cost estimate for job site management.

148005 NOISE MONITORING

LS	04	23	39,905.00
LS	11	1	9,760.00

Figure 26: Cost estimate for noise monitoring.

840501 THERMOPLASTIC TRAFFIC STRIPE

LF	04	1	3,600.0	1.5000	5,400.00
LF	05	1	22,700.0	.6000	13,620.00

Figure 27: Cost estimate for thermoplastic traffic stripe.

THERMOPLASTIC PAVEMENT MARKING

SQFT	01	12	4,414.0	6.3133	27,867.00
SQFT	02	19	23,634.0	5.7679	136,319.30
SQFT	03	5	5,300.0	4.8919	25,927.20
SQFT	04	23	41,902.0	4.0171	168,322.50
SQFT	05	20	64,370.0	3.2334	208,131.60
SQFT	06	27	23,399.0	3.7907	88,699.50
SQFT	07	29	72,015.0	3.6410	262,210.00
SQFT	08	22	30,057.0	3.3000	99,189.00
SQFT	09	3	4,240.0	4.0566	17,200.00
SQFT	10	22	50,860.0	3.9222	199,485.25
SQFT	11	1	1,460.0	3.0300	4,423.80
SQFT	12	6	2,810.0	4.2110	11,833.00

Figure 28: Cost estimate for thermoplastic pavement marking.

861501 MODIFY SIGNAL AND LIGHTING

LS	03	3	375,730.00
LS	04	1	4,294.50
LS	05	1	320,000.00
LS	07	4	1,043,005.00

Figure 29: Cost estimate for signal and lighting.

APPENDIX D

County of Santa Clara Traffic Report Files

```
--------------------------------------------------------------------------------
                       2040 Expressway Planning Study
                           Lawrence Expressway LOS
                     Existing Conditions - AM Peak Hour
--------------------------------------------------------------------------------
                     Level Of Service Computation Report
             2000 HCM Operations Method (Base Volume Alternative)
********************************************************************************
Intersection #5626 LAWRENCE EXPWY(NS)/PRUNERIDGE AVE(EW) [HOV:AM 6-9 PM 3-7 CRD]
********************************************************************************
Cycle (sec):         190                Critical Vol./Cap.(X):         0.782
Loss Time (sec):      12                Average Delay (sec/veh):        67.3
Optimal Cycle:       203                Level Of Service:                  E
********************************************************************************
Approach:      North Bound      South Bound       East Bound       West Bound
Movement:     L  -  T  -  R    L  -  T  -  R    L  -  T  -  R    L  -  T  -  R
------------|---------------||---------------||---------------||---------------|
Control:        Protected        Protected        Protected        Protected
Rights:            Ovl              Ovl              Ovl              Ovl
Min. Green:    19  113   113    16  111   111    19   37    37    24   42    42
Y+R:          4.0  4.0   4.0   4.0  4.0   4.0   4.0  4.0   4.0   4.0  4.0   4.0
Lanes:        2  0  3  0  1    2  0  3  0  1    2  0  1  1  0    2  0  1  1  0
------------|---------------||---------------||---------------||---------------|
Volume Module: >> Count Date: 19 Sep 2013 << 8 : 00 - 9 : 00
Base Vol:      81 3800   145   122 1319   121    84  157    87   160  385   264
Growth Adj:  1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00
Initial Bse:   81 3800   145   122 1319   121    84  157    87   160  385   264
User Adj:    1.00 0.87  1.00  1.00 0.87  1.00  1.00 1.00  1.00  1.00 1.00  1.00
PHF Adj:     1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00
PHF Volume:    81 3306   145   122 1148   121    84  157    87   160  385   264
Reduct Vol:     0    0     0     0    0     0     0    0     0     0    0     0
Reduced Vol:   81 3306   145   122 1148   121    84  157    87   160  385   264
PCE Adj:     1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00
MLF Adj:     1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00
FinalVolume:   81 3306   145   122 1148   121    84  157    87   160  385   264
------------|---------------||---------------||---------------||---------------|
Saturation Flow Module:
Sat/Lane:    1900 1900  1900  1900 1900  1900  1900 1900  1900  1900 1900  1900
Adjustment:  0.83 1.00  0.92  0.83 1.00  0.92  0.83 1.00  0.92  0.83 1.00  0.92
Lanes:       2.00 3.00  1.00  2.00 3.00  1.00  2.00 1.25  0.75  2.00 1.15  0.85
Final Sat.:  3150 5700  1750  3150 5700  1750  3150 2373  1315  3150 2178  1494
------------|---------------||---------------||---------------||---------------|
Capacity Analysis Module:
Vol/Sat:     0.03 0.58  0.08  0.04 0.20  0.07  0.03 0.07  0.07  0.05 0.18  0.18
Crit Moves:       ****        ****                  ****        ****
Green/Cycle: 0.09 0.56  0.68  0.08 0.55  0.64  0.09 0.18  0.28  0.12 0.21  0.29
Volume/Cap:  0.27 1.03  0.12  0.49 0.37  0.11  0.28 0.36  0.24  0.43 0.85  0.62
Delay/Veh:   86.1 84.2  18.1  91.1 18.0   6.6  86.2 73.0  57.1  83.9 86.9  64.0
User DelAdj: 1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00  1.00 1.00  1.00
AdjDel/Veh:  86.1 84.2  18.1  91.1 18.0   6.6  86.2 73.0  57.1  83.9 86.9  64.0
LOS by Move:    F    F     B     F    B     A     F    E     E     F    F     E
HCM2kAvgQ:      3   76     5     4    9     1     3    7     6     6   22    18
********************************************************************************
Note: Queue reported is the number of cars per lane.
********************************************************************************
```

2040 Expressway Planning Study
Lawrence Expressway LOS
Existing Conditions - PM Peak Hour

Level Of Service Computation Report
2000 HCM Operations Method (Base Volume Alternative)

Intersection #5626 LAWRENCE EXPWY(NS)/PRUNERIDGE AVE(EW) [HOV:AM 6-9 PM 3-7 CRD]

Cycle (sec):	190	Critical Vol./Cap.(X):	0.537
Loss Time (sec):	12	Average Delay (sec/veh):	36.6
Optimal Cycle:	202	Level Of Service:	D

Approach:	North Bound			South Bound			East Bound			West Bound		
Movement:	L	T	R	L	T	R	L	T	R	L	T	R
Control:		Protected			Protected			Protected			Protected	
Rights:		Ovl			Ovl			Ovl			Ovl	
Min. Green:	18	107	107	28	117	117	17	33	33	22	38	38
Y+R:	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lanes:	2 0 3 0 1			2 0 3 0 1			2 0 1 1 0			2 0 1 1 0		
Volume Module: >> Count Date: 17 Sep 2013 << 5:30-6:30 PM												
Base Vol:	54	1919	303	418	3652	221	51	178	15	196	154	173
Growth Adj:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Initial Bse:	54	1919	303	418	3652	221	51	178	15	196	154	173
User Adj:	1.00	0.77	1.00	1.00	0.82	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PHF Adj:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PHF Volume:	54	1478	303	418	2995	221	51	178	15	196	154	173
Reduct Vol:	0	0	0	0	0	0	0	0	0	0	0	0
Reduced Vol:	54	1478	303	418	2995	221	51	178	15	196	154	173
PCE Adj:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MLF Adj:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
FinalVolume:	54	1478	303	418	2995	221	51	178	15	196	154	173
Saturation Flow Module:												
Sat/Lane:	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Adjustment:	0.83	1.00	0.92	0.83	1.00	0.92	0.83	1.00	0.92	0.83	1.00	0.92
Lanes:	2.00	3.00	1.00	2.00	3.00	1.00	2.00	1.83	0.17	2.00	1.00	1.00
Final Sat.:	3150	5700	1750	3150	5700	1750	3150	3481	293	3150	1900	1750
Capacity Analysis Module:												
Vol/Sat:	0.02	0.26	0.17	0.13	0.53	0.13	0.02	0.05	0.05	0.06	0.08	0.10
Crit Moves:		****		****				****		****		
Green/Cycle:	0.09	0.53	0.64	0.14	0.58	0.66	0.08	0.16	0.25	0.11	0.19	0.33
Volume/Cap:	0.19	0.49	0.27	0.96	0.91	0.19	0.19	0.31	0.20	0.57	0.43	0.30
Delay/Veh:	85.6	21.8	7.7	118.6	27.6	5.2	86.5	74.8	59.6	87.8	72.8	51.0
User DelAdj:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AdjDel/Veh:	85.6	21.8	7.7	118.6	27.6	5.2	86.5	74.8	59.6	87.8	72.8	51.0
LOS by Move:	F	C	A	F	C	A	F	E	E	F	E	D
HCM2kAvgQ:	2	13	4	16	46	2	2	5	5	8	8	8

Note: Queue reported is the number of cars per lane.

Lawrence Expressway AM

AM	N-crosswalk		S-crosswalk		E-crosswalk		W-crosswalk		N-Bound Bicy			S-Bound Bicy			E-Bound Bicy			W-Bound Bicy		
	Ped.	Bicy	Ped.	Bicy	Ped.	Bicy	Ped.	Bicy	L	T	R	L	T	R	L	T	R	L	T	R
Prunridge	14	10	13	9	2	8	4	1	0		0	0		0	1		0	2		0

Lawrence Expressway PM

PM	N-crosswalk		S-crosswalk		E-crosswalk		W-crosswalk		N-Bound Bicy			S-Bound Bicy			E-Bound Bicy			W-Bound Bicy		
	Ped.	Bicy	Ped.	Bicy	Ped.	Bicy	Ped.	Bicy	L	T	R	L	T	R	L	T	R	L	T	R
Prunridge	8	10	2	9	0	1	10	3	0		0	2		0	1		0	1		0

Santa Clara County — Timing Sheet — 11/30/2015 11:34:23 AM

Station : 5626 - Lw-Prunridge (Standard File)

Phase	1 (SL)	2 (NT)	3 (EL)	4 (WT)	5 (NL)	6 (ST)	7 (WL)	8 (ET)	9	10	11	12	13	14	15	16
Walk		7		7		7		7								
Ped Clearance		18		30		18		30								
Min Green	8	12	8	8	8	12	8	8								
Passage	3	4	3	6	3	4	3	4								
Max1	30	60	26	34	30	60	26	34								
Max2	99	125	99	99	99	125	99	99								
Yellow	3	4.7	3.6	3.6	3	4.7	3	3.6								
Red	2.1	1	2.1	1	2.1	1	1.8	1								
Red Revert	2	2	2	2	2	2	2	2								
Added Initial		12		13		12		13								
Max Initial		12		13		12		13								
Time Before Reduce																
Cars Before Reduce																
Time To Reduce																
Reduce By																
Min Gap																
Dynamic Max Limit		110				110										
Dynamic Max Step		10				10										
Enable	ON	ON	ON	ON	ON	ON	ON	ON								
Auto Entry																
Auto Exit																
Non Act1																
Non Act2																
Lock Call	ON	ON	ON	ON	ON	ON	ON	ON								
Min Recall		ON				ON										
Max Recall																
Ped Recall																
Soft Recall																
Dual Entry		ON		ON		ON		ON								
Sim Gap Enable		ON				ON										
Guar Passage																
Rest In Walk																
Cond Service																
Add Init Calc																
Bike Clear		6		5		6		5								

Preemption

Channel	1	2	3	4	5	6
Lock Input	ON	ON	ON	ON	ON	ON
Override Flash						
Override Higher						
Flash Dwell						
Link						
Delay						
Min Duration	10	10	10	10	10	10
Min Green	10	10	10	10	10	10
Min Walk	7	7	7	7	7	7
Ped Clear	21	21	21	21	21	21
Track Green						
Min Dwell						
Max Presence						
Track R1						
Track R2						
Track R3						
Track R4						
Dwell Ped1						
Exit R1			2	1	4	3
Exit R2			5	6	7	8
Exit R3						
Exit R4						

Preempt LP

Channel	1	2	3	4
Min				
Max				
Type	OFF	OFF	OFF	OFF
Platoon Rx				
Cond Lockout				
Coord in Preempt				
Platoon Tx				
Lock				
Begin Mode	SKIP	SKIP	SKIP	SKIP
Priority P1				
Priority P2				
Priority P3				
Priority P4				
Max Lockout				
Ext Dwell				
Ant Arrival				
Max Grn 1				
Max Grn 2				
Max Grn 3				
Max Grn 4				
Max Grn 5				
Max Grn 6				
Max Grn 7				
Max Grn 8				
Max Grn 9				
Max Grn 10				
Max Grn 11				
Max Grn 12				
Max Grn 13				
Max Grn 14				
Max Grn 15				

Max Grn 16				
Headway Group				
Queue Jump				
Headway Time				
TX Time				
PP Hold Time				
PP Tx Phase 1				
PP Tx Phase 2				
PP Tx Phase 3				
PP Tx Phase 4				

Santa Clara County | Timing Sheet | 11/30/2015 11:34:23 AM

Station : 5626 - Lw-Prunridge (Standard File)

Coordination

Hour	Minute	Action	Pattern	Cycle	Offset	Split	Seqnc	Short	Long	Dwell	Split 1	Split 2	Split 3	Split 4	Split 5	Split 6	Split 7	Split 8	Split 9	Split 10	Split 11	Split 12	Split 13	Split 14	Split 15	Split 16
Day Plan 1											**Easy**															
	1	54	254																							
6		1	254																							
7		2	5	190	166	5	3	10	17		17	106	22	45	22	101	25	42								
9		3	5	190	166	5	3	10	17		17	106	22	45	22	101	25	42								
10		4	4	170	107	4	3	10	17		18	85	22	45	22	81	25	42								
11	30	5	11	150	105	11	3	10	17		21	62	25	42	21	62	25	42								
15		6	21	160	24	21	3	10	17		25	71	22	42	19	77	22	42								
16	45	7	23	190	4	23	3	10	17		28	108	17	37	19	117	22	32								
18	30	8	22	170	114	22	3	10	17		29	77	22	42	19	87	22	42								
19		9	22	170	114	22	3	10	17		29	77	22	42	19	87	22	42								
20		10	20	150	65	20	3	10	17		21	67	20	42	21	67	20	42								
21		54	254																							
16		8	22	170	114	22	3	10	17		29	77	22	42	19	87	22	42								
Day Plan 2											**Easy**															
	1	54	254																							
9		28	28	130	9	28	3	10	17		18	52	18	42	20	50	18	42								
10	30	29	29	150	144	29	3	10	17		20	68	20	42	20	68	20	42								
12	30	30	30	160	142	30	3	10	17		23	66	27	44	23	66	27	44								
14	30	29	29	150	144	29	3	10	17		20	68	20	42	20	68	20	42								
17		28	28	130	9	28	3	10	17		18	52	18	42	20	50	18	42								
19		54	254																							
Day Plan 3											**Easy**															
	1	54	254																							
9	30	28	28	130	9	28	3	10	17		18	52	18	42	20	50	18	42								
11		29	29	150	144	29	3	10	17		20	68	20	42	20	68	20	42								
12	30	30	30	160	142	30	3	10	17		23	66	27	44	23	66	27	44								
14		29	29	150	144	29	3	10	17		20	68	20	42	20	68	20	42								
17		28	28	130	9	28	3	10	17		18	52	18	42	20	50	18	42								
19		54	254																							

Santa Clara County | Timing Sheet | 11/30/2015 11:34:23 AM

Station : 5626 - Lw-Prunridge (Standard File)

Hour	Minute	Action	Pattern	Cycle	Offset	Split	Seqnc	Short	Long	Dwell	Split 1	Split 2	Split 3	Split 4	Split 5	Split 6	Split 7	Split 8	Split 9	Split 10	Split 11	Split 12	Split 13	Split 14	Split 15	Split 16
Day Plan 4											**Easy**															
	1	54	254																							
9		20	29	150	144	29	3	10	17		20	68	20	42	20	68	20	42								
10	30	21	31	170	158	31	3	10	17		20	78	28	44	23	75	28	44								
14		22	30	160	142	30	3	10	17		23	66	27	44	23	66	27	44								
19	30	23	29	150	144	29	3	10	17		20	68	20	42	20	68	20	42								
21		24																								

Scheduler

	Month												Day of Week							Day of Month									1										2										3		
Plan	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**S**	**M**	**T**	**W**	**T**	**F**	**S**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**0**	**1**	**Day Plan**
1														1	1	1	1	1																																	1
2																			1																																2
3													1																																						3
4	1																	1		1																															4
5		1												1																					1																4
6					1									1																														1							4
7							1											1				1																													4
8									1					1												1																									4
9											1						1																												1						4
10											1							1																												1					4
11												1						1																										1							4
12																																																			1
13																																																			1
14																																																			1
15																																																			1
16																																																			1
17																																																			1
18																																																			1
19																																																			1
20																																																			1
21																																																			1
22																																																			1
23																																																			1
24																																																			1
25																																																			1
26																																																			1
27																																																			1
28																																																			1
29																																																			1
30																																																			1
31																																																			1
32																																																			1

User Comments:

APPENDIX E

Data Collection

Table 10: Manually recorded timing signal durations and vehicle counts for intersection of Lawrence Expy and Pruneridge Ave.

Date:	11/17/2015									
Time:	8 AM - 9 AM									
Our Data					**Given Data (PM)**				**Our Data (PM)**	
Left Turns	Green Left Turn	Red light	Total (s)		Peak Hour Factor Volume				Peak Hour Factor Volume	
Pruneridge to Lawrence (NB)	15 s	2m 57s	192							
Pruneridge to Lawrence (SB)	22 s	2m 45s	187		**North Bound**				**North Bound**	
Lawrence to Pruneridge (EB)	13 s	2m 56s	189	Left	Thru	Right		Left	Thru	Right
Lawrence to Pruneridge (WB)	19 s	2m 29s	168	54	1478	303		84	1928	232
					South Bound				**South Bound**	
Straight	Green light	Red light		Left	Thru	Right		Left	Thru	Right
Lawrence (SB)	2m 3s	1m 23s	206	418	2995	221		452	3076	184
Lawrence (NB)	1m 47s	1m 20s	187		**East Bound**				**East Bound**	
Pruneridge (EB)	45 s	2m 30s	195	Left	Thru	Right		Left	Thru	Right
Pruneridge (WB)	22 s	3m 10s	212	51	178	15		124	360	188
		AVG	192		**West Bound**				**West Bound**	
Date:	1/13/2016			Left	Thru	Right		Left	Thru	Right
Time:	5 PM - 6 PM			196	154	173		228	112	120
Our Data					**Given Data (AM)**				**Our Data (AM)**	
Left Turns	Green Left Turn	Red light	Total (s)		Peak Hour Factor Volume				Peak Hour Factor Volume	
Pruneridge to Lawrence (NB)	12s	2m 55s	187							
Pruneridge to Lawrence (SB)	18s	2m 50s	188		**North Bound**				**North Bound**	
Lawrence to Pruneridge (EB)	22s	2m 45s	187	Left	Thru	Right		Left	Thru	Right
Lawrence to Pruneridge (WB)	15s	2m 53s	188	81	3306	145		152	3012	124
					South Bound				**South Bound**	
Straight	Green light	Red light		Left	Thru	Right		Left	Thru	Right
Lawrence (SB)	1m 51s	1m 16s	187	122	1148	121		96	1276	52
Lawrence (NB)	1m 46s	1m 16s	182		**East Bound**				**East Bound**	
Pruneridge (EB)	27s	2m 42s	189	Left	Thru	Right		Left	Thru	Right
Pruneridge (WB)	32s	2m 28s	180	84	157	87		172	96	112
			187		**West Bound**				**West Bound**	
				Left	Thru	Right		Left	Thru	Right
				160	385	264		392	400	392

Table 11: Manually recorded vehicle counts for intersections along Pruneridge Ave during AM peak hour.

	Tuesday			Tuesday			Tuesday			Tuesday			Tuesday	
	1/26/2016			1/26/2016			1/26/2016			1/26/2016			2/9/2016	
	8 AM - 9 AM			8 AM - 9 AM			8 AM - 9 AM			8 AM - 9 AM			8 AM - 9 AM	
	15 min interval			15 min interval			15 min interval			15 min interval			15 min interval	
Pruneridge Ave & Pomeroy Ave			**Pruneridge Ave & Tracy Dr**			**Pruneridge Ave & Geneva Dr**			**Pruneridge Ave & Rosemont Dr**			**Pruneridge Ave & Harvard Ave**		
	East Bound			**East Bound**			**East Bound**			**East Bound**			**East Bound**	
Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
28	340	N/A	N/A	N/A	4	N/A	N/A	0	N/A	N/A	4	12	476	0
	West Bound			**West Bound**			**West Bound**			**West Bound**			**West Bound**	
Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
N/A	960	384	12	N/A	N/A	12	N/A	N/A	8	N/A	N/A	20	852	12
	South Bound			**South Bound**			**South Bound**			**South Bound**			**South Bound**	
Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
96	N/A	172	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	8	44
	North Bound			**North Bound**			**North Bound**			**North Bound**			**North Bound**	
Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
N/A	N/A	N/A	8	N/A	0	16	N/A	4	4	N/A	8	8	4	4

Table 12: Manually recorded vehicle counts for intersections along Pruneridge Ave during PM peak hour.

	Tuesday			Tuesday			Tuesday			Tuesday			Tuesday	
	1/26/2016			1/26/2016			1/26/2016			1/26/2016			2/9/2016	
	5 PM - 6 PM			5 PM - 6 PM			5 PM - 6 PM			5 PM - 6 PM			5 PM - 6 PM	
	15 min interval			15 min interval			15 min interval			15 min interval			15 min interval	
Pruneridge Ave & Pomeroy Ave			Pruneridge Ave & Tracy Dr			Pruneridge Ave & Geneva Dr			Pruneridge Ave & Rosemont Dr			Pruneridge Ave & Harvard Ave		
	East Bound			East Bound			East Bound			East Bound			East Bound	
Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
52	984	N/A	N/A	N/A	12	N/A	N/A	12	N/A	N/A	4	84	1168	56
	West Bound			West Bound			West Bound			West Bound			West Bound	
Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
N/A	432	116	20	N/A	N/A	16	N/A	N/A	8	N/A	N/A	12	260	12
	South Bound			South Bound			South Bound			South Bound			South Bound	
Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
276	N/A	88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	0	12
	North Bound			North Bound			North Bound			North Bound			North Bound	
Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
N/A	N/A	N/A	24	N/A	12	4	N/A	0	8	N/A	0	12	4	8