Santa Rosa Road
Assessment of Traffic Signal System Optimization

Final Report

Prepared For:

County of Ventura Transportation Department

February 2019

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0. EXECUTIVE SUMMARY

This signal timing assessment project is a follow up to the Santa Rosa Road Traffic Signal System Optimization Final Report (Kimley-Horn, 2016). The previous study goal was to refine signal timing along Santa Rosa Road between the Cities of Moorpark and Camarillo to optimize throughput, reduce travel time, reduce the number of stops, and minimize signal related delay. Since implementation of the recommended signal timing program, residents have recently reported increased difficulty in making left turns into and out of driveways and unsignalized side streets. This study evaluates the gaps and queues for side streets and travel time runs along the corridor with the current signal timing plan in place (**2018 Study),** and then reverted corridor signal timing to its original pattern with updated Traffic Signal parameters such as increase yellow time and increase pedestrian timing crossing the crosswalks for consistency with the latest CA-MUTCD requirements (**2016 Study)** where a second gap and queue study was conducted. This study then compares the accessibility challenges of the new timing on the un-signalized intersections along Santa Rosa Road with the old timing pattern. The study also included travel time runs to evaluate before and after corridor performance.

The 2016 Study provided more gaps during the AM peak period for majority of the intersections (39 more overall), while there were fewer gaps than the 2018 Study during the PM peak period for majority of the intersections (16 less overall). The AM peak hour traffic volumes along Santa Rosa Road from Las Posas Road to Moorpark Road were less after the 2016 Study was implemented compared to before. This reduction in traffic volumes may have been a factor in the increase in the total number of gaps at the intersection of Santa Rosa Road and Andalusia Drive for the 2016 Study.

The 2016 Study also had reduced travel time in both directions during the morning, and in the eastbound direction during the evening. The greatest benefit to travel times was observed in the eastbound direction during the evening. In the morning, average travel time in the eastbound direction was reduced by 0.9 percent (3 seconds) which suggests little to no difference and in the westbound direction by 5.3 percent (19 seconds) which is enough to suggest better throughput for the 2016 Study. In the evening period, average travel time was reduced by 8.4 percent (33 seconds) in the eastbound direction and increased by 0.7 percent (2 seconds) in the westbound direction.

The 2016 Study had the greatest travel time impact during the PM peak, but given local sentiment, prioritizing safe and convenient access to side streets and driveways would be most consistent with the intent of this analysis. The study team recommends maintaining the 2016 Study signal timing in the AM peak and to the 2018 Study for the PM peak.

1. INTRODUCTION AND METHODOLOGY

This signal timing assessment project is a follow up to the Santa Rosa Road Traffic Signal System Optimization Final Report (Kimley-Horn, 2016). The previous study goal was to refine signal timing along Santa Rosa Road between the Cities of Moorpark and Camarillo to optimize throughput and minimize signal related delay. . Residents have recently reported increased difficulty in making left turns into and out of driveways and unsignalized side streets. This study evaluates the gaps and queues for side streets along the corridor with the current signal timing plan in place (2018 Study), and then reverted corridor signal timing to its original pattern with minor updates for consistency with CA-MUTCD requirements (2016 Study) where a second gap and queue study was conducted. This study then compares the accessibility challenges of the 2018 Study timing on the un-signalized intersections along Santa Rosa Road with the 2016 Study timing pattern. The study also included travel time runs to evaluate before and after corridor performance.

Travel time data collected by Ventura County shows that corridor travel time has stabilized since implementation of the new signal plan. County traffic counts also show that daily traffic volumes fluctuate from year to year, but peak period traffic counts typically vary by fewer than 100 vehicles and should therefore provide consistent year over year operations. At the daily level, average PM peak corridor speeds vary between 45 MPH and 25 MPH with some outliers on either side. These daily changes create unreliable traffic expectations for corridor users.

1.1 STUDY AREA

The study observed the following six (6) unsignalized intersections along Santa Rosa Road:

- Santa Rosa Road/Barbara Drive;
- Santa Rosa Road/Holiday Pines Lane;
- Santa Rosa Road/Duval Road;
- Santa Rosa Road/Arletta Lane;
- Santa Rosa Road/Glenside Lane; and
- Santa Rosa Road/Andalusia Drive.

Figure 1-1 illustrates the observed unsignalized intersections, along with the location of signalized intersections along Santa Rosa Road in the study area.

1.2 STUDY OBJECTIVES

To better understand the current operational performance of six (6) unsignalized intersections along Santa Rosa Road in County of Ventura jurisdiction.

Following the evaluation of the 2018 Study, Kimley-Horn repeated the analysis using the original signal timing prior to re-implementation (2016 Study). Suggested adjustments were documented in the form of marked-up timing sheets. County staff implemented new timing in field controllers prior to the evaluation of the 2016 Study.

Using the same methodology, a gap and queue analysis and travel time runs were conducted following re-implementation of the original coordinated signal timing plans for the 2016 Study. A comparison of the results for both scenarios was conducted to understand the impact of the new timing on the un-signalized intersections along Santa Rosa Road and aid in determining next steps, if any, with respect to the timing along Santa Rosa Road.

1.3 DATA COLLECTION

The data needed to support this assessment was collected during the AM (7:30 – 8:00AM) and PM (5:00 – 5:30 PM) peak periods on Tuesday, September 25, 2018 for the 2018 Study and on Wednesday, October 17, 2018 for the 2016 Study. Data utilized included the following:

- Weekday peak period gap counts at the locations listed below
- Weekday peak period vehicle queue counts at the locations listed below
- Weekday peak period travel time runs

There are twelve unsignalized intersections along Santa Rosa Road in this study area. The six selected and listed below are representative of the twelve. These six locations were chosen to ensure coverage of each corridor segment.

- Barbara Drive
- Holiday Pines Lane
- Duval Road
- Arletta Lane
- Glenside Lane
- Andalusia Drive

Gap & Queue Analysis – Field technicians visited each intersection and observed traffic. They noted how many vehicles were waiting at the intersection to turn into, or out of side streets, and counted the number of gaps in traffic along Santa Rosa Road of at least 5 seconds, which is typically long enough for a vehicle to safely enter. They also recorded how long vehicles had to wait for a sufficient gap in traffic.

Travel Time Runs – Travel time data was collected by driving a GPS equipped car along the full length of the corridor, recording the amount of time the vehicle is stopped at each intersection and how long it takes to traverse the full corridor. GPS data is collected every second during each run. Four (4) travel time runs were completed in each direction on the corridor in each peak period. The GPS data allows for analysis of travel time, stopped time, number of stops, and average travel speed at each roadway segment and along the corridor.

Figure 1-1
Santa Rosa Road Area Signals and Study Intersections

2. 2018 STUDY

The 2018 Study includes 120-second cycles in both the AM and PM peak periods with two-way progression and an uncoordinated 20-minute period at the Vista Grande intersection during school start times to service movements to/from Santa Rosa Technology Magnet School. This section summarizes the observations from the gap and queue analysis and the travel time runs for the 2018 Study.

2.1 GAP & QUEUE ANALYSIS SUMMARY

Using field technician observations described under Data Collection, this section describes how much opportunity there is for vehicles to enter traffic on Santa Rosa Road from side streets.

Table 2-1 displays the AM peak period (7:30 AM to 8:00 AM) summary of the gap and queue analysis performed for the 2018 Study. During this time, the longest side street queue of four vehicles per minute was seen at the Duval Road intersection.

Table 2-1 – 2018 Study Gap & Queue Analysis AM Peak Period Summary

Intersection Side Street	Barbara Drive	Holiday Pines Lane	Duval Road	Arletta Lane	Glenside Lane	Andalusia Drive
Total Number of Gaps	28	13	17	27	20	31
Average Time between Gaps (gap/time period, min)	1:04	2:18	1:46	1:07	1:30	0:58
Max Gap Duration (sec)	19	7	10	10	28	25
Average Gap Duration (sec)	8	5	7	6	9	8
Total Side Street Approach Count	6	3	14	7	12	12
Max Queue per Minute on Side Street (veh)	2	0	4	2	3	3

Table 2-2 displays the PM peak period (5:00 PM to 5:30 PM) summary of the gap and queue analysis performed for the 2018 Study. During this time, the longest side street queue of one vehicle per minute was seen at the Holiday Pines Lane, Glenside Lane, and Andalusia Drive intersections.

Table 2-2 – 2018 Study Gap & Queue Analysis PM Peak Period Summary

Intersection Side Street	Barbara Drive	Holiday Pines Lane	Duval Road	Arletta Lane	Glenside Lane	Andalusia Drive
Total Number of Gaps	34	31	31	29	29	30
Average Time between Gaps (gap/time period, min)	0:53	0:58	0:58	1:02	1:02	1:00
Max Gap Duration (sec)	32	26	28	23	21	27
Average Gap Duration (sec)	8	8	9	8	7	10
Total Side Street Approach Count	2	2	7	4	2	8
Max Queue per Minute on Side Street (veh)	0	1	0	0	1	1

2.2 TRAVEL TIME RUN SUMMARY

Table 2-3 summarizes the AM peak period travel time runs performed for the 2018 Study. During the AM peak period, the average travel time in the eastbound direction was 5.60 minutes with an average speed of 37.6 MPH, while the average travel time in the westbound direction was 6.01 minutes with an average speed of 34.6 MPH.

Table 2-3 – 2018 Study Travel Time Run AM Peak Period Summary

Travel Time Run	Start Time	Length (ft)	Travel Time (min)	# of Stops*	Average Speed (MPH)	Total Delay** (min)
EASTBOUND						
Run 1	7:10 AM	18,361	5:03	1	41.4	1:12
Run 2	7:23 AM	18,438	5:45	2	36.3	1:55
Run 3	7:41 AM	18,222	6:15	2	33.2	2:25
Run 4	8:29 AM	18,475	5:20	1	39.3	1:39
Average	-	**18,374**	**5:36**	**1.5**	**37.6**	**1:45**
WESTBOUND						
Run 1	7:32 AM	18,159	5:58	2	34.6	2:11
Run 2	7:54 AM	18,142	5:59	2	34.5	2:12
Run 3	8:17 AM	18,089	6:45	2	30.6	2:57
Run 4	8:49 AM	18,114	5:20	1	38.7	1:33
Average	-	**18,126**	**6:01**	**1.75**	**34.6**	**2:13**

* Stops based on a Stop Speed of 5 MPH
** Total Delay based on a Normal Speed of 55 MPH

Table 2-4 summarizes the PM peak period travel time runs performed for the 2018 Study. During the PM peak period, the average travel time in the eastbound direction was 6.57 minutes with an average speed of 32.2 MPH, while the average travel time in the westbound direction was 4.63 minutes with an average speed of 45.1 MPH.

Table 2-4 – 2018 Study Travel Time Run PM Peak Period Summary

Travel Time Run	Start Time	Length (ft)	Travel Time (min)	# of Stops*	Average Speed (MPH)	Total Delay** (min)
EASTBOUND						
Run 1	4:01 PM	18,371	6:40	2	31.3	2:51
Run 2	4:45 PM	18,374	5:24	1	38.5	1:33
Run 3	5:00 PM	18,385	6:44	3	30.9	2:55
Run 4	5:34 PM	18,312	7:28	2	27.9	3:38
Average	-	**18,361**	**6:34**	**2**	**32.2**	**2:44**
WESTBOUND						
Run 1	4:11 PM	18,238	4:44	0	43.9	0:56
Run 2	4:26 PM	18,213	4:17	0	48.5	0:27
Run 3	4:39 PM	18,236	5:09	1	40.3	1:20

Run 4	5:56 PM	18,285	4:22	0	47.5	0:31
Average	**-**	**18,243**	**4:38**	**0.25**	**45.1**	**0:49**
* Stops based on a Stop Speed of 5 MPH ** Total Delay based on a Normal Speed of 55 MPH						

3. 2016 STUDY

The 2016 Study includes 100-second cycles with eastbound progression in the AM peak period, 90-second cycles with eastbound progression in the PM peak period, and a 130-second cycle at the Vista Grande intersection from 7:45-8:15 AM. Minor adjustments were also made to the yellow time, all red time, pedestrian walk time, pedestrian flashing don't walk time, and minimum green time to meet CA-MUTCD mandated signal timing parameter requirements. These suggested adjustments were documented in the form of marked-up timing sheets, as seen in Appendix D.
This section summarizes the observations from the gap and queue analysis and the travel time runs for the 2016 Study.

3.1 GAP & QUEUE ANALYSIS SUMMARY

Table 3-1 displays the AM peak period (7:30 AM to 8:00 AM) summary of the gap and queue analysis performed for the 2016 Study. During this time, the longest side street queue of three vehicles was seen at the Arletta Lane intersection.

Table 3-1 – 2016 Study Gap & Queue Analysis AM Peak Period Summary

Intersection Side Street	Barbara Drive	Holiday Pines Lane	Duval Road	Arletta Lane	Glenside Lane	Andalusia Drive
Total Number of Gaps	8	20	26	28	31	62
Average Time between Gaps (gap/time period, min)	3:45	1:30	1:09	1:04	0:58	0:29
Max Gap Duration (sec)	8	16	30	25	24	26
Average Gap Duration (sec)	6	9	9	8	10	8
Max Queue per Minute on Side Street (veh)	1	0	2	3	1	1

Table 3-2 displays the PM peak period (5:00 PM to 5:30 PM) summary of the gap and queue analysis performed for the 2016 Study. During this time, the longest side street queue of two vehicles per minute was seen at the Arletta Lane and Andalusia Drive intersections.

Table 3-2 – 2016 Study Gap & Queue Analysis PM Peak Period Summary

Intersection Side Street	Barbara Drive	Holiday Pines Lane	Duval Road	Arletta Lane	Glenside Lane	Andalusia Drive
Total Number of Gaps	36	28	27	21	19	37
Average Time between Gaps (gap/time period, min)	0:50	1:04	1:07	1:26	1:35	0:49
Max Gap Duration (sec)	30	15	15	36	35	29
Average Gap Duration (sec)	8	7	8	8	10	8

Max Queue per Minute on Side Street (veh)	1	1	1	2	0	2

3.2 TRAVEL TIME RUN SUMMARY

Table 3-3 summarizes the AM peak period travel time runs performed for the 2016 Study. During the AM peak period, the average travel time in the eastbound direction was 5.55 minutes with an average speed of 38.8 MPH, while the average travel time in the westbound direction was 5.69 minutes with an average speed of 37.4 MPH.

Table 3-3 – 2016 Study Travel Time Run AM Peak Period Summary

Travel Time Run	Start Time	Length (ft)	Travel Time (min)	# of Stops*	Average Speed (MPH)	Total Delay** (min)
EASTBOUND						
Run 1	7:00 AM	18,209	6:26	2	32.3	2:36
Run 2	7:35 AM	18,358	6:40	2	31.2	2:52
Run 3	8:01 AM	18,296	4:48	0	43.3	0:59
Run 4	8:23 AM	18,253	4:19	0	48.2	0:29
Average	**-**	**18,279**	**5:33**	**1**	**38.8**	**1:44**
WESTBOUND						
Run 1	7:02 AM	18,148	5:21	1	38.7	1:33
Run 2	7:35 AM	18,775	6:43	2	30.8	2:54
Run 3	8:05 AM	18,199	6:22	2	32.5	2:34
Run 4	8:45 AM	18,147	4:20	0	47.7	0:31
Average	**-**	**18,317**	**5:42**	**1.25**	**37.4**	**1:53**
* Stops based on a Stop Speed of 5 MPH ** Total Delay based on a Normal Speed of 55 MPH						

Table 3-4 summarizes the PM peak period travel time runs performed for the the 2016 Study. During the PM peak period, the average travel time in the eastbound direction was 6.02 minutes with an average speed of 35.4 MPH, while the average travel time in the westbound direction was 4.66 minutes with an average speed of 44.5 MPH.

Table 3-4 – 2016 Study Travel Time Run PM Peak Period Summary

Travel Time Run	Start Time	Length (ft)	Travel Time (min)	# of Stops*	Average Speed (MPH)	Total Delay** (min)
EASTBOUND						
Run 1	4:18 PM	18,399	6:23	1	32.8	2:33
Run 2	4:33 PM	18,360	4:52	0	43.0	1:03
Run 3	4:46 PM	18,372	5:50	2	35.8	2:00
Run 4	5:02 PM	18,389	6:59	3	29.9	3:09
Average	**-**	**18,380**	**6:01**	**1.5**	**35.4**	**2:11**
WESTBOUND						
Run 1	4:12 PM	18,143	4:44	0	43.7	0:55
Run 2	4:27 PM	18,289	4:23	1	47.2	0:36
Run 3	4:43 PM	18,183	5:03	1	41.0	1:16
Run 4	5:05 PM	18,305	4:29	0	46.1	0:41
Average	**-**	**18,230**	**4:40**	**0.5**	**44.5**	**0:52**

* Stops based on a Stop Speed of 5 MPH
** Total Delay based on a Normal Speed of 55 MPH

4. CONCLUSION

4.1 COMPARISON OF SCENARIO RESULTS

The 2016 Study signal timing was implemented on October 14, 2018.

Table 4-1 displays the change in gaps and side street queuing on Santa Rosa Road associated with the changes to the corridor signal timing. As shown in the table, the 2016 Study provided more gaps during the AM peak period for majority of the intersections, while there were fewer gaps during the PM peak period for majority of the intersections. The AM peak hour traffic volumes along Santa Rosa Road from Las Posas Road to Moorpark Road were less on the dates the 2016 Study were evaluated compared to those for the 2018 Study. This reduction in traffic volumes may have been a factor in the increase in the total number of gaps at the intersection of Santa Rosa Road and Andalusia Drive.

Table 4-1 –Santa Rosa Road Gap & Queue Comparison

Intersection Side Street		Barbara Drive	Holiday Pines Lane	Duval Road	Arletta Lane	Glenside Lane	Andalusia Drive
Scenario	***Morning***						
A	Total Number of Gaps	28	13	17	27	20	31
	Max Queue per Minute on Side Street (veh)	2	0	4	2	3	3
B	Total Number of Gaps	8	20	26	28	31	62
	Max Queue per Minute on Side Street (veh)	1	0	2	3	1	1
Percent Change	Total Number of Gaps	-71.4%	53.9%	52.9%	3.7%	55.0%	100.0%
	Max Queue per Minute on Side Street (veh)	-50.0%	-	-50.0%	50.0%	-66.7%	-66.7%
Scenario	***Evening***						
A	Total Number of Gaps	34	31	31	29	29	30
	Max Queue per Minute on Side Street (veh)	0	1	0	0	1	1
B	Total Number of Gaps	36	28	27	21	19	37
	Max Queue per Minute on Side Street (veh)	1	1	1	2	0	2
Percent Change	Total Number of Gaps	5.9%	-9.7%	-12.9%	-27.6%	-34.5%	23.3%
	Max Queue per Minute on Side Street (veh)	New Queue	-	New Queue	New Queue	-100.0%	100.0%

Table 4-2 displays the change in corridor average travel time and average speed on Santa Rosa Road associated with the changes to the corridor signal timing. As shown in the table, the 2016 Study also had reduced travel time in both directions during the morning, and in the eastbound direction during the evening. The greatest benefit to travel times was observed in the eastbound direction during the evening. In the morning, average travel time in the eastbound direction was reduced by 0.9 percent (3 seconds) and in the westbound direction by 5.3 percent (19 seconds). In the evening period, average travel time was reduced by 8.4 percent (33 seconds) in the eastbound direction and increased by 0.7 percent (2 seconds) in the westbound direction.

Table 4-2 –Santa Rosa Road Travel Time Comparison

	2018 Study		2016 Study		Percent Change	
Direction	**Travel Time**	**Avg. Speed**	**Travel Time**	**Avg. Speed**	**Travel Time**	**Avg. Speed**
Morning						
Eastbound	5:36	37.6	5:33	38.8	-0.9%	3.2%
Westbound	6:01	34.6	5:42	37.4	-5.3%	8.1%
Evening						
Eastbound	6:34	32.2	6:01	35.4	-8.4%	9.9%
Westbound	4:38	45.1	4:40	44.5	0.7%	-1.3%

Table 4-3 displays the change in the amount of average stopped time and average number of stops experienced when driving from one end of the corridor to the other. As shown in the table, the total delay and the average number of times a vehicle is forced to stop was reduced in both directions in the morning and in the eastbound direction in the evening. The reduction in the number of stops corresponds with environmental benefits such as reductions in fuel consumption and greenhouse gas emissions.

Table 4-3 –Santa Rosa Road Delays and Stops Comparison

	2018 Study		2016 Study		Percent Change	
Direction	**Total Delay* (min)**	**Avg. # of Stops****	**Total Delay* (min)**	**Avg. # of Stops****	**Total Delay* (min)**	**Avg. # of Stops****
Morning						
Eastbound	1.75	1.5	1.73	1	-1.1%	-33.3%
Westbound	2.22	1.75	1.88	1.25	-18.1%	-28.6%
Evening						
Eastbound	2.74	2	2.19	1.5	-20.1%	-25.0%
Westbound	0.81	0.25	0.87	0.5	7.4%	100.0%
* Total Delay based on a Normal Speed of 55 MPH ** Stops based on a Stop Speed of 5 MPH						

Figures 4-1 and **4-2** show the average progression of the floating car vehicle along Santa Rosa Road before and after the changes to the corridor signal timing.

5. RECOMMENDATION

The analysis team recommends maintaining the 2016 Study signal timing during the AM peak period and using the 2018 Study signal timing during the PM peak period. Additional data collected by County staff supporting this recommendation is provided in Appendix G.

Travel time differences between the two signal timing plans with current traffic volumes were similar, with the 2016 Study slightly outperforming the 2018 Study, and the 2016 Study also provided more traffic gaps for access to unsignalized streets during the AM peak. The 2018 Study provided more traffic gaps for traffic during the PM peak.

The 2016 Study had the greatest travel time impact during the PM peak, but given local sentiment, prioritizing safe and convenient access to side streets and driveways would be most consistent with the intent of this analysis.

As resources allow, it is also recommended that the County explore migrating the corridor to an adaptive signal timing system to better address occasional traffic surges due to disruptions on US 101, or other events that make Santa Rosa Road a by-pass route as part of a broader integrated corridor management strategy.

Figure 5-1 – Santa Rosa Road Eastbound Average Progression

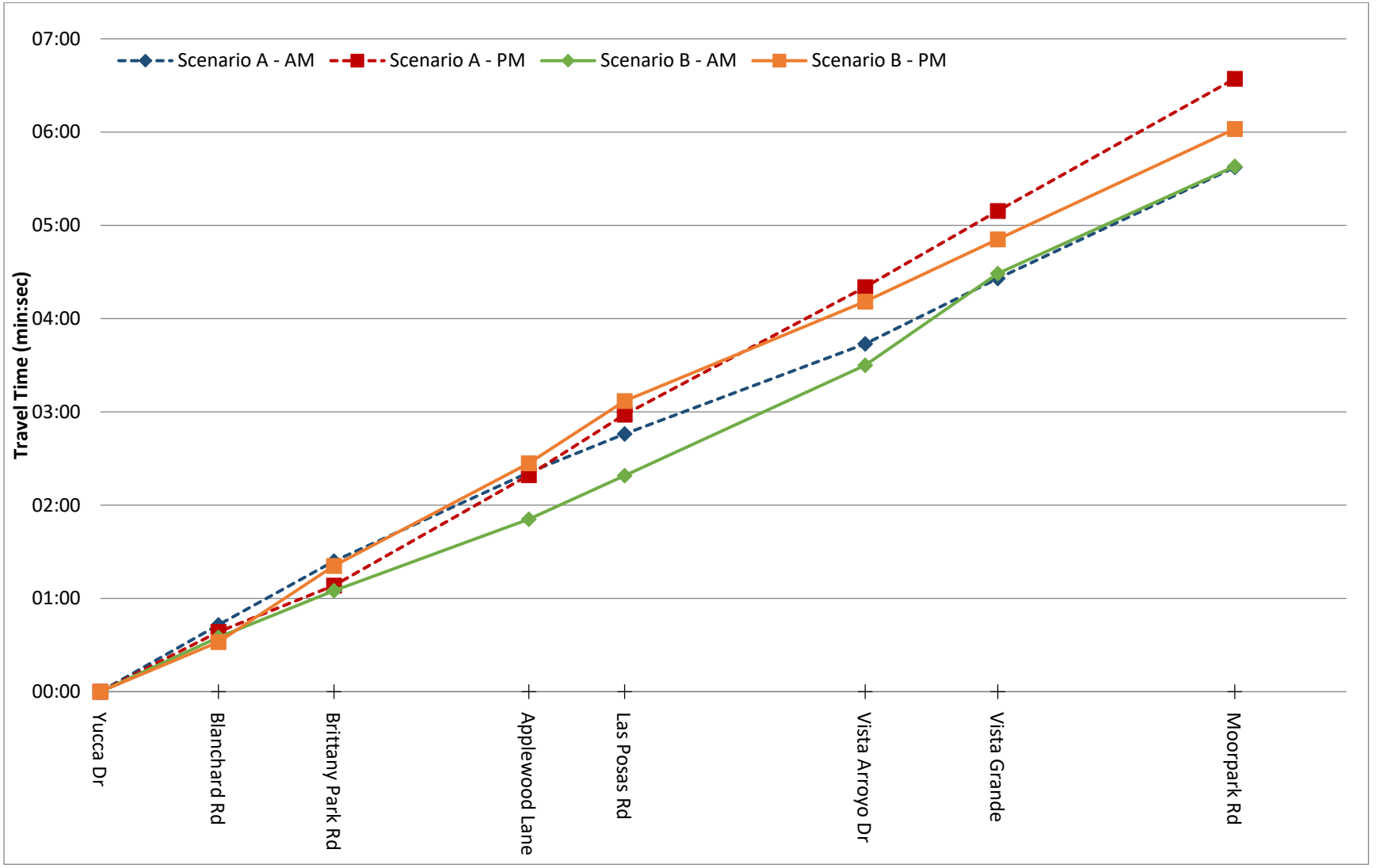
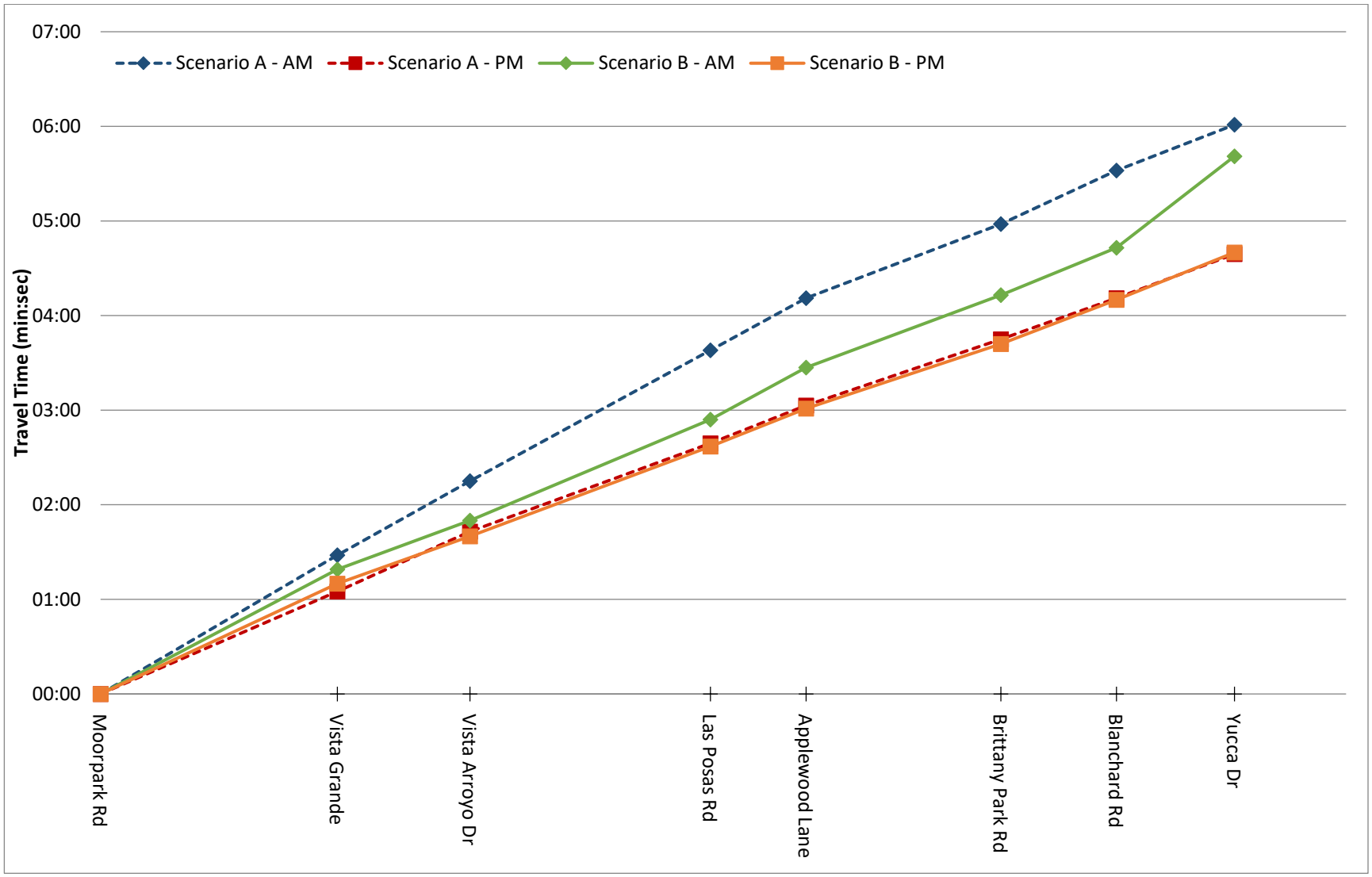


Figure 5-2 – Santa Rosa Road Westbound Average Progression



5.1 SUMMARY OF FINDINGS

The adjusted signal timing implemented on October 14, 2018 (2016 Study) has increased the total number of gaps for side street traffic to turn onto Santa Rosa Road during the morning but has decreased the total number of gaps during the evening. The adjusted signal timing has also decreased travel time and the average number of stops in both directions during the morning and in the eastbound direction during the evening. The reduction in vehicle idling and congestion translates directly to fuel consumption savings and reductions in greenhouse gas emissions, providing both monetary and environmental benefits to corridor users and nearby residents.

The study team recommends maintaining the 2016 Study signal timing with a cycle length of 100 seconds and eastbound progression during the AM peak period and using the 2018 Study signal timing with a cycle length of 120 seconds and two-way progression during the PM peak period.

APPENDIX A – GAP & QUEUE STUDY – 2018 STUDY

APPENDIX B – TURNING MOVEMENT COUNTS – 2018 STUDY

APPENDIX C – TRAVEL TIME RUNS – 2018 STUDY

APPENDIX D – MARKED-UP TIMING SHEETS

APPENDIX E – GAP & QUEUE STUDY – 2016 STUDY

APPENDIX F – TRAVEL TIME RUNS – 2016 STUDY

APPENDIX G – SUPPLEMENTAL TRAVEL TIME AND COUNT DATA