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MEMORANDUM

To: Mr. Darian Avelino – City of Oakland

From: Mark Bowman, Aaron Alias, Kevin Chen – Dowling Associates, Inc.

Project: Redwood Road & 35th Avenue Traffic Study

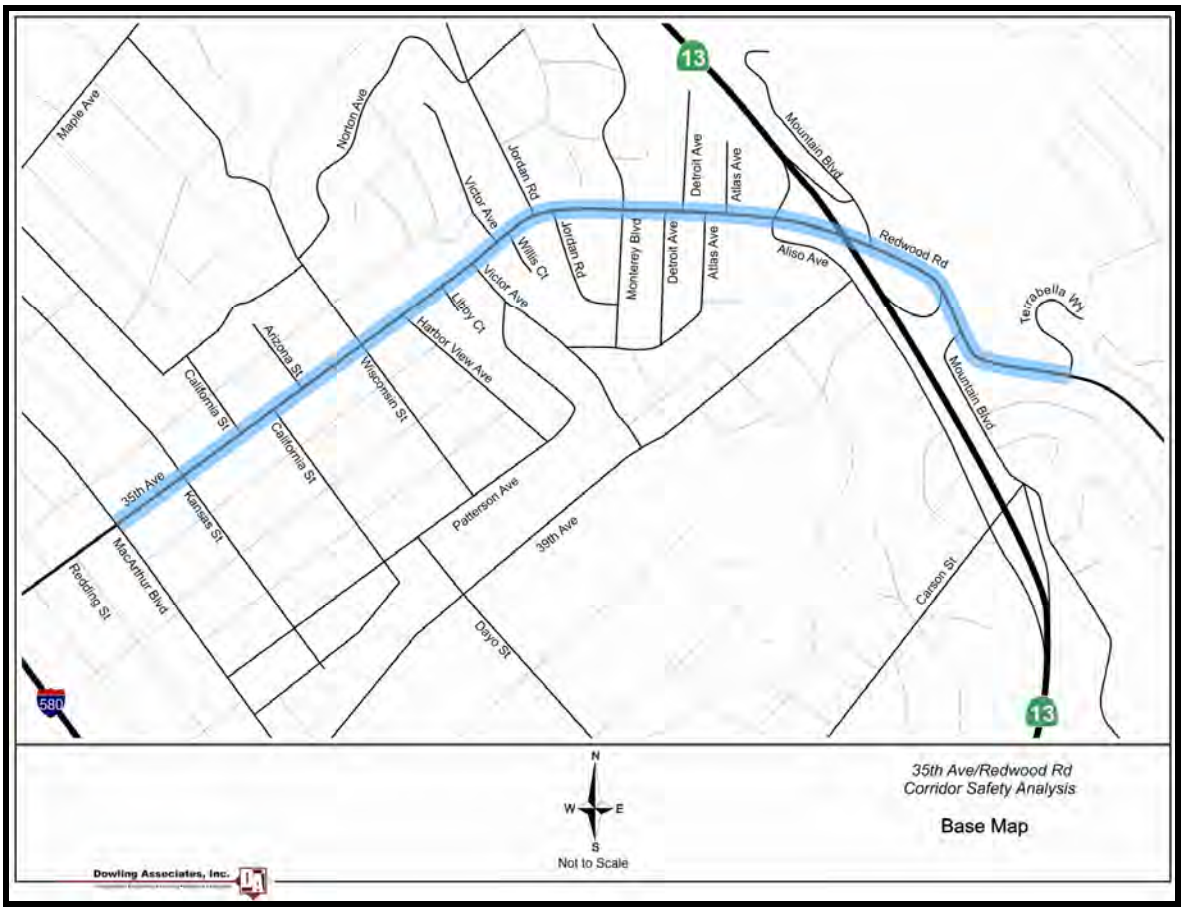
Subject: **Assessment of Traffic Safety and Operations**

Date: March 2, 2011

1. Introduction

The purpose of this memorandum is to provide an assessment of traffic safety and operations on 35th Avenue and Redwood Road in the City of Oakland. The study limits of the corridor extend from MacArthur Boulevard to Terrabella Way, as shown in Exhibit 1.

Exhibit 1 – Study Corridor and Vicinity Map



2. Summary of Key Issues and Potential Remediation

This section presents bullet points of summary findings, which are discussed in further details in later text.

Problems Observed:

- High collision rate along the corridor was found at McArthur Boulevard intersection, with 0.55 collisions per million vehicles entering the intersection (MV). This rate exceeds the California State average of 0.43 collisions per MV.
- The highest collision factor is unsafe speed.
- Vehicles turning left from westbound Redwood Road onto southbound Mountain Boulevard (East) exceed the storage capacity of the left-turn lane during the AM peak period.
- A scarcity of gaps in traffic on Redwood Road make it difficult for motorists to turn left from Mountain Boulevard (West) onto eastbound Redwood Road.
- The horizontal and vertical roadway curvature on 35th Avenue/Redwood Road limits the sight distance for motorists at Jordan Road and other unsignalized cross streets.

Potential Remediation Measures:

- Implement a road diet to convert the existing 4-lane facility to 3-lane facility (one lane in each direction with left turn lanes approaching intersections, from east of MacArthur Boulevard to west of Monterey Boulevard.
- Consider providing a bike lane at least along eastbound 35th Avenue and Redwood Road from east of MacArthur Boulevard to west of Monterey Boulevard through the uphill section of the corridor. If a road diet is implemented, consider installing bike lanes in both directions.
- Install curb extensions at pedestrian crosswalks to shorten the street crossing distance.
- Relocate some bus stops and crosswalks.
- Modify the Mountain Boulevard West intersection to prohibit southbound left-turning movements from Mountain Boulevard West, narrow the width of Mountain Boulevard, and install a pedestrian crosswalk.
- Improve signage for the Highway 13 on-ramp near Lincoln Square Shopping Center
- Prohibit left-turning movements out of the east driveway of the Lincoln Square Shopping Center.
- Signalize the Lincoln Square Shopping Center west driveway to address the many broadside collisions in the vicinity.
- Install a sidewalk between the two Lincoln Square Driveways

3. Data Collection and Field Observations

The data collection tasks for this study included collecting 24-hour machine counts, peak period intersection turn movement counts, speed surveys, collision data, transit services and relevant roadway information.

Machine Counts

Bi-directional 24 hour weekday traffic data were collected on Wednesday September 22, 2010. There were a total of 6 count locations selected along the study corridor at the following locations:

- 35th Avenue East of MacArthur Boulevard
- 35th Avenue West of Wisconsin Street
- Redwood Road East of Jordan Road
- Redwood Road West of Aliso Avenue
- Redwood Road East of Mountain Boulevard West
- Redwood Road West of Lincoln Square East Driveway.

Intersection Turn Movement Counts

Intersections counts were performed on Tuesday September 21, 2010 at 9 locations along the 35th Avenue/Redwood Road corridor. Turn movement volumes for the AM peak period were collected between 7-9AM, while the PM counts were collected from 4-6PM. The locations of the 9 intersection turn movement counts were:

- MacArthur Boulevard & 35th Avenue
- Wisconsin Street & 35th Avenue
- Monterey Boulevard & Redwood Road
- Aliso Avenue/SR 13 SB Off-Ramp & Redwood Road
- Mountain Boulevard West
- Lincoln Square West Driveway
- SR 13 NB On-Ramp
- Mountain Boulevard East
- Lincoln Square East Driveway

Exhibit 2 illustrates the locations of intersection and machine counts.

Speed Data

Speed data were collected at the 6 locations where the machine counts were performed (see Exhibit 2). This data were collected on Wednesday September 22, 2010 between 11AM and 2PM. At each location and for each direction 100 vehicles were sampled using RADAR. The following speed information was then calculated for each direction and location:

- 50th Percentile Speed
- 85th Percentile Speed

- 10 MPH Pace Speed
- Percent of Vehicles Within the Pace Speed
- Range of Speeds Observed
- Average Speed

Collision Data

Collision data were collected using the California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS) data base. All incidents occurring on the analysis corridor between January 1, 2005 and January 1, 2010 were found and analyzed. Those occurring within 50 feet of the intersection were grouped as intersection related collisions while those greater than 50 feet were grouped as midblock collisions. The results of this analysis are reported in a following section.

Transit Services and Additional Data

The 35th/Redwood corridor is classified as an arterial road by the City of Oakland as found in the transportation diagram on page 126 of the LUTE (Land Use and Transportation Element). This corridor is a 4-lane divided arterial with limited direct vehicle access to adjoining properties, separate lanes for left turns, and all major intersections are signalized. Exhibit 3 provides an overview of this corridor with the relevant additional data marked. It is important to note that this corridor has sidewalks on both sides of the road but lacks any designated bike lanes. The 2007 Bicycle Master Plan proposes this corridor in the future be designated a Class 3A bike route.

This corridor is served by one main AC Transit route (Line 54). This line operates at 10 minute headways during the AM commute in both directions. Headways increase to 15 minutes during the PM Peak period. In addition to the main AC Transit route, a number of school routes (600 series routes) also use the 35th/Redwood corridor. Exhibit 3 shows all bus stop locations along with the transit routes serving each one

Exhibit 2 - Data Collection Locations

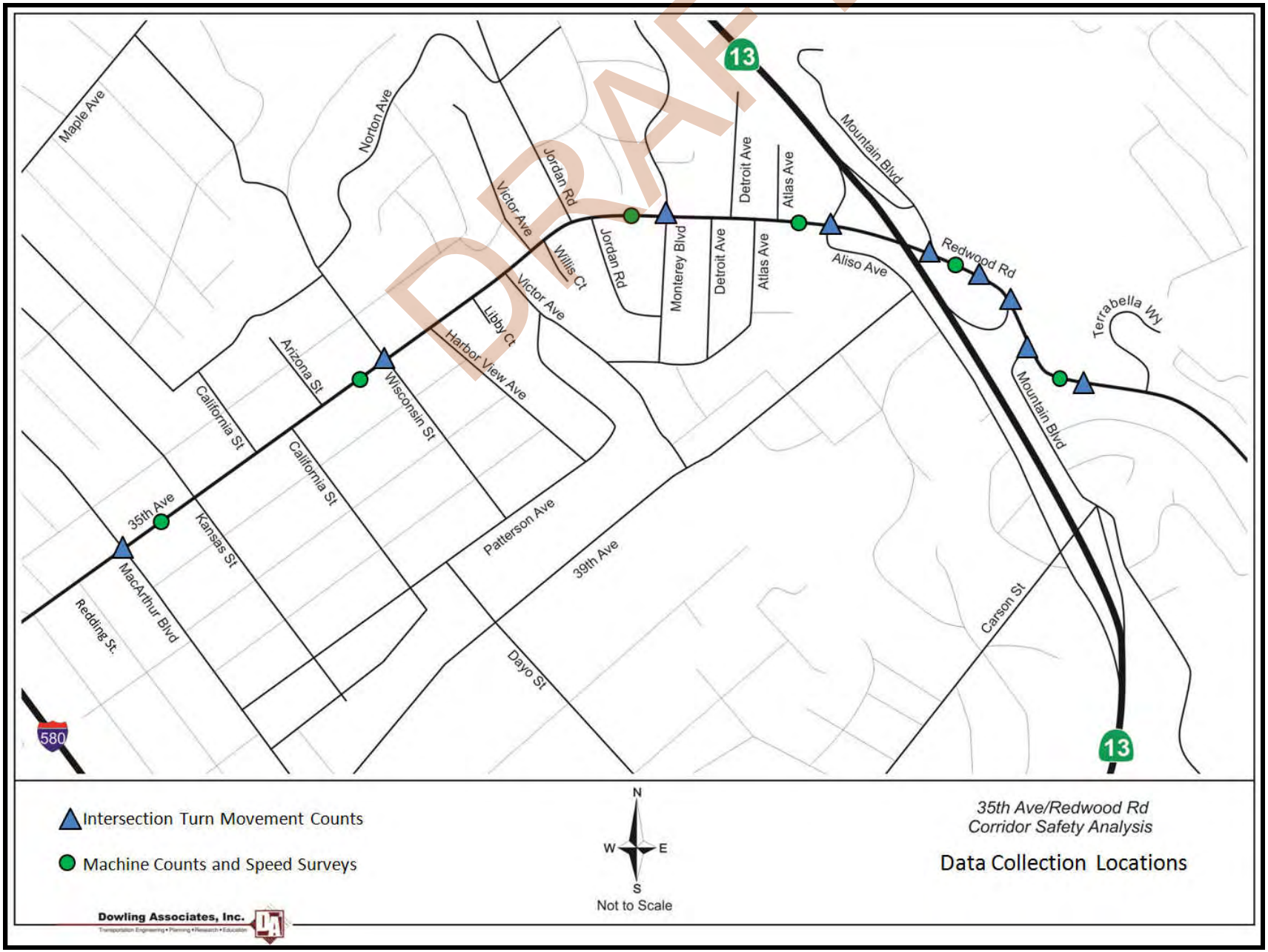
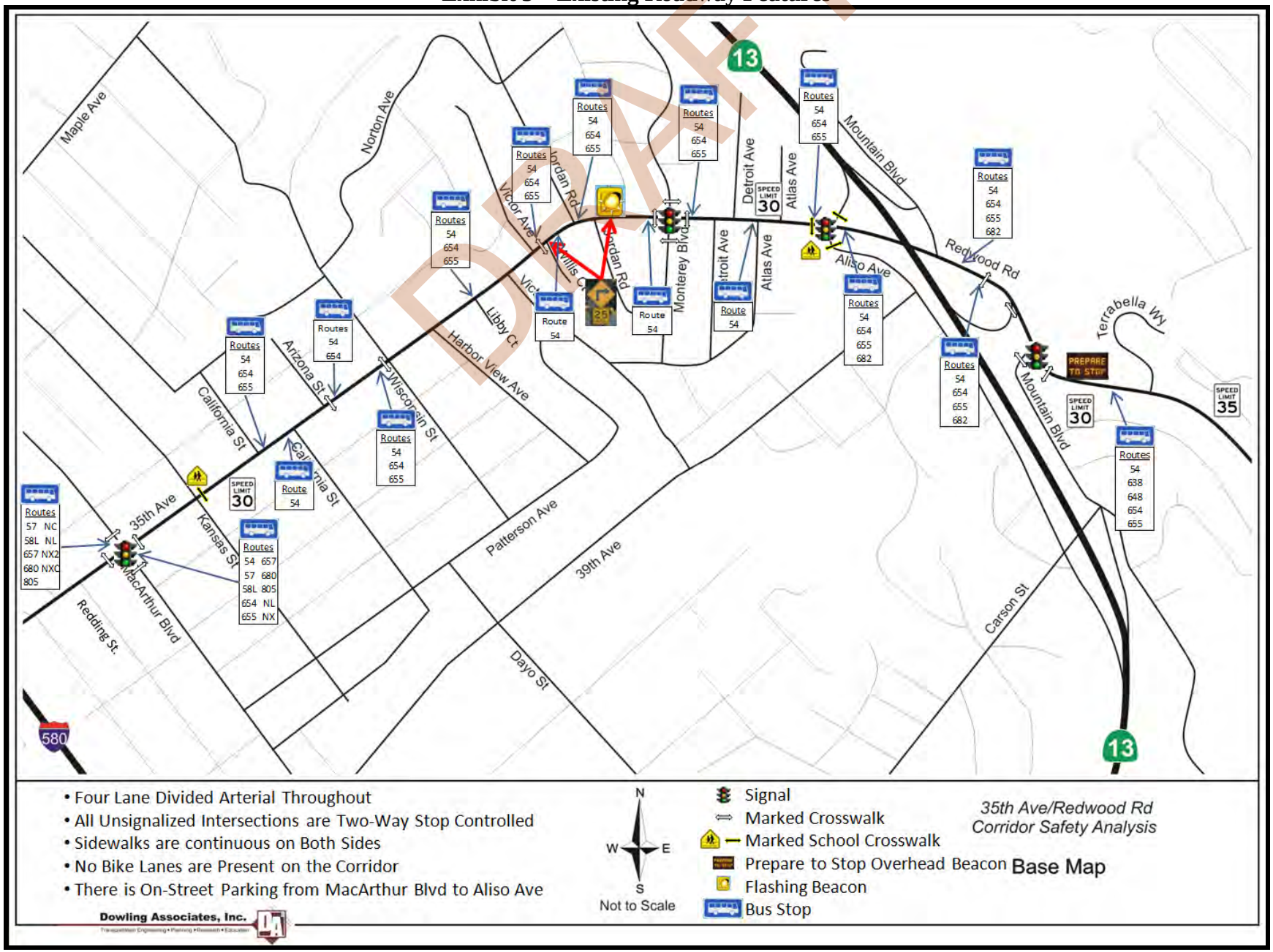


Exhibit 3 – Existing Roadway Features



Field Observations

Dowling staff had conducted a number of field observations to help identify potential safety and operational hazards. These field observations were conducted on September 23, 2010, November 9, 2010, and November 24, 2010.

4. Summary of Existing Data and Analysis

Midblock Counts and Intersection Turn Movements

The results of 24 hour tube counts at the 6 locations specified previously are shown in Exhibit 4. The AM peak hour was revealed to be the busiest part of the day in both directions with an average of 1000 vehicles. The PM peak averaged about 150 less vehicles than the morning at around 850 vehicles at the 6 data collection locations. The busiest segments of the 35th/Redwood corridor were at the ends near MacArthur and Route 13 as expected.
Intersection turn movements were collected at the nine locations shown in Exhibit 5. This figure also displays both the AM and PM peak hour turning volumes at each location.

Speed Survey

The results from 100 vehicle speed surveys at 6 locations are shown in Exhibit 6. All but the westbound direction near Mountain Boulevard East showed 85th percentile speeds at or exceeding 35mph which is faster than the 30mph speed limit. The westbound speed near Wisconsin was especially high at 44mph which is at the downstream end of a steep grade. The maximum speed observed at most locations was around 45mph.

Exhibit 4 - Traffic Counts from Midblock Tube Counts

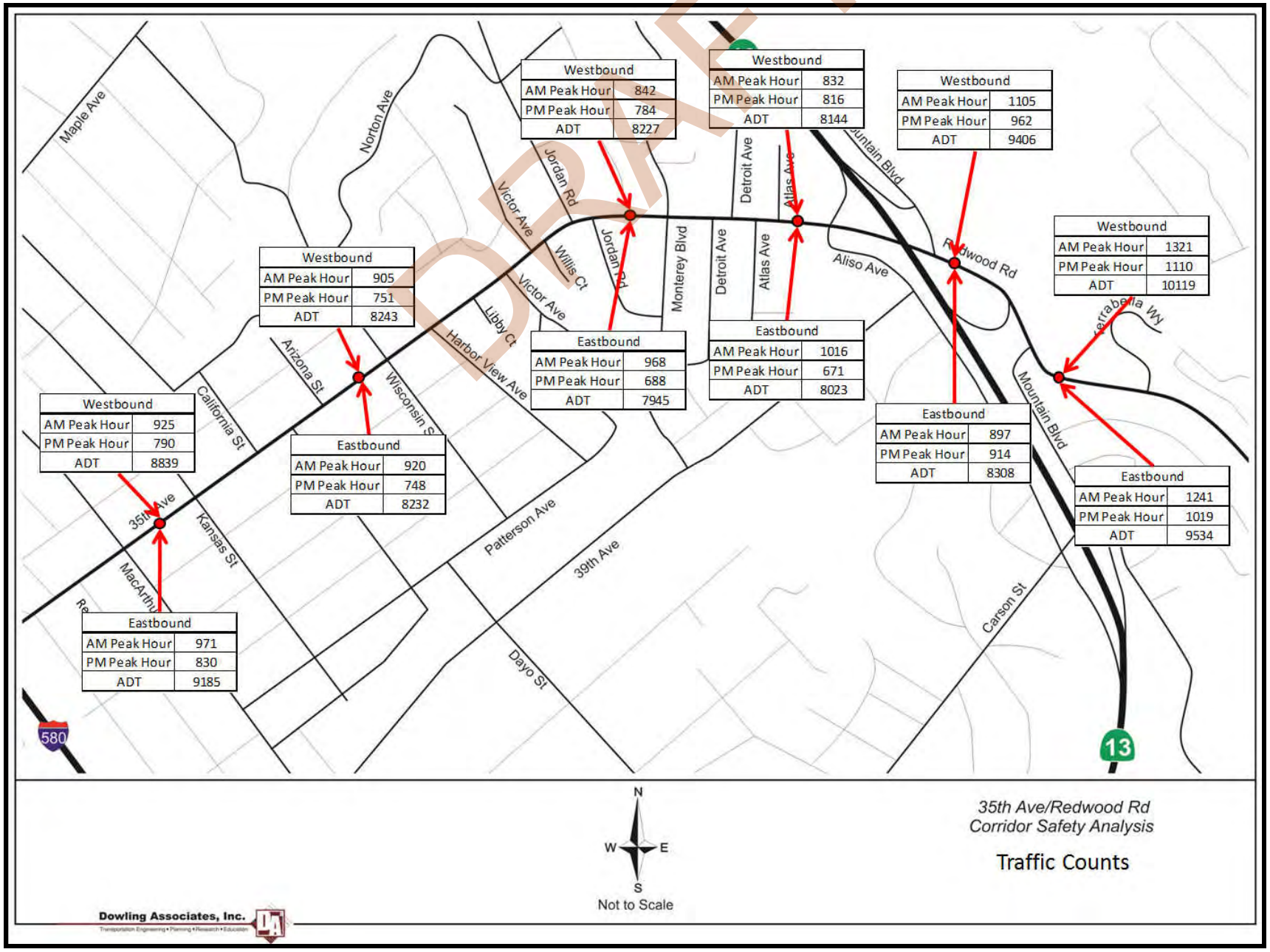


Exhibit 5 - Existing Turn Movement Counts

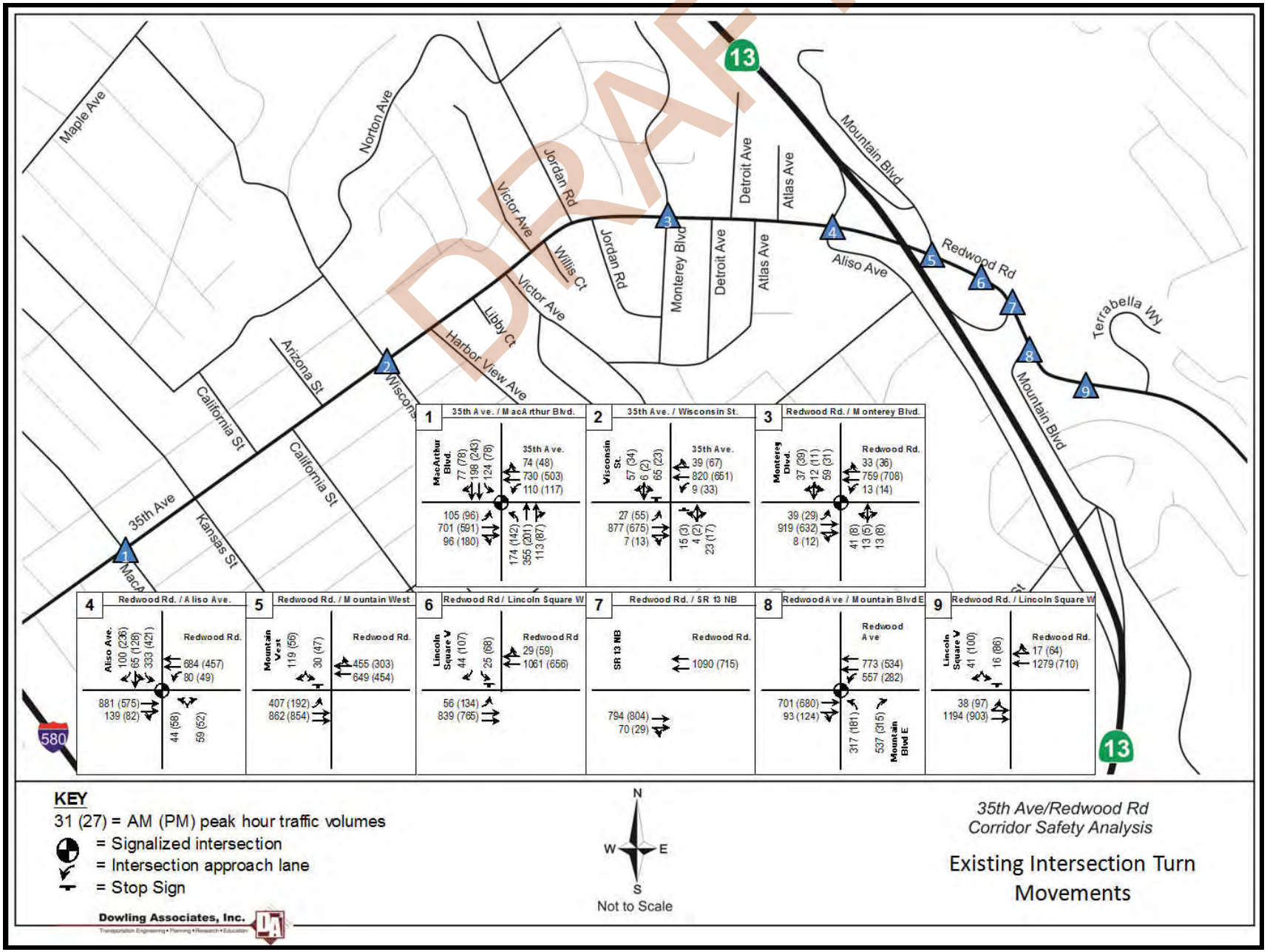
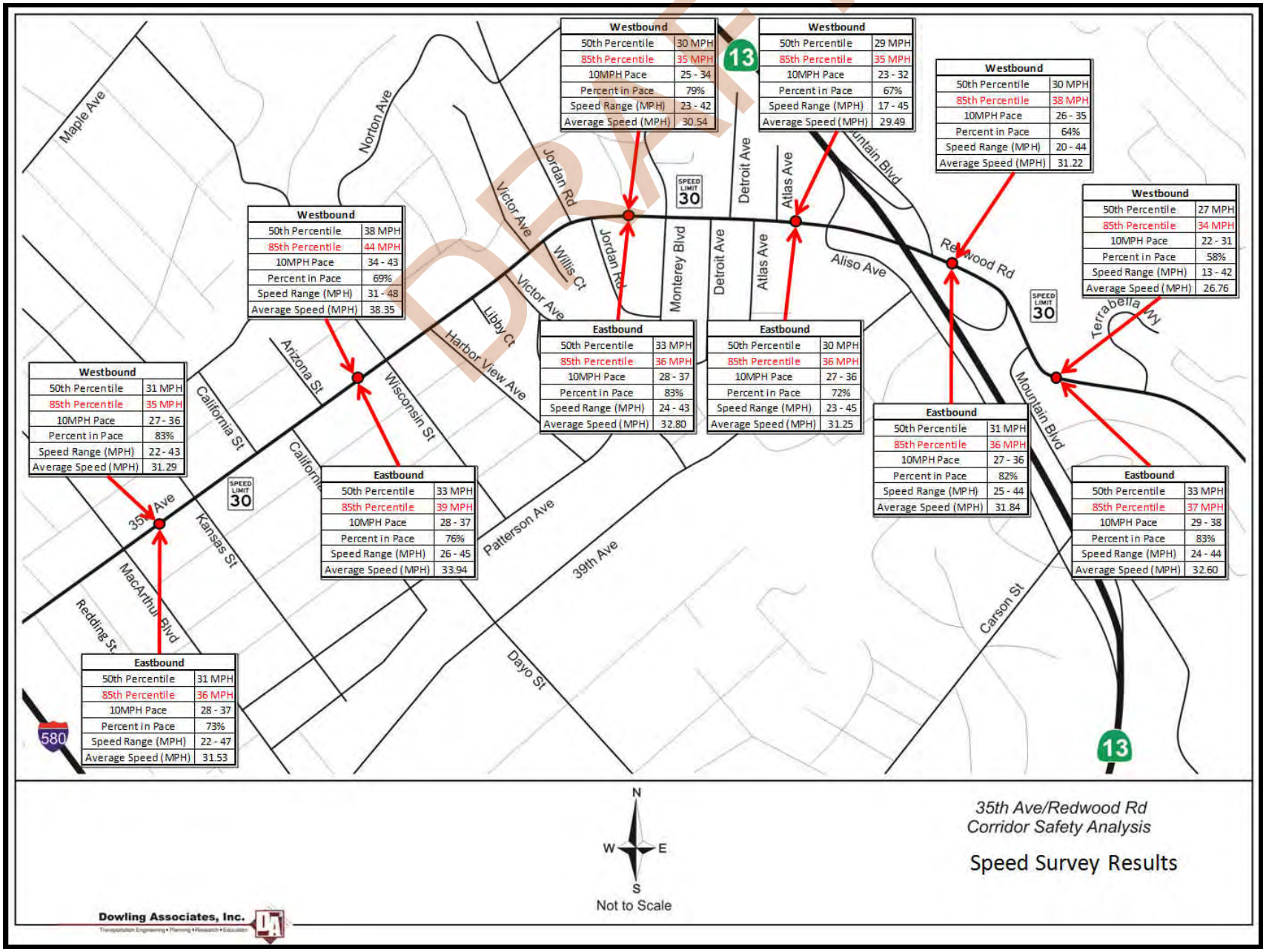


Exhibit 6 - Speed Survey Results



Intersection Analysis

Traffic levels of service (LOS) at study intersections were analyzed for the A.M. and P.M. peak hours using methodologies described in the Highway Capacity Manual.[1] The LOS for signalized and unsignalized intersections is defined in terms of delay. Delay is a complex measure and is dependent upon a number of variables. The most basic of these is the number of vehicles in the traffic stream, but for signalized intersections, delay is also dependent on the quality of signal progression, the signal cycle length, and the "green" ratio for each approach or lane group. The LOS criteria for signalized intersections are shown, while Exhibit 8 shows the criteria for unsignalized intersections.

Exhibit 7
Level of Service Criteria – Signalized Intersections

Level of Service (LOS)	Average Delay (seconds/vehicle)	Description
A	≤ 10	Very Low Delay: This level of service occurs when progression is extremely favorable and most vehicles arrive during a green phase. Most vehicles do not stop at all.
B	> 10 and ≤ 20	Minimal Delays: This level of service generally occurs with good progression, short cycle lengths, or both. More vehicles stop than at LOS A, causing higher levels of average delay.
C	> 20 and ≤ 35	Acceptable Delay: Delay increases due to only fair progression, longer cycle lengths, or both. Individual cycle failures (to service all waiting vehicles) may begin to appear at this level of service. The number of vehicles stopping is significant, though many still pass through the intersection without stopping.
D	> 35 and ≤ 55	Approaching Unstable Operation/Significant Delays: The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high volume / capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.
E	> 55 and ≤ 80	Unstable Operation/Substantial Delays: These high delay values generally indicate poor progression, long cycle lengths, and high volume / capacity ratios. Individual cycle failures are frequent occurrences.
F	> 80	Excessive Delays: This level, considered unacceptable to most drivers, often occurs with over-saturation (that is, when arrival traffic volumes exceed the capacity of the intersection). It may also occur at nearly saturated conditions with many individual cycle failures. Poor progression and long cycle lengths may also contribute significantly to high delay levels.

Source: Transportation Research Board, Highway Capacity Manual, Washington, D.C., 2000, pages 10-16 and 16-2.

[1] *Highway Capacity Manual, 2000*. Transportation Research Board.

Exhibit 8
Level of Service Criteria – Stop Controlled Intersections

Level of Service	Average Control Delay (seconds/vehicle)
A	0 - 10
B	>10 - 15
C	>15 - 25
D	>25 - 35
E	>35 - 50
F	>50

Source: Transportation Research Board, Highway Capacity Manual, Washington, D.C., 2000, pages 10-16 and 16-2.

Synchro Model Setup and Calibration

A Synchro model was setup to evaluate LOS and queues at study the intersections. Using default parameters yielded unrealistically high delays and queues for certain unsignalized intersections (where minor approaches are controlled by stop signs). Therefore, calibration of default parameters was mandatory in order for the program to yield more realistic results and to properly conduct the assessment.

Calibration of the Synchro model began by comparing queue length outputs to those observed in the field. Most of the intersections resulted in reasonable approximations to what was occurring in the field except the following intersections:

- 35th Avenue and Wisconsin Street
- Redwood Road and Mountain Boulevard W
- Redwood Road and Lincoln Square W Driveway
- Redwood Road and Lincoln Square E Driveway

These four stop-controlled intersections showed much larger queues in Synchro than were witnessed during field observations. As a number of vehicles were observed to be performing two-stage gap acceptance at these sites, it was determined that adjustment to critical gap could correct the queue estimation. Therefore, the critical gap of the left and through traffic at these locations was reduced by 1 second resulting in critical gaps of 6.5 and 5.5 seconds respectively. This one second reduction is allowed in HCM 2000 for two stage gap acceptance (Page 17-7 HCM 2000).

Right turns from these intersections were also reduced from 6.9 to 6.2 seconds in the Synchro model to better estimate queues. The 6.9 second critical gap was for four lane major streets while 6.2 seconds is for two lane major streets. With such a large median on this corridor, this roadway functions more like a two lane major street for right-turning traffic.

Existing Intersection LOS

Exhibit 9 summarizes existing intersection operations within the study area. Currently, all locations operate at acceptable LOS D or better overall. However, several minor stop-controlled approaches operated below standard levels:

2. Wisconsin St & 35th St – LOS F
6. Lincoln Square West and Redwood Rd – LOS E
9. Lincoln Square East and Redwood Rd – LOS F

Exhibit 9 – Existing Intersection LOS Summary

No.	Intersection	Traffic Control	Peak Hour	Existing Conditions	
				LOS [1]	Delay [2]
1	MacArthur Blvd. & 35th Ave.	Signal	AM	C	34.2
			PM	C	29.5
2	Wisconsin St. & 35th Ave.	TWSC	AM	A (F)	7.6 (103.1)
			PM	A (D)	2.1 (103.1)
3	Monterey Blvd. & Redwood Rd.	Signal	AM	A	6.6
			PM	A	5.0
4	Aliso Ave. & Redwood Rd.	Signal	AM	B	16.9
			PM	B	14.2
5	Mountain Blvd. W & Redwood Rd.	TWSC	AM	A (D)	7.2 (30.2)
			PM	A (E)	3.8 (30.2)
6	Lincoln Square West & Redwood Rd.	TWSC	AM	A (D)	1.4 (26.8)
			PM	A (E)	5.4 (26.8)
8	Mountain Blvd. E & Redwood Rd.	Signal	AM	D	47.5
			PM	B	15.1
9	Lincoln Square East & Redwood Rd.	TWSC	AM	A (F)	1.9 (56.6)
			PM	A (E)	4.7 (56.6)

Source: Dowling Associates, 2011
Notes:

[1] LOS = Level of Service

[2] Average control delay in seconds per vehicle

[3] Stop-controlled intersections report both the intersection control delay/LOS and the worst approach control delay/LOS (in parenthesis)
* Intersection 7 is an unrestricted ramp movement and will therefore be excluded from this analysis

Intersection 7 is a free movement from Redwood Road eastbound onto Highway 13 northbound. Since the movement is free, there will be no LOS so it will be excluded from the LOS and queue analysis.

Intersection queuing analysis results are summarized in Exhibit 10. There are a number of locations where the 95th percentile queue exceeds the queue storage length which are highlighted in Exhibit 10. These queue spillbacks were all fairly reasonable when compared to what was

observed in the field. For example, eastbound P.M. queues at 35th and MacArthur were observed to have average queues of around 250 feet. Synchro predicted the 95th percentile queue at 350 which is only an additional four vehicles which is very feasible. Mountain Boulevard East also showed insufficient storage for the eastbound through movement with 95th percentile queues backing up to the free right onto SR13 NB. This condition was also observed in the field with AM average queues around 309 feet and PM average queues around 302 feet.

Exhibit 10 – Existing Intersection 95th Percentile Queuing Summary

	Intersection		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
1	MacArthur Blvd. & 35th Ave.	Storage Length (ft)	100	855		160	1753		160	608	50	100	676	50
		AM Queue (ft)	#136	343		129	324		#210	324	80	#190	187	51
		PM Queue (ft)	116	#348		#141	225		151	163	45	102	228	58
2	Wisconsin St. & 35th Ave.	Storage Length (ft)	95	1753		95	1782			542			476	
		AM Queue (ft)	4			1				36			158	
		PM Queue (ft)	6			3				8			35	
3	Monterey Blvd. & Redwood Rd.	Storage Length (ft)	85	1782		85	847			770			594	50
		AM Queue (ft)	26	205		12	167			37			45	15
		PM Queue (ft)	21	131		12	156			14			30	16
4	Aliso Ave. & Redwood Rd.	Storage Length (ft)		847		105	526			595		110	291	55
		AM Queue (ft)		272		#115	167			45		206	43	20
		PM Queue (ft)		155		38	105			45		#312	85	33
5	Mountain Blvd. W & Redwood Rd.	Storage Length (ft)	260	526			314						427	
		AM Queue (ft)	163										98	
		PM Queue (ft)	28										82	
6	Lincoln Square West & Redwood Rd.	Storage Length (ft)	200	314			360						195	200
		AM Queue (ft)	8										41	
		PM Queue (ft)	16										131	
8	Mountain Blvd. E & Redwood Rd.	Storage Length (ft)		253		150	269		546					
		AM Queue (ft)		#309		#548	130		#234					
		PM Queue (ft)		#302		197	77		131					
9	Lincoln Square East & Redwood Rd.	Storage Length (ft)	105	269			268						183	
		AM Queue (ft)	8										77	
		PM Queue (ft)	11										127	

95th percentile volume exceeds capacity, queue may be longer.
* Intersection 7 is an unrestricted ramp movement and will therefore be excluded from this analysis

5. Collision Analysis

Collision reports for this study area were obtained from the California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS) database. A five-year period was analyzed covering January 1, 2005 to January 1, 2010. During this five-year period there were a total of 134 collisions on the 35th Avenue/Redwood Road between MacArthur Boulevard and Terrabella Way.

Intersection collisions (those within 50 feet of the intersection) accounted for 88 of the 134 collisions or 65.7%. Midblock collisions were the remaining 34.3% or 46 collisions. Exhibit 11 presents these collision locations in bar chart form. As an additional resource, Exhibit 12 shows a map view of the collision locations.

Exhibit 11 - Summary of Collision Locations

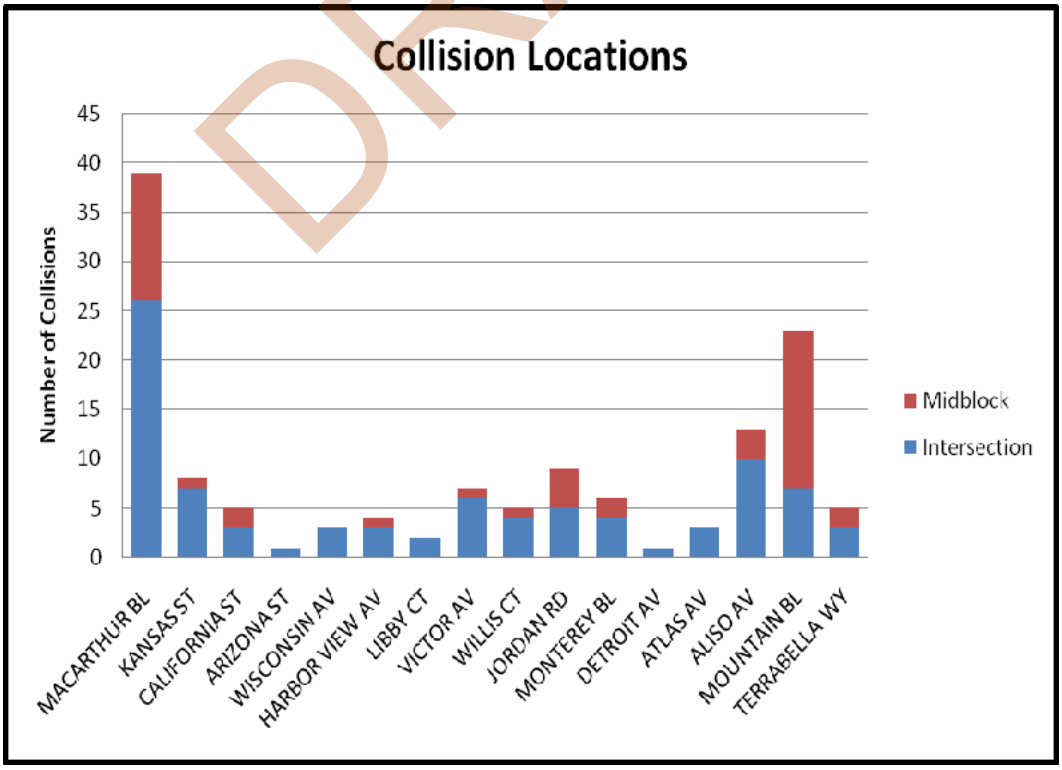
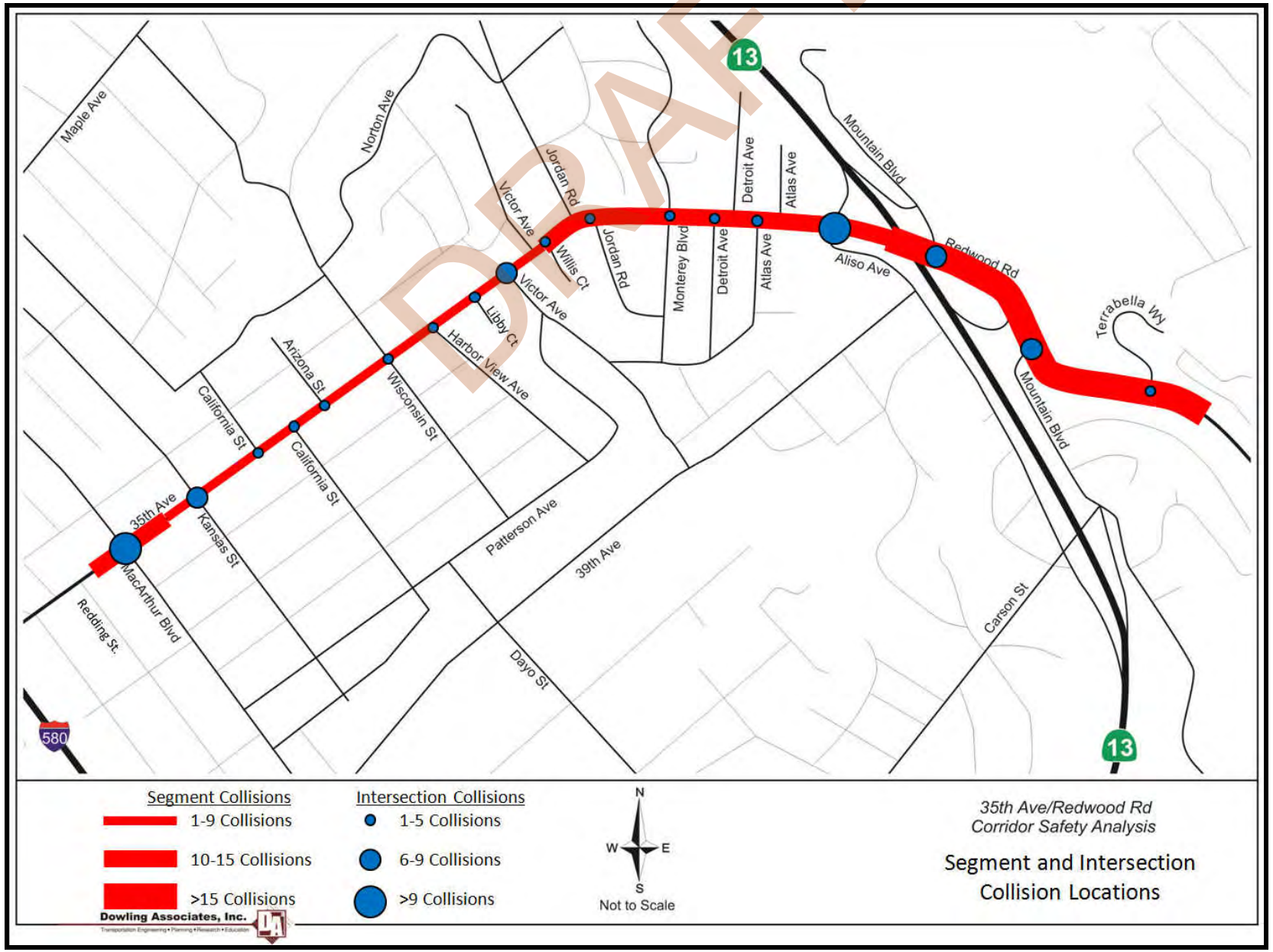


Exhibit 12 - Map View of Collision Locations



Collision Rates

Collision rates in the study area were compared with statewide rates found in the 2006 *Collision Data on California State Highways* and calculated using the equation:

$$\text{Collision Rate} = \frac{(\text{Number of Collisions}) \times 1{,}000{,}000}{\text{Vehicle Miles of Travel}}$$

Exhibit 13 shows the statewide and study area intersection collisions rates. Only the intersection of MacArthur and 35th exceeded the statewide base rate. However, the intersections of California & 35th, Victor & 35th, Willis & 35th, and Monterey & Redwood had a higher percentage of fatal + injury crashes than normal for California. The Victor Avenue and Willis Ct. intersections also both exceeded the fatal + injury base rate which is a better indicator as it's a rate rather than a percentage which can be skewed by few collisions.

Exhibit 13 - Statewide Collision Intersection Collision Rates vs. Study Area

	California State[1]			Study Area		
Intersection	Base Rate	PCT F+I	F+I Base Rate	Base Rate	PCT F+I	F+I Base Rate
MacArthur Blvd & 35th Ave	0.43	44.3%	0.19	**0.55**	19.2%	0.10
Kansas St. & 35th Ave	0.22	42.9%	0.09	0.21	0.0%	0.00
California St & 35th Ave	0.22	42.9%	0.09	0.10	**66.7%**	0.06
Arizona St & 35th Ave	0.22	42.9%	0.09	0.03	0.0%	0.00
Wisconsin St & 35th Ave	0.22	42.9%	0.09	0.09	0.0%	0.00
Harbor View Ave & 35th Ave	0.22	42.9%	0.09	0.10	0.0%	0.00
Libby Ct & 35th Ave	0.22	42.9%	0.09	0.07	0.0%	0.00
Victor Ave. & 35th Ave.	0.22	42.9%	0.09	0.20	**50.0%**	**0.10**
Willis Ct & 35th Ave.	0.22	42.9%	0.09	0.14	**75.0%**	**0.10**
Jordan Rd. & 35th Ave.	0.22	42.9%	0.09	0.17	40.0%	0.07
Monterey Blvd. & Redwood Rd.	0.43	44.3%	0.19	0.13	**75.0%**	0.09
Detroit Ave. & Redwood Rd.	0.22	42.9%	0.09	0.03	0.0%	0.00
Atlas Ave. & Redwood Rd.	0.22	42.9%	0.09	0.10	33.3%	0.03
Aliso Ave. & Redwood Rd.	0.43	44.3%	0.19	0.25	10.0%	0.02
Mountain Blvd. & Redwood Rd.	0.43	44.3%	0.19	0.16	14.3%	0.02
Terrabella Way & Redwood Rd.	0.22	42.9%	0.09	0.14	33.3%	0.05

F + I = Fatality plus Injury Collisions

[1] 2006 Collision Data on California State Highways, Caltrans, Sacramento, October 2007

Average daily intersection vehicle volumes calculated using AM and PM intersection approach volumes multiplied by 5

Exhibit 14 shows how the four main segments of the analysis corridor compare to the statewide collision data. Only the segment around the MacArthur Boulevard intersection experienced collisions rates greater than the statewide base rates. Given the 50 foot cutoff used in this analysis and the queuing observed, it is probable most of these segment collisions at MacArthur are intersection related. The fatality and injury rate was also higher in this segment than the base rates. In addition to analyzing the four main segments, the corridor was also analyzed as a

whole. This analysis is shown on the last line and reveals the collision rate for the entire corridor is actually much less than the statewide rate at only 1 collision per million vehicle miles.

Exhibit 14 - Statewide Roadway Segment Collision Rates vs. Study Area

		California State[1]			Study Area		
Street	Limits	Base Rate	PCT F+I	F+I Base Rate	Base Rate	PCT F+I	F+I Base Rate
35th Ave	Redding to Kansas	3.35	42.8%	1.43	4.69	30.8%	1.44
35th Ave	Kansas to Victor	3.35	42.8%	1.43	0.33	0.0%	0.00
Redwood	Victor to Aliso	3.35	42.8%	1.43	1.16	10.0%	0.12
Redwood	Aliso to Terrabella	3.35	42.8%	1.43	0.92	38.9%	0.36
35th/Redwood	Redding to Terrabella	3.35	42.8%	1.43	1.00	26.1%	0.26

F + I = Fatality plus Injury Collisions

[1] 2006 Collision Data on California State Highways, Caltrans, Sacramento, October 2007
Average daily vehicle volumes taken from nearest tube count location

Primary Collision Factors

There were a number of different collision factors associated with the 134 collisions occurring during the five-year analysis period studied as shown in Exhibit 15. Of the 134 collisions, 39 resulted in injuries with the various severities detailed in Exhibit 16. The three most common factors of all collisions were unsafe speed, improper turning, and auto right of way violations. The rest of this section looks into these three collision factors more closely.

Exhibit 15 - Collision Factor for the 35th/Redwood Corridor

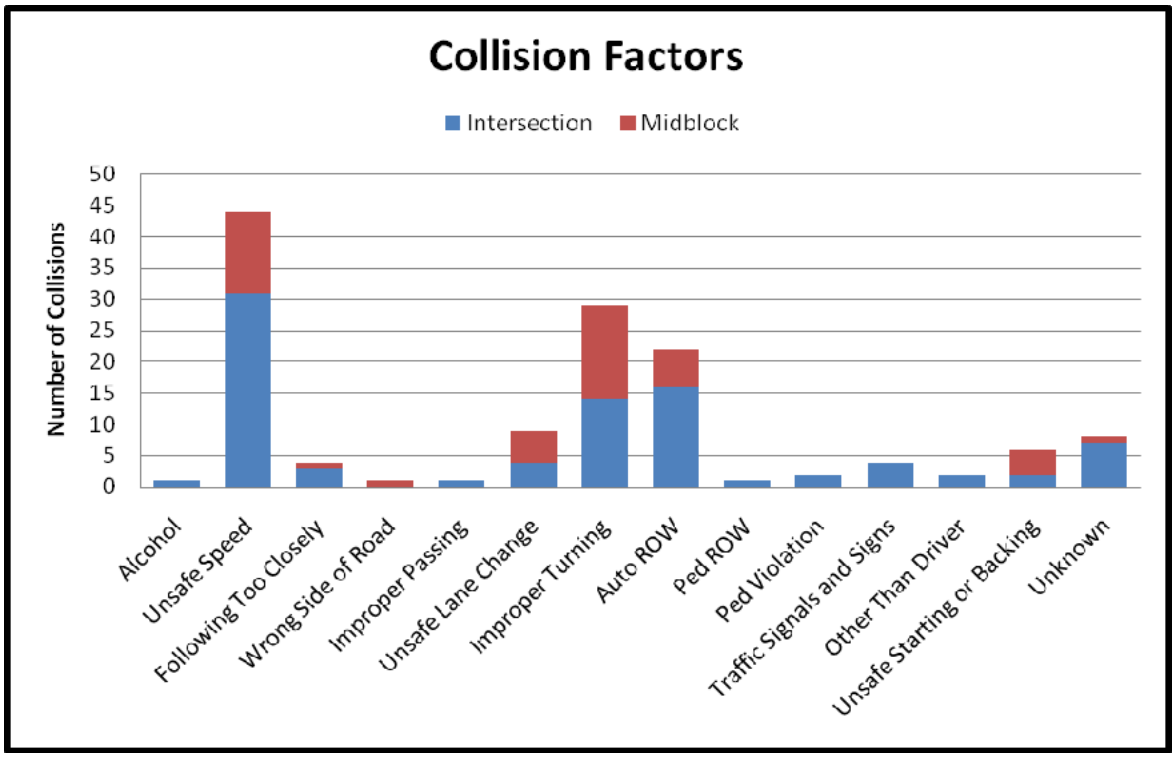
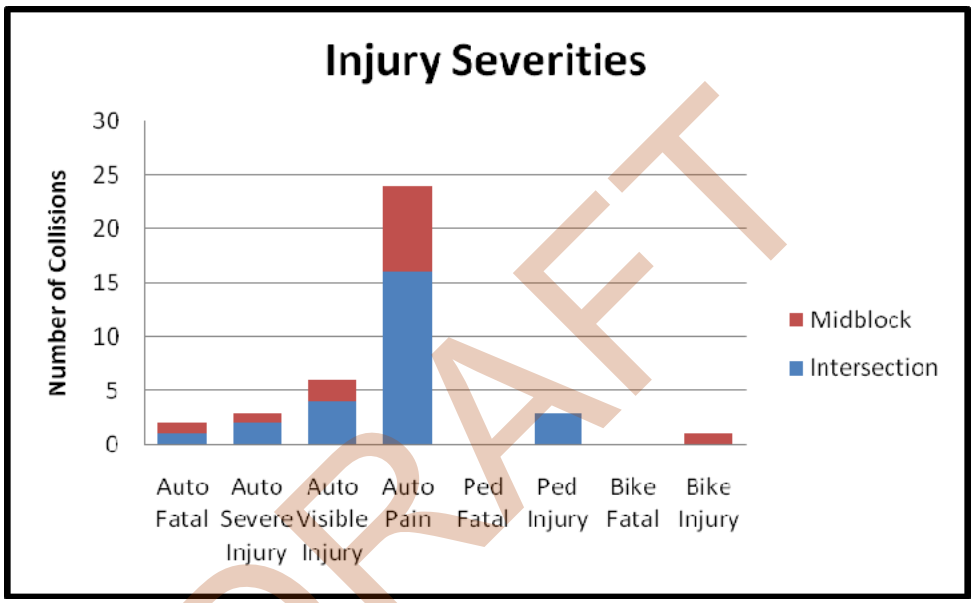


Exhibit 16 - Injury Severities on the 35th/Redwood Corridor

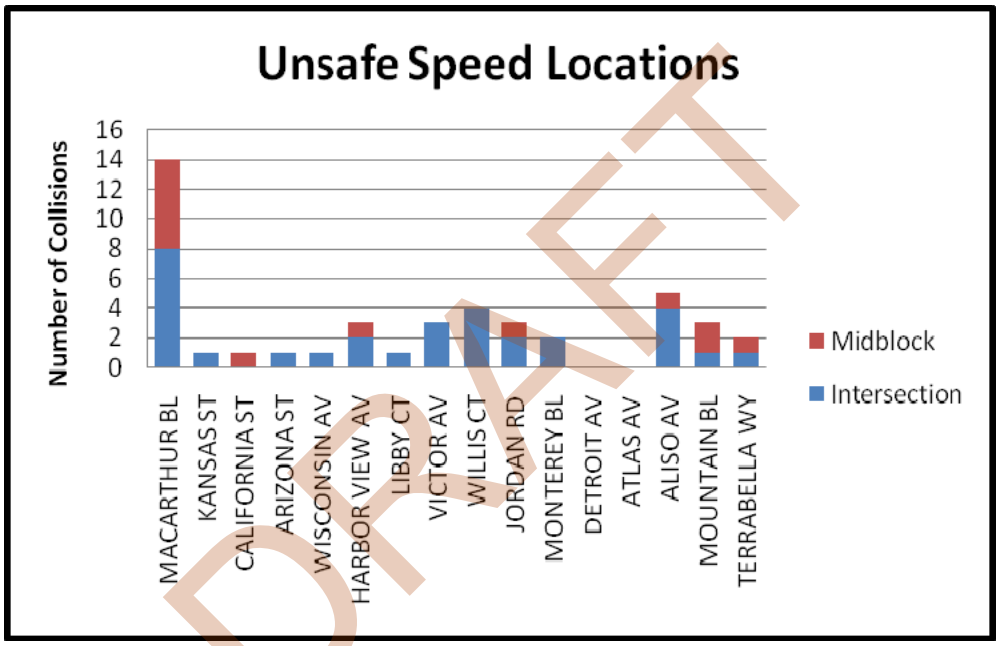


Unsafe Speed

Unsafe speed accounted for 44 of the 134 collisions or 32.8% of all collisions on the study corridor. It was also responsible for 1 of the two fatalities and 2 of the 3 severe injuries. The fatality occurred near the intersection of Victor Avenue where a vehicle was traveling at unsafe speeds on a wet road and hit a fixed object on December 18, 2007. One of the severe injury collisions also occurred near here at Willis Ct. on December 6, 2006 where a speeding vehicle hit a parked car. These two collisions occurred near the roadway curvature that happens between Victor and Monterey.

The other severe injury due to unsafe speeds occurred at the intersection of MacArthur and 35th on June 6, 2008 where a vehicle traveling fast failed to heed a stop signal and hit a parked car. The locations of all the unsafe speed related collisions are shown in Exhibit 17.

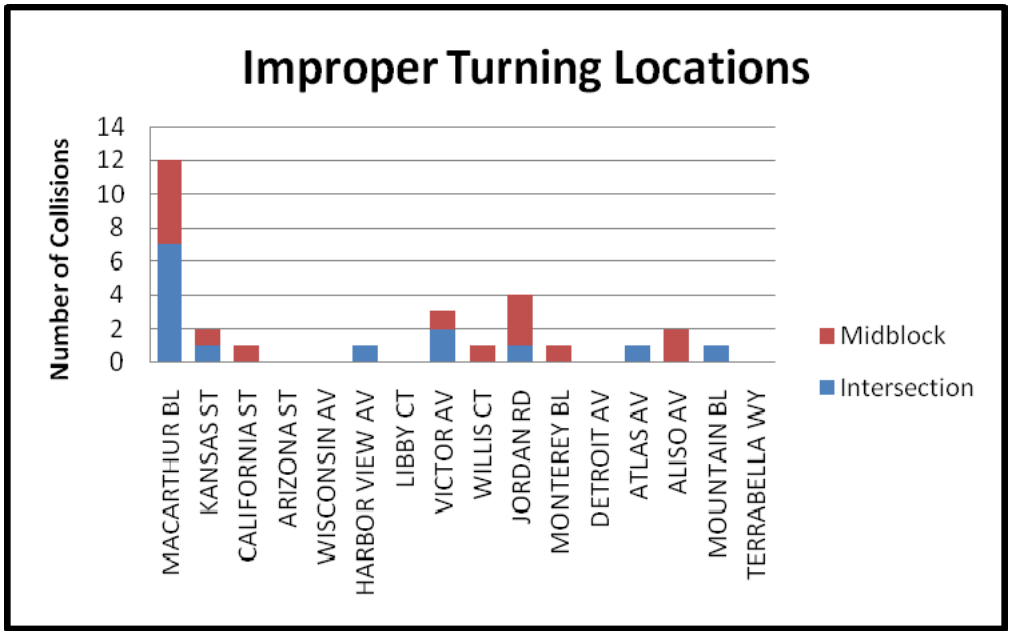
Exhibit 17 - Locations of Unsafe Speed Violations



Improper Turning

The second biggest collision factor was improper turning with 29 of the 134 collisions or 21.6%. Once again the intersection of MacArthur and 35th had the highest number of this type of collision as shown in Exhibit 18. There were also quite a few improper turning violations near the roadway curvature between Victor and Monterey, especially midblock.

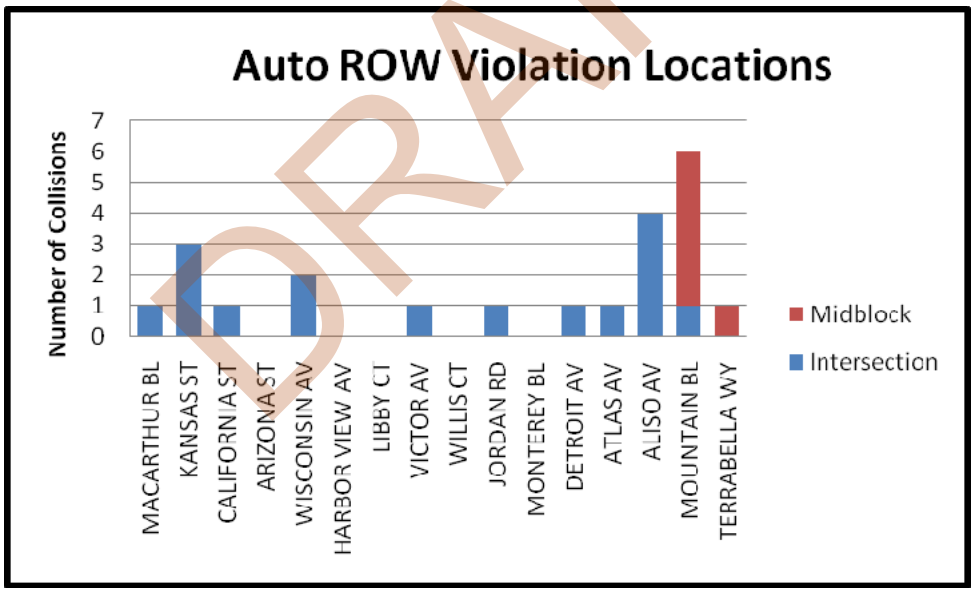
Exhibit 18 - Locations for Improper Turning Collision Factors



Auto ROW Violations

There were a total of 22 auto ROW violations occurring on the analysis corridor over the five-year period or 16.4% of all collisions. The majority of these collisions occurred near the Lincoln Square Shopping center as shown in Exhibit 19. The second fatality for the analysis corridor also occurred in this area near Mountain Boulevard on June 19, 2006. The collision was a broadside occurring on a cloudy day with good visibility and dry pavement.

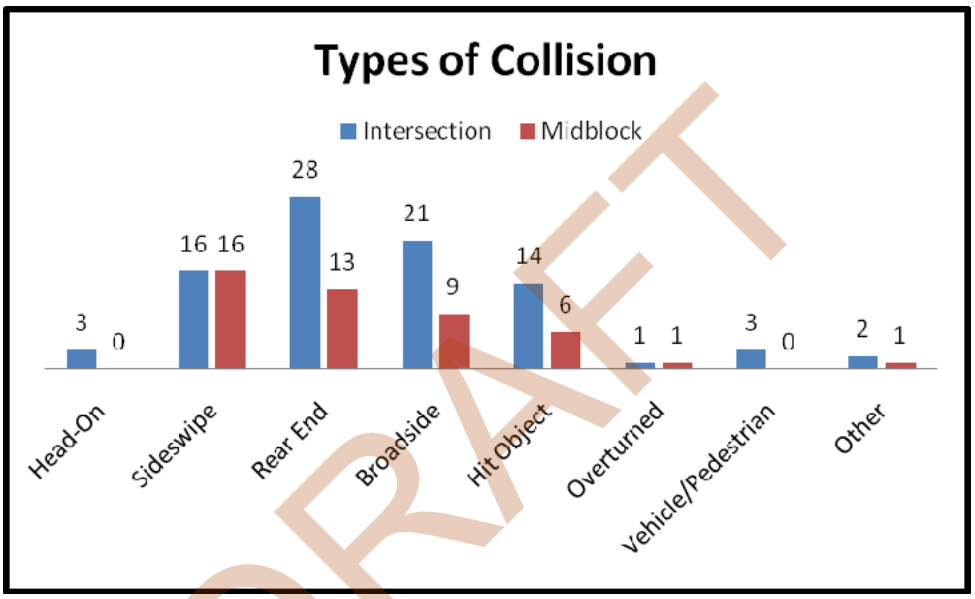
Exhibit 19 - Locations of Auto ROW Violations Causing Collisions



Collision Types

Exhibit 20 presents the types of collisions that occurred on the 35th Avenue/Redwood Road corridor. Rear end crashes were the most prevalent accounting for 41 or 30.6% of all collisions. Sideswipes were the second largest type of collision with 32 or 23.9%. The number of broadside and object collisions were more concerning accounting for 30 (22.4%) and 20 (14.9%) collisions respectively.

Exhibit 20 - Collision Types Occurring on the Analysis Corridor



Examining the broadside collisions more closely revealed that a large number of these collisions occurred midblock near the Lincoln Square Shopping Center. There were also quite a few at the Aliso/Route 13 and Redwood Road intersection as shown in Exhibit 21. There were also a number of object collisions occurring in this general area. However, object collisions were also prevalent at the MacArthur & 35th intersection and at the road curvature between Victor and Monterey as Exhibit 22 shows.

Exhibit 21 - Location Breakdown of all Broadside Collisions

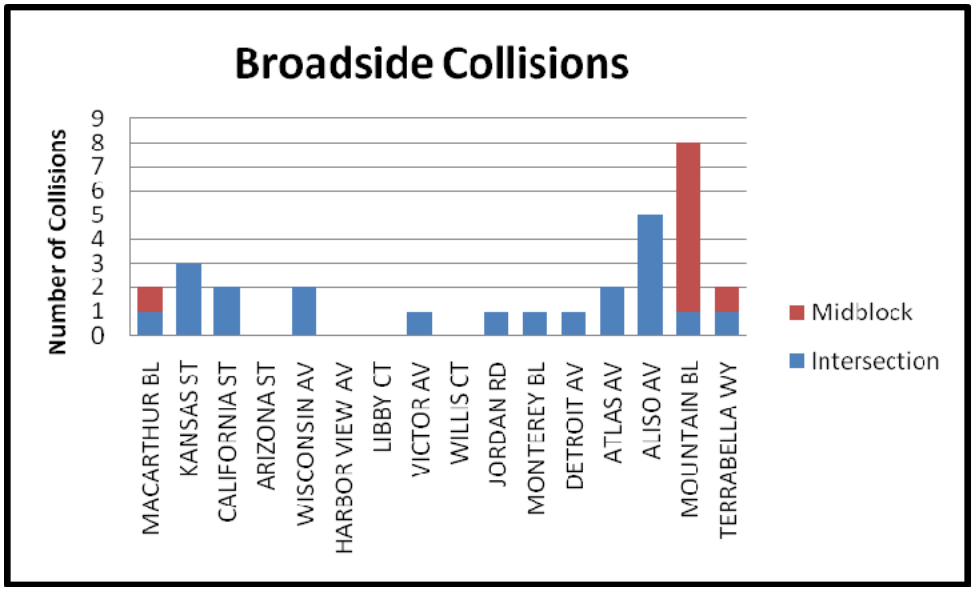
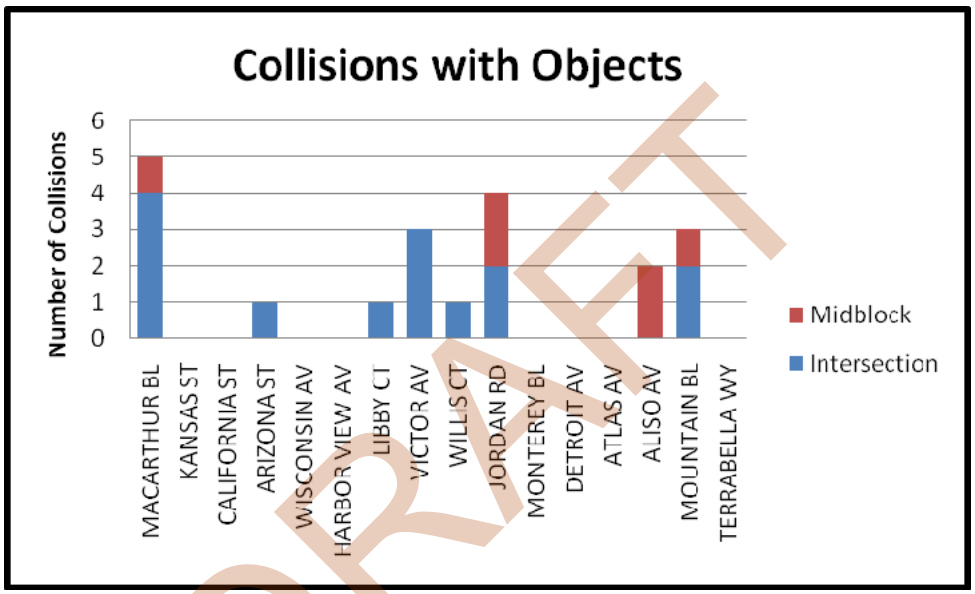


Exhibit 22 - Collision Locations with Objects



Pedestrian and Bicycle Collisions

Of the 134 reported collisions in a five year period, 3 involved pedestrians and 1 involved a bicyclist. The most severe of these was the third severe injury collision on the corridor where an auto violated pedestrian ROW at a midblock crossing at California and 35th on September 1, 2005. Visual obscurement was listed as an associated factor in this collision. The two remaining pedestrian collisions occurred at MacArthur and 35th on June 6, 2007 and April 19, 2008. The pedestrians were 17 and 11 years old and violated the auto's ROW at the intersection.
The single reported bicyclist incident occurred near Redwood and Aliso on November 11, 2005. A citation was issued to the bicyclists for improper turning and resulted in visible injuries to the bicyclist.

6. Future Traffic Forecast

Future traffic forecast volumes were estimated from the official version of Alameda Countywide travel demand model, which reflects land uses from ABAG Projection 2007. The future forecast year was estimated for cumulative long term 2035. Along the Redwood Road and 35th Avenue corridor, 2035 forecast estimated approximately 30-33% of growth. Future intersection volumes are developed using these model growth factors. Future daily roadway segment volumes were estimated using future intersection volumes, and existing peak hour to daily volume ratios. These future volume calculations for 2035 are shown in Exhibit 23 and Exhibit 24.

Exhibit 23 – 2035 Intersection Turning Volumes

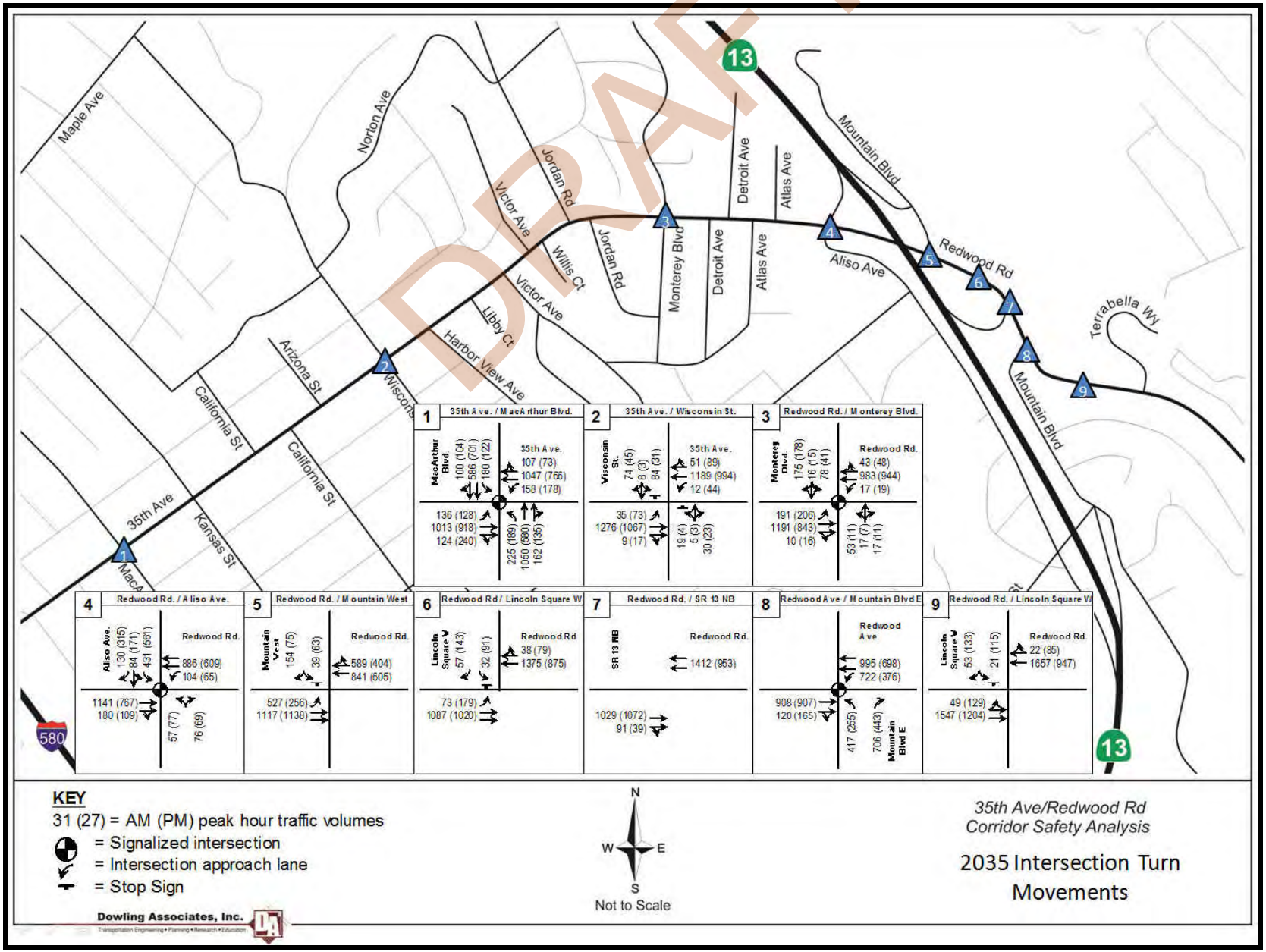
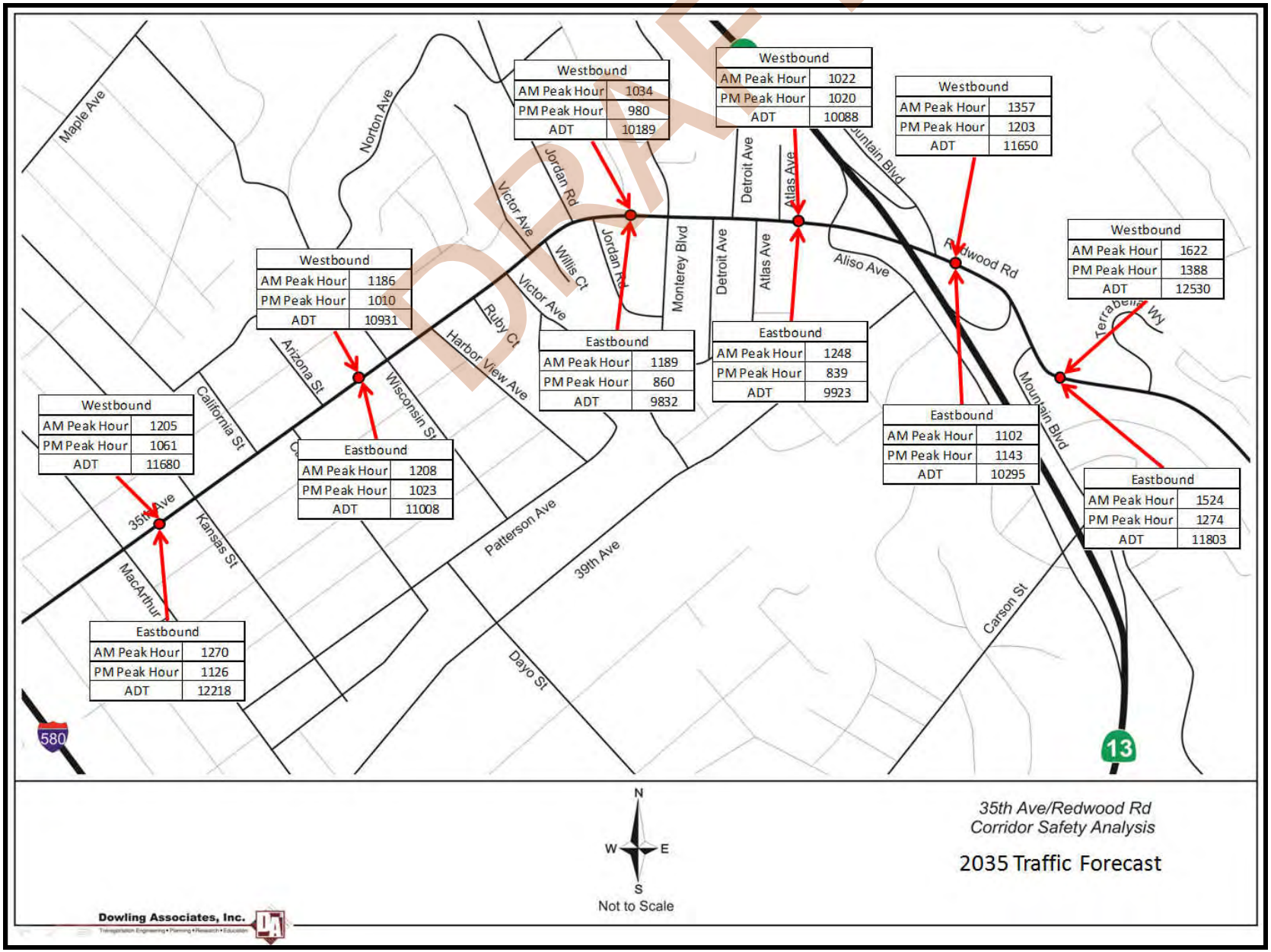


Exhibit 24 – Cumulative 2035 Roadway Segment Volumes



7. Evaluation of Future Traffic Conditions

This section presents a summary of intersection LOS analysis for future conditions, assuming existing traffic controls and roadway conditions remain unchanged from current conditions.

Exhibit 25 – Future Baseline Intersection LOS Summary

No.	Intersection	Traffic Control	Peak Hour	2035 Conditions	
				LOS [1]	Delay [2]
1	MacArthur Blvd. & 35th Ave.	Signal	AM	F	216.2
			PM	F	128.5
2	Wisconsin St. & 35th Ave.	TWSC	AM	F (F)	577.9 (Err)
			PM	B (F)	11.9 (Err)
3	Monterey Blvd. & Redwood Rd.	Signal	AM	B	15.3
			PM	B	13.4
4	Aliso Ave. & Redwood Rd.	Signal	AM	D	46.7
			PM	C	24.4
5	Mountain Blvd. W & Redwood Rd.	TWSC	AM	F (F)	Err (Err)
			PM	A (C)	3.1 (Err)
6	Lincoln Square West & Redwood Rd.	TWSC	AM	A (F)	5.6 (124.5)
			PM	E (F)	48.4 (124.5)
8	Mountain Blvd. E & Redwood Rd.	Signal	AM	F	111.0
			PM	D	43.3
9	Lincoln Square East & Redwood Rd.	TWSC	AM	C (F)	23.5 (774.3)
			PM	E (F)	46.0 (774.3)

Source: Dowling Associates, 2011
Notes:

[1] LOS = Level of Service

[2] Average control delay in seconds per vehicle

[3] Stop-controlled intersections report both the intersection control delay/LOS and the worst approach control delay/LOS (in parenthesis)
* Intersection 7 is an unrestricted ramp movement and will therefore be excluded from this analysis

By 2035, six study intersections would operate below the City's standard service level of LOS D:

1. MacArthur Boulevard & 35th Avenue (LOS F)
2. Wisconsin St & 35th Avenue (LOS F overall AM Peak)
5. Mountain Boulevard W & Redwood Rd (LOS F overall AM Peak)
6. Lincoln Square West & Redwood Rd (LOS E overall PM Peak)
7. Mountain Boulevard E & Redwood Rd (LOS F AM Peak)
8. Lincoln Square East & Redwood Rd (LOS E overall PM Peak)

Intersection queuing analysis for 2035 conditions is shown in Exhibit 26. As this exhibit shows, many of the intersections are experiencing significant queuing problems in the AM and PM Peak

Exhibit 26 – 95th Percentile Queue Results for 2035 Conditions

	Intersection		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
1	MacArthur Blvd. & 35th Ave.	Storage Length (ft)	100	855		160	1753		160	608	50	100	676	50
		AM Queue (ft)	#194	#631		#211	#594		#302	#1422	135	#293	#761	89
		PM Queue (ft)	#180	#647		#265	#375		#224	#647	101	#196	#963	98
2	Wisconsin St. & 35th Ave.	Storage Length (ft)	95	1753		95	1782			542			476	
		AM Queue (ft)	7			2				170			Err	
		PM Queue (ft)	11			6				35			196	
3	Monterey Blvd. & Redwood Rd.	Storage Length (ft)	85	1782		85	847			770			594	50
		AM Queue (ft)	#214	298		18	236			47			57	83
		PM Queue (ft)	#234	186		16	227			17			37	83
4	Aliso Ave. & Redwood Rd.	Storage Length (ft)		847		105	526			595		110	291	55
		AM Queue (ft)		#463		#152	231			67		#354	54	45
		PM Queue (ft)		223		#74	144			57		#460	117	83
5	Mountain Blvd. W & Redwood Rd.	Storage Length (ft)	260	526			314						427	
		AM Queue (ft)	646										Err	
		PM Queue (ft)	29										526	
6	Lincoln Square West & Redwood Rd.	Storage Length (ft)	200	314			360						195	200
		AM Queue (ft)	15										157	
		PM Queue (ft)	29										526	
8	Mountain Blvd. E & Redwood Rd.	Storage Length (ft)		253		150	269		546					
		AM Queue (ft)		#452		#741	181		#366					
		PM Queue (ft)		#479		#327	113		183					
9	Lincoln Square East & Redwood Rd.	Storage Length (ft)	105	269			268						183	
		AM Queue (ft)	18										304	
		PM Queue (ft)	22										527	

95th percentile volume exceeds capacity, queue may be longer.
* Intersection 7 is an unrestricted ramp movement and will therefore be excluded from this analysis

8. Remediation Measures

This section provides a list of potential remediation measures to help alleviate traffic safety and operational issues along the corridor.

Potential Remediation Measures:

One or more of the following measures are suggested for consideration:

- Implement a road diet to convert the existing 4-lane facility to 3-lane facility (one lane in each direction with left turn lanes approaching intersections, from east of MacArthur Boulevard to west of Monterey Boulevard.
- Consider providing a bike lane at least along eastbound 35th Avenue and Redwood Road from east of MacArthur Boulevard to west of Monterey Boulevard through the uphill section of the corridor.
- Install curb extensions or other traffic calming devices.
- Relocate some bus stops and crosswalks.
- Prohibit southbound left-turning movements from Mountain Boulevard West
- Improve signage for the Highway 13 on-ramp near Lincoln Square Shopping Center
- Prohibit left-turning movements out of the east driveway of the Lincoln Square Shopping Center.
- Signalize the Lincoln Square Shopping Center west driveway to address the many broadside collisions in the vicinity.
- Install a sidewalk between the two Lincoln Square Driveways

Road Diet

A road diet is suggested for the portion of Redwood/35th from just east of Kansas Street to just west of Monterey Boulevard. Extending the road diet to just west of Aliso Avenue was also tested. However, this extension would have caused significant and unavoidable operational deficiencies at the Monterey Boulevard intersection.

A road diet would improve safety for motorists, pedestrians, bicyclists and transit service users. Reduced vehicle speeds and more uniform vehicle speeds, improved pedestrian safety, and reduced collision rates are all expected as to result from reducing the number of lanes on Redwood/35th Avenue. Reduced vehicle speeds and the reduced number of lanes will make it easier for vehicles to enter Redwood Road and 35th Avenue from unsignalized side streets.

Safety for pedestrians would also be improved by reducing the number of lanes in each direction on Redwood/35th from two lanes to one. Pedestrians face a particular problem in crossing multi-

lane streets at unsignalized intersections, where a pedestrian may be unseen and struck by a vehicle in the second lane after a vehicle in the first lane has stopped to let the pedestrian pass.

The effects of a road diet on AC Transit operations would be essentially the same as for other motor vehicles. The reduction in travel speeds may increase AC Transit travel times. After implementation of the road diet, buses would pull out of the stream of traffic to pick up passengers at existing bus stops and re-entry into the traffic stream would be required. These effects would be offset at least to some degree by the more uniform speeds and improved traffic safety that would result from the implementation of a road diet. In addition, a more inviting pedestrian environment should support transit ridership to the extent that transit patrons would feel more comfortable walking to and from transit stops. The net effect of the road diet on transit operations is not expected to be significant.

Road diets are typically considered for roadways that carry between 12,000 and 18,000 vehicles daily. Baxter Street in Athens, GA, and Euclid Avenue in Lexington, KY, serve approximately 20,000 vehicles daily. Traffic volumes on Redwood/35th, where the road diet is suggested, range from approximately 16,100 to 16,500 vehicles daily – a traffic volume consistent with road diets that have been successful in other areas. Traffic volumes in the future are expected to range from approximately 20,000 to 22,000, which would press the upper limits of the capacity of this type of facility. The higher traffic volumes expected in the future suggest that some traffic may divert to other routes.

The road diet would achieve the objective of providing a more balanced transportation system and make Redwood Road/35th Street a more "complete street." Improving comfort and safety for walking and bicycling and should encourage more people to walk, bike, and use transit and thereby make a positive contribution to the reduction of greenhouse gases.

Bike Lanes

The City of Oakland Bicycle Master Plan (2007) proposes an Arterial Bike Route (Class 3A) through the project corridor linking to an existing Class 2 Bike Lane facility along MacArthur Boulevard. Although adding bike lanes along the corridor would exceed the requirements of the Bicycle Master Plan, it would enhance mobility and safety for bicyclists.

Implementing a road diet, as described above, on Redwood/35th would allow installation of Class 2 bike lanes in both directions. The addition of bike lanes would improve bicycle safety and rider comfort, especially on the uphill curved section between Willis Ct. and Jordan Road If the road diet is not implemented, a bike lane may be implemented in uphill section of 35th Avenue by reducing the width of travel lanes, medians, and/or elimination of parking in some areas.

Install curb extensions

With or without implementation of other measures suggested in this report, curb extensions may be added where parking is currently provided to shorten the crossing distance for pedestrians. Installation of curb extensions would have little impact on the parking supply and would

significantly improve the ability of motorists to see pedestrians getting ready to enter a crosswalk and would also improve the ability of pedestrians to see approaching motorists before they begin to cross the street. Curb extensions are most needed where marked crosswalks are provided.

Relocate Bus Stops and Crosswalks

The City may consider working with the community and AC Transit staff to develop a comprehensive plan for bus stops along the corridor. AC Transit generally prefers to provide bus stops:

- Along local bus routes at a frequency of approximately 1,000 feet of separation
- At signalized intersections
- At the far side of intersections
- Where there are marked crosswalks
- Where there is at least 20 feet of roadway width in the direction of bus travel

This last item would require limiting the extension of curbs at transit stops if a road diet is implemented.

Crosswalks across streets that have no traffic controls (traffic signals or stop signs) should be high visibility with longitudinal markings (ladder, continental or other high-visibility style). Also, signing for crosswalks should be modified to be consistent with current standards specified in the California Manual on Uniform Traffic Control Devices.

A comprehensive plan for bus stops and crosswalks along 35th Avenue and Redwood Road might include:

1. Far side bus stops:
   - Between California and Arizona Streets
   - At Wisconsin Street
   - Between North and South Victor Avenue
   - At Monterey Boulevard (signal)
   - At Aliso Avenue (signal)
   - At the Lincoln Square Shopping Center west driveway (suggested signal)
2. High visibility crosswalks:
   - South of California Street
   - South of Wisconsin Street
   - South of South Victor Avenue
3. High visibility school crosswalk east of Kansas Street

Modify Mountain Boulevard West Intersection

The intersection of Redwood Road and Mountain Boulevard West (accessing Holy Names University) has a number of safety and operational deficiencies that could be improved. The large radius of curvature for westbound motorists turning right onto Mountain Boulevard allows

high speed turns that pose a challenge for pedestrians and bicyclists. Another challenge for pedestrians is the design of the Redwood Road Bridge, which has a barrier that wraps around the northwest corner of the intersection, requiring pedestrians to cross Mountain Boulevard approximately 70 feet north of the intersection.

The sight distance for vehicles making a left turn from southbound Mountain Boulevard is inadequate when looking to the right over the SR-13 Bridge. It was also observed that there was a significant queue of left turning vehicles on eastbound Redwood Road accessing northbound SR-13 from eastbound Redwood Road. Another alternative for access to northbound SR-13 is provided by a loop ramp located approximately 600 feet further east.

Potential remediation measures for these issues are to:

- Restrict left turns out of Mountain Boulevard with design modifications, pavement markings and regulatory signs.
- Narrow the width of Mountain Boulevard at the intersection, install a pedestrian crosswalk, and open the barrier at the northwest corner of the intersection.
- Install freeway way-finding signs to direct motorists to use the loop ramp to northbound SR-13.

Restricting southbound left turns on Mountain Boulevard will reduce the potential for broadside collisions and decrease the queue on this approach. These left turning motorists could make a right turn onto Redwood Road and a U-turn at Aliso Avenue. Narrowing and realigning the opening width of Mountain Boulevard will help to better align the intersection while slowing right turning traffic. Exhibit 27 shows an illustration of the suggested remediation measure at Mountain Boulevard.

Modify Access to the Lincoln Square Shopping Center

The final set of suggestions deal with the area around the Lincoln Square Shopping Center driveways. The southbound exit from the western driveway can experience long queues in the PM peak period as shoppers leave the shopping center. The sight distance to the west for motorists leaving the shopping center is restricted by the curvature of Redwood Road creating a challenge for motorists who wish to make a left turn to head east. Finally, there is no sidewalk on the northern side of Redwood Road between the two Lincoln Square driveways. To correct these issues it is suggested to install a sidewalk on the northern side of the street, signalize the western driveway (Exhibit 28), and restrict left turns out of the eastern driveway (Exhibit 29).

Restricting left turns out of the eastern driveway will improve safety by reducing the potential for collisions in this area which are higher than statewide averages. These displaced left turning vehicles would be accommodated at the western driveway which is suggested to be signalized as it currently meets the peak hour warrant for the PM peak. Diversion of traffic from the east driveway to the west driveway may affect circulation in the shopping center parking lot.

Signalization of the western driveway presents some design challenges due to the proximity of the Lincoln square western driveway and the driveway for the First Covenant Church. Two

separate designs were considered. The first design option was to signalize the church driveway with its own phase. As the church is expected to have little or no traffic in the peak hours, this phasing would have little impact on peak period traffic conditions. To accommodate this phasing scheme, however, the crosswalk would have to be pushed back to the west side of the church driveway. There may also be increased collision potential with motorists ignoring no right turn on red signs and colliding with vehicles exiting at the church driveway. Finally, left turning traffic from eastbound Redwood Road into the shopping center may be confused by the large distance they have to cover from the stop bar past the church driveway to the shopping center entrance.

The second signalization option, and the one suggested for implementation, is to prohibit left turns into and out of the church driveway with a raised median (Exhibit 28). This option would inconvenience church traffic traveling eastbound on Redwood Road but it is a safer option that conforms more closely to driver expectations.

Exhibit 27 – Proposed Remediation at Mountain Boulevard and Redwood Road

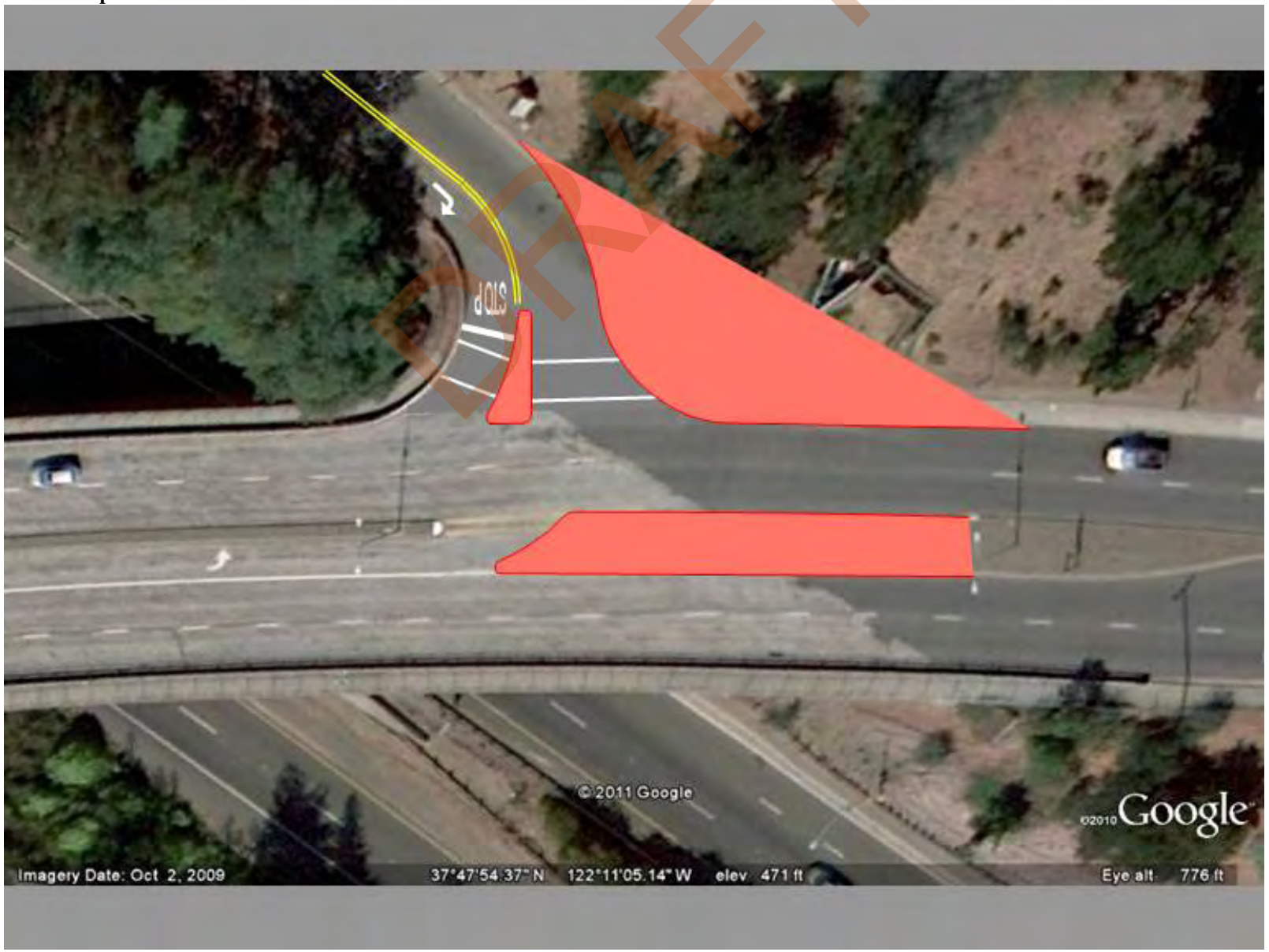


Exhibit 28 – Proposed Remediation at Lincoln Square Driveway West and Redwood Road

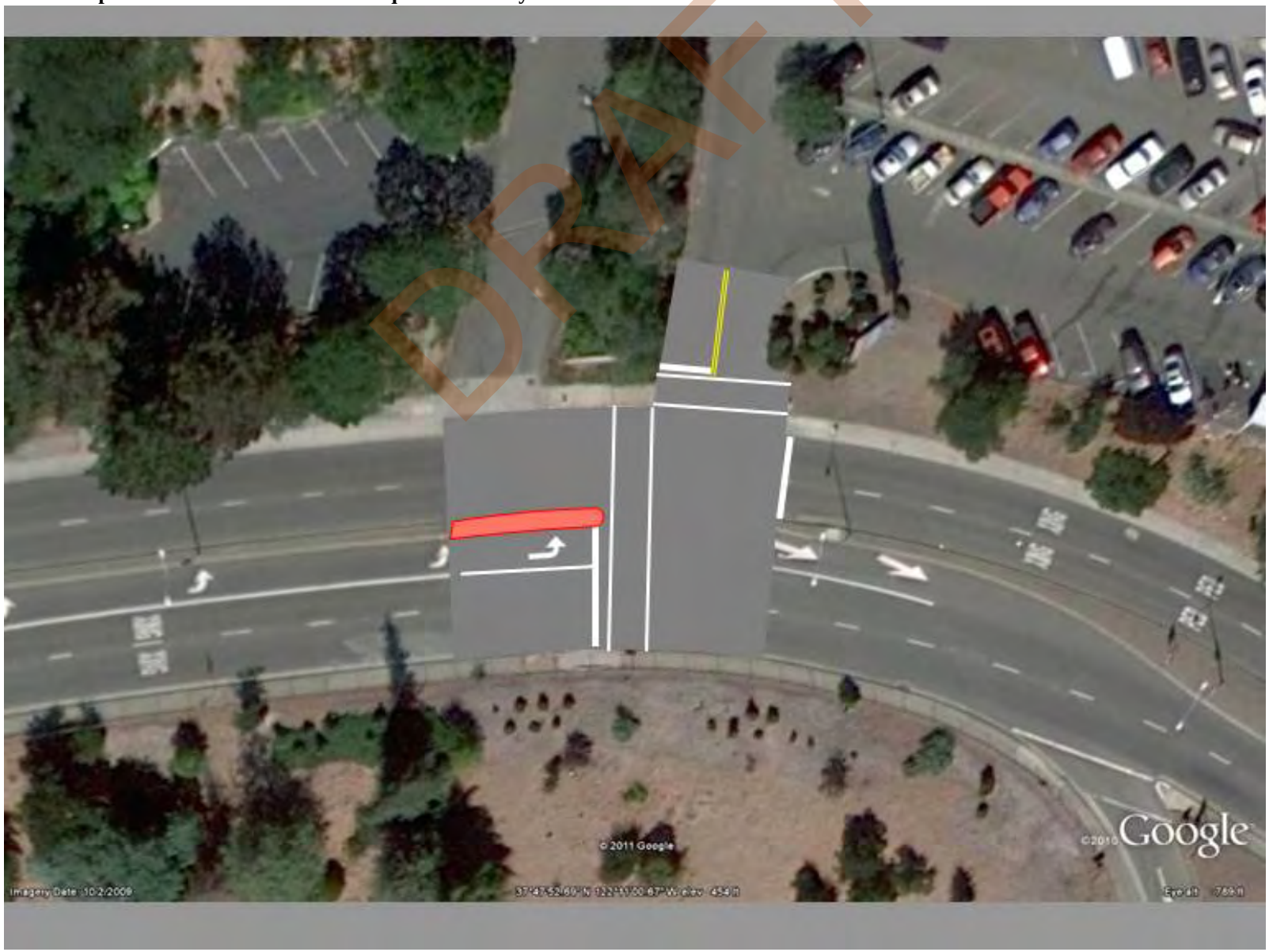


Exhibit 29 - Proposed Remediation at Lincoln Square Driveway East and Redwood Road

Operational Analysis of Remediation Measures

These remediation measures were all tested in SYNCHRO to determine the impact on existing and 2035 conditions. The LOS results are shown in Exhibit 30 and Exhibit 31 for existing and 2035, respectively. As these exhibits show, many of the intersections are improved by the implementation of the remediation measures (road diet, restriction of left turns, and signalization of Lincoln Square. The only intersection to show a significant impact is that of Mountain Boulevard east and Redwood Rd in 2035.

The AM peak in 2035 for Mountain Boulevard and Redwood Road was already operating at LOS F before restrictingleft turns out of the eastern Lincoln Square Driveway. These left turns will divert to the western driveway and then proceed through the Mountain and Redwood intersection altering the V/C ratio by 0.01 which is a significant impact. Additionally, the PM peak went from LOS D to LOS E as a result of the left turn restriction. These impacts can be easily mitigated though by optimizing the signal timing at this intersection. The results of this optimization are shown in Exhibit 32.

Exhibit 30 – LOS Comparison between Existing and Exiting + Project

No.	Intersection	Traffic Control	Peak Hour	Existing No Project		Existing Plus Project	
				LOS [1]	Delay [2]	LOS [1]	Delay [2]
1	MacArthur Blvd. & 35th Ave.	Signal	AM	C	34.2	C	34.2
			PM	C	29.5	C	29.5
2	Wisconsin St. & 35th Ave.	TWSC	AM	A (F)	7.6 (103.1)	A (F)	4.6 (58.2)
			PM	A (D)	2.1 (103.1)	A (C)	2.0 (58.2)
3	Monterey Blvd. & Redwood Rd.	Signal	AM	A	6.6	A	6.6
			PM	A	5	A	5.0
4	Aliso Ave. & Redwood Rd.	Signal	AM	B	16.9	C	20.6
			PM	B	14.2	B	14.2
5	Mountain Blvd. W & Redwood Rd.	TWSC	AM	A (D)	7.2 (30.2)	A (B)	4.5 (12.2)
			PM	A (E)	3.8 (30.2)	A (B)	1.6 (12.2)
6	Lincoln Square West & Redwood Rd.	TWSC/Signal	AM	A (D)	1.4 (26.8)	A	7.1
			PM	A (E)	5.4 (26.8)	B	10.4
8	Mountain Blvd. E & Redwood Rd.	Signal	AM	D	47.5	D	48.2
			PM	B	15.1	B	16.1
9	Lincoln Square East & Redwood Rd.	TWSC	AM	A (F)	1.9 (56.6)	A (B)	0.5 (15)
			PM	A (E)	4.7 (56.6)	A (B)	1.1 (15.0)

Source: Dowling Associates, 2011
Notes:

[1] LOS = Level of Service

[2] Average control delay in seconds per vehicle

[3] The worst approach control delays and LOS are reported in (Parenthesis) for stop-controlled intersections.
* Intersection 7 is an unrestricted ramp movement and will therefore be excluded from this analysis

Exhibit 31 – LOS Comparison between 2035 and 2035 + Project

No.	Intersection	Traffic Control	Peak Hour	2035 No Project		2035 Plus Project	
				LOS [1]	Delay [2]	LOS [1]	Delay [2]
1	MacArthur Blvd. & 35th Ave.	Signal	AM	F	216.2	F	216.2
			PM	F	128.5	F	128.5
2	Wisconsin St. & 35th Ave.	TWSC	AM	F (F)	577.9 (Err)	E (F)	37.0 (598.1)
			PM	B (F)	11.9 (Err)	A (F)	5.5 (598.1)
3	Monterey Blvd. & Redwood Rd.	Signal	AM	B	15.3	B	15.2
			PM	B	13.4	B	13.4
4	Aliso Ave. & Redwood Rd.	Signal	AM	D	46.7	D	54.0
			PM	C	24.4	C	30.6
5	Mountain Blvd. W & Redwood Rd.	TWSC	AM	F (F)	Err (Err)	C (E)	19.1 (35.8)
			PM	A (C)	3.1 (Err)	A (B)	1.9 (35.8)
6	Lincoln Square West & Redwood Rd.	TWSC/Signal	AM	A (F)	5.6 (124.5)	B	12.0
			PM	E (F)	48.4 (124.5)	B	18.2
8	Mountain Blvd. E & Redwood Rd.	Signal	AM	F	111.0	F	113.4
			PM	D	43.3	F	58.7
9	Lincoln Square East & Redwood Rd.	TWSC	AM	C (F)	23.5 (774.3)	A (C)	0.7 (20.2)
			PM	E (F)	46.0 (774.3)	A (C)	1.4 (20.2)

Source: Dowling Associates, 2011
Notes:

[1] LOS = Level of Service

[2] Average control delay in seconds per vehicle

[3] The worst approach control delays and LOS are reported in (Parenthesis) for stop-controlled intersections.
* Intersection 7 is an unrestricted ramp movement and will therefore be excluded from this analysis

Exhibit 32 – 2035 Remediation of Intersection 7

No.	Intersection	Traffic Control	Peak Hour	2035 No Project		2035 Plus Project		2035 Plus Project Mit	
				LOS [1]	Delay [2]	LOS [1]	Delay [2]	LOS [1]	Delay [2]
8	Mountain Blvd. E & Redwood Rd.	Signal	AM	F	111	F	113.4	F	90.1
			PM	D	43.3	F	58.7	C	27.1

Source: Dowling Associates, 2011
Notes:

[1] LOS = Level of Service

[2] Average control delay in seconds per vehicle

[3] The worst approach control delays and LOS are reported in (Parenthesis) for stop-controlled intersections.

In addition to the LOS analysis, a queuing analysis on the existing + project and 2035 + project were performed. The following exhibits detail these results.

Exhibit 33 - 95th Percentile Queue Table for Existing + Project Conditions

	Intersection		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
1	MacArthur Blvd. & 35th Ave.	Storage Length (ft)	100	855		160	1753		160	608	50	100	676	50
		AM Queue (ft)	#136	343		129	324		#210	324	80	#190	187	51
		PM Queue (ft)	116	#348		#141	225		151	163	45	102	228	58
2	Wisconsin St. & 35th Ave.	Storage Length (ft)	95	1753		95	1782			542			476	
		AM Queue (ft)	4			1				26			113	
		PM Queue (ft)	6			3				9			30	
3	Monterey Blvd. & Redwood Rd.	Storage Length (ft)	85	1782		85	847			770			594	50
		AM Queue (ft)	26	205		12	167			37			45	15
		PM Queue (ft)	21	131		12	156			14			30	16
4	Aliso Ave. & Redwood Rd.	Storage Length (ft)		847		105	526			595		110	291	55
		AM Queue (ft)		272		#160	167			46		207	43	20
		PM Queue (ft)		155		69	105			45		#312	85	33
5	Mountain Blvd. W & Redwood Rd.	Storage Length (ft)	260	526			314						427	
		AM Queue (ft)	129										49	
		PM Queue (ft)	23										15	
6	Lincoln Square West & Redwood Rd.	Storage Length (ft)	200	314			360						195	200
		AM Queue (ft)	49	85			207						37	
		PM Queue (ft)	#85	111			103						63	
7	Mountain Blvd. E & Redwood Rd.	Storage Length (ft)		253		150	269		546					
		AM Queue (ft)		#318		#548	130		#234					
		PM Queue (ft)		#353		197	77		131					
8	Lincoln Square East & Redwood Rd.	Storage Length (ft)	105	269			268						183	
		AM Queue (ft)	8											14
		PM Queue (ft)	11											16

95th percentile volume exceeds capacity, queue may be longer.
* Intersection 7 is an unrestricted ramp movement and will therefore be excluded from this analysis

Exhibit 34 - 95th Percentile Queue Table for 2035 + Project Conditions

	Intersection		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
1	MacArthur Blvd. & 35th Ave.	Storage Length (ft)	100	855		160	1753		160	608	50	100	676	50
		AM Queue (ft)	#194	#631		#211	#594		#302	#1422	135	#293	#761	89
		PM Queue (ft)	#180	#647		#265	375		#224	#647	101	#196	#963	98
2	Wisconsin St. & 35th Ave.	Storage Length (ft)	95	1753		95	1782			542			476	
		AM Queue (ft)	7			2				102			402	
		PM Queue (ft)	11			6				28			129	
3	Monterey Blvd. & Redwood Rd.	Storage Length (ft)	85	1782		85	847			770			594	50
		AM Queue (ft)	#214	298		18	236			47			57	81
		PM Queue (ft)	#234	186		16	227			17			37	83
4	Aliso Ave. & Redwood Rd.	Storage Length (ft)		847		105	526			595		110	291	55
		AM Queue (ft)		#463		#163	231			67		#354	54	45
		PM Queue (ft)		223		#158	144			63		#461	117	83
5	Mountain Blvd. W & Redwood Rd.	Storage Length (ft)	260	526			314						427	
		AM Queue (ft)	505										104	
		PM Queue (ft)	41										24	
6	Lincoln Square West & Redwood Rd.	Storage Length (ft)	200	314			360						195	200
		AM Queue (ft)	88	173			472						87	
		PM Queue (ft)	#155	156			#256						#220	
8	Mountain Blvd. E & Redwood Rd.	Storage Length (ft)		253		150	269		546					
		AM Queue (ft)		#464		#741	181		#366					
		PM Queue (ft)		#550		#327	113		183					
9	Lincoln Square East & Redwood Rd.	Storage Length (ft)	105	269			268							183
		AM Queue (ft)	18											26
		PM Queue (ft)	22											29

95th percentile volume exceeds capacity, queue may be longer.
* Intersection 7 is an unrestricted ramp movement and will therefore be excluded from this analysis

Queue lengths generally improve or remain the same over no project conditions except for the westbound left turn at Aliso Avenue, one movement at the western Lincoln Square Driveway, and the eastbound approach to Mountain Boulevard East.

For existing conditions, the project would cause the 95th percentile queue for the westbound left turn lane at Aliso Avenue to exceed the capacity of the turn pocket by approximately 2 vehicles in the AM peak hour. In 2035, a comparable 95th percentile queue would exist at this location during the AM and PM peak hours.

For existing conditions, the new traffic signal at the Lincoln Square West driveway would have 95th percentile peak hour through movement queues in the westbound direction that would not extend beyond the upstream intersection. In 2035, the 95th percentile queue would extend beyond the upstream intersection by 4.5 vehicles during the PM peak hour. The new signal would reduce the queue for vehicles exiting the shopping center by more than half.

For existing conditions at the Mountain Boulevard East intersection, the 95th percentile queue for the eastbound through movement would exceed the storage capacity without the project, and the project would cause the 95th percentile queue to extend by approximately 2 vehicles in the PM peak hour. In 2035, the 95th percentile queue would exceed the storage capacity by 8 to 9 vehicles for the AM and PM peak hours, respectively, and the project would extend the queue by less than 1 vehicle during the AM peak hour and 3 vehicles during the PM peak hour.