

**INITIAL  
TRAFFIC ENGINEERING REPORT  
KOLB ROAD: CONNECTION  
TO SABINO CANYON  
TUCSON, ARIZONA**

Prepared by

**P S O M A S**

800 East Wetmore Road, Suite 110  
Tucson, AZ 85719  
(520) 292 2300

Prepared for



**CITY OF  
TUCSON**

201 North Stone Avenue  
Tucson, AZ 85701

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## 1. INTRODUCTION

This project, which consists of constructing a new roadway to extend Sabino Canyon Road from Tanque Verde Road to Kolb Road (Figure 1), is part of the *Regional Transportation Authority's (RTA) Transportation Plan*<sup>1</sup> approved by voters in 2006. The purpose of this evaluation is to provide a preliminary analysis of existing conditions and projected future conditions for the Kolb Road: Connection to Sabino Canyon project. A more comprehensive traffic report will be completed in the future to provide further detail and to address items such as turn lane storage lengths, signal timing, and recommendations on multimodal facilities.

It is anticipated that the construction of this project will change travel patterns and affect operations in a large area of northeast Tucson. Therefore, the study area for the traffic analysis extends beyond the limits of physical improvements to include nine signalized intersections. The study area is bound by Speedway Boulevard to the south, Tanque Verde Road to the north, Pantano Road to the east, and Kolb Road to the west, as indicated in Figure 1 below.

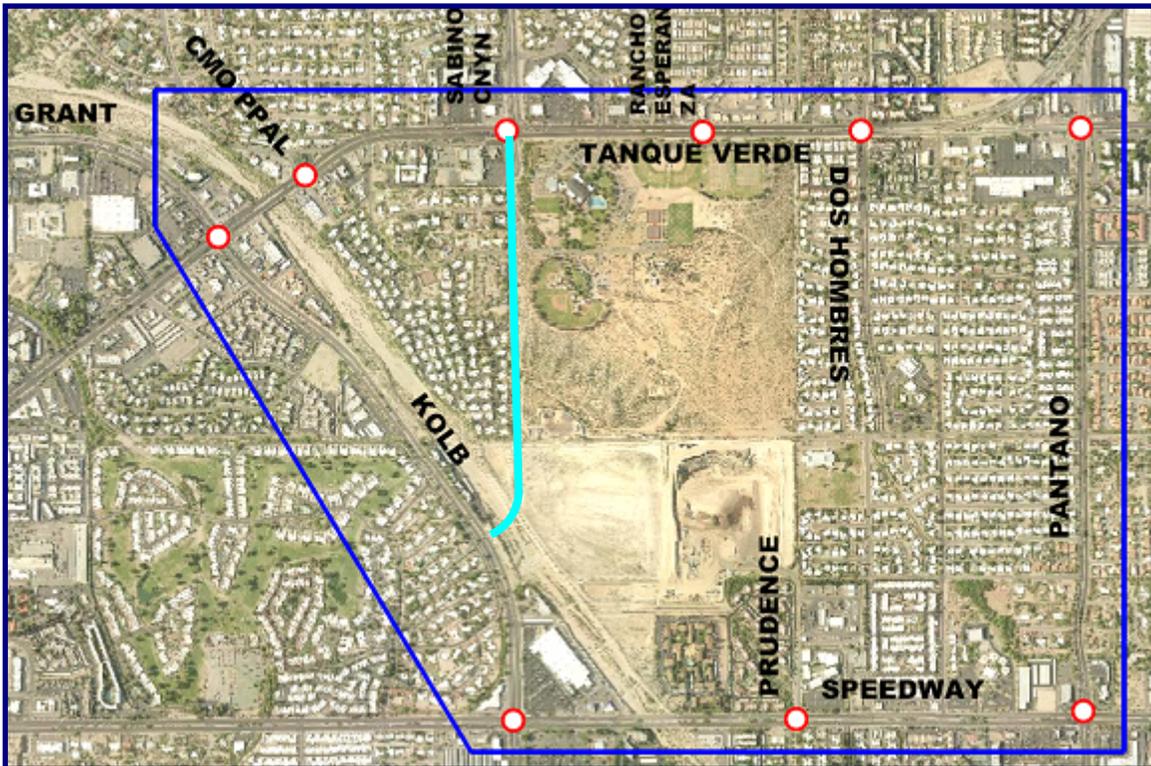


Figure 1. Study Area

## 2. EXISTING CONDITIONS

### 2.1. ROADWAY NETWORK

Several roadways in the study area are part of the City of Tucson's *Major Streets and Routes Plan*<sup>2</sup>. The primary geometric, functional and design characteristics of those roadways are summarized in Table 1.

**Table 1. Existing Roadway Characteristics**

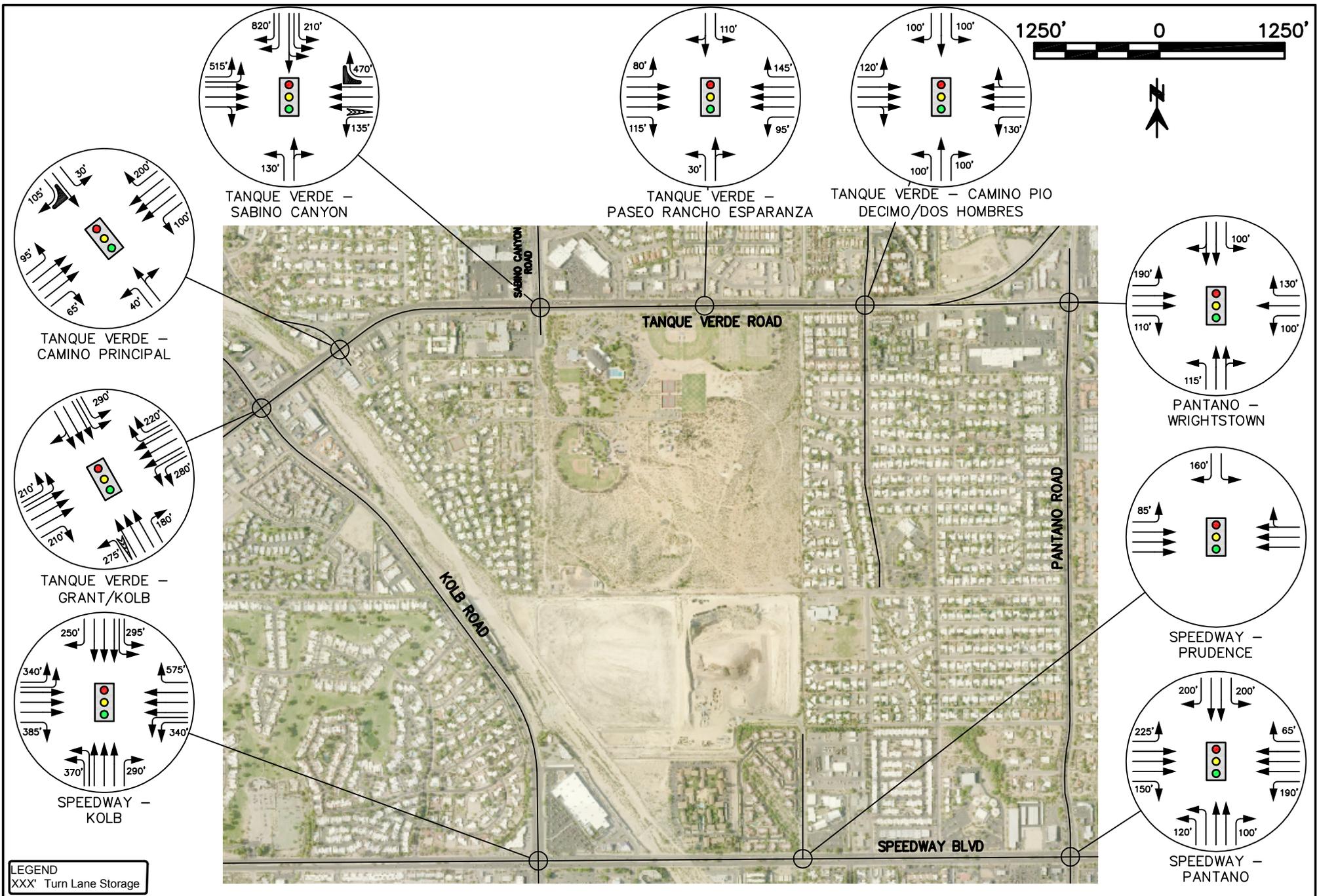
Roadway	Functional Classification	Number of Lanes	Multi-use Lanes	Sidewalks	Speed Limit	MS&R Right-of-Way	Existing R/W Meets Ultimate Width
Grant Road	Principal Arterial	6		x	40	150 ft	
Kolb Road	Principal Arterial	6	x	x	40	150 ft	x
Sabino Canyon Road	Principal Arterial	4	x	x	45	150 ft	x
Pantano Road	Minor Arterial	4	x	x	40	150 ft	x
Tanque Verde Road	Principal Arterial	6	x	x	40-45	150 ft	
Wrightstown Road	Minor Arterial	2	x		35	150 ft	
Speedway Boulevard	Principal Arterial	6	x	x	40	150 ft*	x

\*Assumed; not shown on MS&R plan map

The speed limit for Tanque Verde Road is 40 mph west of Sabino Canyon Road and is 45 mph east of Sabino Canyon Road. Note that Grant Road, Tanque Verde Road, and Wrightstown Road have existing rights-of-way that meet the ultimate width in some segments in the project area, but not all.

As previously mentioned, there are a total of 9 signalized intersections within the study area. Those intersections are listed below. The lane configuration and available storage lengths for turning movements at each of the intersections is shown in Figure 2.

1. Kolb Road/Grant Road and Tanque Verde Road
2. Camino Principal and Tanque Verde Road
3. Sabino Canyon Road and Tanque Verde Road
4. Paseo Rancho Esperanza and Tanque Verde Road
5. Dos Hombres Road/Camino Pio Decimo and Tanque Verde Road
6. Pantano Road and Wrightstown Road
7. Kolb Road and Speedway Boulevard
8. Prudence Road and Speedway Boulevard
9. Pantano Road and Speedway Boulevard



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**FIGURE 2  
 EXISTING INTERSECTION GEOMETRY**

**PSOMAS**

**OCTOBER 2009**

## 2.2. TRAFFIC VOLUMES

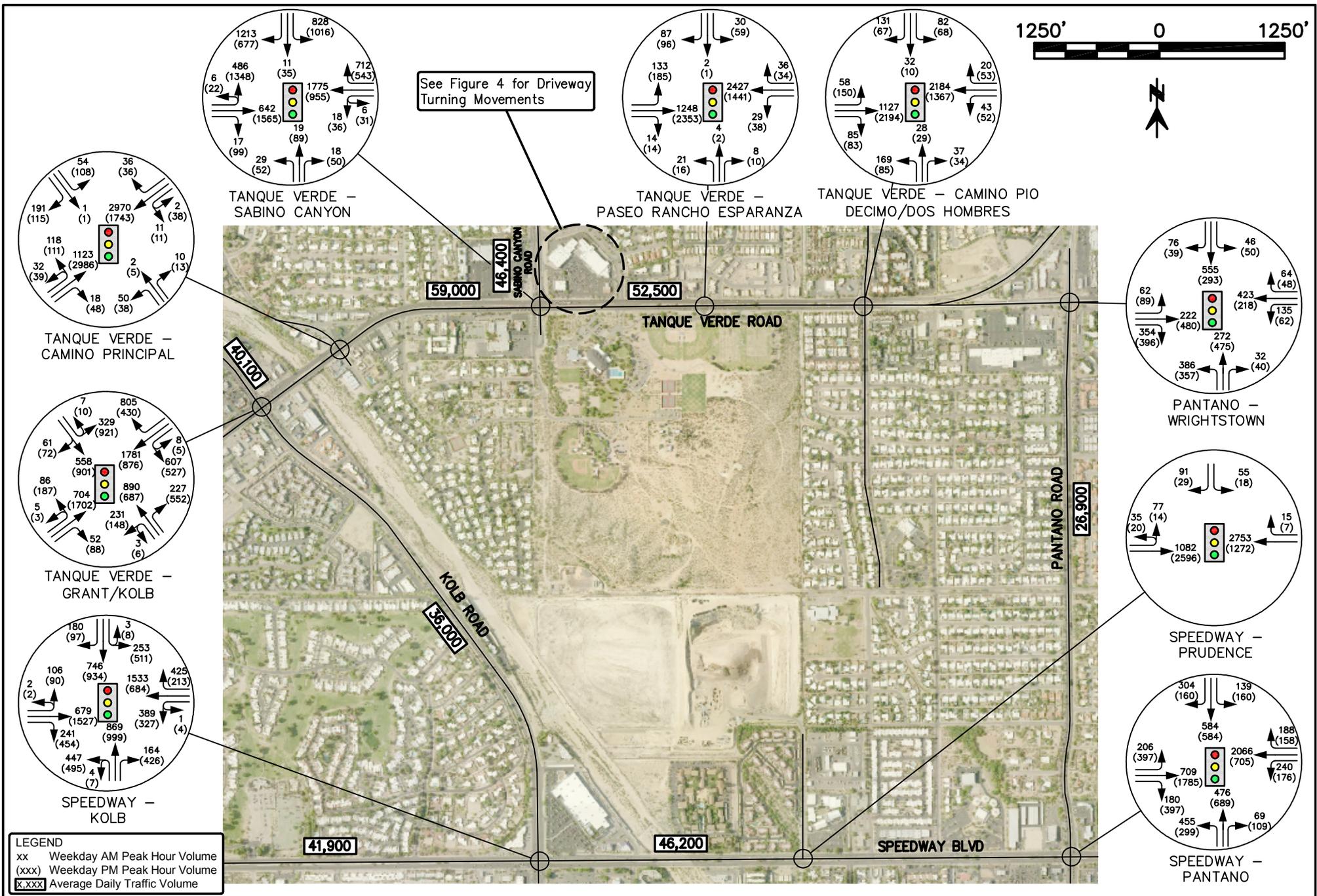
Traffic volumes were collected for Psomas at each of the signalized intersections shown in Figure 1 on May 12-14, 2009 by ACCEPT Consulting Services. In addition, volumes were also collected in May 2009 at each of the four driveways for the Colonia Verde shopping center, located at the northeast corner of the intersection of Sabino Canyon Road and Tanque Verde Road. Two driveways are located on Sabino Canyon Road and the other two driveways are located on Tanque Verde Road. Volumes at the major intersections were collected in both the AM and PM peak periods, while volumes at the shopping center driveways were only collected in the PM peak hour.

From the traffic volume data, it was found that the AM peak hour for the project area is from 7:30 AM to 8:30 AM, and the PM peak hour is from 4:30 PM to 5:30 PM. Figure 3 shows the existing traffic volumes at the signalized intersections, and Figure 4 shows the volumes at the Colonia Verde driveways. The traffic counts are included in Appendix A.

As seen in Figure 3, westbound volumes are generally higher than eastbound volumes in the AM peak hour, and the reverse is true in the PM peak hour. This is an indication of drivers traveling from the residential areas to the north and east of this project into central Tucson in the morning, then returning home in the afternoon/evening.

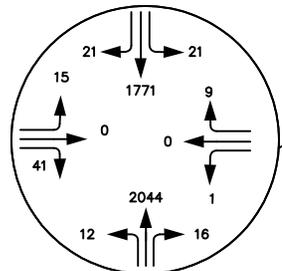
In addition to the high through volumes, several turning movement volumes in the project area are significant. For example, at the intersection of Grant Road/Kolb Road and Tanque Verde Road, the westbound left and right turn volumes from Tanque Verde Road are very high in the AM peak hour (607 and 805 vehicles per hour, respectively). In the afternoon peak hour, the southbound left turn volume from Grant Road (921 veh/hr) and the northbound right turn volume from Kolb Road (552 veh/hr) are also high. It should be noted that these counts were conducted as construction was ongoing at the intersection of Grant Road and Craycroft Road, so the turning volumes discussed above may be even higher than the measured levels.

At the intersection of Sabino Canyon Road and Tanque Verde Road, southbound left and right turns are very heavy in the AM peak hour (828 and 1,213 veh/hr, respectively), and both southbound left turns and eastbound left turns are heavy in the PM peak hour (1,016 veh/hr and 1,348 veh/hr, respectively).

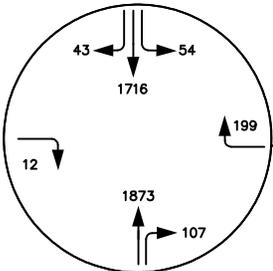


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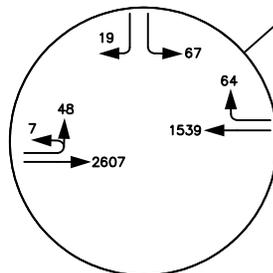
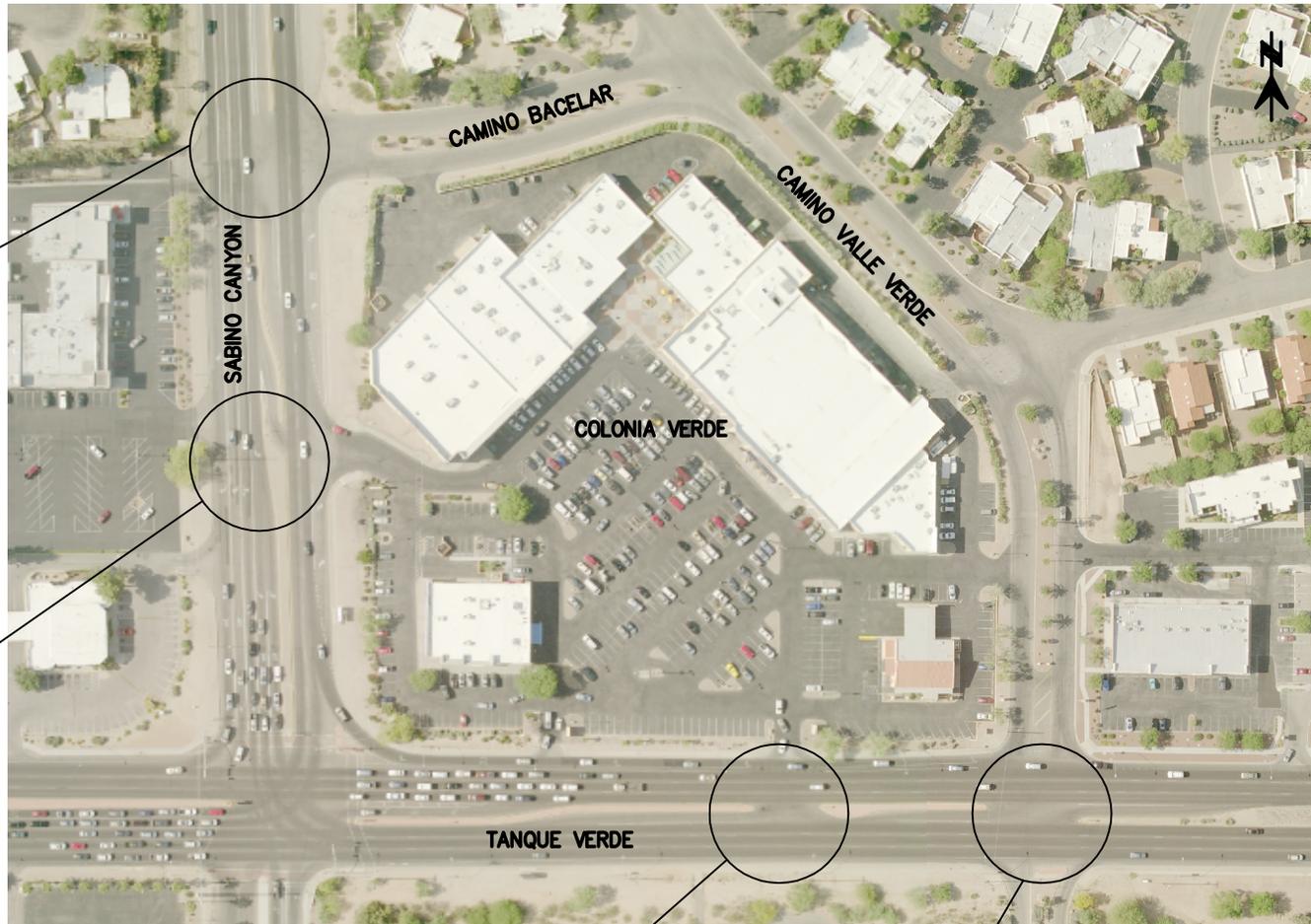
**FIGURE 3  
EXISTING TRAFFIC VOLUMES (2009)**



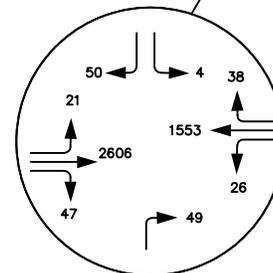
SABINO CANYON – CAMINO BACELAR



SABINO CANYON – SOUTH DRIVEWAY



TANQUE VERDE – WEST DRIVEWAY



TANQUE VERDE – CAMINO VALLE VERDE



LEGEND  
xx Weekday PM Peak Hour Volume

### 2.3. OPERATIONAL ANALYSIS

The existing Level of Service (LOS) at each of the signalized intersections in the study area was found using *Synchro 7*, a traffic modeling software that follows the methodology of the *Highway Capacity Manual*<sup>3</sup>. Level of Service is a qualitative measure that describes operational conditions in terms of travel speed (for arterials), density (for freeways), and delays (for intersections). LOS ranges from A to F, with A representing the best operating conditions and F representing the worst. LOS D is generally considered acceptable for major intersections in an urban area.

Model inputs include the existing intersection geometry and the traffic volumes collected in May 2009 (shown in Figures 2, 3 and 4). In addition, with one exception, the existing timing obtained from the City of Tucson was used in both the AM and PM peak hour models. At the intersection of Sabino Canyon Road and Tanque Verde Road, field observations reflected a cycle length that differed from the information provided by the City during the PM peak period. Therefore, in order to model the existing conditions as accurately as possible, the observed timing was used for the intersection of Sabino Canyon Road and Tanque Verde Road in the PM peak period, and the timing obtained from the City was used for the AM peak period. Table 2 shows the results from the *Synchro* model. The *Synchro* reports are included in Appendix B.

As seen in the table, most of the intersections currently operate at LOS D or better in the morning peak hour, with the exceptions being the intersections of Sabino Canyon Road/Tanque Verde Road and Pantano Road/Speedway Boulevard, which both currently operate at LOS E. In the PM peak hour, the intersections of Grant Road/Kolb Road/Tanque Verde Road and Sabino Canyon Road/Tanque Verde Road operate at LOS F. The intersection of Pantano Road/Speedway Boulevard operates at LOS E, and all other signalized intersections in the study area operate at LOS D or better.

In addition to some intersections operating at LOS E or F overall, there are 25 movements that currently operate at LOS F during the morning or evening peak period. Of those movements, 16 serve volumes greater than 200 vehicles per hour. Some of the movements with the greatest delays are the eastbound throughs, westbound left turns, and southbound left turns at Grant Road/Kolb Road/Tanque Verde Road in the PM peak

hour (delays of 175 seconds per vehicle, 141 sec/veh, and 121 sec/veh, respectively). Northbound right turns at the same intersection have an existing delay of 93 sec/veh in the PM peak hour, corresponding to LOS F. Eastbound left turns and southbound left turns at Sabino Canyon Road/Tanque Verde Road have delays of 278 sec/veh and 119 sec/veh in the PM peak hour, respectively.

**Table 2. Existing Level of Service (LOS)**

<b>Kolb Road/Grant Road and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	D	C	A	C	C	A	F	E	C	E	E	E	D
	Delay	43.5	29.6	6.0	24.1	30.6	9.0	95.9	73.2	30.3	79.5	64.1	64.1	40.5
PM	LOS	C	F	B	F	C	A	D	D	F	F	D	D	F
	Delay	33.2	175.4	16.4	140.6	31.2	3.2	35.5	42.0	92.6	120.8	52.5	52.5	92.8

<b>Camino Principal and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	F	A	A	A	D	A	F	C	C	E	C	C	D
	Delay	93.1	6.9	2.4	3.3	51.6	5.1	149.3	23.8	23.8	63.5	33.4	33.4	43.4
PM	LOS	C	B	A	B	B	A	E	B	B	E	A	A	B
	Delay	26.3	16.6	2.1	18.1	14.3	5.1	70.1	19.1	19.1	57.5	9.9	9.9	17.6

<b>Sabino Canyon Road and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	E	C	C	E	E	C	F	F	F	F	F	D	E
	Delay	58.7	34.8	34.8	78.5	58.0	34.8	81.2	84.8	84.8	80.6	88.0	54.6	55.9
PM	LOS	F	D	D	E	D	B	E	F	F	F	F	B	F
	Delay	277.6	44.9	44.9	74.3	51.2	10.9	66.0	126.6	126.6	118.5	134.8	15.9	102.0

<b>Paseo Rancho Esperanza and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	E	A	A	A	A	A	D	C	C	D	B	B	A
	Delay	65.6	6.3	2.6	1.3	3.4	0.4	54.1	30.2	30.2	53.6	15.1	15.1	7.3
PM	LOS	C	B	A	B	A	A	D	C	C	E	B	B	B
	Delay	27.2	12.0	4.1	11.5	5.9	1.9	49.2	24.7	24.7	56.0	13.1	13.1	11.3

<b>Dos Hombres Road/Camino Pio Decimo and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	C	B	B	B	C	C	E	C	A	D	C	A	C
	Delay	30.0	13.3	13.3	12.1	22.5	22.5	56.9	31.8	8.0	36.0	31.4	6.2	21.5
PM	LOS	B	A	A	C	B	B	E	D	B	D	D	B	B
	Delay	16.4	8.6	8.6	22.3	11.6	11.6	58.0	42.3	11.6	48.2	39.6	10.5	12.6

<b>Pantano Road and Wrightstown Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	D	C	A	C	D	B	E	C	C	B	D	D	D
	Delay	38.0	24.7	5.3	25.0	45.7	11.9	61.1	30.3	30.3	12.5	40.0	40.0	35.1
PM	LOS	B	B	A	B	B	A	F	C	C	B	B	B	C
	Delay	13.0	17.2	4.6	13.5	18.2	5.5	82.7	22.9	22.9	14.7	18.4	18.4	25.7

**Table 2. Existing Level of Service (LOS) (cont'd)**

<b>Kolb Road and Speedway Boulevard</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	C	C	A	C	C	B	E	D	A	C	D	B	C
	Delay	21.1	22.5	8.3	27.6	22.9	11.3	55.6	35.1	5.8	25.0	36.7	13.7	27.1
PM	LOS	B	F	C	D	B	A	F	D	D	F	C	A	D
	Delay	15.0	84.6	29.7	35.6	12.2	4.7	109.0	35.8	37.0	96.6	32.3	6.1	52.7

<b>Prudence Road and Speedway Boulevard</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	B	A			C	C				D		B	C
	Delay	19.0	1.0			32.5	32.5				38.4		15.8	24.1
PM	LOS	A	A			A	A				D		B	A
	Delay	1.8	3.0			3.1	3.1				36.0		12.6	3.4

<b>Pantano Road and Speedway Boulevard</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	F	B	A	D	F	B	E	D	A	C	D	C	E
	Delay	136.4	19.2	4.9	53.8	123.7	15.4	61.1	35.2	8.7	31.6	41.1	25.7	69.8
PM	LOS	F	F	A	D	C	A	D	D	B	D	D	A	E
	Delay	207.4	97.3	6.3	51.8	20.4	6.2	39.8	53.6	13.9	50.7	41.3	6.8	67.7

When simulations were run in *SimTraffic* to verify the results from *Synchro*, some queue spillback was observed. Most notably, the southbound left turns on Sabino Canyon Road at Tanque Verde Road back up past the driveway into the Colonia Verde shopping center, occasionally blocking the left turn bay that provides access to the shopping center. Further, because of the location of the shopping center driveway, the southbound left turn storage on Sabino Canyon Road at Tanque Verde Road is limited to approximately 210 feet.

Field visits were also conducted in both the AM and PM peak periods. The results from *Synchro* and *SimTraffic* mirrored what was observed in the field, such as the heavy northbound right turns and southbound left turns at the intersection of Grant Road/Kolb Road and Tanque Verde Road in the evening peak hour. In the morning peak hour at the same intersection, it was observed (in the field) that westbound right turns back up to the intersection of Camino Principal and Tanque Verde Road, partly because the westbound through traffic blocks the right turn lane on Tanque Verde Road at Grant Road/Kolb Road. Very long eastbound and southbound left turn queues were also observed at the intersection of Sabino Canyon Road and Tanque Verde Road in the afternoon peak period, which corresponds with the *Synchro* and *SimTraffic* results.

## 2.4. CRASH HISTORY

Psomas obtained crash data from the City of Tucson for the latest available five-year period (January 2004 to December 2008) for the following roadway sections:

- Tanque Verde Road, from Grant Road/Kolb Road to Camino Pio Decimo/Dos Hombres Road
- Kolb Road, from Tanque Verde Road to Speedway Boulevard
- Sabino Canyon Road, from Camino del Rio to Tanque Verde Road

This section presents an analysis of the records obtained, which are included in Appendix C. During the 5-year study period, there were a total of 1,203 crashes in the study area; 657 crashes at signalized intersections, 45 crashes at unsignalized intersections, and 501 crashes on road segments between intersections.

It should be noted that while the data received from the City was mostly complete, information about the distance that the crash occurred from an intersection was not included. Crashes were considered to be intersection crashes if the data cited that they were intersection related. Otherwise, crashes were considered to be roadway segment crashes, not related to an intersection. Therefore, the distinction between intersection and non-intersection related crashes was based entirely on what the reporting officer determined at the crash scene.

Table 3 shows the crashes at the signalized intersections. Approximately 45% of the signalized intersection crashes were rear-end crashes. The next most common type of crash was left turn crashes (29%), followed by angle crashes (12%). Note that the crashes at the intersection of Grant Road/Kolb Road and Tanque Verde Road were split into two periods; the first is the period from January 2004 until the month before red light cameras were installed at the intersection (October 2007), and the second is from the time the cameras were installed (November 2007) until December 2008.

During the 5-year period of the data, the most number of crashes occurred at the intersection of Grant Road/Kolb Road/Tanque Verde Road, followed by the intersections of Kolb Road/Speedway Boulevard and Sabino Canyon Road/Tanque Verde Road. At most of the intersections, and overall for the signalized intersections in the study area,

rear-end crashes were the most common type of crash. The lone exception is the intersection of Grant Road/Kolb Road and Tanque Verde Road, where there were more left turn crashes than rear end crashes. Before the red light cameras were installed, there were 75 left turn crashes compared to 60 rear end crashes, but after the cameras were installed, there were 19 left turn crashes compared to 24 rear end crashes. The most common left turn crash at Grant Road/Kolb Road/Tanque Verde Road involved southbound left turning vehicles.

**Table 3. Signalized Intersection Crash Type Summary**

Intersection	Angle	Left Turn	Sideswipe	Rear End	Single Vehicle	Head-On	Pedestrian	Bicycle	Other	Total Crashes
Grant/Kolb and Tanque Verde (w/o Red Light Cameras)	24	75	11	60	5	2	1	1	11	190
Grant/Kolb and Tanque Verde (w/ Red Light Cameras)	5	19	3	24	1	0	0	0	5	57
Camino Principal and Tanque Verde	4	6	2	35	2	0	0	1	3	53
Sabino Canyon and Tanque Verde	16	41	4	55	1	0	0	2	8	127
Paseo Rancho Esperanza and Tanque Verde	1	1	0	21	0	0	0	0	0	23
Dos Hombres/Camino Pio Decimo and Tanque Verde	3	1	1	16	0	0	0	0	0	21
Kolb and Speedway	24	48	7	82	9	1	3	1	11	186
<b>TOTAL</b>	<b>77</b>	<b>191</b>	<b>28</b>	<b>293</b>	<b>18</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>38</b>	<b>657</b>

Table 4 shows the crashes at the unsignalized intersections. The intersections of Sabino Canyon Road/Redbud Road and Sabino Canyon Road/Crestline Drive are not included because there were no intersection related crashes at those locations during the time period and because this project will significantly alter Sabino Canyon Road south of Tanque Verde Road, where both Redbud Road and Crestline Drive are located.

**Table 4. Unsignalized Intersection Crash Type Summary**

Intersection	Angle	Left Turn	Sideswipe	Rear End	Single Vehicle	Head-On	Pedestrian	Bicycle	Other	Total Crashes
Indian Ruins and Tanque Verde	3	10	0	9	0	0	0	0	3	25
Indian Ridge and Tanque Verde	1	1	0	0	0	0	0	0	0	2
Camino Valle Verde and Tanque Verde	0	0	0	2	0	0	0	0	0	2
Avenida Valiente and Tanque Verde	1	1	0	2	0	0	0	0	0	4
Sabino Canyon and Acoma	0	0	0	0	0	0	0	0	1	1
Sabino Canyon and Camino Bacelar	1	7	0	0	0	0	0	0	1	9
Kolb and Calle La Paz	0	2	0	0	0	0	0	0	0	2
<b>TOTAL</b>	<b>6</b>	<b>21</b>	<b>0</b>	<b>13</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>5</b>	<b>45</b>

The most common type of crashes at the unsignalized intersections were left turns (47%), followed by rear-ends (29%) and angle crashes (13%). Left turn crashes at unsignalized intersections likely occur when drivers attempt to make a turn from or onto the minor street without a sufficient gap in cross traffic.

Tables 5, 6, and 7 present the crash rates and crash severity for signalized intersections, unsignalized intersections, and road segments, respectively. The crash rates were calculated using the following equations:

$$Crash\ Rate_{(Road\ segment)} = \frac{Crashes \times 10^6}{365 \times Period \times ADT \times Length} = Crashes / MVM$$

$$Crash\ Rate_{(Inter\ sec\ tion)} = \frac{Crashes \times 10^6}{365 \times Period \times ADT_{(Entering)}} = Crashes / MVE$$

Note that crashes with unknown injuries were not included in the crash severity calculations, but were included in the crash rate calculations. The ADTs used in the equations above are from the middle year of the analysis period, 2006. The severity index is calculated based on the following equation, which weighs fatal and injury accidents more heavily than property damage only crashes.

$$Severity\ Index = \frac{5.8 \times (C_F + C_I) + 2 \times (C_{NI} + C_P) + C_N}{Total\ Crashes}$$

Where,

$C_F$  = Crashes with fatality

$C_I$  = Crashes with incapacitating injury

$C_{NI}$  = Crashes with non-incapacitating injury

$C_P$  = Crashes with possible injury

$C_N$  = Crashes without injury

From Table 5, each of the signalized intersections has a severity index near or above the Pima County average of 1.41 (the City of Tucson does not publish crash rates). The highest is 1.61 at the intersection of Paseo Rancho Esperanza and Tanque Verde Road, followed by the intersection of Kolb Road and Speedway Boulevard (1.52). The latter was the location of the only fatality at a signalized intersection in the project area during the 5 years of available data. Note that at the intersection of Grant Road/Kolb Road and Tanque Verde Road, the severity index decreased slightly after the red light cameras

were installed (1.49 to 1.45). The crash rate for that intersection also decreased after the cameras were installed (1.41 per Million Vehicles Entering to 1.34 per MVE), though it is still significantly greater than the County average rate of 0.99 per MVE.

Comparisons of crash rates with Pima County Averages are provided for reference, but should be used with care, as the crash rate is highly dependent on how each jurisdiction determines which crashes are attributable to an intersection.

**Table 5. Signalized Intersection Crash Rate and Severity**

Intersection	Fatality	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	No Injury	Total Crashes	Severity Index	Entering Veh/Day (2006)	Crash Rate (per MVE)
Grant/Kolb and Tanque Verde (w/o Red Light Cameras)	0	5	22	32	99	158	1.49	97,000	1.41
Grant/Kolb and Tanque Verde (w/ Red Light Cameras)	0	2	5	9	37	53	1.45	97,000	1.34
Camino Principal and Tanque Verde	0	1	10	5	29	45	1.44	33,556	0.87
Sabino Canyon and Tanque Verde	0	3	13	26	67	109	1.49	77,000	0.90
Paseo Rancho Esperanza and Tanque Verde	0	0	3	11	9	23	1.61	28,032	0.45
Dos Hombres/Camino Pio Decimo and Tanque Verde	0	0	3	4	11	18	1.39	30,669	0.38
Kolb and Speedway	1	4	22	31	91	149	1.52	88,500	1.15
<b>TOTAL</b>	<b>1</b>	<b>15</b>	<b>78</b>	<b>118</b>	<b>343</b>	<b>555</b>	<b>1.49</b>		

**Table 6. Unsignalized Intersection Crash Severity**

Intersection	Fatality	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	No Injury	Total Crashes	Severity Index
Indian Ruins and Tanque Verde	0	0	5	7	11	23	1.52
Indian Ridge and Tanque Verde	0	0	0	0	1	1	1.00
Camino Valle Verde and Tanque Verde	0	0	0	0	2	2	1.00
Avenida Valiente and Tanque Verde	0	0	2	0	1	3	1.67
Sabino Canyon and Acoma	0	0	0	0	1	1	1.00
Sabino Canyon and Camino Bacelar	0	0	1	2	5	8	1.38
Kolb and Calle La Paz	0	0	0	0	2	2	1.00
<b>TOTAL</b>	<b>0</b>	<b>0</b>	<b>8</b>	<b>9</b>	<b>23</b>	<b>40</b>	<b>1.43</b>

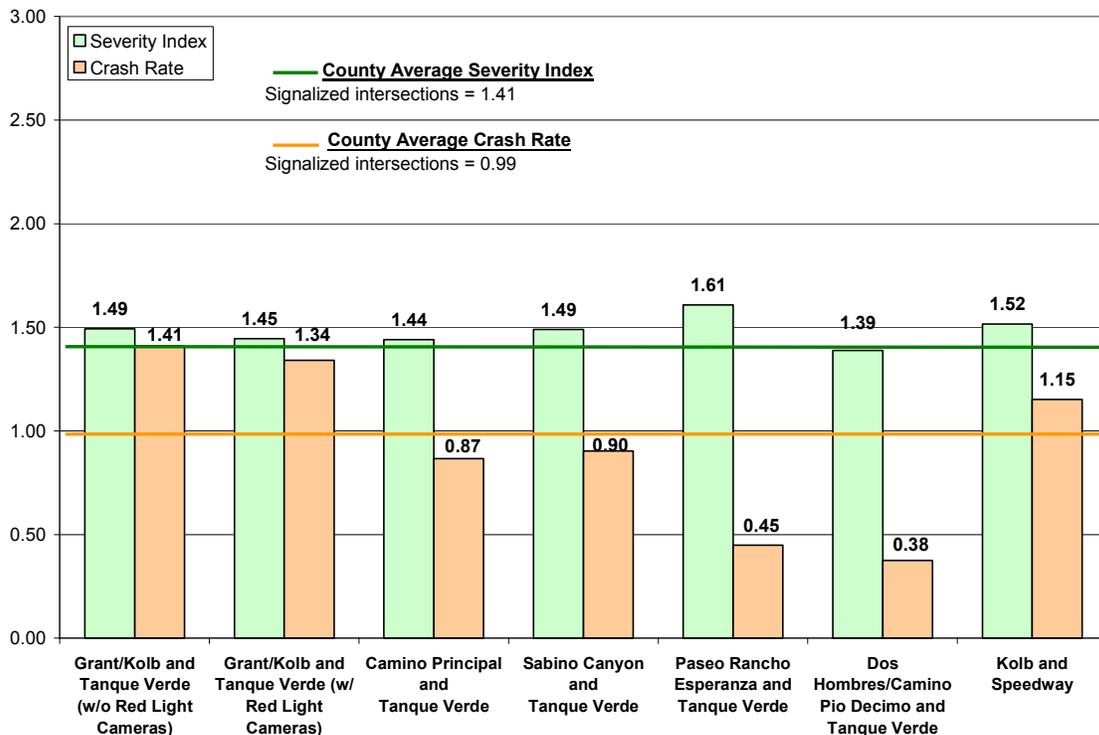
As shown in Table 6, the only unsignalized intersection with a severity rate higher than the Pima County average of 1.54 (for unsignalized intersections) is the intersection of Avenida Valiente and Tanque Verde Road (1.67). However, the severity index is well

within one standard deviation of the average. The severity index for each of the roadway segments included in this analysis is below the County average of 1.61, as seen in Table 7.

**Table 7. Road Segment Crash Rate and Severity**

Road Segment	Fatality	Incapacitating Injury	Non-Incapacitating Injury	Possible Injury	No Injury	Total Crashes	Severity Index	Entering Veh/Day	Segment Length (mi)	Crash Rate (per MVM)
Kolb Rd, Tanque Verde to Speedway	0	6	12	17	133	168	1.34	42,000	1.05	2.81
Tanque Verde Rd, Kolb to Cmo Pio Decimo/Dos Hombres	2	5	33	54	172	266	1.45	56,000	1.20	3.55
Sabino Canyon Rd, Camino del Rio to Tanque Verde	0	4	4	3	56	67	1.39	42,000	0.75	1.55
<b>TOTAL</b>	<b>2</b>	<b>15</b>	<b>49</b>	<b>74</b>	<b>361</b>	<b>501</b>	<b>1.41</b>			

Figure 5 graphically represents the information in Table 5 and compares the severity and rate of signalized intersection crashes to the 2005-2007 Pima County averages. As shown, the crash rate for the intersections of Grant Road/Kolb Road/Tanque Verde Road and Kolb Road/Speedway Boulevard is greater than the County average of 0.99 per MVE. The crash rate for all of the other intersections (where information was available) is less than the County average. However, the severity indices were very close to or above the County average for all of the signalized intersections.



**Figure 5. Crash Rate and Severity Comparison for Signalized Intersections**

### 3. FUTURE CONDITIONS – WITHOUT PROJECT (2030)

#### 3.1. TRAFFIC VOLUMES

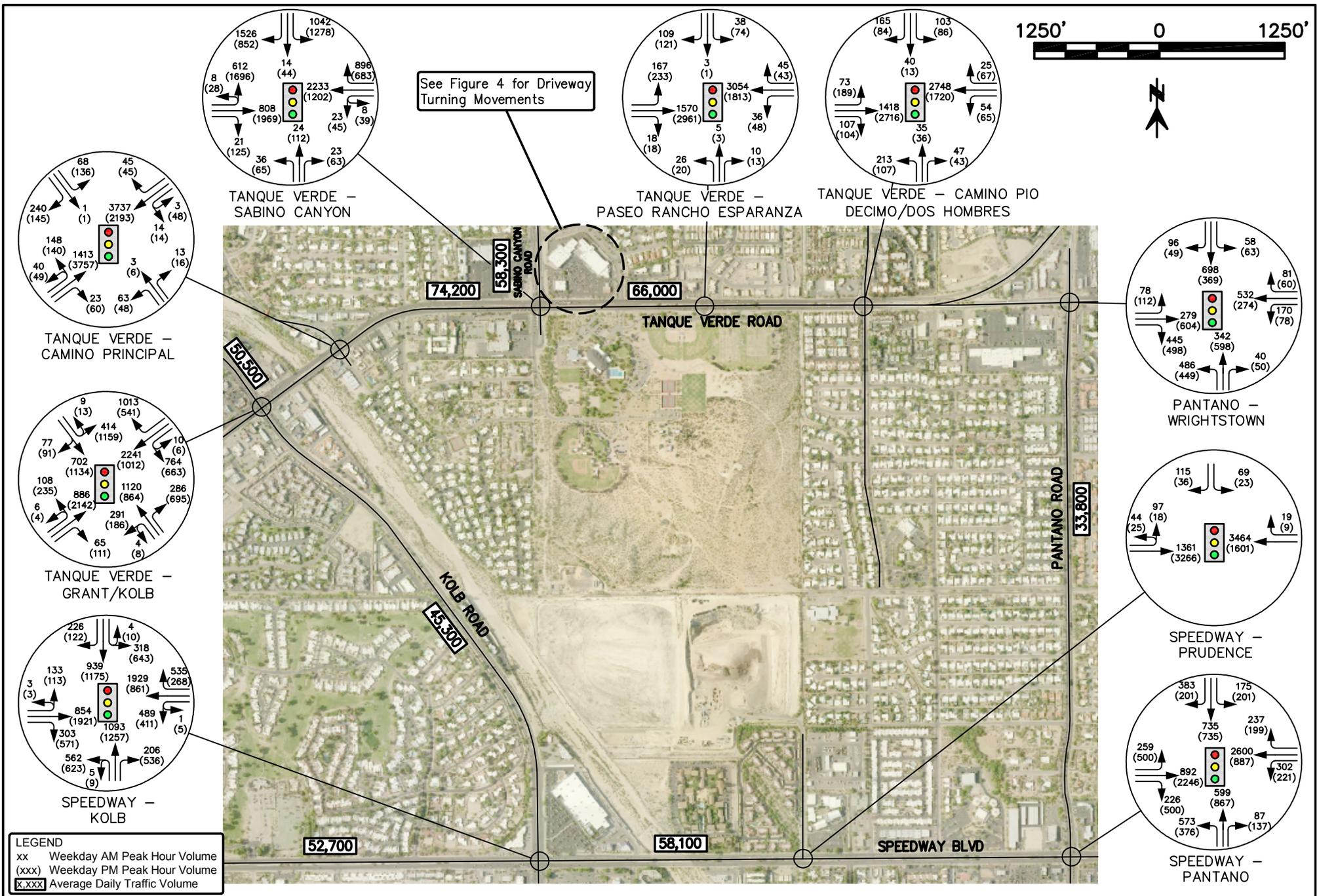
In order to determine the growth of traffic volumes in the project area without this project, data from the Pima Association of Governments (PAG) was used<sup>4</sup>. Volumes from four locations were chosen to determine an average growth rate, including Grant Road north of Tanque Verde Road, Sabino Canyon Road north of Tanque Verde Road, Tanque Verde Road east of Sabino Canyon Road, and Kolb Road north of Speedway Boulevard. The locations were chosen because they are outside the area where the most significant redistribution will take place once the new roadway is constructed. Therefore, volumes in those areas will be stable with or without the project.

As shown in Table 8, the average growth rate based on the most recent available PAG volumes and the 2030 PAG volume projections in the area is 1.1% per year, which is reasonable for a mostly built-up area. Instead of using individual growth rates for each roadway, the average rate (1.1%) was used for all roadways in consideration that individual growth variations may be due to the fact that the 2030 PAG model includes the Kolb Road/Sabino Canyon Road connection.

**Table 8. Background Growth Rate (PAG Projections)**

PAG Volumes	2004	2006	2007	2030	Growth Rt
Grant, N of Tanque Verde			49,000	59,300	0.8%
Sabino Canyon, N of Tanque Verde		42,000		60,500	1.5%
Tanque Verde, E of Sabino Canyon	52,000			60,800	0.6%
Kolb, New Connection to Speedway			42,000	57,800	1.4%
<b>Average Growth Rate = 1.1%</b>					

The 1.1% growth rate was applied to the existing turning movement counts at each of the study intersections to determine the projected 2030 traffic volumes without the project. Figure 6 shows the projected 2030 volumes without the project. Note that the turning movement volumes into and out of the Colonia Verde shopping center are not expected to change because the shopping center is already built out.



**KOLB ROAD: CONNECTION  
 TO SABINO CANYON  
 INITIAL TRAFFIC  
 ENGINEERING REPORT**

**FIGURE 6  
 PROJECTED 2030 TRAFFIC VOLUMES -  
 WITHOUT PROJECT**

### 3.2. OPERATIONAL ANALYSIS

#### 3.2.1. Level of Service

As with the existing conditions, the LOS for each of the signalized intersections in the study area was found using *Synchro* and the projected volumes shown in Figure 6. For this scenario, the lane configuration and storage lengths remained unchanged from the existing conditions at all of the intersections. The network was optimized only by making signal timing and phasing changes. The resulting delays and LOS are shown in Table 9, and the *Synchro* reports are included in Appendix B.

**Table 9. 2030 Delays and LOS – Without Project**

<b>Kolb Road/Grant Road and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	C	C	A	F	E	B	F	F	A	F	F	F	E
	Delay	32.1	29.9	4.9	96.9	64.6	16.5	91.4	113.7	8.5	116.9	137.6	137.6	73.2
PM	LOS	D	F	C	F	C	A	F	F	F	F	E	E	F
	Delay	46.8	201.1	21.9	322.0	34.1	4.9	80.5	131.5	598.8	182.0	57.8	57.8	170.9

<b>Camino Principal and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	F	A	A	A	F	A	E	B	B	D	D	E	F
	Delay	91.5	5.9	3.7	4.9	145.3	5.4	68.4	18.6	18.6	54.4	46.0	68.1	101.5
PM	LOS	D	F	A	D	A	A	E	D	D	E	D	C	E
	Delay	49.4	86.1	2.3	38.4	9.6	1.8	66.5	48.5	48.5	77.1	48.0	25.0	56.2

<b>Sabino Canyon Road and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	E	B	B	E	F	D	E	D	D	F	F	F	F
	Delay	73.8	10.5	10.5	78.7	83.0	47.9	67.7	47.5	47.5	158.8	160.6	180.2	100.0
PM	LOS	F	D	D	F	F	E	E	F	F	F	F	B	F
	Delay	320.3	42.4	42.4	178.1	126.5	64.5	66.1	144.2	144.2	168.8	175.5	15.0	136.4

<b>Paseo Rancho Esperanza and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	D	A	A	A	A	A	E	C	C	D	B	B	A
	Delay	53.8	9.5	4.7	1.4	6.6	1.2	58.0	29.4	29.4	54.4	14.7	14.7	9.8
PM	LOS	E	C	A	B	A	A	D	C	C	E	B	B	C
	Delay	71.0	26.3	6.2	10.1	9.5	4.7	50.1	23.2	23.2	57.0	12.1	12.1	22.3

<b>Dos Hombres Road/Camino Pio Decimo and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total Intersection
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS	D	B	B	C	D	D	E	C	A	D	C	C	D
	Delay	49.2	14.2	14.2	25.1	51.7	51.7	67.4	31.3	9.2	35.7	31.0	28.0	39.1
PM	LOS	E	C	C	C	B	B	E	D	A	D	D	A	C
	Delay	65.0	20.5	20.5	29.2	14.5	14.5	57.5	39.9	9.8	46.3	37.0	8.9	21.6

**Table 9. 2030 Delays and LOS – Without Project (cont'd)**

		<b>Pantano Road and Wrightstown Road</b>												<b>Total Intersection</b>
		<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>			
		<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	
<b>AM</b>	<b>LOS</b>	E	C	A	C	F	B	F	C	C	B	E	E	E
	<b>Delay</b>	64.2	27.0	5.8	32.6	96.3	14.5	112.2	33.9	33.9	12.8	64.7	64.7	58.6
<b>PM</b>	<b>LOS</b>	C	C	B	D	D	A	D	D	D	B	C	C	C
	<b>Delay</b>	33.0	34.6	15.6	38.5	35.8	8.4	45.1	42.5	42.5	15.6	31.1	31.1	33.7

		<b>Kolb Road and Speedway Boulevard</b>												<b>Total Intersection</b>
		<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>			
		<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	
<b>AM</b>	<b>LOS</b>	D	D	A	E	E	B	F	F	B	D	E	C	D
	<b>Delay</b>	49.1	35.9	5.5	69.0	57.0	14.0	94.0	82.5	17.7	48.9	57.8	33.3	54.6
<b>PM</b>	<b>LOS</b>	C	F	C	F	C	A	F	F	F	E	E	C	F
	<b>Delay</b>	25.7	141.6	34.0	118.9	20.1	2.8	126.5	118.6	163.0	79.8	69.1	24.1	97.0

		<b>Prudence Road and Speedway Boulevard</b>												<b>Total Intersection</b>
		<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>			
		<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	
<b>AM</b>	<b>LOS</b>	F	A			F	F				E		E	E
	<b>Delay</b>	121.3	8.6			80.1	80.1				62.1		62.2	62.9
<b>PM</b>	<b>LOS</b>	A	A			B	B				E		C	A
	<b>Delay</b>	1.8	7.2			11.3	11.3				69.3		23.6	9.2

		<b>Pantano Road and Speedway Boulevard</b>												<b>Total Intersection</b>
		<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>			
		<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	
<b>AM</b>	<b>LOS</b>	F	C	B	D	F	C	F	F	C	F	F	E	F
	<b>Delay</b>	275.9	30.8	14.7	42.2	133.1	21.2	231.6	80.9	32.0	86.6	142.9	74.6	111.7
<b>PM</b>	<b>LOS</b>	F	F	C	F	E	D	F	F	C	F	E	B	F
	<b>Delay</b>	81.3	179.9	31.4	101.8	69.8	42.5	141.7	95.4	32.5	176.6	67.4	18.1	112.8

As seen in the table, seven of the nine signalized intersections will operate at LOS E or F in at least one peak hour. The intersections of Sabino Canyon Road/Tanque Verde Road and Pantano Road/Speedway Boulevard will operate at LOS F in both the morning and evening peak hours. In addition, there are 50 movements that would operate at LOS F during the morning or evening peak period. Of those movements, 39 serve volumes greater than 200 veh/hr. This is compared to the 25 movements that operate at LOS F today (16 of which serve more than 200 vehicles per hour).

Further, several individual movements will operate with more than 3 minutes of delay per vehicle, including the eastbound throughs, westbound and southbound left turns, and the northbound right turns at the intersection of Grant Road/Kolb Road and Tanque Verde Road in the PM peak hour. Also at the Grant Road/Kolb Road/Tanque Verde Road intersection, the southbound through and right turns will operate with more than 2 minutes of delay per vehicle in the AM peak hour.

At the intersection of Sabino Canyon Road and Tanque Verde Road, all of the southbound movements will operate with at least 155 seconds of delay per vehicle in both peak hours with the exception of the right turns in the PM peak hour, which will operate at LOS B.

Several movements at the intersections of Kolb Road/Speedway Boulevard and Pantano Road/Speedway Boulevard will also operate at LOS F in 2030 without the construction of the Kolb Road/Sabino Canyon Road connection. Overall, with only timing and phasing changes (no lane additions), the network will operate with considerably higher delays in 2030 than under existing conditions. Further, *SimTraffic* shows that queues from one intersection will often impact another, a scenario which is not considered in the *Synchro* analysis and which will increase the overall delays above what has been reported in Table 9. For example, *SimTraffic* shows that the westbound queue on Tanque Verde Road at Grant Road/Kolb Road will back up to Camino Principal, blocking the intersection.

### **3.2.2. Queues**

In addition to evaluating the projected delays and LOS for the study area in 2030 without the project, the projected queue lengths were also evaluated. As with the delays, the queue lengths were taken from *Synchro*. The 95<sup>th</sup> percentile queues, those which are exceeded in only 5% of the peak hour signal cycles, are presented in Table 10. Note that the queues were only evaluated for the intersections of Grant Road/Kolb Road/Tanque Verde Road, Camino Principal/Tanque Verde Road, Sabino Canyon Road/Tanque Verde Road, and Kolb Road/Speedway Boulevard because the queues at other intersections in the project area will likely not be significantly affected by this project.

Highlighted cells indicate that the projected queue will exceed the storage currently available for the movement in question. As seen in the table, there are several movements with 95<sup>th</sup> percentile queues that significantly exceed the available storage. Those that are most likely to be affected by this project are the westbound left turn and northbound right turn queues at the intersection of Grant Road/Kolb Road and Tanque Verde Road, and the eastbound, westbound, and southbound left turn, and southbound right turn queues at the intersection of Sabino Canyon Road and Tanque Verde Road.

**Table 10. 2030 95<sup>th</sup> Percentile Queues – Without Project**

<b>Kolb Road/Grant Road and Tanque Verde Road</b>												
	<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>		
	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>
<b>AM</b>	<100	279	<100	186	502	116	332	538	<100	344	445	445
<b>PM</b>	101	1,181	<100	584	306	<100	171	358	911	938	529	529
<b>Storage</b>	210		210	280		220	275		180	290		

<b>Camino Principal and Tanque Verde Road</b>												
	<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>		
	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>
<b>AM</b>	320	216	5	4	1,460	<100	85	<100	<100	111	<100	306
<b>PM</b>	86	396	3	52	241	<100	66	<100	<100	208	<100	113
<b>Storage</b>	95		65	100		200	40			30		105

<b>Sabino Canyon Road and Tanque Verde Road</b>												
	<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>		
	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>
<b>AM</b>	447	105	105	<100	1,069	953	<100	<100	<100	631	705	1,225
<b>PM</b>	1,148	489	489	212	632	649	108	265	265	770	871	278
<b>Storage</b>	515			135		470	130			210		820

<b>Kolb Road and Speedway Boulevard</b>												
	<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>		
	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>
<b>AM</b>	<100	292	<100	144	699	201	377	515	120	<100	327	<100
<b>PM</b>	<100	947	447	327	128	<100	456	637	817	285	419	<100
<b>Storage</b>	340		385	340		575	370		290	295		250

Without the project in 2030, the 95<sup>th</sup> percentile southbound left turn queue in the PM peak hour at Grant Road/Kolb Road/Tanque Verde Road will be over 900 feet, with only 290 feet of available storage. The 95<sup>th</sup> percentile queue for the same movement will also exceed the storage in the AM peak hour, though only by approximately 55 feet. The westbound right turn queue at Grant Road/Kolb Road/Tanque Verde Road is not expected to exceed the available storage in either peak hour. However, the westbound through queue at the intersection will likely block the right turn lane in both peak hours, increasing westbound right turn delay. This phenomenon was observed in *SimTraffic*.

At the intersection of Sabino Canyon Road and Tanque Verde Road, the eastbound left turns are expected to have a 95<sup>th</sup> percentile queue of over 1,100 feet in the PM peak hour without the project in 2030, which means that the left turn queue will block the shopping center entrance and the turnout at Indian Ridge Road, and will block the inside through lane. The southbound left turn queue will continue to block the shopping center entrance (as it does today during the PM peak hour), and the southbound right turn queue will also exceed the 820 feet of available storage.

## **4. FUTURE CONDITIONS – WITH PROJECT (2030)**

In order to evaluate traffic conditions with the project it is necessary to make baseline assumptions regarding the cross-section of the proposed roadway and the improvements anticipated as part of this project at the intersections in the study area. Under those assumptions, traffic volumes were then redistributed in the projected roadway network, and the operational performance (LOS and queues) was evaluated.

### **4.1. PROPOSED IMPROVEMENTS**

#### **4.1.1. Roadway Improvements**

The proposed roadway is an extension of Sabino Canyon Road from Tanque Verde Road to Kolb Road. At the north end, the new roadway will become the new south leg of the intersection of Sabino Canyon Road and Tanque Verde Road. At the south end, the roadway will form a t-intersection with Kolb Road approximately 2,000 feet north of Speedway Boulevard.

This project is included in the Regional Transportation Authority's (RTA) plan, and is scheduled for construction during the first period (2007-2011). From the RTA plan, the roadway should be constructed as a four-lane divided roadway, with multi-use lanes and sidewalks.

#### **4.1.2. Intersection Improvements**

The intersection geometry and lane configuration at the intersection of Sabino Canyon Road and Tanque Verde Road will be the most affected by the construction of the Kolb Road: Connection to Sabino Canyon project. Because of the expected increase in westbound left turns at the intersection, a second westbound left turn lane will be added. The west leg (serving eastbound traffic) will remain unchanged. One additional southbound lane will be added, and the southbound lane configuration will be changed to provide two left turn lanes, two through lanes, and two right turn lanes. The new south leg (for northbound traffic) will have one left turn lane, two through lanes, and one right turn lane.

At the new intersection of Kolb Road and the new roadway, Kolb Road will have a southbound left turn lane and a northbound right turn lane, in addition to the existing three through lanes in each direction. A northbound left turn lane will also be provided to allow u-turns at the intersection. The new roadway will have dual left turn lanes and a single right turn lane. No changes in configuration are anticipated at any of the other intersections in the study area.

#### **4.1.3. Access Management**

One of the most efficient means of providing a high level of mobility and maintaining safety on major arterials is to manage access onto the roadway, while still serving the needs of the adjacent land uses. Although existing access points are difficult to eliminate, left turn opportunities should be properly spaced to reduce the number of vehicular conflict points.

The *Transportation Access Management Guidelines for the City of Tucson, Arizona*<sup>5</sup> requires 660 feet for median openings on major arterials. In order to provide access to neighboring residential, commercial, and recreational areas, four median openings will be provided along the new roadway. The first will be located at the existing southernmost driveway of the shopping center located on the southwest corner of the Sabino Canyon Road/Tanque Verde Road intersection. The driveway is approximately 500 feet from the intersection, which does not meet the standard of 660 feet. However, because the median opening will only provide a northbound left turn lane and not a southbound left turn lane, there will still be room to provide sufficient storage for the northbound left turn lane at Tanque Verde Road.

The second median opening will be located at Crestline Drive, and will allow all movements to and from all four legs of the intersection. The existing driveway that provides access to Udall Park will be realigned to tie in directly across from Crestline Drive. A third median opening will be provided approximately 670 feet south of Crestline Drive, where Calle Malaga will be realigned to tee in to the new roadway. The final median opening will be provided 950 feet south of Calle Malaga, and will provide access to the existing reclaimed water facility. Figure 7 shows the proposed median openings and the spacing between each along the new roadway.



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**FIGURE 7  
PROPOSED  
MEDIAN OPENINGS**

**P S O M A S**

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As discussed in Section 2.3, the Colonia Verde driveway on Sabino Canyon Road limits the southbound left turn storage at the intersection of Sabino Canyon Road and Tanque Verde Road. In order to provide additional storage and maintain the existing access into the shopping center, it is recommended that the median be reconstructed similarly to the existing median on the west leg of the intersection, shown in Figure 8. The new configuration would still allow left turns into the shopping center, but by removing part of the median south of the shopping center driveway, would provide approximately 300 feet of storage for the southbound left turns at Tanque Verde Road (compared to the approximately 210 feet of existing southbound left turn storage). A porkchop should be constructed at the shopping center driveway with this change in order to prevent westbound left turns out of the shopping center, which are currently prohibited. The porkchop would also allow the left turn queue to block the median opening without creating additional delays for vehicles wishing to exit the shopping center.

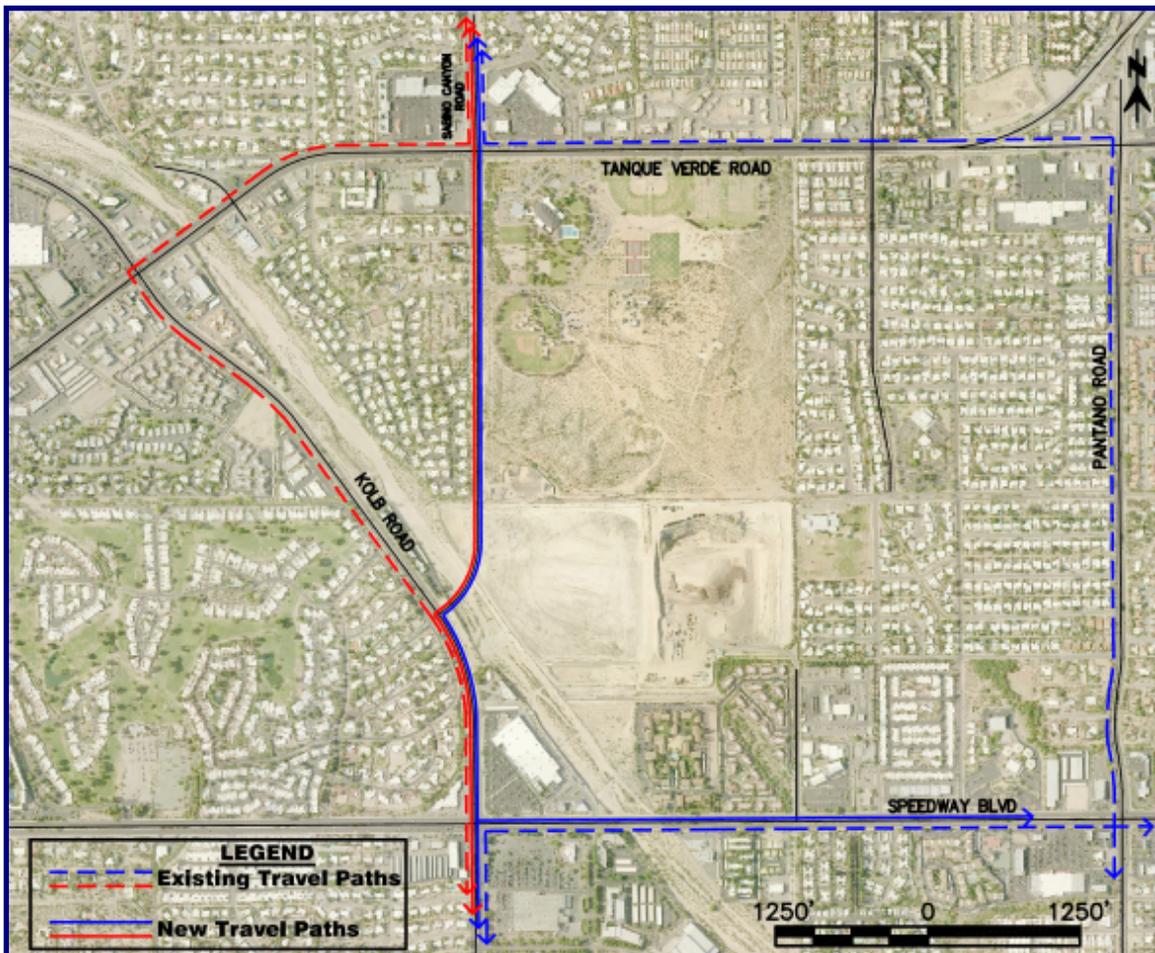


**Figure 8. West Leg of Sabino Canyon Rd and Tanque Verde Rd Intersection**

#### **4.2. TRAFFIC VOLUMES**

The construction of a four-lane roadway from Tanque Verde Road to Kolb Road will likely change travel patterns at several intersections in the area. Traffic volumes were redistributed to the new roadway network using the anticipated origins and destinations and finding the shortest path between each origin and destination. Supporting information was obtained from the PAG regional travel demand model. Appendix D, from PAG, shows the destination of vehicles that make southbound left turns from Sabino Canyon Road onto Tanque Verde Road in the evening peak period.

Figure 9 shows the most significant changes in travel paths resulting from the construction of the project. As shown in the figure, the project will significantly reduce volumes at the Grant Road/Kolb Road/Tanque Verde Road intersection, which will help decrease delays at the intersection. In addition, some of the southbound left turns at the intersection of Sabino Canyon Road and Tanque Verde Road will now continue through in the southbound direction. Since through movements have higher capacities than left turn movements, delays at the Sabino Canyon Road/Tanque Verde Road intersection are also expected to improve with the project.



**Figure 9. Changes in Travel Paths With Project**

More specifically, the addition of the project was assumed to result in the following changes in travel patterns. At Sabino Canyon Road and Tanque Verde Road, southbound left turns are expected to decrease by 25% because vehicles will instead continue through onto the new roadway to reach Kolb Road. Southbound right turns are expected to decrease by 25% in the morning peak hour and 30% in the evening peak

hour for the same reason. Eastbound left turns will also decrease by 20%, which will in turn decrease the northbound right turn volume at the intersection of Grant Road/Kolb Road and Tanque Verde Road.

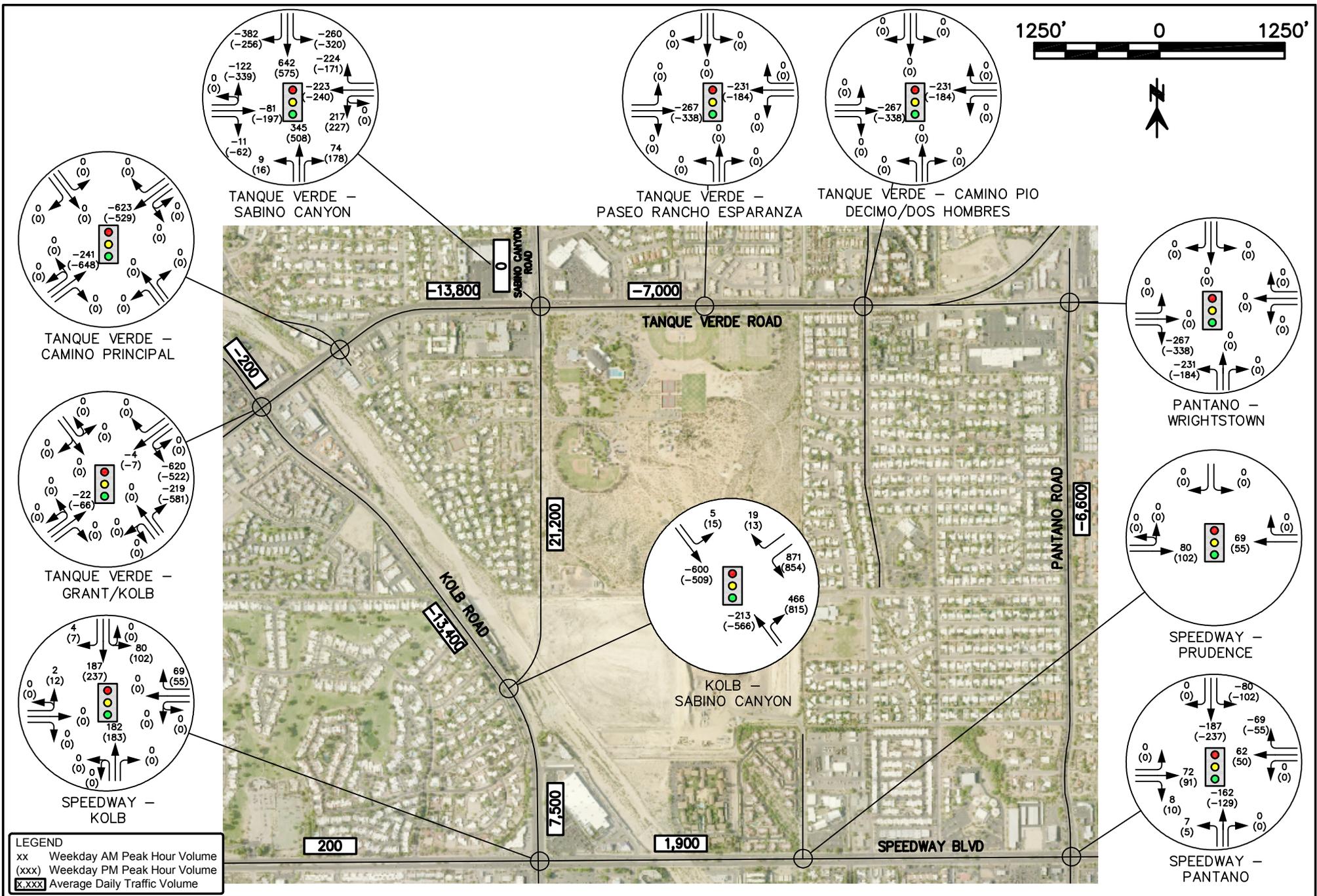
Because of the changes at the Sabino Canyon Road/Tanque Verde Road intersection, other movements at nearby intersections will be affected, similar to the expected decrease in the northbound right turn movement at the intersection of Grant Road/Kolb Road and Tanque Verde Road. For example, the southbound through and left turn volumes at the intersection of Kolb Road and Speedway Boulevard will increase, since vehicles that previously used Pantano Road or Wilmot Road will use the new connection and will subsequently travel through the Kolb Road/Speedway Boulevard intersection.

Once the redistribution was complete, the projected 2030 ADTs with the project were calculated, and the growth rate was again calculated. As seen in Table 11, the overall growth percentage is 1.1%, which matches the original growth rate calculated from the PAG data. Further, the individual growth rates are consistent with the PAG projections. Note that Tanque Verde Road east of Sabino Canyon Road will grow at a lower rate than the average because traffic from that segment is expected to use the new roadway. The higher than average growth on Kolb Road can be similarly explained in that traffic using the new roadway will travel on Kolb Road instead of Tanque Verde Road.

The ADT on the new roadway is expected to be 21,200 vehicles per day. From the Florida Quality/Level of Service Tables<sup>6</sup>, the capacity of a two-lane roadway is 14,900 vehicles per day at LOS D. Therefore, the new roadway will need to be a four-lane divided roadway, which has a capacity of 33,000 vehicles per day at LOS D. Figure 10 shows the change in turning volumes with the project, and the projected 2030 volumes with the project are shown in Figure 11.

**Table 11. Projected Growth Rate (2030 with Project)**

<b>Psomas Projections</b>	<b>2009*</b>	<b>2030</b>	<b>PAG Growth Rt</b>	<b>Calculated Growth Rt</b>
Grant, N of Tanque Verde	40,100	50,300	0.8%	1.1%
Sabino Canyon, N of Tanque Verde	46,350	58,300	1.5%	1.1%
Tanque Verde, E of Sabino Canyon	51,881	59,000	0.6%	0.6%
Kolb, New Connection to Speedway	36,363	52,400	1.4%	1.8%
		<b>Average Growth Rate</b>	<b>1.1%</b>	<b>1.1%</b>

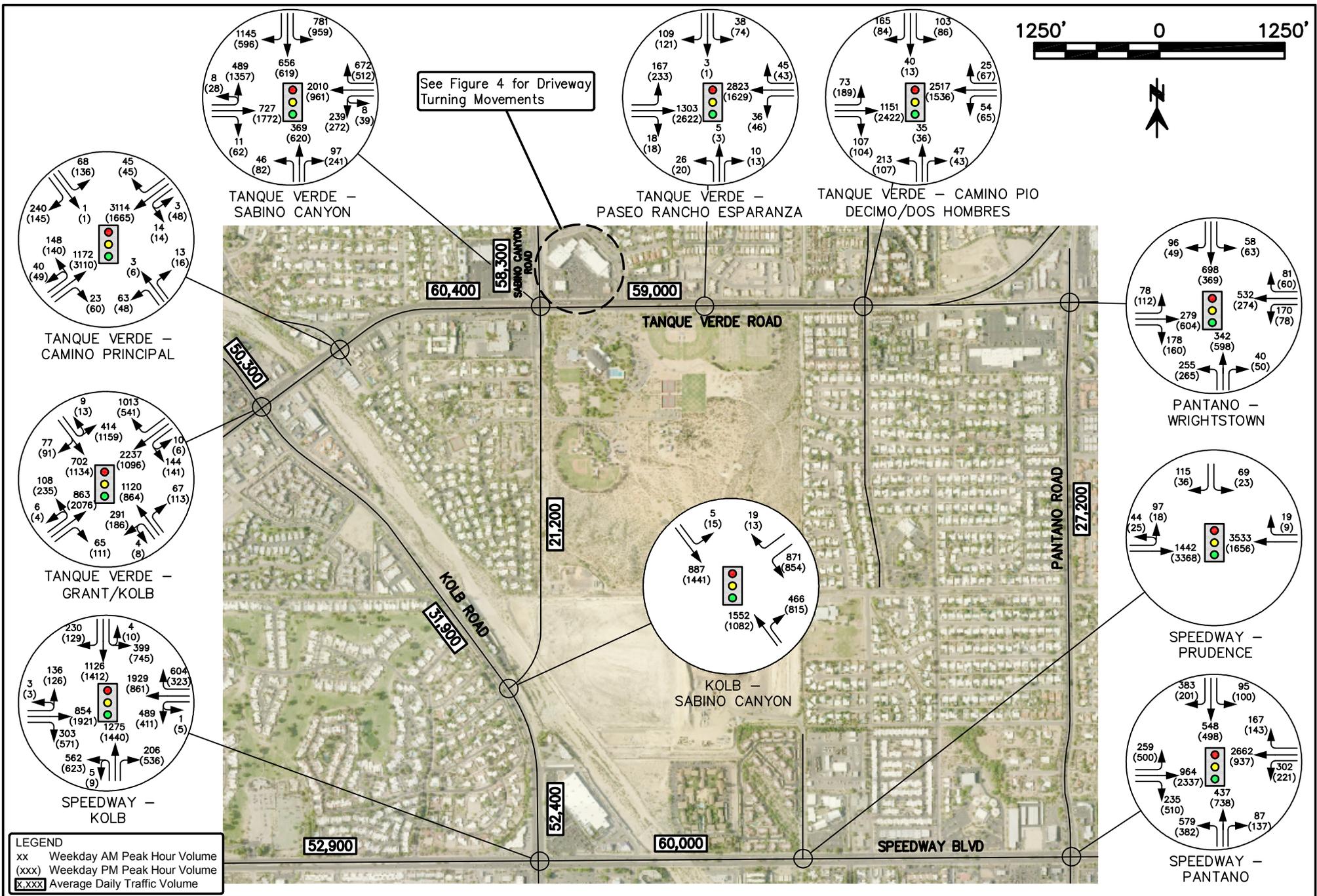


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**FIGURE 10  
 CHANGE IN TRAFFIC VOLUMES  
 WITH PROJECT (2030)**

**PSOMAS**

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**FIGURE 11  
PROJECTED 2030 TRAFFIC VOLUMES - WITH PROJECT**

**PSOMAS**

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### 4.3. OPERATIONAL ANALYSIS

#### 4.3.1. Level of Service

The delays and LOS shown in Table 12 are based on the 2030 volumes shown in Figure 11 and the lane configurations discussed in the two previous sections. Again, the information was taken from *Synchro*. The *Synchro* reports are included in Appendix B.

**Table 12. 2030 Delays and LOS – With Project**

<b>Kolb Road/Grant Road and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	Intersection
AM	LOS	E	C	A	B	C	A	F	E	A	D	E	E	D
	Delay	60.2	26.2	4.3	11.8	26.2	4.4	83.6	62.5	6.0	49.9	62.7	62.7	36.6
PM	LOS	E	F	B	F	C	A	F	F	B	F	D	D	E
	Delay	78.9	95.9	16.4	101.3	20.4	2.2	96.9	140.8	20.0	127.2	49.0	49.0	78.6

<b>Camino Principal and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	Intersection
AM	LOS	F	A	A	A	C	A	E	B	B	E	D	E	C
	Delay	92.8	8.0	3.3	4.2	33.0	2.2	75.1	19.1	19.1	56.9	47.0	56.8	31.6
PM	LOS	E	B	A	D	A	A	E	D	D	E	D	D	B
	Delay	71.7	12.8	3.6	54.6	8.4	0.2	66.5	36.5	36.5	77.1	48.0	45.8	17.6

<b>Sabino Canyon Road and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	Intersection
AM	LOS	F	C	C	B	E	B	C	F	B	E	D	D	E
	Delay	128.0	29.6	29.6	19.8	73.5	16.5	32.9	111.9	17.2	73.9	51.1	46.1	59.5
PM	LOS	F	F	F	E	F	D	C	F	E	F	D	A	F
	Delay	211.2	104.1	104.1	71.9	116.0	40.6	24.6	137.5	74.9	150.7	43.6	7.6	110.0

<b>Paseo Rancho Esperanza and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	Intersection
AM	LOS	E	B	A	A	A	A	E	C	C	D	B	B	B
	Delay	58.4	13.8	6.8	1.5	5.2	0.7	57.6	29.3	29.3	54.1	18.1	18.1	10.6
PM	LOS	C	B	A	B	B	A	D	C	C	E	B	B	B
	Delay	32.8	12.9	4.8	13.7	12.5	3.4	50.1	23.2	23.2	57.0	12.1	12.1	14.5

<b>Dos Hombres Road/Camino Pio Decimo and Tanque Verde Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	Intersection
AM	LOS	C	B	B	B	D	D	E	C	A	D	C	B	C
	Delay	27.9	11.5	11.5	14.8	36.0	36.0	66.2	31.1	7.5	35.5	30.8	16.3	29.7
PM	LOS	D	B	B	C	B	B	E	D	A	D	D	A	C
	Delay	36.5	19.0	19.0	25.6	15.2	15.2	57.5	39.9	9.8	46.3	37.0	8.9	20.2

<b>Pantano Road and Wrightstown Road</b>														
		Eastbound			Westbound			Northbound			Southbound			Total
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	Intersection
AM	LOS	E	C	A	C	E	B	D	C	C	B	D	D	D
	Delay	56.8	24.2	4.9	27.6	64.9	13.6	44.8	29.9	29.9	13.6	45.3	45.3	39.9
PM	LOS	C	C	A	C	C	A	C	C	C	B	C	C	C
	Delay	23.8	26.1	8.1	27.4	27.2	6.5	28.1	32.8	32.8	17.7	25.4	25.4	26.2

**Table 12. 2030 Delays and LOS – With Project (cont'd)**

		<b>New Intersection</b>												<b>Total Intersection</b>
		<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>			
		<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	
<b>AM</b>	<b>LOS</b>				D		A		A	A	A	A		B
	<b>Delay</b>				38.5		5.5		7.9	0.2	2.0	3.0		12.8
<b>PM</b>	<b>LOS</b>				C		A		A	A	A	A		B
	<b>Delay</b>				34.5		4.5		4.5	9.3	3.2	3.9		11.3

		<b>Kolb Road and Speedway Boulevard</b>												<b>Total Intersection</b>
		<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>			
		<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	
<b>AM</b>	<b>LOS</b>	E	D	A	E	E	B	F	E	B	C	D	D	D
	<b>Delay</b>	55.4	47.9	8.7	63.4	71.7	13.2	84.9	68.4	18.6	30.4	51.5	37.5	54.9
<b>PM</b>	<b>LOS</b>	C	F	D	F	C	A	F	F	F	F	E	B	F
	<b>Delay</b>	26.2	180.8	39.0	212.2	20.3	7.8	126.1	112.0	158.8	158.6	76.6	16.9	114.9

		<b>Prudence Road and Speedway Boulevard</b>												<b>Total Intersection</b>
		<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>			
		<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	
<b>AM</b>	<b>LOS</b>	F	A			F	F				E		E	E
	<b>Delay</b>	123.8	3.2			89.4	89.4				61.2		64.6	67.5
<b>PM</b>	<b>LOS</b>	A	B			A	A				E		C	A
	<b>Delay</b>	5.2	10.6			5.3	5.3				69.3		27.1	9.3

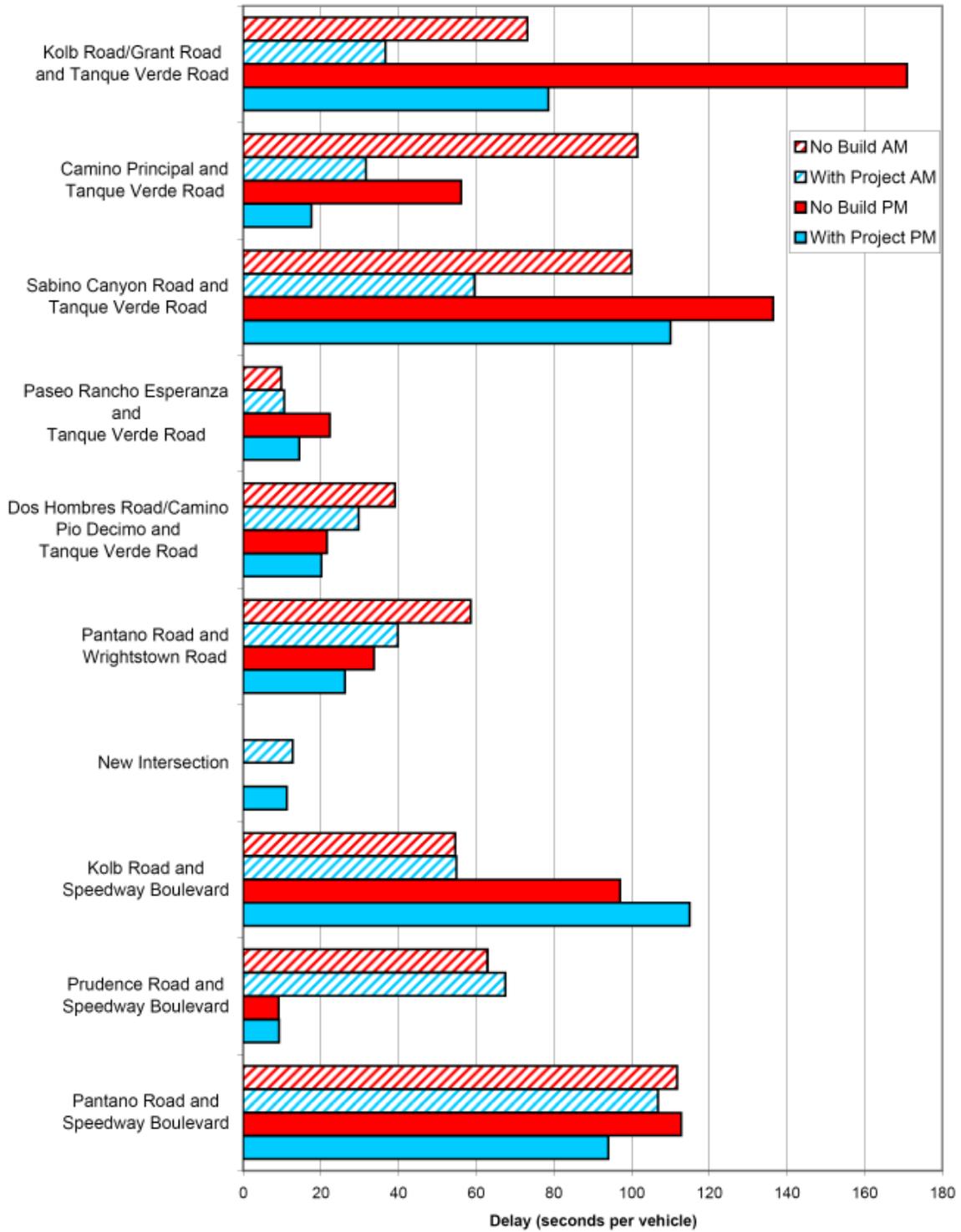
		<b>Pantano Road and Speedway Boulevard</b>												<b>Total Intersection</b>
		<b>Eastbound</b>			<b>Westbound</b>			<b>Northbound</b>			<b>Southbound</b>			
		<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	<b>LT</b>	<b>TH</b>	<b>RT</b>	
<b>AM</b>	<b>LOS</b>	F	C	A	D	F	B	F	E	C	D	F	F	F
	<b>Delay</b>	179.7	21.5	7.5	50.0	130.4	18.7	142.9	69.8	29.3	48.0	230.2	132.6	106.8
<b>PM</b>	<b>LOS</b>	E	F	C	F	E	D	E	F	D	E	F	B	F
	<b>Delay</b>	56.4	142.7	21.3	106.0	61.6	36.4	55.8	108.9	35.6	58.0	93.0	15.8	94.0

As seen in the table, the intersections of Sabino Canyon Road/Tanque Verde Road, Kolb Road/Speedway Boulevard, and Pantano Road/Speedway Boulevard will operate at LOS F in the PM peak hour. The intersection of Pantano Road and Speedway Boulevard will also operate at LOS F in the AM peak hour. However, even though those intersections will be operating at LOS F, the average delay per vehicle will be significantly less than it would be without the project. For example, the intersection of Sabino Canyon Road and Tanque Verde Road is expected to operate with 110.0 seconds of delay per vehicle with the project in the PM peak hour, but with 136.4 seconds of delay per vehicle without the project. The intersection of Kolb Road/Grant Road/Tanque Verde Road is expected to operate with delays of 36.6 sec/veh and 78.6 sec/veh in the AM and PM peak hours with the project, respectively, and with delays of 73.2 sec/veh and 170.9 sec/veh in the AM and PM peak hours without the project, respectively.

The other intersections will operate at LOS E or better in both peak hours, with a majority operating at LOS D or better in both peak hours. The latter group includes the new intersection on Kolb Road, which will operate at LOS B in both peak hours. The project will slightly increase delays at the intersection of Kolb Road and Speedway Boulevard, although the LOS will be the same with or without the project (LOS D in the AM peak hour, LOS F in the PM peak hour).

In terms of individual movements, there are 34 movements that will operate at LOS F during the morning or evening peak period. Of those 34 movements, 28 serve volumes greater than 200 vehicles per hour. This is compared to the 50 movements that would operate at LOS F without the project (39 of them serving more than 200 veh/hr).

Figure 12 shows the overall intersection delays for both the AM and PM peak hours in 2030 with and without the project. The figure illustrates that in most cases, the intersection delays will be lower (often much lower) with the project than without in 2030. The exceptions are at the intersections of Kolb Road/Speedway Boulevard and Prudence Road/Speedway Boulevard in both peak hours. In addition, there will be a slight increase in the delay at Paseo Rancho Esperanza and Tanque Verde Road in the AM peak hour (9.8 sec/veh compared to 10.6 sec/veh), likely the result of signal timing at adjacent intersections and signal coordination changes along Tanque Verde Road.



**Figure 12. Intersection Delays With and Without Project (2030)**

### 4.3.2. Queues

As with the 2030 conditions without the project, the 95<sup>th</sup> percentile queues with the project in 2030 were evaluated using *Synchro*. The results are shown in Table 13. The queues were only evaluated for the intersections of Grant Road/Kolb Road/Tanque Verde Road, Camino Principal/Tanque Verde Road, Sabino Canyon Road/Tanque Verde Road, Kolb Road/Speedway Boulevard, and the intersection of the new road with Kolb Road because the queues at other intersections in the project area will not be significantly affected by this project.

**Table 13. 2030 95<sup>th</sup> Percentile Queues – With Project**

<b>Kolb Road/Grant Road and Tanque Verde Road</b>												
	Eastbound			Westbound			Northbound			Southbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
<b>AM</b>	<100	253	<100	<100	641	<100	437	636	<100	240	350	350
<b>PM</b>	139	1,014	<100	103	227	<100	313	500	114	885	497	497
<b>Storage</b>	210		210	280		220	275		180	290		

<b>Camino Principal and Tanque Verde Road</b>												
	Eastbound			Westbound			Northbound			Southbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
<b>AM</b>	326	216	9	4	1,372	<100	85	<100	<100	111	<100	262
<b>PM</b>	78	435	12	44	497	<100	66	<100	<100	208	<100	166
<b>Storage</b>	95		65	100		200	40			30		105

<b>Sabino Canyon Road and Tanque Verde Road</b>												
	Eastbound			Westbound			Northbound			Southbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
<b>AM</b>	376	205	205	<100	932	502	<100	289	<100	441	362	817
<b>PM</b>	1,009	938	938	151	520	599	<100	484	225	652	317	134
<b>Storage</b>	515			135		470	130			300		820

<b>New Intersection</b>												
	Eastbound			Westbound			Northbound			Southbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
<b>AM</b>				492		<100		168	<100	<100	<100	
<b>PM</b>				446		<100		<100	417	<100	<100	

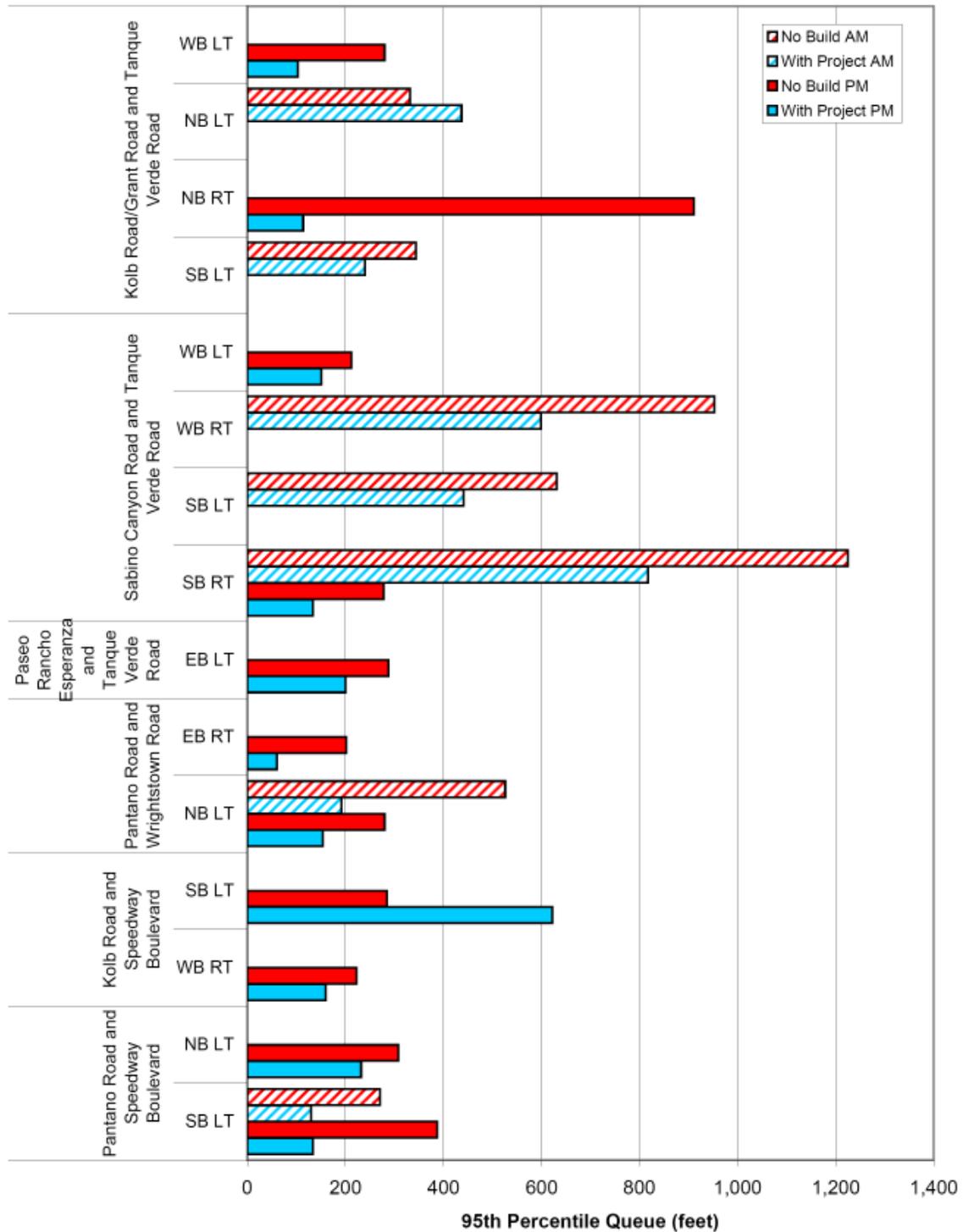
  

<b>Kolb Road and Speedway Boulevard</b>												
	Eastbound			Westbound			Northbound			Southbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
<b>AM</b>	<100	336	<100	145	578	160	365	550	134	161	415	158
<b>PM</b>	<100	998	464	352	299	200	456	711	867	622	683	<100
<b>Storage</b>	340		385	340		575	370		290	295		250

With the project, the westbound left turn and northbound right turn queues at the intersection of Grant Road/Kolb Road and Tanque Verde Road are not expected to

exceed the available storage in either peak hour, and are therefore unlikely to spill back into and affect adjacent intersections. Recall that in 2030 without the project, the queues for those movements will exceed the available storages by at least 300 feet in the PM peak hour. The reduction in queue length (and corresponding reduction in delays) is a result of traffic using the new roadway and no longer traveling through the Grant Road/Kolb Road and Tanque Verde Road intersection. Figure 13 presents a comparison of 95<sup>th</sup> percentile queue lengths with and without the project in 2030 for turning movements with queues longer than 200 feet without the project and an anticipated queue length change of 25% or more with the project.

At the intersection of Sabino Canyon Road and Tanque Verde Road, the eastbound left turn queue is expected to exceed the available storage, but will be approximately 150 feet shorter with the project than without the project. With the project, the southbound left turn storage will be extended to approximately 300 feet (as discussed in Section 4.1.3). The 95<sup>th</sup> percentile southbound left turn queue is expected to exceed the new storage length in 2030 with or without the project, as it exceeds the existing storage today. However, the queue with the project will be somewhat shorter than without the project. Further, there will only be two southbound left turn lanes with the project, where there will be dual left turn lanes and a shared through-left turn lane without the project.



**Figure 13. 95<sup>th</sup> Percentile Queue Lengths With and Without Project (2030)**

## 5. RECOMMENDATIONS

The proposed project consists of constructing a new roadway to extend Sabino Canyon Road from Tanque Verde Road to Kolb Road. The new roadway will provide relief for the intersection of Grant Road/Kolb Road and Tanque Verde Road, since drivers will have a direct route to travel south on Kolb Road (or east/west on Speedway Boulevard) and will therefore no longer need to detour through the Grant Road/Kolb Road/Tanque Verde Road intersection.

Data from the Pima Association of Governments (PAG) was used to project future traffic volumes for the design year of 2030 and determine how traffic patterns in the study area might change with the construction of the project. Based on the traffic volume projections and redistribution presented in this analysis, it was found that the new roadway will carry approximately 21,200 vehicles per day. Therefore, it is recommended that the project consist of constructing a four-lane divided roadway with multi-use lanes, bus facilities, and sidewalks. The recommended geometry is consistent with the roadway cross section included in the RTA plan.

The construction of the new roadway will result in decreased delays and improved Level of Service (LOS) at multiple intersections in the study area. At the intersection of Grant Road/Kolb Road/Tanque Verde Road, the intersection delays will decrease from 73.2 seconds per vehicle and 170.9 sec/veh in the AM and PM peak hours (respectively) without the project to 36.6 sec/veh and 78.6 sec/veh in the AM and PM peak hours with the project, respectively. There is expected to be a slight increase in delays at Kolb Road and Speedway Boulevard because of the increased traffic expected to use that intersection. However, the intersection will operate at LOS D in the AM peak hour and LOS F in the PM peak hour both with and without the project in 2030. There will also be significant improvements in delays and LOS at the Sabino Canyon Road/Tanque Verde Road intersection, including a 34% decrease in the eastbound left turn delays in the PM peak hour compared to 2030 without the project, and a 24% decrease compared to existing conditions.

The intersection of Grant Road/Kolb Road and Tanque Verde Road currently has the worst Level of Service (LOS) and the highest carbon monoxide concentration of all the

intersections in the City of Tucson (*PAG 2007 Air Quality Report*<sup>7</sup>), but the construction of the new roadway is expected to help mitigate the problem. Further, the new intersection of the new roadway and Kolb Road is expected to operate at LOS B in both peak hours in 2030, with a majority of movements in both peak hours operating with fewer than 10 seconds of delay per vehicle.

The only intersection improvements that will take place with this project are at the intersection of Sabino Canyon Road and Tanque Verde Road and at the intersection of the new roadway and Kolb Road. Because of the increase in the westbound left turns at Sabino Canyon Road and Tanque Verde Road, a second westbound left turn lane should be added. In addition, it is recommended that a sixth southbound lane be added at the intersection. The new southbound lane configuration should include two left turn lanes, two through lanes, and two right turn lanes. The eastbound lane configuration will not change. The lane configuration for the new south leg (serving northbound traffic) should have one left turn lane, two through lanes, and one right turn lane.

While the design storage lengths will be determined later with consideration of existing constraints, the desirable storage lengths (the storages that would accommodate the 2030 95<sup>th</sup> percentile queues) are presented here in Table 14. The lengths shown in the table may not be achievable due to existing geometry and right-of-way constraints, but it is recommended that the design provide as much of the required storage lengths as possible.

**Table 14. Required Storage Lengths at Sabino Canyon Rd and Tanque Verde Rd**

<b>Sabino Canyon Road and Tanque Verde Road</b>								
	<b>Eastbound</b>		<b>Westbound</b>		<b>Northbound</b>		<b>Southbound</b>	
	<b>LT</b>	<b>RT</b>	<b>LT</b>	<b>RT</b>	<b>LT</b>	<b>RT</b>	<b>LT</b>	<b>RT</b>
<b>Existing (ft)</b>	515	*	135	470	130	*	210	820
<b>Required (ft)</b>	1,015	*	175	600	75	225	900	500

\*Shared lane

<b>New Intersection</b>								
	<b>Eastbound</b>		<b>Westbound</b>		<b>Northbound</b>		<b>Southbound</b>	
	<b>LT</b>	<b>RT</b>	<b>LT</b>	<b>RT</b>	<b>LT</b>	<b>RT</b>	<b>LT</b>	<b>RT</b>
<b>Existing (ft)</b>			N/A	N/A		N/A	N/A	
<b>Required (ft)</b>			500	**		110	110	

\*\*Trap lane

## 6. REFERENCES

- 
- 1 Regional Transportation Authority Plan, 2006.
  - 2 City of Tucson, Major Streets and Routes Map, 2008.
  - 3 Highway Capacity Manual. Transportation Research Board, Washington D.C., 2002.
  - 4 Pima Association of Governments Projected 2030 Traffic Volumes Map. Accessed July 2009.  
[http://www.pagnet.org/RegionalData/TransportationTrendsandData/ProjectedTrafficVolumeMaps/  
tabid/865/Default.aspx](http://www.pagnet.org/RegionalData/TransportationTrendsandData/ProjectedTrafficVolumeMaps/tabid/865/Default.aspx).
  - 5 Transportation Access Management Guidelines for City of Tucson, Arizona. City of Tucson, March 17, 2003.
  - <sup>6</sup> Florida Quality/Level of Service Tables. Florida Department of Transportation, September 4, 2009.
  - <sup>7</sup> Air Quality Report 2007. Pima Association of Governments, June 2007.

## 7. APPENDIX A – TRAFFIC COUNTS

## 8. APPENDIX B – SYNCHRO REPORTS

## 9. APPENDIX C – CRASH DATA

## 10. APPENDIX D – PAG DATA