An aerial photograph of a highway interchange, likely I-10, with several lanes and ramps. The surrounding area is a mix of open land, some vegetation, and a few buildings. The image is in grayscale and serves as the background for the report cover.

# SUNSET ROAD: I-10 TO RIVER ROAD

## INITIAL TRAFFIC ENGINEERING REPORT

PCDOT Project No. 4SRRIV  
SGI Project No. 19023.00  
Kittelson Project No. 243120.000

March 2020

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Prepared for:



Submitted to:



Submitted by:



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# 1.0 EXECUTIVE SUMMARY

The Pima County Department of Transportation (PCDOT), in coordination with the Arizona Department of Transportation (ADOT) and the City of Tucson Department of Transportation, is investigating alternatives to extend Sunset Road from Interstate 10 (I-10) to River Road. The plan to connect Sunset Road from Silverbell Road to River Road was split into two phases.

The first phase connected Silverbell Road to the existing I-10 Eastbound Frontage Road (EBFR). Phase 1 was completed in 2017 and consists of a three-lane roadway, which includes a two-way left-turn lane and a 720-foot long bridge over the Santa Cruz River. The bridge has a shared-use path along the southern side and a pedestrian sidewalk on the northern side.

The second phase will extend Sunset Road from the I-10 Westbound Frontage Road (WBFR) to River Road. Phase 2 will occur in conjunction with the reconstruction of the Sunset Road Traffic Interchange (TI) as part of the widening of I-10 from Ruthrauff Road to Ina Road. The new TI will cross over I-10.

This report documents the traffic analysis conducted to determine the roadway and intersection capacity and lane configuration requirements for Phase 2, including a new TI and extension of Sunset Road from I-10 to River Road. The analysis also considered capacity and traffic control requirements on the section of Sunset Road recently constructed (Phase 1) to serve a large planned development adjacent to the Sunset Road TI.

## 1.1 Existing Conditions

Sunset Road, between Silverbell Road and the EBFR, is a three-lane urban collector roadway that is approximately 3,000 feet long. The daily traffic volume on the segment for 2019 existing conditions is 5,700 vehicles per day (vpd). The posted speed limit is 35 miles per hour (mph). The existing intersections at the I-10/Sunset Road TI operate at acceptable levels of service (LOS D or better) during the weekday AM and PM peak hours. A review of five-year crash data from September 2014 through September 2019 did not reveal any patterns or trends in the area indicating a safety issue requiring mitigation.

Extending Sunset Road from I-10 to River Road will require reconstruction of the traffic interchange with Sunset Road crossing over I-10, allowing the roadway to cross over the adjacent Union Pacific Railroad (UPRR) mainline. The extension will also impact the existing regional multi-use path, the Chuck Huckelberry Loop (the Loop), and River Road on the north/east side. River Road is a four-lane urban principal arterial with a posted speed of 45 mph.

## 1.2 Future Conditions

The extension of Sunset Road from Silverbell Road to River Road is included in the Regional Transportation Authority (RTA) plan with the intent to provide needed access across I-10, improve regional mobility, and support development in the area. The Pima Association of Governments (PAG) regional travel demand model estimates that traffic demand on Sunset Road by 2045 will increase to 16,000 from Silverbell Road to the Santa Cruz River, 22,000 from the Santa Cruz River to I-10, and will be 18,000 vpd on the new connection that will be constructed between I-10 and River Road. Much

of the increase in traffic demand is expected to come from new development in the area, the Sunset Innovation Campus, being developed by Pima County on property located south of Sunset Road between the Santa Cruz River and the I-10 Eastbound Frontage Road.

ADOT has plans to reconstruct the I-10/Sunset TI as part of the upcoming I-10 widening from Ina Road to Ruthrauff Road. The planned interchange configuration will be a tight diamond with a bridge over the future widened I-10 mainline. The Sunset Road extension will cross over the UPRR mainline and connect with River Road. The I-10 bridge and Sunset Road extension will include bicycle lanes/paved shoulder and pedestrian walkways connecting to the Loop.

## 1.3 Recommendations

Based on the analysis of existing and future traffic conditions, the following recommendations should be considered:

- Sunset Road from I-10 to River Road
  - The extension of Sunset Road from I-10 to River Road will require a four-lane roadway section. The recommended cross-section includes 11-foot wide travel lanes, a raised median, six-foot wide paved shoulders/bicycle lanes, and six-foot wide concrete sidewalk facilities on both sides. The raised median should be a minimum of 10-foot wide, widening to a minimum of 18-feet to accommodate left-turn lanes at intersections.
  - Install a traffic signal and intersection street lighting at the new Sunset Road/River Road intersection.
  - Provide ADA compliant connections on Sunset Road to the multi-use path located on the southern embankment of the Rillito Creek.
  - Provide a posted speed limit of 35 mph on Sunset Road.
  - Maintain a design speed of 50 mph and a posted speed limit of 45 mph on River Road.
  - Provide access to Pima County Flood Control District storage yard.
- Sunset Road West (south) of I-10
  - Widen the existing three-lane section to a four-lane divided section with raised median and six-foot wide paved shoulders for approximately 900 feet west of the I-10 frontage road and construct intersections at the planned driveways to the Sunset Innovation Campus development.
  - Install conduit and pull boxes for a future traffic signal at the main campus driveway.
- Provide the lane configurations for each study intersection, as illustrated in Figure 14. Proposed Sunset Road Layout and turn-lane storage lengths, as provided in Table 9. Capacity analysis results indicate that the proposed improvements will provide sufficient capacity to serve the projected 2045 transportation demand.
- Right-turn lanes at the planned Sunset Innovation Campus driveways on Sunset Road and the I-10 EBFR can be installed in conjunction with development.

## 2.0 INTRODUCTION

In 2006, the Regional Transportation Authority (RTA) 20-year multimodal plan and sales tax were approved by the voters of Pima County. One of the 35 roadway projects included constructing Sunset Road from Silverbell Road to I-10 and from I-10 to River Road. Sunset Road once extended from Silverbell Road to Interstate 10 (I-10), but the Sunset Road Bridge over the Santa Cruz River collapsed during the flood of 1983, losing an important connection. See Figure 1 for location and vicinity maps.

Due to the expected population and employment growth in the northwest Tucson region, the connection of Silverbell Road to I-10 and extension to River Road was included in the RTA plan to provide needed access, improve regional mobility, and support development in the area. The Sunset Road connection between Silverbell Road and River Road will also include the reconstruction of the I-10/Sunset Road Traffic Interchange (TI) over I-10 by ADOT as part of the widening of I-10 from Ruthrauff Road to Ina Road.

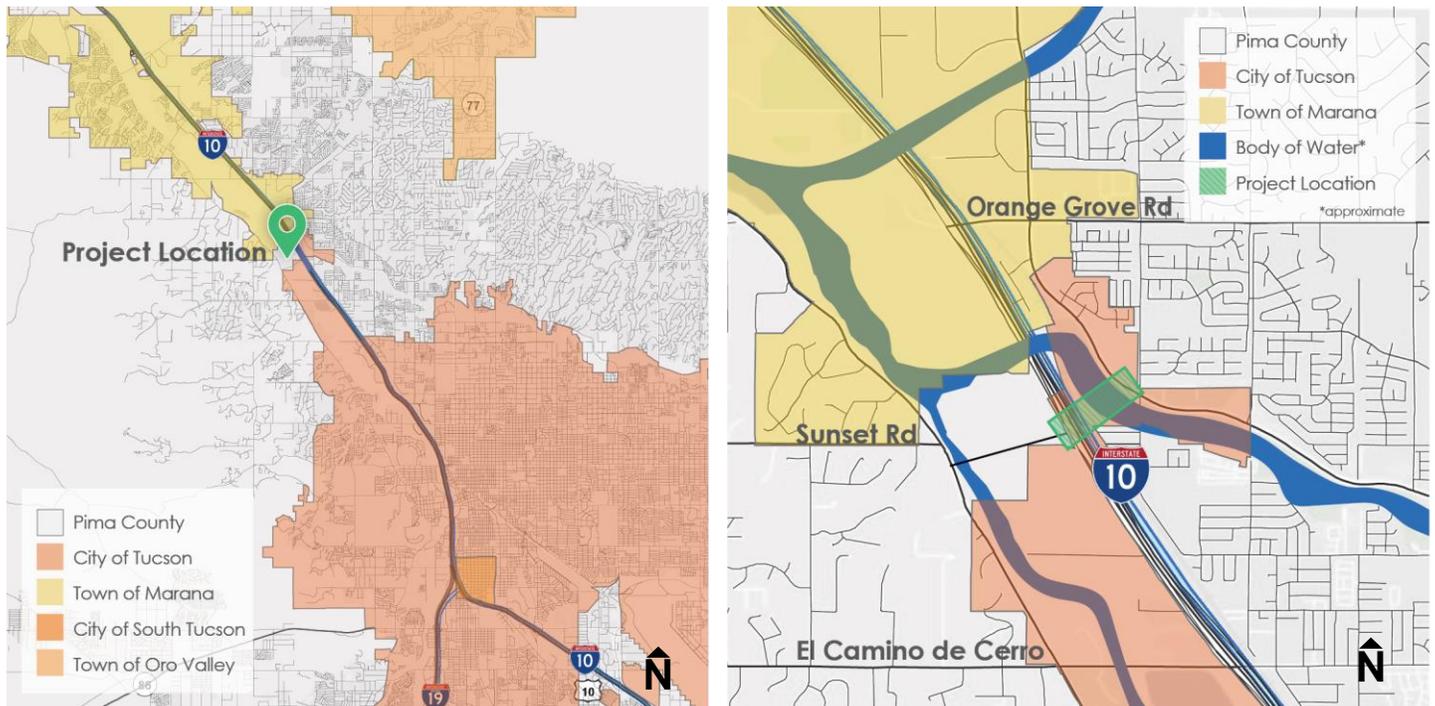
The Sunset Road extension from I-10 to River Road will consist of constructing new bridges over the I-10 mainline, the Union Pacific Railroad (UPRR), and the Rillito Creek. The traffic interchange bridge structure over I-10 is included in the I-10 Mainline, Ina Road TI to Ruthrauff Road TI Design Concept Report (DCR) prepared by ADOT in 2012.

The first phase connected Silverbell Road to the existing I-10 Eastbound Frontage Road (EBFR). Phase 1 was completed in 2017 and consists of a three-lane roadway, which includes a two-way left-turn lane and a 720-foot long bridge over the Santa Cruz River. The bridge has a shared-use path along the southern side and a pedestrian sidewalk on the northern side.

The second phase will extend Sunset Road from the I-10 Westbound Frontage Road (WBFR) to River Road. Phase 2 is expected to occur in conjunction with ADOT's reconstruction of the Sunset Road TI.

This report documents the traffic analysis conducted to determine the roadway and intersection capacity and lane configuration requirements for Phase 2, including a new TI and extension of Sunset Road from I-10 to River Road. The analysis also considered capacity and traffic control requirements on the section of Sunset Road recently constructed (Phase 1) to serve the Sunset Innovation Campus development that is planned for property adjacent to the Sunset Road TI.

Figure 1. Project Location and Vicinity Map



## 2.1 Traffic Report Overview

The traffic analysis evaluated existing (2019) and future (2045) traffic conditions on Sunset Road between Silverbell Road and River Road to determine roadway and intersection capacity, lane configuration, traffic control requirements and multi-modal needs on Sunset Road from the planned Sunset Innovation Campus to River Road. The following intersections were evaluated:

- Sunset Road/Silverbell Road
- Sunset Road/Sunset Innovation Campus South Driveway
- Sunset Road/Sunset Innovation Campus Main Driveway
- Sunset Road/I-10 EBFR
- Sunset Road/I-10 WBFR
- Sunset Road/River Road
- I-10 EBFR/Sunset Innovation Campus West Driveway
- I-10 EBFR/Sunset Innovation Campus East Driveway

The traffic analysis followed the guidelines provided in the *Pima County Roadway Design Manual* and the 2016 *Pima County Subdivision and Development Street Standards, ADOT Traffic Guidelines and Processes and City of Tucson Transportation Access Management Guidelines*. Existing and future (2045) traffic conditions during the AM and PM peak hours were evaluated. Future traffic projections included the estimated traffic demand generated by the planned Sunset Innovation Campus.

## 3.0 EXISTING CONDITIONS

Sunset Road, from Silverbell Road to I-10, consists of a three-lane roadway classified as an urban collector. The following sections describe the existing land-use and roadway conditions within the study area.

### 3.1 Land Use

The property between I-10 and River Road along the proposed Sunset Road extension alignment has little development and little space for new development, given the constraints created by the Rillito Creek and UPRR mainline. Existing land use includes a Pima County Flood Control District storage yard and residential/industrial businesses to the south and east along Tres Nogales Road and West Sunset Road. These roadways connect to Camino de la Tierra to provide access. The proposed Sunset Road extension cuts through the Pima County property and would not impact the other properties or their access.

Zoning of the properties adjacent to the corridor includes residential and business/commercial land uses. The zoning within and around the vicinity of the project is provided in Figure 2.

South (west) of the I-10/Sunset Road TI, the land is zoned as GR-1 under Pima County zoning ordinances and I-1 in the City of Tucson limits. GR-1 is the rural residential zone, which is intended to discourage commercial development and serve the needs of the rural area. I-1 provides for industrial uses that do not have offensive characteristics to land uses permitted in more restrictive nonresidential zones.

North of the I-10/Sunset Road TI and up to River Road, the land where the future Sunset Road alignment lies is mostly under the City of Tucson zoning ordinances, including land zoned as C-2, MU, and SH. The descriptions of the City of Tucson zoning ordinances are as follows:

- C-2 is a commercial zone. It provides for general commercial uses serving the community and region. Residential uses are also permitted here.
- SH is the suburban homestead zone. It provides for low-density, large-lot residential development.
- MU is the multiple-use zone, which allows for residential, agricultural, civic, commercial, and recreational land uses.

Figure 2. Zoning Map



Data from PimaMaps November 2019



## 3.2 Physical Conditions

### 3.2.1 Roadway

Sunset Road from Silverbell Road to I-10 provides one travel lane in each direction, a center turn lane, and six-foot wide paved shoulders. On the south side of the roadway, 11-12 feet of additional pavement is present from just east of the Santa Cruz River Bride to approximately 800 feet west of the EBFR. A temporary curb between the paved shoulder and this additional pavement is in place. A 10-foot wide multiuse path runs on the south side of Sunset Road, and a six-foot asphalt paved pedestrian walkway runs on the north side.

At the I-10/Sunset Road TI, Sunset Road runs under I-10 with a single lane per direction, providing access onto the eastbound and westbound frontage roads and I-10 ramps. Sunset Road is uncurbed at this location, with paved shoulders on both sides of the road. There are curb and gutter and sidewalk ramps at the intersections which currently operate under stop control. The I-10 bridge clearance is 14' 1", providing adequate clearance for most heavy vehicles.

Existing Sunset Road lies primarily within Pima County right-of-way, except for the roadway segment near the I-10/Sunset Road TI, which is located within ADOT right-of-way.

River Road is a four-lane divided roadway with a 20-foot raised median, eight-foot paved shoulders, and six-foot sidewalks on both sides.

### 3.2.2 Speed Limits

The posted speed on Sunset Road between Silverbell Road and I-10 is 35 mph. The posted speed on the I-10 frontage roads and River Road is 45 mph.

### 3.2.3 Intersections and Driveways

Existing intersection lane configurations and traffic control are provided in Figure 3. The I-10/Sunset Road TI has both intersections operating with stop control. The EBFR/Sunset Road intersection has all the approaches controlled by stop signs. The WBFR/Sunset Road intersection has the traffic on Sunset Road having to stop while traffic on the frontage roads is free-flow.

On Sunset Road just west of the EBFR, there is an enhanced crossing of The Loop multi-use path that runs parallel to the frontage road in this area. This crossing operates as a two-stage crossing where bicyclists and pedestrians on the multi-use path yield for vehicles on Sunset Road.

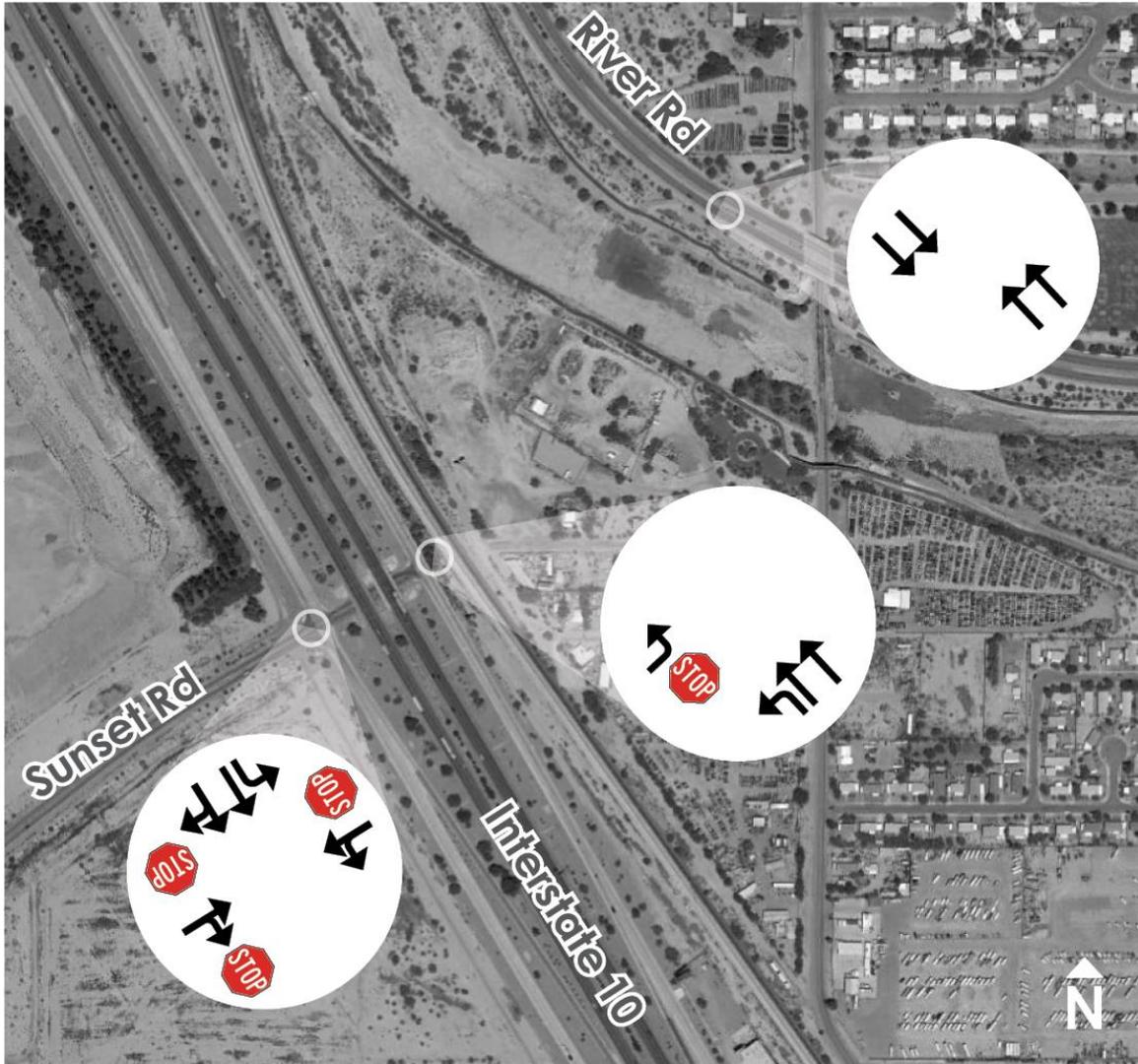
Figure 3. Sunset Road Crossing for The Loop



Source: Google Maps

There are no driveways in the immediate vicinity of the I-10/Sunset Road TI or at the proposed Sunset Road/River Road intersection. A driveway providing access to the Pima County Parks & Recreation facility on River Road is approximately ¼ mile west of the future intersection with Sunset Road. Shannon Road intersects River Road about ½ mile to the east. Camino de la Tierra does not connect to River Road. The Loop crosses the Sunset Road extension alignment along both banks of the Rillito Creek. New connections to this multi-use path will need to be provided.

Figure 4. Existing Lane Configurations and Traffic Control

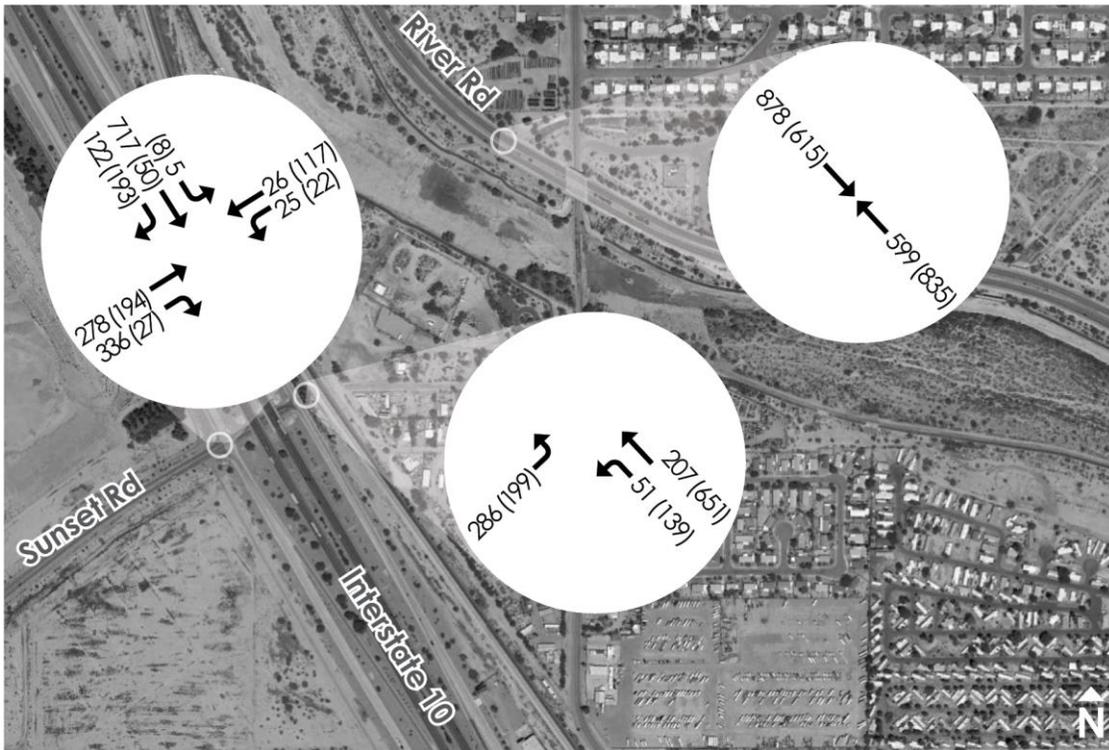


### 3.3 Traffic Volumes and Existing Levels of Service

In 2019, turning-movement counts were collected by Pima County Department of Transportation on November 6, 2019, for the two intersections located at the I-10/Sunset Road TI. The counts were conducted on a mid-weekday during the morning (from 7:00 to 9:00 a.m.) and evening (from 4:00 to 6:00 p.m.) peak periods. The AM and PM peak hours occurred from 7:15 to 8:15 a.m. and from 4:45 to 5:45 p.m., respectively.

Figure 5 provides a summary of the existing intersection turning movement counts. Appendix A contains the traffic count data.

Figure 5. Existing Volumes – AM and PM Peak Hours



Intersection Level of Service (LOS) is measured by the average control delay in seconds per vehicle and is a performance measure used to evaluate intersection operations. According to the *Highway Capacity Manual (HCM)*, there are six levels of service that have been defined to measure unsignalized and signalized operations, and they range from LOS A to LOS F. Intersections with a LOS A experience a greater degree of mobility, while intersections with a LOS F operate with congestion and experience extended queueing. Table 1 defines each level of service for stop-controlled and signalized intersections.

**Table 1 Level of Service Thresholds for Stop-Controlled and Signalized Intersections**

Level of Service	Stop-Controlled Intersection Control Delay (sec/veh)	Signalized Intersection Control Delay (sec/veh)	Definitions
<b>A</b>	0-10	≤ 10	The intersection operates with free-flow conditions and experiences minimal control delay.
<b>B</b>	> 10-15	> 10-20	The intersection experiences insignificant control delay.
<b>C</b>	> 15-25	> 20-35	The intersection has stable operations, though individual cycle failures occur.
<b>D</b>	> 25-35	> 35-55	Small increases in flow affect the travel speed and increase the delay. Many vehicles stop. This is the limit of acceptable delay in an urban area.
<b>E</b>	> 35-50	> 55-80	There is significant control delay with poor progression, high volume-to-capacity ratios, etc.
<b>F</b>	> 50	> 80	The control delay at the intersection is unacceptable, as it is over capacity. The volume-to-capacity ratio is greater than 1.0.

Source: HCM, Sixth Edition

Level of service and delay analyses were performed utilizing Synchro 10, as it is a software that can provide a macroscopic evaluation of transportation systems. Methods from the *Highway Capacity Manual, Sixth Edition* were used to obtain the intersection level of service and delay.

Pima County and the City of Tucson have specific design requirements for all intersections and roadway segments. Outlined in the 2016 *Pima County Subdivision and Development Street Standards* (10), all intersections and through movements shall operate at a LOS D or better, and no turning lane movement shall fall below a LOS E.

Table 2 presents the results of the existing AM and PM peak hour traffic conditions for the unsignalized, stop-controlled intersections at the traffic interchange. Appendix B contains the capacity analysis worksheets.

**Table 2. Existing Levels of Service**

Time Period	EB		WB		NB		SB		Overall Intersection	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
<b>I-10 Eastbound Frontage Road at Sunset Road</b>										
<b>AM</b>	E	38.7	-	-	22.7	C	13.4	B	31.0	D
<b>PM</b>	A	9.7	-	-	10.7	B	10.6	B	10.3	B
<b>I-10 Westbound Frontage Road at Sunset Road</b>										
<b>AM</b>	-	-	14.4	B	-	-	-	-	7.6	B*
<b>PM</b>	-	-	21.6	C	-	-	-	-	4.3	C*

\*Two-way LOS based on Critical Movement

\*\*Sunset Road is designated as northbound/southbound.

The Sunset Road/EBFR intersection operates at LOS D in the AM peak hour and LOS B in the PM peak hour. The LOS results indicate that during the morning and afternoon peak hours, the I-10/Sunset Road TI operates at an acceptable level of service (D or better); however, the EBFR approach is operating close to capacity (LOS E) in the AM peak hour.

PAG collected 24-hour traffic count data on River Road in 2016 between Orange Grove Road and Shannon Road. From the gathered data, the K-factor (the proportion of average daily traffic occurring in one hour) and the D factor (the directional distribution of traffic traveling in the peak direction) were calculated.

Table 3 provides the existing average daily volume and traffic factors on River Road. During the AM peak hour, the majority of commuter vehicles are traveling eastbound on River Road, towards La Cholla Boulevard. During the PM peak hour, the majority of commuter vehicles are traveling westbound on River Road towards Orange Grove Road.

**Table 3. River Road Traffic Factors**

Street-Segment	ADT	K <sub>AM</sub>	K <sub>PM</sub>	D <sub>AM</sub>	D <sub>PM</sub>
<b>East Bound</b>					
River Road - Orange Grove Road to Shannon Road	9,289	0.12	0.13	67%	38%
<b>West Bound</b>					
River Road - Orange Grove Road to Shannon Road	9,293	0.12	0.13	33%	62%

### 3.4 Crash Analysis

The crash history on Sunset Road and River Road was reviewed to identify potential safety issues. ADOT provided crash data for the most recent five-year period, from September 2014 to September 2019 for Sunset Road and April 2014 to April 2019 for River Road. The crash data evaluated for River Road correspond to the segment of River Road from Joiner Road (about ¼ mile west of the proposed Sunset Road/River Road intersection) to Shannon Road (about ½ mile east of the future intersection).

During these periods, no fatal crashes were reported. Table 4 summarizes the reported crashes by severity according to the following: fatal, incapacitating injury, non-incapacitating injury, and property damage only (PDO) crashes. Table 5 organizes the data by collision type. Appendix C includes the crash datasheets.

**Table 4. Intersection Crashes by Injury Severity**

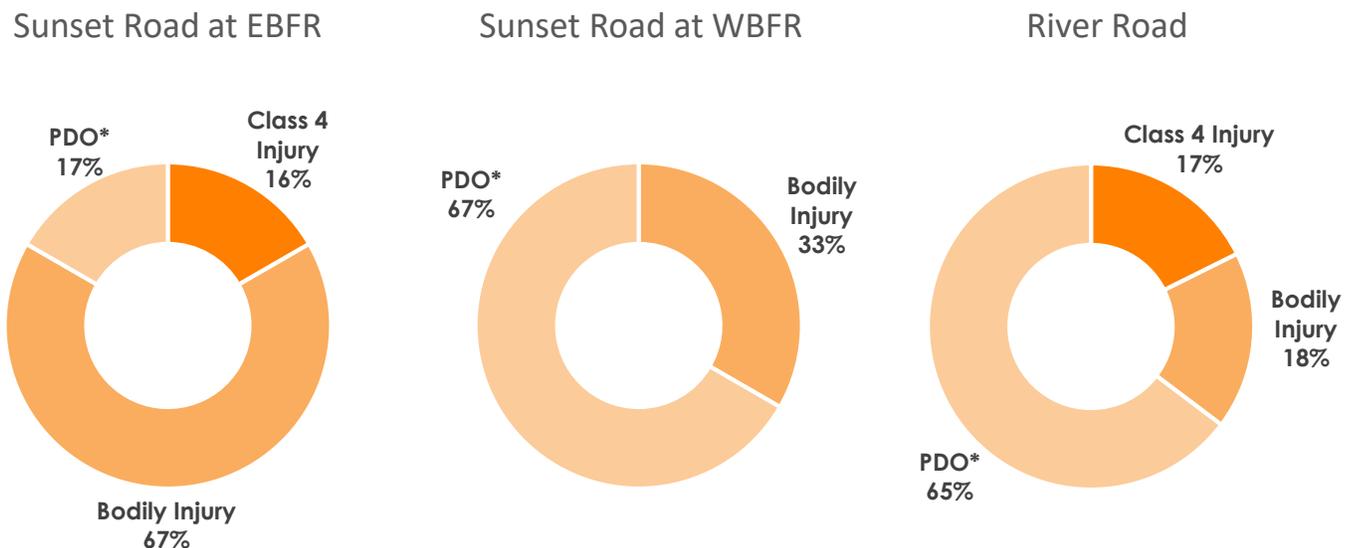
Injury Severity	Sunset Road at EBFR	Sunset Road at WBFR	River Road Segment between Joiner Road and Camino de la Tierra
Fatal	-	-	-
Class 4 (incapacitating) Injury	1	-	3
Bodily (non-incapacitating) Injury	4	2	3
PDO*	1	4	11
<b>Total Crashes</b>	<b>6</b>	<b>6</b>	<b>17</b>
<b>Severity Index**</b>	<b>14.8</b>	<b>8</b>	<b>-</b>

\*PDO – property damage only

\*\*Severity index was calculated based on crash severity parameters developed by the National Safety Council.

The Severity Index was calculated using the formula provided by Pima County.  $Index = [5.8(Fatality \& \text{Class } 4 \text{ Injury}) + 2(\text{Class } 2 \& \text{3 Bodily Injury}) + \text{Property Damage}]/(\text{Total No. of Crashes})$

**Figure 6. Intersection Crashes**



**Table 5. Intersection Crashes by Type**

Crash Type	Sunset Road at EBFR Intersection		Sunset Road at WBFR Intersection		River Road from Joiner Road to Shannon Road	
	Number	% of Total	Number	% of Total	Number	% of Total
Single Vehicle	-	-	1	17%	9	53%
Rear End	-	-	1	17%	1	6%
Turning	-	-	1	17%	2	12%
Angle	5	83%	2	33%	4	23%
Sideswipe	-	-	1	17%	-	-
Miscellaneous	-	-	-	-	-	-
Fixed Object	-	-	-	-	-	-
Backing	-	-	-	-	-	-
Head On	-	-	-	-	-	-
Other	1	17%	-	-	1	6%
Animal	-	-	-	-	-	-
<b>Total Crashes</b>	<b>6</b>		<b>6</b>		<b>17</b>	

### 3.5 Alternative Transportation Modes

Alternative transportation modes include existing public transportation services by Sun Tran, as well as pedestrian, bicycle, and equestrian amenities within the project area.

Currently, no transit service is provided on Silverbell Road, Sunset Road, or River Road within the study area. The PAG Long Range Regional Transit Plan Update does not include transit service on these roadways.

River Road is a designated bike route that is 8-ft wide and striped with paved shoulders on both sides of the four-lane divided roadway.

The Loop, a Pima County paved non-motorized multi-use path (6), generally runs along the banks of the Santa Cruz River, the Rillito Creek, and the Cañada del Oro Wash. In the area of the I-10/Sunset Road TI, the Loop runs along the west side of the EBFR and crosses Sunset Road, west of the traffic interchange.

In the area of River Road, The Loop runs along both the north and south banks of the Rillito Creek. There is an existing connection from The Loop to River Road. The Loop runs along the south side of Sunset Road between the I-10 EBFR and Silverbell Road.

Figure 7 illustrates the existing and planned multi-use path facilities in the vicinity of the Sunset Road TI.

A 6-foot wide asphalt path runs on the north side of Sunset Road from I-10 to Silverbell Road. River Road has sidewalks running along both the north and south sides of the road.

There are no trails in the area designated explicitly for equestrian usage.

Figure 7. The Loop Pathway System Map – Pima County



## 4.0 FUTURE CONDITIONS

The future conditions analysis identifies how the study area's transportation system will operate with the extension of Sunset Road from I-10 to River Road, with traffic generated by the proposed Sunset Innovation Campus, other planned developments within the area and general growth in the region.

### 4.1 Planned Developments

Pima County acquired over 100 acres of property near Sunset Road in 2012 and has plans to develop the land as an employment center. The Sunset Innovation Campus will be a new campus-style employment site with nearly one million square feet of office and technical research space. Access to the campus would be located off of Sunset Road and the EBFR. The campus location, in relation to the Sunset Road improvements, is shown in Figure 8.

A preliminary conceptual site plan for the campus is provided in Figure 9. In addition to the office space, an amphitheater, connection to the Loop, a park, and several parking structures are also proposed as part of the development.

Current access plans for the site (unlike that shown in Figure 9) includes two driveways on Sunset Road – a South Driveway and a Main Driveway and two driveways on the I-10 EBFR. Construction of this development is expected to begin in 2022 with buildout completed by 2045.

Currently, there are no plans to develop the property between I-10 and River road. Pima County has longer term development plans for the property adjacent to the Sunset Innovation Campus.

Figure 8. Sunset Professional Campus Location



Figure 9. Sunset Innovation Campus – Preliminary Site Plan

CONCEPTUAL SITE PLAN



**LEGEND**

- PROJECT BOUNDARY
- - - EASEMENT
- - - 100 YEAR FEMA FLOODPLAIN
- ARCHEOLOGY LIMITS

**KEY**

- 1 OFFICE 1A: 50,000 SF
- 2 OFFICE 1B: 90,000 SF
- 3 PARKING STRUCTURE 1A
- 4 OFFICE 2A: 40,000 SF
- 5 OFFICE 2B: 40,000 SF
- 6 OFFICE 2C / PARKING 2A: 17,500 SF
- 7 OFFICE 2D / PARKING 2B: 17,500 SF
- 8 OFFICE 3A / PARKING 3A: 35,000 SF
- 9 OFFICE 3B / PARKING 3B: 35,000 SF
- 10 OFFICE 3C: 60,000 SF
- 11 PARKING STRUCTURE 3C
- 12 PARKING STRUCTURE 3D
- 13 OFFICE 4A: 180,000 SF
- 14 PARKING STRUCTURE 4A
- 15 OFFICE 4B: 180,000 SF
- 16 OFFICE 4C: 120,000 SF
- 17 PARKING STRUCTURE 4B
- 18 OFFICE 5A: 40,000 SF
- 19 OFFICE 5B: 20,000 SF
- 20 OFFICE 5C: 20,000 SF
- 21 OFFICE 5D: 40,000 SF
- 22 THE LOOP (MULT-USE PATH)
- 23 SUNSET GARDENS
- 24 CAMPUS COMMONS
- 25 CAMPUS SQUARE
- 26 SUNSET AMPHITHEATER
- 27 CAMPUS TRAILHEAD
- 28 SANTA CRUZ RIVER PATH
- 29 SUNSET PARK
- 30 CAMPUS PARKLET

SUNSET PROFESSIONAL CAMPUS

THE DESIGN WAS CREATED USING THE MOST RECENT AVAILABLE AERIAL PHOTOGRAPHY AND DESIGN DATA PROVIDED BY THE DESIGNER. COORDINATE, HEIGHTS AND DIMENSIONS HAVE BEEN CHECKED FOR ACCURACY AND CORRECTED WHERE NECESSARY. THIS PLAN IS FOR INFORMATION ONLY AND DOES NOT REPRESENT A CONTRACT. ALL DIMENSIONS AND LOCATIONS ARE APPROXIMATE. THE DESIGNER ASSUMES NO LIABILITY FOR ANY ERRORS OR OMISSIONS. PROJECT: PCD-14 CONCEPT/2021-14 DWG. PIMA COUNTY PLANNING & COMMUNITY DEVELOPMENT DEPARTMENT

## Trip Generation

Weekday AM and PM peak-hour vehicle trip estimates for the Sunset Innovation Campus were estimated using the Institute of Transportation Engineer's *Trip Generation Manual*, 9<sup>th</sup> Edition (13). Table 6 summarizes the anticipated number of trips that will be generated by the proposed development.

**Table 6. Estimated Trip Generation**

Land Use	ITE Code	Size	Daily Trips	Weekday AM Peak Hour Trips			Weekday PM Peak Hour Trips		
				Total	In	Out	Total	In	Out
General Office Building	710	50,000 SF	552	78	69	9	75	13	62
General Office Building	710	90,000 SF	993	140	124	16	134	23	111
General Office Building	710	40,000 SF	441	62	55	7	60	10	50
General Office Building	710	40,000 SF	441	62	55	7	60	10	50
General Office Building	710	17,500 SF	193	27	24	3	26	4	22
General Office Building	710	17,500 SF	193	27	24	3	26	4	22
General Office Building	710	35,000 SF	386	55	48	7	52	9	43
General Office Building	710	35,000 SF	386	55	48	7	52	9	43
General Office Building	710	60,000 SF	662	94	82	12	89	15	74
General Office Building	710	180,000 SF	1,985	281	247	34	268	46	222
General Office Building	710	180,000 SF	1,985	281	247	34	268	46	222
General Office Building	710	120,000 SF	1,324	187	165	22	179	30	149
General Office Building	710	40,000 SF	441	62	55	7	60	10	50
General Office Building	710	20,000 SF	221	31	27	4	30	5	25
General Office Building	710	20,000 SF	221	31	27	4	30	5	25
General Office Building	710	40,000 SF	441	62	55	7	60	10	50
<b>Net New Trips</b>			<b>10,865</b>	<b>1,535</b>	<b>1,352</b>	<b>183</b>	<b>1,469</b>	<b>249</b>	<b>1,220</b>

Based on the ITE trip generation method, the Sunset Innovation Campus is projected to generate 10,865 net new trips each day; 1,535 net new trips during the weekday AM peak hour and 1,469 net new trips during the weekday PM peak hour.

## 4.2 Planned Transportation Improvements

Recently constructed and planned transportation improvements in the project vicinity include:

- **Ina Road, Silverbell Road to I-10** – The Town of Marana widened Ina Road from a two-lane facility to a four-lane facility. The widening included the construction of two new bridges over the Santa Cruz River and tied into the ADOT I-10/Ina Road TI improvements. Construction was completed in May 2019.
- **Silverbell Road, Grant Road to Ina Road** – This RTA project will widen the existing two-lane roadway to a divided four-lane roadway with pedestrian facilities and bike lanes. The project is being designed and constructed in multiple phases. The first phase, Grant Road to Goret Road, finished construction in January 2017. Phase two, Goret Road to El Camino del Cerro, is currently under design and is expected to start construction in 2022. Phase three, El Camino del Cerro to Ina Road, is scheduled to begin design in 2021, with the construction of the entire corridor anticipated to be completed by 2026.

## 4.3 Daily Traffic Volume Projections

Future traffic volume projections were developed utilizing PAG's 2045 regional travel demand model. PAG recently revised the socioeconomic data used in the model to reflect a reduction in expected regional population growth. Regional population estimates for 2045 were reduced from 1.5 million to 1.2 million residents in the greater Tucson area. The current population in the region is approximately 1.0 million.

Key aspects of the 2045 roadway network included in PAG's travel demand model include:

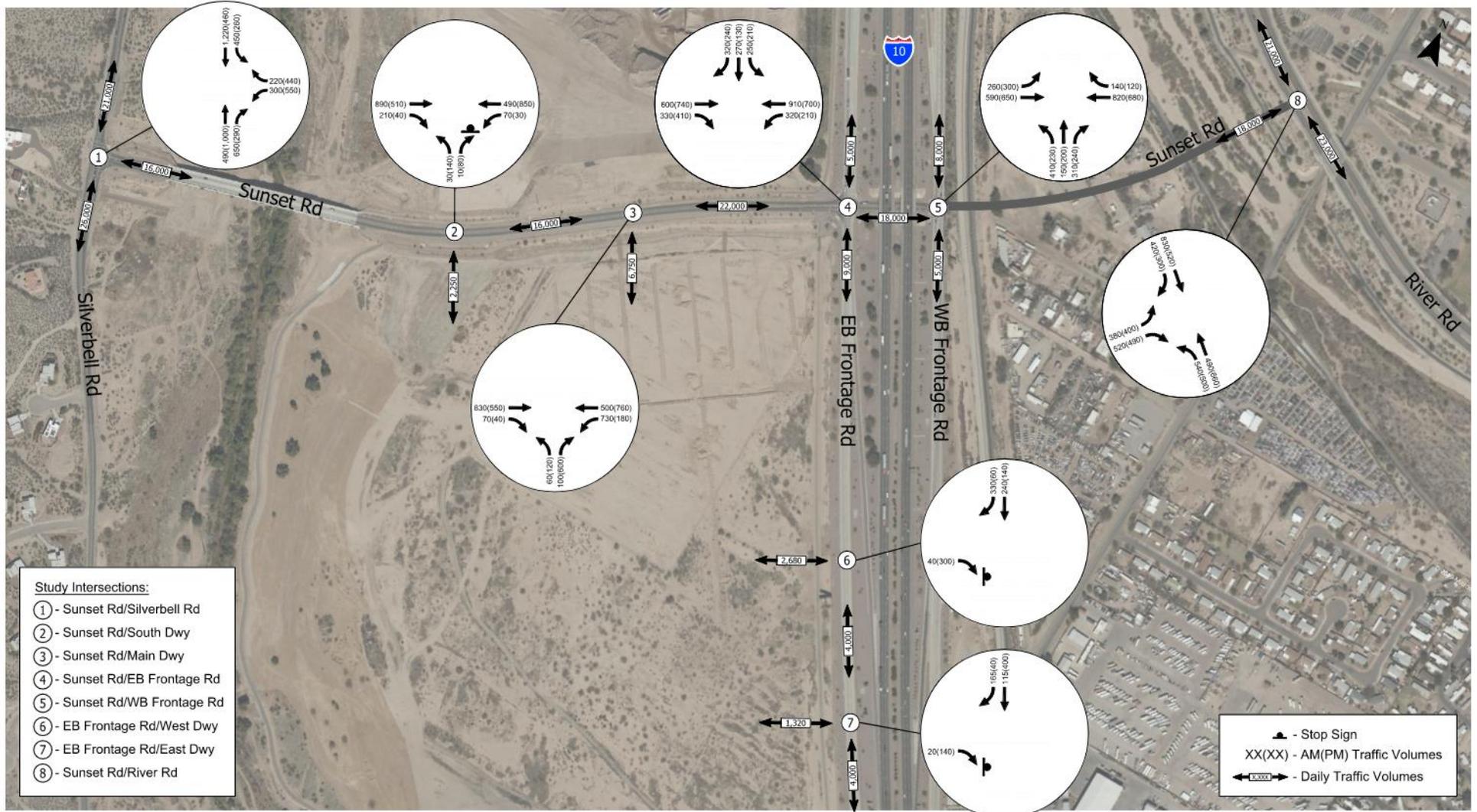
- Sunset Road extends from Silverbell Road to River Road as three-lane section
- I-10 has an eight-lane section in the vicinity of the Sunset Road TI.
- Silverbell Road has a four-lane cross-section

PAG's current travel demand model accounts for the proposed Sunset Innovation Campus development. The model is estimating that the development will generate some 14,000 trips, approximately 3,000 trips more than estimated using the ITE Trip Generation method.

### 4.3.1 Peak Hour Traffic Volume Projections

Using the PAG 2045 traffic volume forecasts, future peak-hour intersection traffic volumes were developed. Figure 10 presents the estimated 2045 average daily traffic and peak-hour intersection volumes used for the traffic analysis.

Figure 10. 2045 Traffic Volume Projections



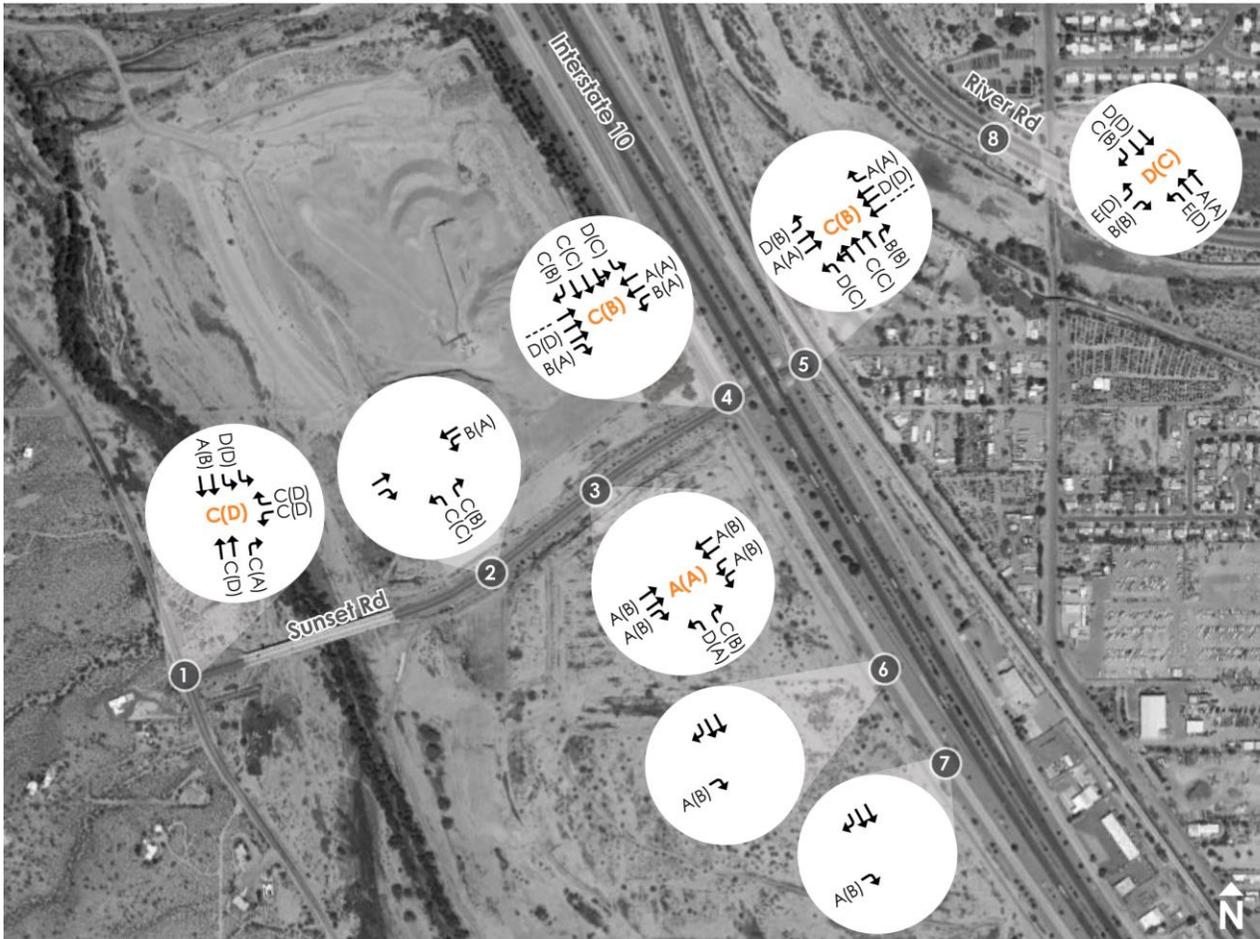
## 4.4 Capacity and Level of Service Analysis

The weekday AM and PM peak hour turning movement volumes shown in Figure 10 were used to determine lane configurations at each existing and proposed intersection in the project area and determine the 2045 traffic levels of service. The capacity of a roadway segment depends on the capacity of the intersections along the segment, as well as street environment factors, including driveway density and activity, speed limit, median type, intersection density, and pedestrian crossings. Planning-level roadway capacity estimates have been developed by the Florida Department of Transportation (FDOT). Using the FDOT capacity tables, a two-lane arterial roadway with exclusive left-turn lanes (i.e., two-way left-turn lane) can generally accommodate 17,700 vpd at LOS D. The 2045 traffic volume projections on Sunset Road between Silverbell Road and River Road range between 16,000 and 22,000 vpd. Based on these criteria, the following number of travel lanes will be required on Sunset Road to serve the projected traffic demand: Silverbell Road to Sunset Innovation Campus – 2 lanes; Sunset Innovation Campus to River Road – 4 lanes.

Intersection capacity requirements for the future traffic volumes provided were evaluated using Synchro 10 following the methodologies set forth in the *Highway Capacity Manual, Sixth Edition (7)*. Figure 11 provides the estimated level of service for the proposed lane configuration at each study intersection. Note that at unsignalized intersections with only stop control on the minor side street or driveway, the HCM methodology only provides the level of service estimates for movements from the side street/driveway or left-turn movements into the side street/driveway. Other movements on the major street are presumed to operate without delay due to the side street/driveway traffic. Appendix D includes 2045 analysis worksheets.

Detailed analyses of the intersections are discussed below. Signal warrants and turn lane warrants are discussed separately in Sections 4.5 and 4.6. Recommended turn-lane storage lengths each intersection can be found in Section 5.3.

Figure 11. 2045 Level of Service Projections



#### 4.4.1 Sunset Road/Silverbell Road Intersection

Sunset Road/Silverbell Road was modeled with the following signal operations for 2045 projected traffic volumes:

- 60-second cycle length during the AM peak hour
- 90-second cycle length during the PM peak hour
- Semi actuated-uncoordinated control
- Overlap phase for westbound right-turn lane (Silverbell Road to Sunset Road) and southbound left-turn lane

The overall intersection and individual turning movements are estimated to operate under capacity, with a LOS D or better, during the weekday AM and PM peak hours. For the lane configuration at the intersection, Silverbell Road was analyzed with a four-lane divided cross-section as currently planned by the RTA, with a designated westbound right-turn lane (which is existing) and one eastbound left-turn lane. Sunset Road was analyzed using the existing lane configuration.

#### 4.4.2 Sunset Road/Sunset Innovation Campus South Driveway Intersection

Sunset Road/Sunset Innovation Campus South Driveway was modeled as an unsignalized T-intersection with the following characteristics:

- The Sunset Innovation Campus South Driveway is stop-controlled.

The overall intersection delay is anticipated to operate under capacity during the AM peak hour at a LOS C and near capacity during the PM peak hour at a LOS E. The critical movement at this intersection is the westbound left-turn lane from the campus onto Sunset Road during the afternoon peak. Operations of all other movements are LOS C or better. Should vehicles turning left from the campus driveway experience lengthy delay, it is anticipated that they will divert to the main driveway, which is signalized.

#### 4.4.3 Sunset Road/Sunset Innovation Campus Main Driveway Intersection

Sunset Road/Main Driveway was analyzed as a signalized T-intersection with the following signal operations:

- 90 second cycle length during the AM and PM peak hours
- Actuated-uncoordinated control
- Free-flowing channelized westbound right-turn lane
- Overlap phase for westbound right-turn lane and southbound left-turn lane

As shown in **Error! Reference source not found.**, a large number (730) southbound left-turns are anticipated into the Sunset Innovation Campus. As such, dual southbound left-turn lanes were analyzed as part of the intersection assessment. The intersection is projected to operate at a LOS A during both the AM and PM peak hours with the lane configurations illustrated in Figure 11.

#### **4.4.4 I-10/Sunset Road Traffic Interchange**

Per the recommendations of the I-10, Ina Road TI to Ruthrauff Road TI DCR, the two frontage road intersections will be signalized with the reconstruction of the Sunset Road TI. The following signal operations were assumed in the analysis:

- 120-second cycle length during the AM peak hour
- 90-second cycle length during the PM peak hour
- Actuated-coordinated control

For 2045 traffic projections, the Sunset Road/EBFR and Sunset Road/WBFR intersections are forecast to operate at levels of service C and B during the AM and PM peak hours. The EBFR and WBFR were analyzed with one left and right-turn lane, one shared left-through lane and two through lanes. Sunset Road, across the TI, was analyzed with a five-lane cross-section including one left and right-turn lane and two through lanes. No individual movements are expected to operate at worse than LOS D.

#### **4.4.5 Sunset Road/River Road Intersection**

Sunset Road will tie into River Road approximately 375 feet west of the center of the Camino De La Tierra bridge. For 2045 traffic conditions, the intersection was analyzed as a signalized T-intersection with the following parameters:

- 120-second cycle length during the AM peak hour
- 90-second cycle length during the PM peak hour
- Actuated-coordinated control
- Overlap phase for northbound right-turn lane and westbound left-turn lane

The intersection is projected to operate at acceptable levels of service, LOS D and LOC C, during the AM and PM peak hours, respectively, with the lane configuration provided in Figure 11. Two turning movements, the westbound and northbound left-turns, are anticipated to operate near capacity at LOS E during the AM peak hour.

#### **4.4.6 Eastbound Frontage Road and Sunset Innovation Campus Driveways**

Two driveways, intersecting the EBFR, are planned as part of the Sunset Innovation Campus development. The East and West Driveways were modeled as unsignalized T-intersections with the following characteristics:

- Stop control on the driveways only.
- Eastbound movements are free

The critical movement for this intersection is the exiting (northbound) right-turn lane. During both the AM and PM peak hours, the right-turn lane is projected to operate under capacity at a LOS A and LOS B, respectively.

## 4.5 Signal Warrant Analysis

A preliminary signal warrant analysis was conducted for 2045 traffic conditions at the following intersections:

- Sunset Road/Sunset Innovation Campus Main Driveway
- Sunset Road/River Road

The warrant analysis was performed using Warrant 1, Eight-Hour Vehicular volume, and Warrant 2, Four-Hour Vehicular Volume, of the 2009 *Manual on Uniform Traffic Control Devices* (8).

To determine eight-hour and four-hour volumes ADOT *Traffic, Guidelines and Procedures (TGP) 611 (9)* was used to obtain the hourly adjustment factors. The intersections of Sunset Road/Sunset Innovation Campus Main Driveway and Sunset Road/River Road both meet Warrants 1 and 2 for 2045 traffic conditions. Table 7 and Table 8 summarize the eight-hour warrants for each intersection, as both were analyzed under Conditions A and B. Figure 12 displays the four-hour warrant graph, as taken from the *Manual on Uniform Traffic Control Devices (MUTCD)*.

**Table 7. Signal Warrant 1 – Sunset Road/Sunset Innovation Campus Main Driveway**

Number of Lanes		Vehicles Per Hour		Condition A		Condition B	
Major Street	Minor Street	Major Street*	Minor Street**	100%	70%	100%	70%
2	1	1,600	110	No	Yes	No	Yes

\* Major street vehicles per hour (vph) represents the total 8-hour average of both approaches

\*\*Minor street vph represents the 8-hour average of one approach

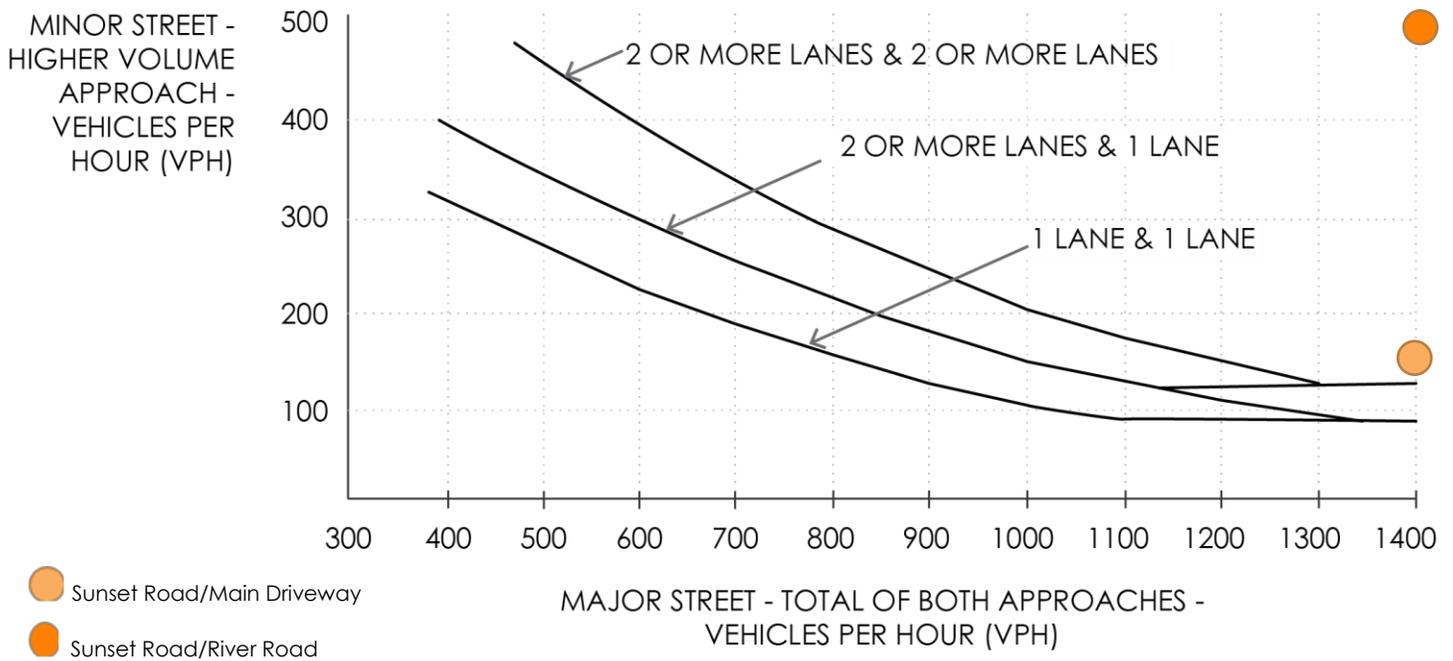
**Table 8. Signal Warrant 1 – Sunset Road/Sunset Innovation Campus Main Driveway**

Number of Lanes		Vehicles Per Hour		Condition A		Condition B	
Major Street	Minor Street	Major Street*	Minor Street**	100%	70%	100%	70%
2	2	2,052	676	Yes	Yes	Yes	Yes

\* Major street vehicles per hour (vph) represents the total 8-hour average of both approaches

\*\*Minor street vph represents the 8-hour average of one approach

Figure 12. Signal Warrant 2 – Four-Hour Vehicular Volume



Based on the signal warrant analysis for Warrant 1 and Warrant 2, the Sunset Road/Sunset Innovation Campus Main Driveway and Sunset Road/River Road intersections will meet the need for traffic signal control for 2045 traffic conditions. It is recommended that a signal be installed at the Sunset Road/River Road intersection with the construction of the Sunset Road extension. While it is expected that a traffic signal will be required at the Sunset Innovation Campus Main Driveway, it is recommended that the traffic signal be installed with the construction of the Sunset campus. As part of Sunset Road improvements, it is recommended that conduit and pull boxes to accommodate a signal be installed. Appendix E contains the traffic signal warrant worksheets.

## 4.6 Turn Lane Warrant Analysis

Right-turn lane warrant analysis for 2045 future traffic conditions was conducted for the following study intersections:

- Sunset Road/Sunset Innovation Campus South Driveway
- Sunset Road/Sunset Innovation Campus Main Driveway
- Sunset Road/EBFR
- Sunset Road/WBFR
- EBFR/Sunset Innovation Campus West Driveway
- EBFR/Sunset Innovation Campus East Driveway

The two-lane right-turn lane warrant outlined in the *Pima County Subdivision and Development Street Standards* were utilized for the South Driveway and Main Driveway access points. The ADOT TGP 245 criteria was used to evaluate the turn lane requirements at the I-10/Sunset Road TI and the access points for the Sunset Innovation Campus along the EBFR. The results from the turn lane warrant analysis are summarized below:

- Sunset Road/Sunset Innovation Campus South Driveway – Turn lane warrant is met for northbound right-turn movements
- Sunset Road/Sunset Innovation Campus Main Driveway – Turn lane warrant is met for the northbound right-turn movements
- Sunset Road/EBFR – Turn lane warrant is met for the eastbound right-turn movements
- Sunset Road/WBFR – Turn lane warrant is met for the westbound right-turn movements
- EBFR/Sunset Innovation Campus West Driveway – Turn lane warrant is met for the eastbound right-turn movements
- EBFR/Sunset Innovation Campus East Driveway – Turn lane warrant is met for the eastbound right-turn movements

For the Sunset Innovation Campus access driveways intersecting the EBFR, it is recommended that the eastbound turn-lanes be installed with the development. For additional information regarding right-turn lane warrants, see Appendix F.

# 5.0 PROPOSED IMPROVEMENTS

Proposed recommendations for Sunset Road are a result of capacity and level of service outcomes for 2045 traffic conditions, traffic signal warrant findings, and right-turn lane analyses.

## 5.1 Design Parameters

Sunset Road should be designed according to the requirements and standards identified in the Pima County Roadway Design Manual (12), ADOT Roadway Design Guidelines, and AASHTO's *A Policy on Geometric Design of Highways and Streets*, 2018 edition (The Green Book) (14).

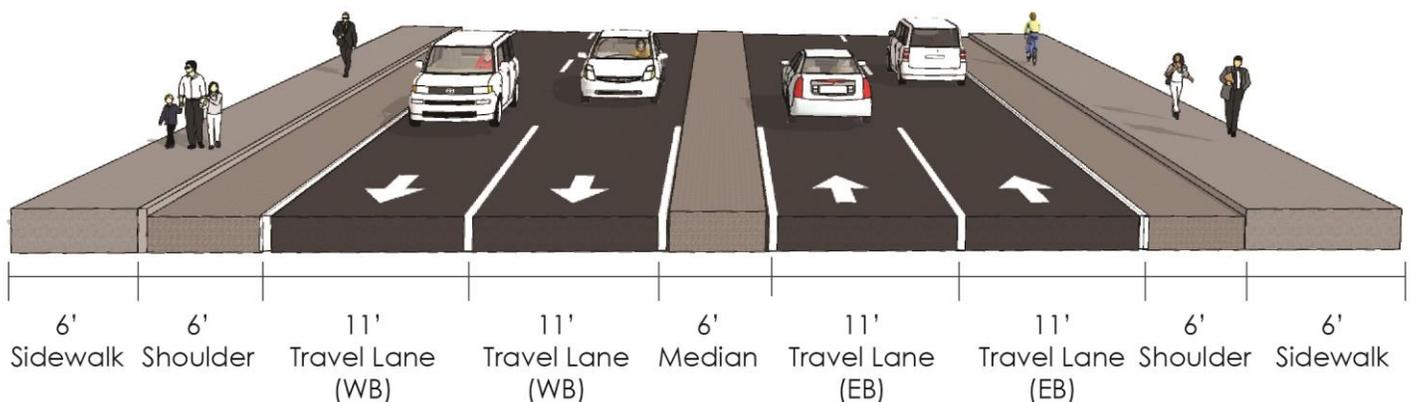
The following design criteria are recommended for this project.

- **Design Speed:** Sunset Road, from I-10 to River Road, will serve as a collector road. As Sunset Road, from Silverbell Road to the EBFR, has an existing posted speed limit of 35 mph, it is suggested that this speed be maintained for the extension from I-10 to River Road.
- **Stopping Sight Distance:** The stopping sight distance should be a minimum of 305 feet for a design speed of 40 mph, according to the criteria established in Table 7-1 of the AASHTO Green Book, 2018 (14).
- **Clear Zone:** According to the AASHTO Roadside Design Guide (15), the clear zone for a design speed less than or equal to 40 mph with an ADT over 6,000 vpd should range between 16 - 18 feet for foreslopes and backslopes.
- **Design Vehicle:** Sunset Road should be designed to accommodate a WB-67 design vehicle.

## 5.2 Roadway Segments

An urban four-lane roadway is proposed for the extension of Sunset Road from I-10 to River Road. The proposed cross-section includes 11-foot travel lanes, a raised median, six-foot-wide paved shoulders, vertical curb, and six-foot-wide concrete sidewalk facilities located on both sides of Sunset Road.

Figure 13. Sunset Road, I-10 to River Road Typical Section



## 5.3 Turn Bay Storage Lengths

Storage length requirements are based on the 95<sup>th</sup> percentile queue lengths estimated for 2045 traffic volumes. These queue lengths were calculated using Synchro, HCM, Sixth Edition, and microsimulation (SimTraffic). Guidance from the PCDOT/TDOT *Pavement Marking Design Manual* (16) and the *ADOT TGP 490* (9) were used for minimum storage length requirements. According to PCDOT/TDOT guidelines, the minimum right-turn lane length for a road with a posted speed of 40 mph or less is 110 feet. Per ADOT guidelines, the storage length for a right-turn lane is the sum of the braking distance and the queue length. Table 9 summarizes the recommended turn bay storage lengths at each study intersection based on the analysis of the queue lengths calculated using three analysis methodologies or the minimum right-turn lane length.

Table 9. Recommended Storage Lengths (feet)

Intersection	Eastbound		Westbound		Northbound		Southbound	
	EB LT	EB RT	WB LT	WB RT	NB LT	NB RT	SB LT	SB RT
Sunset Road/ Silverbell Road	250	-	-	200	-	-	475	-
Sunset Road/ South Driveway	-	-	110	110	-	110	200	-
Sunset Road/ Main Driveway	-	-	110	250	-	110	200	-
Sunset Road/ EBFR	-	400	-	-	200	365	-	-
Sunset Road/ WBFR	-	-	-	335	-	-	150	415
Sunset Road/ River Road	-	270	520	-	450	-	-	-
Driveway 1/ EBFR	-	150	-	-	-	110	-	-
Driveway 2/ EBFR	-	150	-	-	-	110	-	-

\*Sunset Road is designated as northbound/southbound.

## 5.4 Access

It is not expected that side street or driveway connections will be required to provide access to properties adjacent to the Sunset Road extension except for Pima County Flood Control District storage yard.

## 5.5 Alternative Transportation Modes

The Sunset Road extension will impact the existing multiuse path located on both sides of the Rillito Creek. A connection with the path on the northern bank path and the new roadway is recommended to provide connectivity between the east and west sides of I-10 for multi-modal users.

## 5.6 Lighting

Intersection lighting will be provided at the Sunset Road TI and the new signalized intersections at Sunset Road/River Road and Sunset Road/Sunset Innovation Campus Main Driveway. As part of the Sunset Innovation Campus development, roadway lighting should also be extended from the Sunset Road TI along the frontage of the campus on Sunset Road and the EBFR.

# 6.0 CONCLUSIONS AND RECOMMENDATIONS

Existing traffic volumes, historical crash data, and 2045 traffic volume projections were evaluated to determine the roadway and intersection capacity, lane configuration, and traffic control requirements for Sunset Road from west of I-10 to River Road. The findings of this analysis and the proposed recommendations for the extension of Sunset Road and the Sunset Innovation Campus access driveways are discussed below.

## Findings

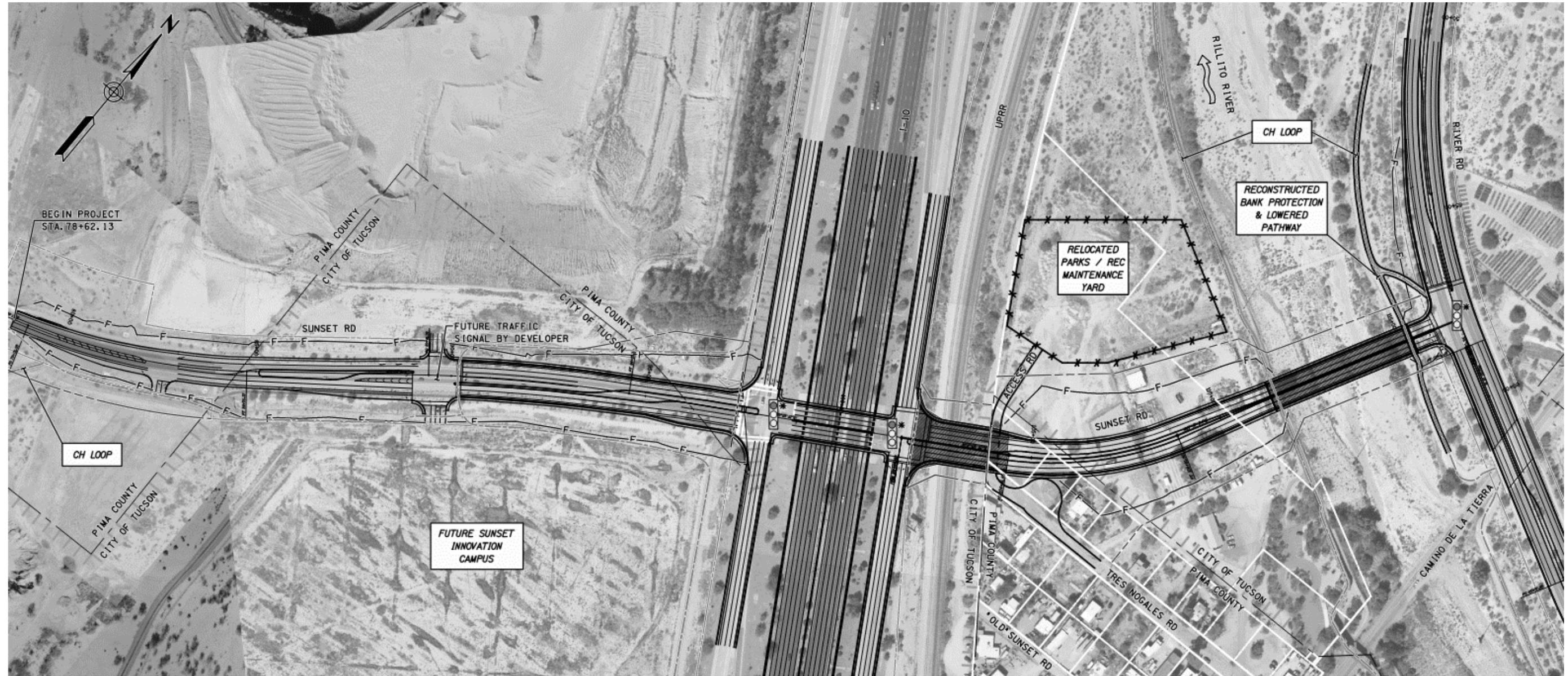
- The existing intersections at the I-10/Sunset Road TI meet acceptable intersection levels of service (LOS D or better), during the weekday AM and PM peak hours.
- A review of historical crash data did not reveal any patterns or trends in the area that require mitigation.
- The PAG regional travel demand model estimates a traffic demand on Sunset Road between Silverbell Road and I-10 will range between 16,000 and 22,000 vpd and will be 18,000 vpd on the new Sunset extension from I-10 and River Road. The Sunset Innovation Campus development is expected to generate 14,000 new daily trips in 2045.
- A four-lane cross-section from the Sunset Innovation Campus to River Road will provide sufficient capacity to provide acceptable levels of service.
- Traffic signals are warranted at the Sunset Road/ River Road and Sunset Road/Sunset Innovation Campus Main Driveway based on 2045 traffic projections.
- Capacity analysis results indicate that the lane configurations provided in Figure 11 will provide an acceptable level of service for 2045 traffic projections. Overall intersection and through lane level of service will be at LOS D or better and turn lanes will operate no worse than LOS E during peak traffic demand.

## Recommendations

Based on the analysis of existing and future traffic conditions, the following recommendations should be considered:

- Sunset Road from I-10 to River Road
  - The extension of Sunset Road from I-10 to River Road will require a four-lane roadway section. The recommended cross-section includes 11-foot wide travel lanes, a raised median, six-foot wide paved shoulders/bicycle lanes, and six-foot wide concrete sidewalk facilities on both sides. The raised median should be a minimum of 10-feet wide, widening to a minimum of 18-feet to accommodate left-turn lanes at intersections.
  - Install a traffic signal and intersection street lighting at the Sunset Road/River Road intersection.
  - Provide ADA compliant connections on Sunset Road to the multi-use path located on the embankment of the Rillito Creek.
  - Provide a posted speed limit of 35 mph on Sunset Road.
  - Maintain a design speed of 50 mph and a posted speed limit of 45 mph on River Road.
  - Provide access to Pima County Flood Control District storage yard.
- Sunset Road West of I-10
  - Widen the existing three-lane section to a four-lane divided section with raised median and 6-foot wide paved shoulders/bicycle lanes for approximately 900 feet west of the I-10 frontage road and construct intersections at the planned driveways to the planned Sunset Innovation Campus development.
  - Install conduit and pull boxes for a future traffic signal at the main campus driveway.
- Provide the lane configurations for each study intersection, as illustrated in Figure 11, and turn-lane storage lengths as provided in Table 9. Capacity analysis results indicate that the proposed improvements will provide sufficient capacity to serve the projected 2045 transportation demand. Refer to Figure 14 for an initial layout of the proposed Sunset Road improvements.
- Right-turn lanes at the planned Sunset Innovation Campus driveways on Sunset Road and the I-10 EBFR can be installed in conjunction with development.

Figure 14. Proposed Sunset Road Layout



## 7.0 REFERENCES

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# Appendix A Traffic Volumes

# Pima County DOT

Traffic Engineering Division  
TRAFFIC MOVEMENT COUNT

November 06, 2019

## I10 Frontage Rd @ Sunset Rd (East Intersection)

File Name : I10FrontageRd@SunsetRd (East Intersection) 2019.11.06

Site Code : 00000000

Start Date : 11/6/2019

Page No : 1

### Groups Printed- Unshifted

Start Time	I10 FRONTAGE RD SB					SUNSET RD WB					I10 FRONTAGE RD NB					SUNSET RD EB					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
07:00 AM	0	0	0	0	0	0	0	0	0	0	16	53	0	0	69	55	0	0	0	55	124
07:15 AM	0	0	1	0	1	0	0	0	0	0	15	49	0	0	64	73	0	0	0	73	138
07:30 AM	0	0	0	0	0	0	0	0	0	0	17	45	0	0	62	75	0	0	0	75	137
07:45 AM	0	0	0	0	0	0	0	0	0	0	12	62	0	0	74	96	0	0	0	96	170
Total	0	0	1	0	1	0	0	0	0	0	60	209	0	0	269	299	0	0	0	299	569
08:00 AM	0	0	0	0	0	0	0	0	0	0	7	51	0	0	58	67	0	0	0	67	125
08:15 AM	0	0	0	0	0	0	0	0	0	0	3	41	0	0	44	63	0	0	0	63	107
08:30 AM	0	0	0	0	0	0	0	0	0	0	14	50	0	0	64	49	0	0	0	49	113
08:45 AM	0	0	0	0	0	0	0	0	0	0	11	28	0	0	39	39	0	0	0	39	78
Total	0	0	0	0	0	0	0	0	0	0	35	170	0	0	205	218	0	0	0	218	423
*** BREAK ***																					
04:00 PM	0	0	0	0	0	0	0	0	0	0	26	104	0	0	130	37	0	0	0	37	167
04:15 PM	0	0	0	0	0	0	0	0	0	0	32	123	0	0	155	58	0	0	0	58	213
04:30 PM	0	0	0	0	0	0	0	0	0	0	41	133	0	0	174	46	0	0	0	46	220
04:45 PM	0	0	0	0	0	0	0	0	0	0	40	130	0	0	170	56	0	0	0	56	226
Total	0	0	0	0	0	0	0	0	0	0	139	490	0	0	629	197	0	0	0	197	826
05:00 PM	0	0	0	0	0	0	0	0	0	0	41	157	0	0	198	56	0	0	0	56	254
05:15 PM	0	0	0	0	0	0	0	0	0	0	25	165	0	0	190	52	0	0	0	52	242
05:30 PM	0	0	0	0	0	0	0	0	0	0	37	177	0	0	214	36	0	0	0	36	250
05:45 PM	0	0	0	0	0	0	0	0	0	0	36	152	0	0	188	55	0	0	0	55	243
Total	0	0	0	0	0	0	0	0	0	0	139	651	0	0	790	199	0	0	0	199	989
Grand Total	0	0	1	0	1	0	0	0	0	0	373	1520	0	0	1893	913	0	0	0	913	2807
Apprch %	0	0	100	0		0	0	0	0		19.7	80.3	0	0		100	0	0	0		
Total %	0	0	0	0		0	0	0	0		13.3	54.2	0	0	67.4	32.5	0	0	0	32.5	

# Pima County DOT

Traffic Engineering Division  
TRAFFIC MOVEMENT COUNT

November 06, 2019

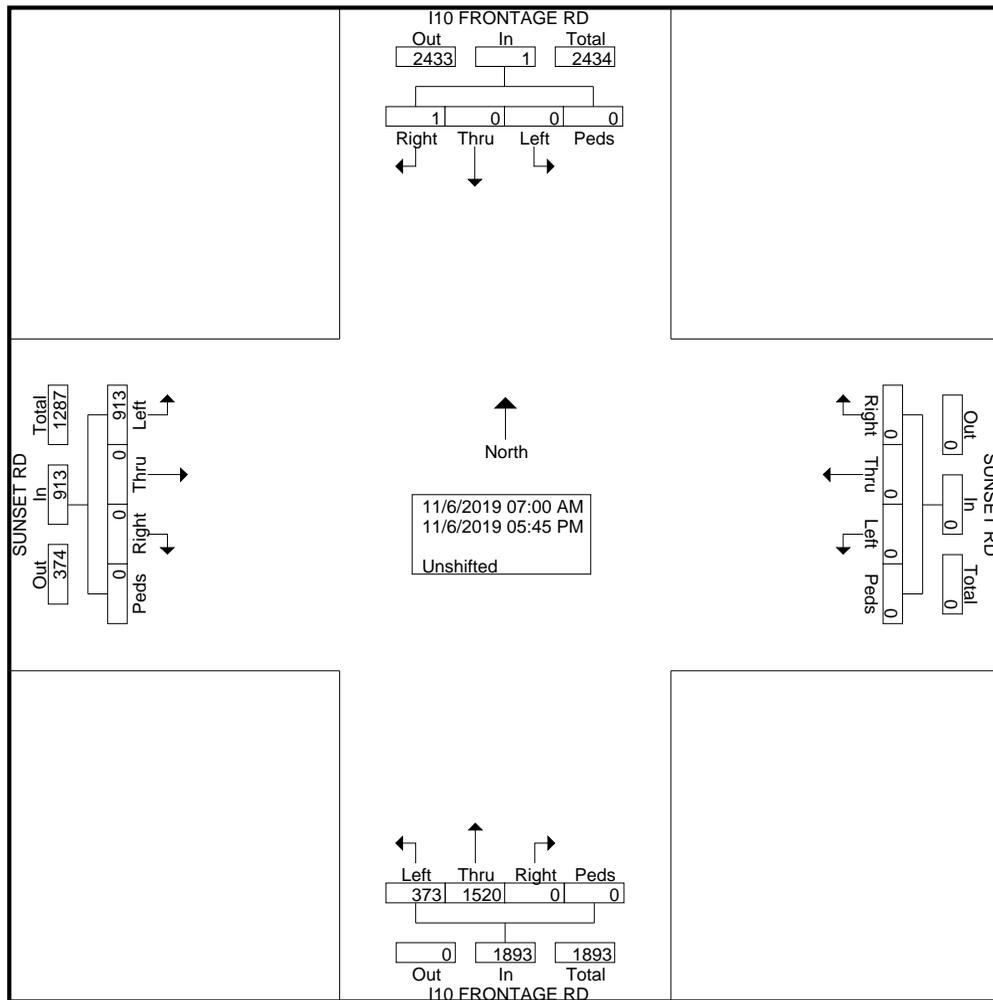
## I10 Frontage Rd @ Sunset Rd (East Intersection)

File Name : I10FrontageRd@SunsetRd (East Intersection) 2019.11.06

Site Code : 00000000

Start Date : 11/6/2019

Page No : 2



# Pima County DOT

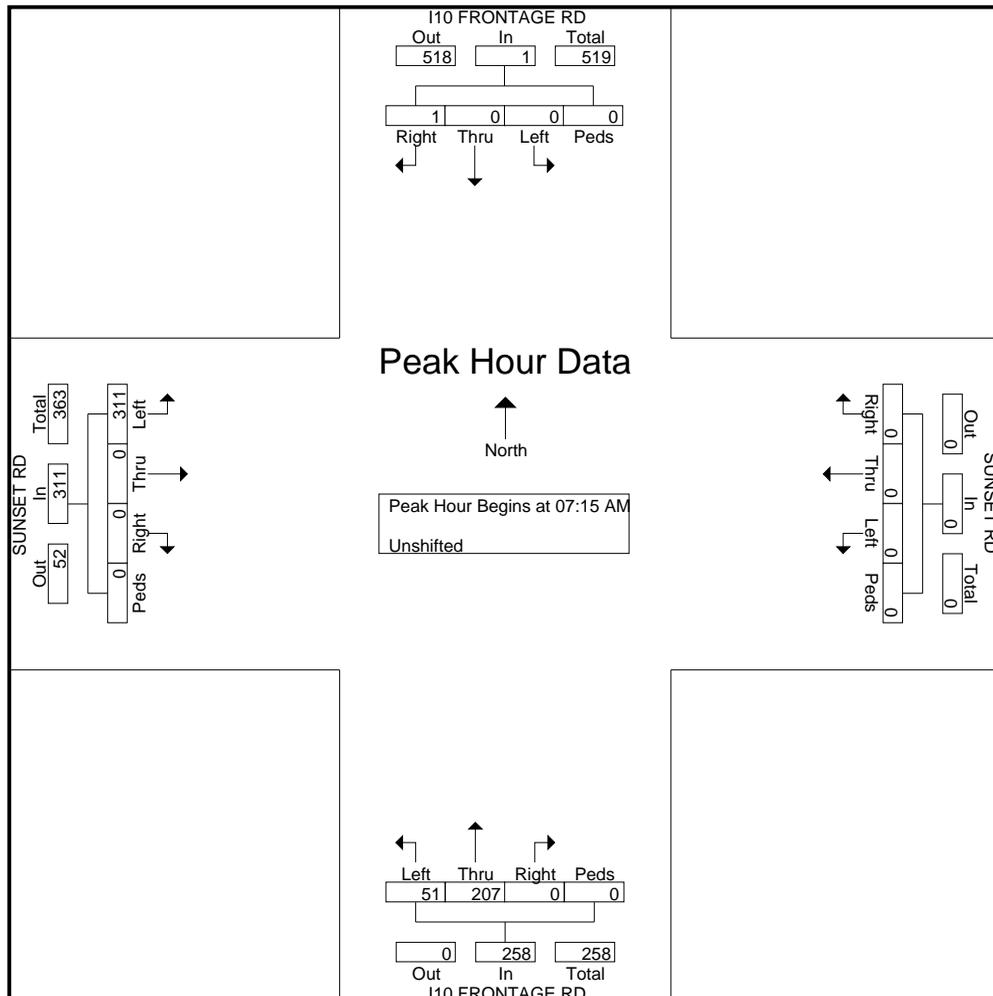
Traffic Engineering Division  
TRAFFIC MOVEMENT COUNT

November 06, 2019

## I10 Frontage Rd @ Sunset Rd (East Intersection)

File Name : I10FrontageRd@SunsetRd (East Intersection) 2019.11.06  
Site Code : 00000000  
Start Date : 11/6/2019  
Page No : 3

Start Time	I10 FRONTAGE RD SB					SUNSET RD WB					I10 FRONTAGE RD NB					SUNSET RD EB					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	0	0	1	0	1	0	0	0	0	0	15	49	0	0	64	73	0	0	0	73	138
07:30 AM	0	0	0	0	0	0	0	0	0	0	17	45	0	0	62	75	0	0	0	75	137
07:45 AM	0	0	0	0	0	0	0	0	0	0	12	62	0	0	74	96	0	0	0	96	170
08:00 AM	0	0	0	0	0	0	0	0	0	0	7	51	0	0	58	67	0	0	0	67	125
Total Volume	0	0	1	0	1	0	0	0	0	0	51	207	0	0	258	311	0	0	0	311	570
% App. Total	0	0	100	0		0	0	0	0		19.8	80.2	0	0		100	0	0	0		
PHF	.000	.000	.250	.000	.250	.000	.000	.000	.000	.000	.750	.835	.000	.000	.872	.810	.000	.000	.000	.810	.838



# Pima County DOT

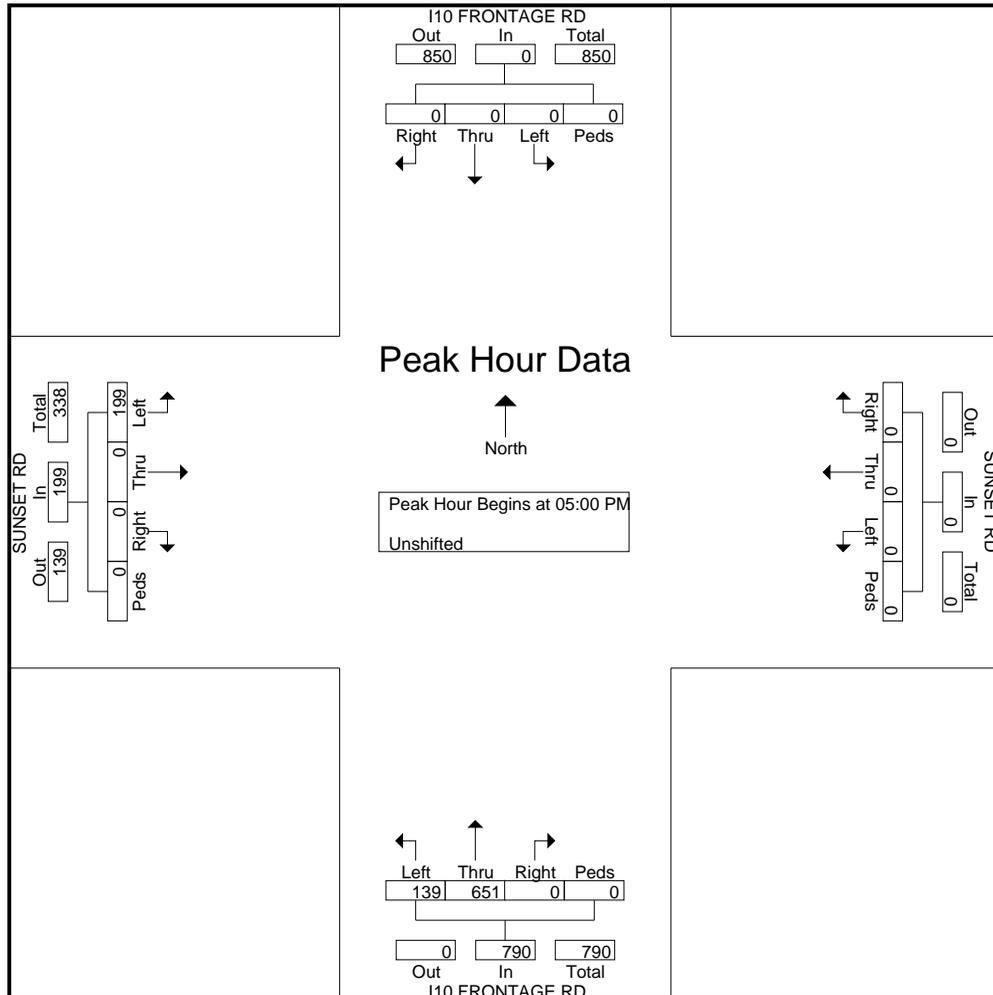
Traffic Engineering Division  
TRAFFIC MOVEMENT COUNT

November 06, 2019

## 110 Frontage Rd @ Sunset Rd (East Intersection)

File Name : I10FrontageRd@SunsetRd (East Intersection) 2019.11.06  
 Site Code : 00000000  
 Start Date : 11/6/2019  
 Page No : 4

Start Time	110 FRONTAGE RD SB					SUNSET RD WB					110 FRONTAGE RD NB					SUNSET RD EB					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 05:00 PM																					
05:00 PM	0	0	0	0	0	0	0	0	0	0	41	157	0	0	198	56	0	0	0	56	254
05:15 PM	0	0	0	0	0	0	0	0	0	0	25	165	0	0	190	52	0	0	0	52	242
05:30 PM	0	0	0	0	0	0	0	0	0	0	37	177	0	0	214	36	0	0	0	36	250
05:45 PM	0	0	0	0	0	0	0	0	0	0	36	152	0	0	188	55	0	0	0	55	243
Total Volume	0	0	0	0	0	0	0	0	0	0	139	651	0	0	790	199	0	0	0	199	989
% App. Total	0	0	0	0	0	0	0	0	0	0	17.6	82.4	0	0		100	0	0	0		
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.848	.919	.000	.000	.923	.888	.000	.000	.000	.888	.973



# Pima County DOT

Traffic Engineering Division  
TRAFFIC MOVEMENT COUNT

November 06, 2019

## I10 Frontage Rd @ Sunset Rd (West Intersection)

File Name : I10FrontageRd@SunsetRd (West Intersection) 2019.11.06

Site Code : 00000000

Start Date : 11/6/2019

Page No : 1

### Groups Printed- Unshifted

Start Time	I10 FRONTAGE RD SB					SUNSET RD WB					I10 FRONTAGE RD NB					SUNSET RD EB					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
07:00 AM	1	92	26	0	119	8	2	0	0	10	0	0	0	0	0	0	49	53	0	102	231
07:15 AM	1	154	21	0	176	9	9	0	0	18	0	0	0	0	0	0	67	83	0	150	344
07:30 AM	2	216	20	0	238	7	5	0	0	12	0	0	0	0	0	0	68	92	0	160	410
07:45 AM	1	189	43	0	233	6	5	0	0	11	0	0	0	0	0	0	82	107	0	189	433
Total	5	651	110	0	766	30	21	0	0	51	0	0	0	0	0	0	266	335	0	601	1418
08:00 AM	4	158	38	0	200	3	3	0	0	6	0	0	0	0	0	0	61	54	0	115	321
08:15 AM	7	109	39	0	155	2	3	0	0	5	0	0	0	0	0	0	44	41	0	85	245
08:30 AM	1	109	32	1	143	4	7	0	0	11	0	0	0	0	0	0	42	29	0	71	225
08:45 AM	0	22	20	0	42	7	7	0	0	14	0	0	0	0	0	0	28	16	0	44	100
Total	12	398	129	1	540	16	20	0	0	36	0	0	0	0	0	0	175	140	0	315	891
*** BREAK ***																					
04:00 PM	2	4	45	0	51	8	20	0	0	28	0	0	0	0	0	0	30	7	0	37	116
04:15 PM	2	9	31	0	42	6	25	0	0	31	0	0	0	0	0	0	43	5	0	48	121
04:30 PM	1	14	55	0	70	8	31	0	0	39	0	0	0	0	0	0	42	6	0	48	157
04:45 PM	0	15	47	0	62	3	32	1	0	36	0	0	0	0	0	0	42	4	0	46	144
Total	5	42	178	0	225	25	108	1	0	134	0	0	0	0	0	0	157	22	0	179	538
05:00 PM	3	12	43	1	59	6	28	0	0	34	0	0	0	0	0	0	45	7	0	52	145
05:15 PM	1	9	48	0	58	5	18	0	0	23	0	0	0	0	0	0	41	10	0	51	132
05:30 PM	0	10	40	0	50	4	30	0	0	34	0	0	0	0	0	0	31	12	0	43	127
05:45 PM	1	5	44	0	50	3	26	0	0	29	0	0	0	0	0	0	36	11	0	47	126
Total	5	36	175	1	217	18	102	0	0	120	0	0	0	0	0	0	153	40	0	193	530
Grand Total	27	1127	592	2	1748	89	251	1	0	341	0	0	0	0	0	0	751	537	0	1288	3377
Apprch %	1.5	64.5	33.9	0.1		26.1	73.6	0.3	0		0	0	0	0	0	0	58.3	41.7	0		
Total %	0.8	33.4	17.5	0.1	51.8	2.6	7.4	0	0	10.1	0	0	0	0	0	0	22.2	15.9	0	38.1	

# Pima County DOT

Traffic Engineering Division  
TRAFFIC MOVEMENT COUNT

November 06, 2019

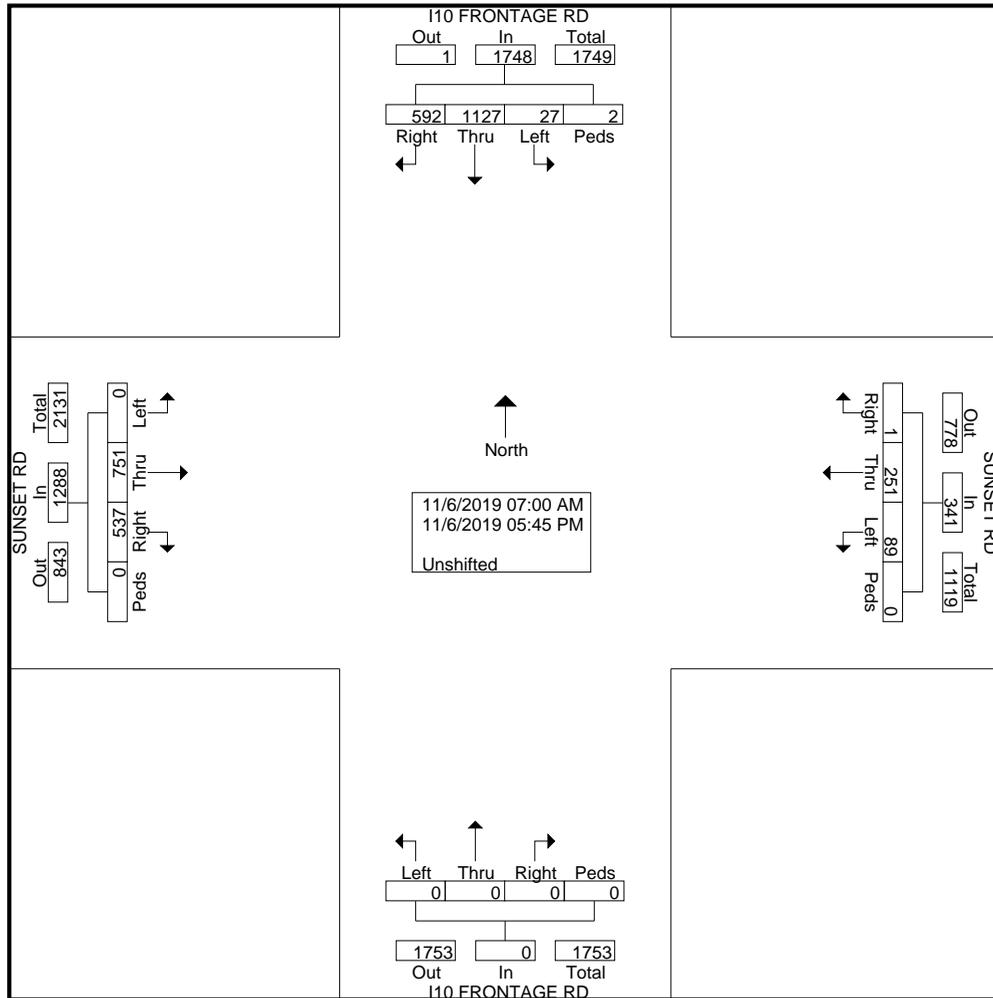
## I10 Frontage Rd @ Sunset Rd (West Intersection)

File Name : I10FrontageRd@SunsetRd (West Intersection) 2019.11.06

Site Code : 00000000

Start Date : 11/6/2019

Page No : 2



# Pima County DOT

Traffic Engineering Division  
TRAFFIC MOVEMENT COUNT

November 06, 2019

## I10 Frontage Rd @ Sunset Rd (West Intersection)

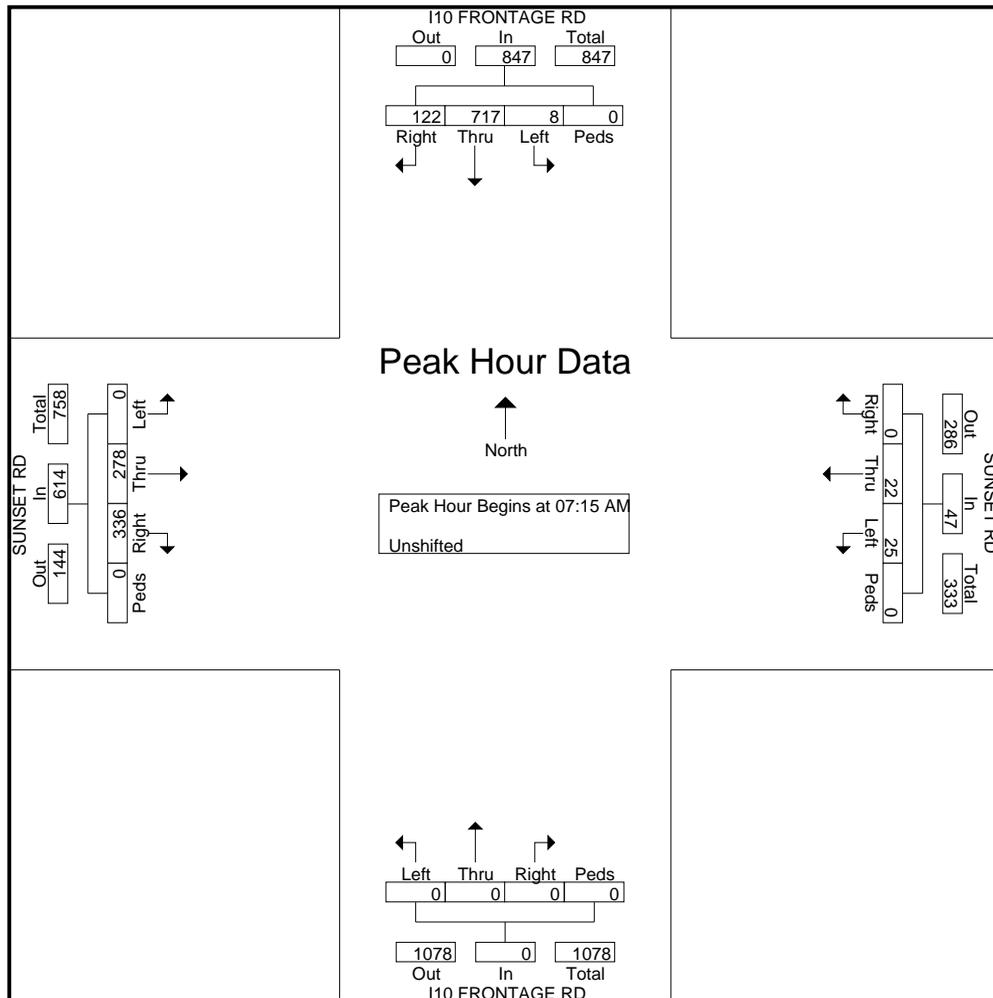
File Name : I10FrontageRd@SunsetRd (West Intersection) 2019.11.06

Site Code : 00000000

Start Date : 11/6/2019

Page No : 3

Start Time	I10 FRONTAGE RD SB					SUNSET RD WB					I10 FRONTAGE RD NB					SUNSET RD EB					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	1	154	21	0	176	9	9	0	0	18	0	0	0	0	0	0	67	83	0	150	344
07:30 AM	2	216	20	0	238	7	5	0	0	12	0	0	0	0	0	0	68	92	0	160	410
07:45 AM	1	189	43	0	233	6	5	0	0	11	0	0	0	0	0	0	82	107	0	189	433
08:00 AM	4	158	38	0	200	3	3	0	0	6	0	0	0	0	0	0	61	54	0	115	321
Total Volume	8	717	122	0	847	25	22	0	0	47	0	0	0	0	0	0	278	336	0	614	1508
% App. Total	0.9	84.7	14.4	0		53.2	46.8	0	0		0	0	0	0		0	45.3	54.7	0		
PHF	.500	.830	.709	.000	.890	.694	.611	.000	.000	.653	.000	.000	.000	.000	.000	.000	.848	.785	.000	.812	.871



# Pima County DOT

Traffic Engineering Division  
TRAFFIC MOVEMENT COUNT

November 06, 2019

## I10 Frontage Rd @ Sunset Rd (West Intersection)

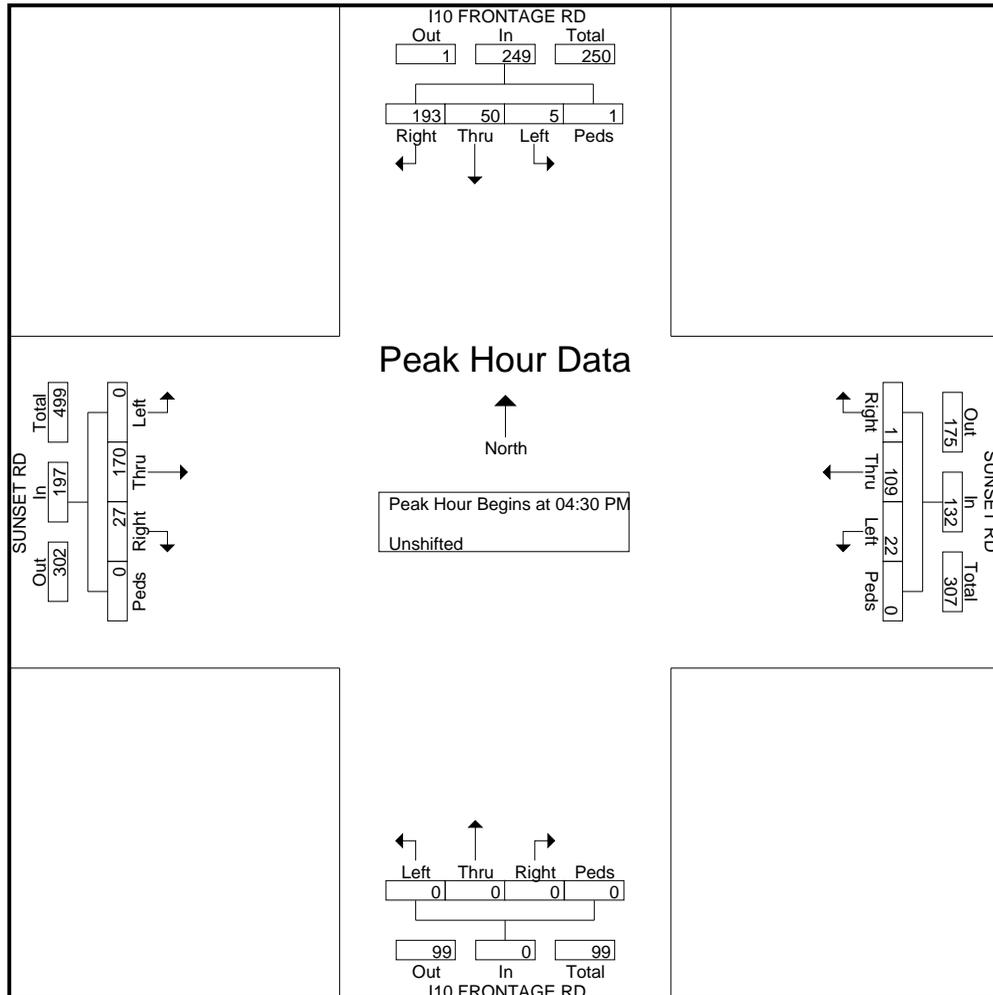
File Name : I10FrontageRd@SunsetRd (West Intersection) 2019.11.06

Site Code : 00000000

Start Date : 11/6/2019

Page No : 4

Start Time	I10 FRONTAGE RD SB					SUNSET RD WB					I10 FRONTAGE RD NB					SUNSET RD EB					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	1	14	55	0	70	8	31	0	0	39	0	0	0	0	0	0	42	6	0	48	157
04:45 PM	0	15	47	0	62	3	32	1	0	36	0	0	0	0	0	0	42	4	0	46	144
05:00 PM	3	12	43	1	59	6	28	0	0	34	0	0	0	0	0	0	45	7	0	52	145
05:15 PM	1	9	48	0	58	5	18	0	0	23	0	0	0	0	0	0	41	10	0	51	132
Total Volume	5	50	193	1	249	22	109	1	0	132	0	0	0	0	0	0	170	27	0	197	578
% App. Total	2	20.1	77.5	0.4		16.7	82.6	0.8	0		0	0	0	0	0	0	86.3	13.7	0		
PHF	.417	.833	.877	.250	.889	.688	.852	.250	.000	.846	.000	.000	.000	.000	.000	.000	.944	.675	.000	.947	.920



Appendix B  
Existing Level of Services  
Worksheets

Intersection	
Intersection Delay, s/veh	31
Intersection LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑	↑		↑					↑	↑↑	
Traffic Vol, veh/h	0	278	336	25	26	0	0	0	0	8	717	122
Future Vol, veh/h	0	278	336	25	26	0	0	0	0	8	717	122
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.95	0.87
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	320	386	29	30	0	0	0	0	9	755	140
Number of Lanes	0	1	1	0	1	0	0	0	0	1	2	0

Approach	EB	WB	SB
Opposing Approach	WB	EB	
Opposing Lanes	1	2	0
Conflicting Approach Left	SB		WB
Conflicting Lanes Left	3	0	1
Conflicting Approach Right		SB	EB
Conflicting Lanes Right	0	3	2
HCM Control Delay	22.7	13.4	38.7
HCM LOS	C	B	E

Lane	EBLn1	EBLn2	WBLn1	SBLn1	SBLn2	SBLn3
Vol Left, %	0%	0%	49%	100%	0%	0%
Vol Thru, %	100%	0%	51%	0%	100%	66%
Vol Right, %	0%	100%	0%	0%	0%	34%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	278	336	51	8	478	361
LT Vol	0	0	25	8	0	0
Through Vol	278	0	26	0	478	239
RT Vol	0	336	0	0	0	122
Lane Flow Rate	320	386	59	9	503	392
Geometry Grp	8	8	8	7	7	7
Degree of Util (X)	0.642	0.7	0.148	0.018	0.94	0.706
Departure Headway (Hd)	7.232	6.524	9.112	7.229	6.723	6.483
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	498	552	396	494	538	556
Service Time	5.003	4.295	6.812	4.99	4.484	4.244
HCM Lane V/C Ratio	0.643	0.699	0.149	0.018	0.935	0.705
HCM Control Delay	22.2	23.2	13.4	10.1	51.2	23.4
HCM Lane LOS	C	C	B	B	F	C
HCM 95th-tile Q	4.5	5.5	0.5	0.1	11.8	5.6

Intersection						
Int Delay, s/veh	7.6					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	286	0	51	207	0	0
Future Vol, veh/h	286	0	51	207	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	16965	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	84	84	84	84	84	84
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	340	0	61	246	0	0

Major/Minor	Minor2	Major1	
Conflicting Flow All	245	-	0
Stage 1	0	-	-
Stage 2	245	-	-
Critical Hdwy	6.84	-	4.14
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	5.84	-	-
Follow-up Hdwy	3.52	-	2.22
Pot Cap-1 Maneuver	722	0	-
Stage 1	-	0	-
Stage 2	773	0	-
Platoon blocked, %			-
Mov Cap-1 Maneuver	722	-	-
Mov Cap-2 Maneuver	722	-	-
Stage 1	-	-	-
Stage 2	773	-	-

Approach	EB	NB
HCM Control Delay, s	14.4	
HCM LOS	B	

Minor Lane/Major Mvmt	NBL	NBT	EBLn1
Capacity (veh/h)	-	-	722
HCM Lane V/C Ratio	-	-	0.472
HCM Control Delay (s)	-	-	14.4
HCM Lane LOS	-	-	B
HCM 95th %tile Q(veh)	-	-	2.5

HCM 6th Signalized Intersection Summary  
8: Silverbell Rd & Sunset Rd

Exist AM Peak Hour  
01/20/2020

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	108	40	90	200	414	200
Future Volume (veh/h)	108	40	90	200	414	200
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	117	43	98	217	450	217
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	191	170	1076	912	874	1076
Arrive On Green	0.11	0.11	0.58	0.58	0.58	0.58
Sat Flow, veh/h	1781	1585	1870	1585	1065	1870
Grp Volume(v), veh/h	117	43	98	217	450	217
Grp Sat Flow(s),veh/h/ln	1781	1585	1870	1585	1065	1870
Q Serve(g_s), s	1.6	0.6	0.6	1.7	8.3	1.4
Cycle Q Clear(g_c), s	1.6	0.6	0.6	1.7	8.9	1.4
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	191	170	1076	912	874	1076
V/C Ratio(X)	0.61	0.25	0.09	0.24	0.52	0.20
Avail Cap(c_a), veh/h	1132	1007	2674	2266	1783	2674
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	10.7	10.3	2.4	2.6	4.4	2.6
Incr Delay (d2), s/veh	3.2	0.8	0.0	0.1	0.5	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.2	0.0	0.1	0.3	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	13.9	11.1	2.4	2.8	4.9	2.7
LnGrp LOS	B	B	A	A	A	A
Approach Vol, veh/h			315			667
Approach Delay, s/veh			2.7			4.1
Approach LOS			A			A
Timer - Assigned Phs		2			6	8
Phs Duration (G+Y+Rc), s		18.5			18.5	6.7
Change Period (Y+Rc), s		4.0			4.0	4.0
Max Green Setting (Gmax), s		36.0			36.0	16.0
Max Q Clear Time (g_c+I1), s		3.7			10.9	3.6
Green Ext Time (p_c), s		1.3			3.6	0.3
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			5.0			
HCM 6th LOS			A			

Intersection	
Intersection Delay, s/veh	10.3
Intersection LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑	↗		↖					↖	↑↑	
Traffic Vol, veh/h	0	194	27	22	117	0	0	0	0	5	50	193
Future Vol, veh/h	0	194	27	22	117	0	0	0	0	5	50	193
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	211	29	24	127	0	0	0	0	5	54	210
Number of Lanes	0	1	1	0	1	0	0	0	0	1	2	0

Approach	EB	WB	SB
Opposing Approach	WB	EB	
Opposing Lanes	1	2	0
Conflicting Approach Left	SB		WB
Conflicting Lanes Left	3	0	1
Conflicting Approach Right		SB	EB
Conflicting Lanes Right	0	3	2
HCM Control Delay	10.7	10.6	9.7
HCM LOS	B	B	A

Lane	EBLn1	EBLn2	WBLn1	SBLn1	SBLn2	SBLn3
Vol Left, %	0%	0%	16%	100%	0%	0%
Vol Thru, %	100%	0%	84%	0%	100%	8%
Vol Right, %	0%	100%	0%	0%	0%	92%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	194	27	139	5	33	210
LT Vol	0	0	22	5	0	0
Through Vol	194	0	117	0	33	17
RT Vol	0	27	0	0	0	193
Lane Flow Rate	211	29	151	5	36	228
Geometry Grp	8	8	8	7	7	7
Degree of Util (X)	0.328	0.04	0.245	0.009	0.056	0.312
Departure Headway (Hd)	5.598	4.894	5.849	6.082	5.579	4.93
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	637	724	607	585	638	722
Service Time	3.382	2.678	3.643	3.852	3.349	2.699
HCM Lane V/C Ratio	0.331	0.04	0.249	0.009	0.056	0.316
HCM Control Delay	11.1	7.9	10.6	8.9	8.7	9.9
HCM Lane LOS	B	A	B	A	A	A
HCM 95th-tile Q	1.4	0.1	1	0	0.2	1.3

Intersection						
Int Delay, s/veh	4.3					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↘		↖↗			
Traffic Vol, veh/h	199	0	139	651	0	0
Future Vol, veh/h	199	0	139	651	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	16965	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	205	0	143	671	0	0

Major/Minor	Minor2	Major1	
Conflicting Flow All	622	-	0
Stage 1	0	-	-
Stage 2	622	-	-
Critical Hdwy	6.84	-	4.14
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	5.84	-	-
Follow-up Hdwy	3.52	-	2.22
Pot Cap-1 Maneuver	419	0	-
Stage 1	-	0	-
Stage 2	498	0	-
Platoon blocked, %			-
Mov Cap-1 Maneuver	419	-	-
Mov Cap-2 Maneuver	419	-	-
Stage 1	-	-	-
Stage 2	498	-	-

Approach	EB	NB
HCM Control Delay, s	21.6	
HCM LOS	C	

Minor Lane/Major Mvmt	NBL	NBT	EBLn1
Capacity (veh/h)	-	-	419
HCM Lane V/C Ratio	-	-	0.49
HCM Control Delay (s)	-	-	21.6
HCM Lane LOS	-	-	C
HCM 95th %tile Q(veh)	-	-	2.6

HCM 6th Signalized Intersection Summary  
8: Silverbell Rd & New Sunset Rd

Exist PM Peak Hour  
01/20/2020

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	100	210	260	101	120	160
Future Volume (veh/h)	100	210	260	101	120	160
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	109	228	283	110	130	174
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	417	371	724	613	616	724
Arrive On Green	0.23	0.23	0.39	0.39	0.39	0.39
Sat Flow, veh/h	1781	1585	1870	1585	991	1870
Grp Volume(v), veh/h	109	228	283	110	130	174
Grp Sat Flow(s),veh/h/ln	1781	1585	1870	1585	991	1870
Q Serve(g_s), s	1.1	2.7	2.3	1.0	2.3	1.3
Cycle Q Clear(g_c), s	1.1	2.7	2.3	1.0	4.6	1.3
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	417	371	724	613	616	724
V/C Ratio(X)	0.26	0.61	0.39	0.18	0.21	0.24
Avail Cap(c_a), veh/h	2025	1802	2480	2102	1547	2480
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	6.6	7.2	4.7	4.3	6.3	4.4
Incr Delay (d2), s/veh	0.3	1.7	0.3	0.1	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.6	0.3	0.1	0.2	0.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	6.9	8.9	5.0	4.4	6.5	4.5
LnGrp LOS	A	A	A	A	A	A
Approach Vol, veh/h	337		393			304
Approach Delay, s/veh	8.3		4.8			5.4
Approach LOS	A		A			A
Timer - Assigned Phs		2			6	8
Phs Duration (G+Y+Rc), s		12.2			12.2	8.9
Change Period (Y+Rc), s		4.0			4.0	4.0
Max Green Setting (Gmax), s		28.0			28.0	24.0
Max Q Clear Time (g_c+I1), s		4.3			6.6	4.7
Green Ext Time (p_c), s		2.0			1.6	1.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			6.1			
HCM 6th LOS			A			

## Appendix C Crash Data

IncidentID	Microfilm	ADOTRece Status	DataConv2	IncidentDa	IncidentDa	IncidentYe	IncidentM	IncidentDa	IncidentHo	OfficerNcic	OfficerId	FileNumbe	ExtendedN	DamageOv	PhotosTaki	Photografi	Photografi	Photografi	Investigate	DateTime	CollisionM	LightCondi	FirstHarmf	FirstHarmf	TotalUnits	TotalMoto	TotalNonV	TotalInjur	TotalFatal	TotalMoto	TotalNonV	TotalMoto	TotalNonV	InjurySevei	MedicalTrc
2881088	#####	200	#####	#####	2014	10	7	15	799			2.01E+09	1003								1	1	1	1	1	0	1	0	1	0	0	0	0	4	
2894789	#####	200	#####	#####	2014	11	6	10	799			2.01E+09	1000								1	1	38	1	1	0	1	0	1	0	0	0	0	2	
2919869	#####	200	#####	#####	2015	2	2	0	799			2.02E+09	1003								1	5	36	1	1	0	1	0	1	0	0	0	0	4	
2949310	#####	200	#####	#####	2015	4	6	15	799			2.02E+09	1003								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
2958528	#####	200	#####	#####	2015	5	5	5	799			2.02E+09	1000								6	2	16	2	2	0	0	0	0	0	0	0	0	1	
2986263	#####	200	#####	#####	2015	8	6	19	799			2.02E+09	1003								1	3	31	1	1	0	0	0	0	0	0	0	0	1	
2988958	#####	200	#####	#####	2015	8	3	13	1000			1.51E+08	1000								4	1	16	2	2	0	2	0	2	0	0	0	0	2	
2990213	#####	200	#####	#####	2015	9	4	15	799			2.02E+09	1000								6	1	16	2	2	0	0	0	0	0	0	0	0	1	
2993884	#####	200	#####	#####	2015	9	4	8	799			2.02E+09	1003								4	1	16	5	6	0	2	0	2	0	0	0	0	3	
2993885	#####	200	#####	#####	2015	9	2	7	799			2.02E+09	1003								4	1	16	3	3	0	1	0	1	0	0	0	0	3	
2996912	#####	200	#####	#####	2015	9	5	16	799			2.02E+09	1003								1	1	36	1	1	0	0	0	0	0	0	0	0	1	
3007908	#####	200	#####	#####	2015	9	4	17	799			2.02E+09	1000								1	1	1	1	1	0	1	0	1	0	0	0	0	3	
3019760	#####	200	#####	#####	2015	11	2	17	799			2.02E+09	1003								6	3	16	2	2	0	1	0	1	0	0	0	0	3	
3032939	#####	200	#####	#####	2016	1	1	6	799			2.02E+09	1003								6	5	16	2	8	0	0	0	0	0	0	0	0	1	
3048086	#####	200	#####	#####	2016	2	6	19	799			2.02E+09	1003								1	4	49	1	1	0	0	0	0	0	0	0	0	1	
3055676	#####	200	#####	#####	2016	2	3	7	799			2.02E+09	1003								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3084850	#####	200	#####	#####	2016	5	3	17	799			2.02E+09	1000								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3091910	#####	200	#####	#####	2016	5	3	8	799			2.02E+09	1000								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3099871	#####	200	#####	#####	2016	6	6	14	799			2.02E+09	1003								1	1	39	1	2	0	0	0	0	0	0	0	0	1	
3100522	#####	200	#####	#####	2016	6	4	13	799			2.02E+09	1000								1	1	45	1	1	0	0	0	0	0	0	0	0	1	
3116295	#####	200	#####	#####	2016	7	5	16	799			2.02E+09	1003								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3129309	#####	200	#####	#####	2016	8	4	7	799			2.02E+09	1003								4	1	16	2	4	0	1	0	1	0	0	0	0	3	
3136164	#####	200	#####	#####	2016	9	5	17	799			2.02E+09	1003								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3138861	#####	200	#####	#####	2016	9	5	7	799			2.02E+09	1003								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3145034	#####	200	#####	#####	2016	10	5	7	799			2.02E+09	1000								4	1	16	2	3	0	0	0	0	0	0	0	0	1	
3152051	#####	200	#####	#####	2016	10	3	7	799			2.02E+09	1000								4	1	16	3	4	0	1	0	1	0	0	0	0	2	
3165145	#####	200	#####	#####	2016	12	2	7	799			2.02E+09	1003								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3172658	#####	200	#####	#####	2016	12	6	19	799			2.02E+09	1000								6	4	16	2	4	0	0	0	0	0	0	0	0	1	
3187524	#####	200	#####	#####	2017	2	5	7	799			2.02E+09	1003								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3214550	#####	200	#####	#####	2017	3	5	14	799			2.02E+09	1003								4	1	16	2	4	0	0	0	0	0	0	0	0	1	
3229542	#####	200	#####	#####	2017	5	6	6	799			2.02E+09	1003								4	1	16	3	3	0	0	0	0	0	0	0	0	1	
3236044	#####	200	#####	#####	2017	6	1	17	799			2.02E+09	1003								2	1	16	2	2	0	1	0	1	0	0	0	0	3	
3237569	#####	200	#####	#####	2017	6	4	17	799			2.02E+09	1000								4	1	16	3	4	0	0	0	0	0	0	0	0	1	
3243388	#####	200	#####	#####	2017	6	3	16	799			2.02E+09	1000								6	1	16	2	2	0	0	0	0	0	0	0	0	1	
3245662	#####	200	#####	#####	2017	6	5	15	1003			1.71E+09	1003								2	1	16	2	2	0	1	0	1	0	0	0	0	3	
3263066	#####	200	#####	#####	2017	8	4	15	799			2.02E+09	1003								2	1	16	2	2	0	0	0	0	0	0	0	0	1	
3271526	#####	200	#####	#####	2017	8	7	21	1000			1.71E+08	1000								1	5	34	1	2	0	2	0	2	0	0	0	0	3	
3272489	#####	200	#####	#####	2017	9	3	7	799			2.02E+09	1003								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3291561	#####	200	#####	#####	2017	11	6	12	799			2.02E+09	1003								1	1	39	1	1	0	0	0	0	0	0	0	0	1	
3302607	#####	200	#####	#####	2017	12	6	7	799			2.02E+09	1003								1	1	41	1	1	0	0	0	0	0	0	0	0	1	
3304978	#####	200	#####	#####	2017	12	6	18	1003			1.71E+09	1003								4	5	16	2	2	0	2	0	2	0	0	0	0	2	
3317367	#####	200	#####	#####	2018	1	6	21	799			2.02E+09	1000								6	5	16	2	6	0	0	0	0	0	0	0	0	1	
3321857	#####	200	#####	#####	2018	1	5	6	799			2.02E+09	1003								1	2	28	1	1	0	0	0	0	0	0	0	0	1	
3323358	#####	210	#####	#####	2018	1	6	9	1000			1.8E+08	1000								97	1	18	2	1	1	1	0	0	1	0	0	0	4	
3328826	#####	200	#####	#####	2017	12	2	8	1003			1.71E+09	1003								1	1	30	1	1	0	0	0	0	0	0	0	0	1	
3330364	#####	200	#####	#####	2018	2	4	5	799			2.02E+09	1003								6	5	16	2	2	0	0	0	0	0	0	0	0	1	
3331413	#####	200	#####	#####	2018	2	4	17	799			2.02E+09	1000								4	1	16	2	2	0	0	0	0	0	0	0	0	1	
3348888	#####	200	#####	#####	2018	3	4	6	799			2.02E+09	1003								1	1	39	1	1	0	0	0	0	0	0	0	0	1	
3357348	#####	200	#####	#####	2018	4	2	9	799			2.02E+09	1003								6	1	16	2	2	0	0	0	0	0	0	0	0	1	
3366902	#####	200	#####	#####	2018	5	3	7	799			2.02E+09	1003								4	1	16	3	3	0	0	0	0	0	0	0	0	1	
3369910	#####	200	#####	#####	2018	5	5	15	799			2.02E+09	1003								4	1	16	2	8	0	0	0	0	0	0	0	0	1	
3379506	#####	200	#####	#####	2018	6	2	7	799			2.02E+09	1003								4	1	16	2	2	0	1	0	1	0	0	0	0	2	
3392083	#####	200	#####	#####	2018	7	7	17	799			2.02E+09	1000								1	1	41	1	1	0	0	0	0	0	0	0	0	1	
3396607	#####	200	#####	#####	2018	8	6	7	799			2.02E+09	1003								6	1	16	2	2	0	2	0	2	0	0	0	0	2	
3402698	#####	200	#####	#####	201																														



Appendix D  
2045 Future Traffic Level of  
Service Worksheets

HCM 6th Signalized Intersection Summary  
 1: Silverbell Rd & Sunset Rd

2045 AM Peak Hour  
 02/11/2020



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	300	220	490	650	450	1220
Future Volume (veh/h)	300	220	490	650	450	1220
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No		No			No
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	326	239	516	684	474	1284
Peak Hour Factor	0.92	0.92	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	403	359	834	731	527	2012
Arrive On Green	0.23	0.23	0.23	0.23	0.21	0.57
Sat Flow, veh/h	1781	1585	3647	1585	1781	3647
Grp Volume(v), veh/h	326	239	516	684	474	1284
Grp Sat Flow(s),veh/h/ln	1781	1585	1777	1585	1781	1777
Q Serve(g_s), s	9.6	7.6	7.2	13.0	9.1	13.6
Cycle Q Clear(g_c), s	9.6	7.6	7.2	13.0	9.1	13.6
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	403	359	834	731	527	2012
V/C Ratio(X)	0.81	0.67	0.62	0.94	0.90	0.64
Avail Cap(c_a), veh/h	531	472	834	731	564	2053
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	20.3	19.5	19.0	11.6	19.4	8.2
Incr Delay (d2), s/veh	6.9	2.2	1.4	19.4	16.7	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	7.8	5.0	5.1	18.3	12.1	7.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	27.2	21.8	20.4	31.0	36.1	8.8
LnGrp LOS	C	C	C	C	D	A
Approach Vol, veh/h	565		1200			1758
Approach Delay, s/veh	24.9		26.4			16.2
Approach LOS	C		C			B
Timer - Assigned Phs	1	2			6	8
Phs Duration (G+Y+Rc), s	17.4	20.0			37.4	18.0
Change Period (Y+Rc), s	6.0	* 7			6.0	5.5
Max Green Setting (Gmax), s	12.5	* 13			32.0	16.5
Max Q Clear Time (g_c+I1), s	11.1	15.0			15.6	11.6
Green Ext Time (p_c), s	0.3	0.0			8.7	0.9

Intersection Summary

HCM 6th Ctrl Delay	21.1
HCM 6th LOS	C

Notes

\* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Intersection						
Int Delay, s/veh	1					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗	↘	↑↑	↘	↗
Traffic Vol, veh/h	890	210	70	490	30	10
Future Vol, veh/h	890	210	70	490	30	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	250	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	967	228	76	533	33	11

Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	1195	0	1386 967
Stage 1	-	-	-	-	967 -
Stage 2	-	-	-	-	419 -
Critical Hdwy	-	-	4.13	-	6.63 6.23
Critical Hdwy Stg 1	-	-	-	-	5.43 -
Critical Hdwy Stg 2	-	-	-	-	5.83 -
Follow-up Hdwy	-	-	2.219	-	3.519 3.319
Pot Cap-1 Maneuver	-	-	582	-	145 307
Stage 1	-	-	-	-	368 -
Stage 2	-	-	-	-	633 -
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	582	-	126 307
Mov Cap-2 Maneuver	-	-	-	-	256 -
Stage 1	-	-	-	-	368 -
Stage 2	-	-	-	-	550 -

Approach	EB	WB	NB
HCM Control Delay, s	0	1.5	20.1
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	256	307	-	-	582	-
HCM Lane V/C Ratio	0.127	0.035	-	-	0.131	-
HCM Control Delay (s)	21.1	17.2	-	-	12.1	-
HCM Lane LOS	C	C	-	-	B	-
HCM 95th %tile Q(veh)	0.4	0.1	-	-	0.4	-

HCM 6th Signalized Intersection Summary  
3: Main Dwy & Sunset Rd

2045 AM Peak Hour  
02/11/2020



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑	↗	↖	↑↑	↖	↗
Traffic Volume (veh/h)	830	70	730	500	60	100
Future Volume (veh/h)	830	70	730	500	60	100
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	902	76	793	543	67	109
Peak Hour Factor	0.92	0.92	0.92	0.92	0.90	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	2375	1059	1171	2935	152	314
Arrive On Green	0.67	0.67	0.11	0.83	0.09	0.09
Sat Flow, veh/h	3647	1585	3456	3647	1781	1585
Grp Volume(v), veh/h	902	76	793	543	67	109
Grp Sat Flow(s),veh/h/ln	1777	1585	1728	1777	1781	1585
Q Serve(g_s), s	10.2	1.5	5.3	2.8	3.2	5.3
Cycle Q Clear(g_c), s	10.2	1.5	5.3	2.8	3.2	5.3
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	2375	1059	1171	2935	152	314
V/C Ratio(X)	0.38	0.07	0.68	0.19	0.44	0.35
Avail Cap(c_a), veh/h	2375	1059	1701	2935	475	602
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(l)	1.00	1.00	0.86	0.86	1.00	1.00
Uniform Delay (d), s/veh	6.6	5.2	5.1	1.6	39.1	31.1
Incr Delay (d2), s/veh	0.5	0.1	0.6	0.1	2.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	6.2	0.8	2.0	0.9	2.7	3.7
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	7.1	5.3	5.7	1.7	41.1	31.7
LnGrp LOS	A	A	A	A	D	C
Approach Vol, veh/h	978			1336	176	
Approach Delay, s/veh	7.0			4.1	35.3	
Approach LOS	A			A	D	
Timer - Assigned Phs		2	3	4		8
Phs Duration (G+Y+Rc), s		11.7	14.2	64.1		78.3
Change Period (Y+Rc), s		4.0	4.0	4.0		4.0
Max Green Setting (Gmax), s		24.0	24.0	30.0		58.0
Max Q Clear Time (g_c+I1), s		7.3	7.3	12.2		4.8
Green Ext Time (p_c), s		0.4	2.9	6.4		4.2
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			7.4			
HCM 6th LOS			A			
<b>Notes</b>						
User approved pedestrian interval to be less than phase max green.						

Volume  
4: EB Frontage Rd & Sunset Rd

2045 AM Peak Hour  
02/11/2020



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑	↗	↘	↑↑					↘	↑↑↑	↗
Traffic Volume (vph)	0	600	330	320	910	0	0	0	0	250	270	320
Future Volume (vph)	0	600	330	320	910	0	0	0	0	250	270	320
Satd. Flow (prot)	0	5085	1583	1770	3539	0	0	0	0	1522	4734	1583
Flt Permitted				0.950						0.950	0.985	
Satd. Flow (perm)	0	5085	1583	1770	3539	0	0	0	0	1522	4734	1583
Satd. Flow (RTOR)			318									173
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	0	652	359	348	989	0	0	0	0	272	293	348
Shared Lane Traffic (%)										49%		
Lane Group Flow (vph)	0	652	359	348	989	0	0	0	0	139	426	348
Turn Type		NA	Perm	Prot	NA					Perm	NA	Perm
Protected Phases		2		1	2 1						4 12	
Permitted Phases			2							4 12		4 12
Total Split (s)		30.0	30.0	45.0								
Total Lost Time (s)		6.0	6.0	4.0								
Act Effct Green (s)		24.2	24.2	42.9	71.2					31.4	31.4	31.4
Actuated g/C Ratio		0.21	0.21	0.38	0.62					0.28	0.28	0.28
v/c Ratio		0.60	0.61	0.52	0.45					0.33	0.33	0.62
Control Delay		44.5	12.2	12.9	5.7					35.3	33.5	22.6
Queue Delay		0.3	0.0	2.5	0.7					0.0	0.0	0.0
Total Delay		44.9	12.2	15.4	6.4					35.3	33.5	22.6
LOS		D	B	B	A					D	C	C
Approach Delay		33.3			8.7						29.6	
Approach LOS		C			A						C	
Queue Length 50th (ft)		171	26	106	256					98	101	116
Queue Length 95th (ft)		215	123	294	329					155	125	203
Internal Link Dist (ft)		766			244			320			664	
Turn Bay Length (ft)			150									350
Base Capacity (vph)		1078	586	693	2206					489	1524	627
Starvation Cap Reductn		0	0	225	783					0	0	0
Spillback Cap Reductn		99	0	0	0					0	0	0
Storage Cap Reductn		0	0	0	0					0	0	0
Reduced v/c Ratio		0.67	0.61	0.74	0.70					0.28	0.28	0.56

Intersection Summary

Cycle Length: 120	
Actuated Cycle Length: 114.1	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.63	
Intersection Signal Delay: 22.2	Intersection LOS: C
Intersection Capacity Utilization 58.8%	ICU Level of Service B

Volume  
5: WB Frontage Rd & Sunset Rd

2045 AM Peak Hour  
02/11/2020

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	260	590	0	0	820	140	410	150	310	0	0	0
Future Volume (vph)	260	590	0	0	820	140	410	150	310	0	0	0
Satd. Flow (prot)	1770	3539	0	0	5085	1583	1522	4671	1583	0	0	0
Flt Permitted	0.950						0.950	0.972				
Satd. Flow (perm)	1770	3539	0	0	5085	1583	1522	4671	1583	0	0	0
Satd. Flow (RTOR)						168			255			
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	283	641	0	0	891	152	446	163	337	0	0	0
Shared Lane Traffic (%)							50%					
Lane Group Flow (vph)	283	641	0	0	891	152	223	386	337	0	0	0
Turn Type	Prot	NA			NA	Perm	Perm	NA	Perm			
Protected Phases	5	6 5			6			8 16				
Permitted Phases						6	8 16		8 16			
Total Split (s)	35.0				40.0	40.0						
Total Lost Time (s)	5.5				6.0	6.0						
Act Effct Green (s)	32.2	69.4			31.7	31.7	32.6	32.6	32.6			
Actuated g/C Ratio	0.28	0.61			0.28	0.28	0.29	0.29	0.29			
v/c Ratio	0.57	0.30			0.63	0.27	0.51	0.29	0.53			
Control Delay	14.3	4.2			38.7	5.1	39.0	32.4	12.1			
Queue Delay	30.7	0.5			0.6	0.0	0.0	0.0	0.0			
Total Delay	45.0	4.7			39.3	5.1	39.0	32.4	12.1			
LOS	D	A			D	A	D	C	B			
Approach Delay		17.0			34.3			26.7				
Approach LOS		B			C			C				
Queue Length 50th (ft)	226	65			219	0	169	91	48			
Queue Length 95th (ft)	325	194			267	40	247	114	129			
Internal Link Dist (ft)		244			1409			1117			318	
Turn Bay Length (ft)						150			350			
Base Capacity (vph)	499	2233			1527	592	503	1546	694			
Starvation Cap Reductn	219	1085			0	0	0	0	0			
Spillback Cap Reductn	0	0			275	0	0	0	0			
Storage Cap Reductn	0	0			0	0	0	0	0			
Reduced v/c Ratio	1.01	0.56			0.71	0.26	0.44	0.25	0.49			

Intersection Summary

Cycle Length: 120	
Actuated Cycle Length: 114.1	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.63	
Intersection Signal Delay: 26.3	Intersection LOS: C
Intersection Capacity Utilization 58.8%	ICU Level of Service B

Intersection						
Int Delay, s/veh	0.6					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗			↕↕	↗
Traffic Vol, veh/h	0	40	0	0	240	330
Future Vol, veh/h	0	40	0	0	240	330
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	100
Veh in Median Storage, #	0	-	-	16974	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	43	0	0	261	359

Major/Minor	Minor2	Major2
Conflicting Flow All	- 131	- 0
Stage 1	- -	- -
Stage 2	- -	- -
Critical Hdwy	- 6.94	- -
Critical Hdwy Stg 1	- -	- -
Critical Hdwy Stg 2	- -	- -
Follow-up Hdwy	- 3.32	- -
Pot Cap-1 Maneuver	0 894	- -
Stage 1	0 -	- -
Stage 2	0 -	- -
Platoon blocked, %		- -
Mov Cap-1 Maneuver	- 894	- -
Mov Cap-2 Maneuver	- -	- -
Stage 1	- -	- -
Stage 2	- -	- -

Approach	EB	SB
HCM Control Delay, s	9.2	0
HCM LOS	A	

Minor Lane/Major Mvmt	EBLn1	SBT	SBR
Capacity (veh/h)	894	-	-
HCM Lane V/C Ratio	0.049	-	-
HCM Control Delay (s)	9.2	-	-
HCM Lane LOS	A	-	-
HCM 95th %tile Q(veh)	0.2	-	-

Intersection						
Int Delay, s/veh	0.6					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗			↕↕	↗
Traffic Vol, veh/h	0	20	0	0	115	165
Future Vol, veh/h	0	20	0	0	115	165
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	100
Veh in Median Storage, #	0	-	-	16974	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	22	0	0	125	179

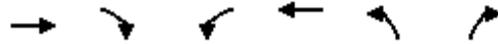
Major/Minor	Minor2		Major2	
Conflicting Flow All	-	63	-	0
Stage 1	-	-	-	-
Stage 2	-	-	-	-
Critical Hdwy	-	6.94	-	-
Critical Hdwy Stg 1	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-
Follow-up Hdwy	-	3.32	-	-
Pot Cap-1 Maneuver	0	988	-	-
Stage 1	0	-	-	-
Stage 2	0	-	-	-
Platoon blocked, %			-	-
Mov Cap-1 Maneuver	-	988	-	-
Mov Cap-2 Maneuver	-	-	-	-
Stage 1	-	-	-	-
Stage 2	-	-	-	-

Approach	EB	SB
HCM Control Delay, s	8.7	0
HCM LOS	A	

Minor Lane/Major Mvmt	EBLn1	SBT	SBR
Capacity (veh/h)	988	-	-
HCM Lane V/C Ratio	0.022	-	-
HCM Control Delay (s)	8.7	-	-
HCM Lane LOS	A	-	-
HCM 95th %tile Q(veh)	0.1	-	-

HCM 6th Signalized Intersection Summary  
8: Sunset Rd & River Rd

2045 AM Peak Hour  
02/11/2020



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑	↑	↓	↑↑	↓	↑
Traffic Volume (veh/h)	830	420	540	490	380	520
Future Volume (veh/h)	830	420	540	490	380	520
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	874	442	568	516	400	547
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	962	797	603	2375	413	904
Arrive On Green	0.27	0.27	0.34	0.67	0.23	0.23
Sat Flow, veh/h	3647	1585	1781	3647	1781	1585
Grp Volume(v), veh/h	874	442	568	516	400	547
Grp Sat Flow(s),veh/h/ln	1777	1585	1781	1777	1781	1585
Q Serve(g_s), s	26.2	21.2	34.1	6.2	24.5	0.0
Cycle Q Clear(g_c), s	26.2	21.2	34.1	6.2	24.5	0.0
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	962	797	603	2375	413	904
V/C Ratio(X)	0.91	0.55	0.94	0.22	0.97	0.61
Avail Cap(c_a), veh/h	985	807	603	2375	413	904
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.93	0.93
Uniform Delay (d), s/veh	38.8	18.9	35.3	7.1	41.9	15.5
Incr Delay (d2), s/veh	13.9	2.8	23.4	0.2	34.5	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	19.0	18.3	25.4	4.1	20.6	13.5
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	52.7	21.7	58.7	7.3	76.4	16.6
LnGrp LOS	D	C	E	A	E	B
Approach Vol, veh/h	1316			1084	947	
Approach Delay, s/veh	42.3			34.2	41.9	
Approach LOS	D			C	D	
Timer - Assigned Phs		2	3	4		8
Phs Duration (G+Y+Rc), s		31.0	42.7	36.3		79.0
Change Period (Y+Rc), s		5.5	5.5	6.5		5.5
Max Green Setting (Gmax), s		25.5	36.5	30.5		73.5
Max Q Clear Time (g_c+I1), s		26.5	36.1	28.2		8.2
Green Ext Time (p_c), s		0.0	0.1	1.6		4.0
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			39.5			
HCM 6th LOS			D			

HCM 2010 Signalized Intersection Summary  
1: Silverbell Rd & Sunset Rd

2045 PM Peak Hour  
02/18/2020

								
Movement	WBL	WBR	NBT	NBR	SBL	SBT		
Lane Configurations								
Traffic Volume (veh/h)	550	440	1000	290	260	460		
Future Volume (veh/h)	550	440	1000	290	260	460		
Number	3	18	2	12	1	6		
Initial Q (Qb), veh	0	0	0	0	0	0		
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00		
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863		
Adj Flow Rate, veh/h	579	463	1053	305	274	484		
Adj No. of Lanes	1	1	2	1	1	2		
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95		
Percent Heavy Veh, %	2	2	2	2	2	2		
Cap, veh/h	613	547	1123	1049	345	1910		
Arrive On Green	0.35	0.35	0.32	0.32	0.15	0.54		
Sat Flow, veh/h	1774	1583	3632	1583	1774	3632		
Grp Volume(v), veh/h	579	463	1053	305	274	484		
Grp Sat Flow(s),veh/h/ln	1774	1583	1770	1583	1774	1770		
Q Serve(g_s), s	31.7	27.1	28.9	8.0	10.5	7.3		
Cycle Q Clear(g_c), s	31.7	27.1	28.9	8.0	10.5	7.3		
Prop In Lane	1.00	1.00		1.00	1.00			
Lane Grp Cap(c), veh/h	613	547	1123	1049	345	1910		
V/C Ratio(X)	0.94	0.85	0.94	0.29	0.79	0.25		
Avail Cap(c_a), veh/h	630	562	1133	1054	345	1910		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	31.8	30.3	33.2	7.0	38.9	12.3		
Incr Delay (d2), s/veh	22.9	11.3	15.5	0.7	12.0	0.3		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(95%),veh/ln	26.5	19.5	23.1	11.8	13.1	6.6		
LnGrp Delay(d),s/veh	54.7	41.6	48.7	7.7	50.9	12.6		
LnGrp LOS	D	D	D	A	D	B		
Approach Vol, veh/h	1042		1358			758		
Approach Delay, s/veh	48.9		39.5			26.5		
Approach LOS	D		D			C		
Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	21.2	38.7				60.0		40.0
Change Period (Y+Rc), s	6.0	7.0				6.0		5.5
Max Green Setting (Gmax), s	14.0	32.0				53.0		35.5
Max Q Clear Time (g_c+I1), s	12.5	30.9				9.3		33.7
Green Ext Time (p_c), s	0.7	0.8				4.5		0.8
<b>Intersection Summary</b>								
HCM 2010 Ctrl Delay			39.4					
HCM 2010 LOS			D					

Intersection						
Int Delay, s/veh	2.7					
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗	↘	↑↑	↘	↗
Traffic Vol, veh/h	510	40	30	850	140	80
Future Vol, veh/h	510	40	30	850	140	80
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	250	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	554	43	33	924	152	87

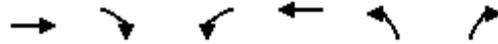
Major/Minor	Major1	Major2	Minor1		
Conflicting Flow All	0	0	597	0	1082
Stage 1	-	-	-	-	554
Stage 2	-	-	-	-	528
Critical Hdwy	-	-	4.13	-	6.63
Critical Hdwy Stg 1	-	-	-	-	5.43
Critical Hdwy Stg 2	-	-	-	-	5.83
Follow-up Hdwy	-	-	2.219	-	3.519
Pot Cap-1 Maneuver	-	-	978	-	226
Stage 1	-	-	-	-	574
Stage 2	-	-	-	-	557
Platoon blocked, %	-	-	-	-	-
Mov Cap-1 Maneuver	-	-	978	-	218
Mov Cap-2 Maneuver	-	-	-	-	353
Stage 1	-	-	-	-	574
Stage 2	-	-	-	-	538

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	19.2
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	353	531	-	-	978	-
HCM Lane V/C Ratio	0.431	0.164	-	-	0.033	-
HCM Control Delay (s)	22.7	13.1	-	-	8.8	-
HCM Lane LOS	C	B	-	-	A	-
HCM 95th %tile Q(veh)	2.1	0.6	-	-	0.1	-

HCM 6th Signalized Intersection Summary  
3: Main Dwy & Sunset Rd

2045 PM Peak Hour  
02/11/2020



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑	↑	↵	↑↑	↵	↑
Traffic Volume (veh/h)	550	40	180	760	120	600
Future Volume (veh/h)	550	40	180	760	120	600
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	598	43	196	826	130	652
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	956	426	725	1500	753	790
Arrive On Green	0.27	0.27	0.08	0.42	0.42	0.42
Sat Flow, veh/h	3647	1585	3456	3647	1781	1585
Grp Volume(v), veh/h	598	43	196	826	130	652
Grp Sat Flow(s),veh/h/ln	1777	1585	1728	1777	1781	1585
Q Serve(g_s), s	7.6	1.1	1.9	9.0	2.3	18.1
Cycle Q Clear(g_c), s	7.6	1.1	1.9	9.0	2.3	18.1
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	956	426	725	1500	753	790
V/C Ratio(X)	0.63	0.10	0.27	0.55	0.17	0.83
Avail Cap(c_a), veh/h	3033	1353	1001	3860	898	919
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	16.6	14.2	11.4	11.2	9.3	11.0
Incr Delay (d2), s/veh	0.7	0.1	0.2	0.3	0.1	5.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	5.1	0.6	1.1	5.4	1.4	10.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	17.2	14.3	11.6	11.5	9.4	16.5
LnGrp LOS	B	B	B	B	A	B
Approach Vol, veh/h	641			1022	782	
Approach Delay, s/veh	17.0			11.6	15.3	
Approach LOS	B			B	B	
Timer - Assigned Phs		2	3	4		8
Phs Duration (G+Y+Rc), s		25.8	7.9	17.9		25.8
Change Period (Y+Rc), s		4.0	4.0	4.0		4.0
Max Green Setting (Gmax), s		26.0	8.0	44.0		56.0
Max Q Clear Time (g_c+I1), s		20.1	3.9	9.6		11.0
Green Ext Time (p_c), s		1.7	0.2	4.2		7.1
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			14.2			
HCM 6th LOS			B			

Volume  
4: EB Frontage Rd & Sunset Rd

2045 PM Peak Hour  
02/11/2020



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑↑	↗	↘	↑↑					↖	↑↑↑	↗
Traffic Volume (vph)	0	740	410	210	700	0	0	0	0	210	130	240
Future Volume (vph)	0	740	410	210	700	0	0	0	0	210	130	240
Satd. Flow (prot)	0	5085	1583	1770	3539	0	0	0	0	1522	4700	1583
Flt Permitted				0.950						0.950	0.978	
Satd. Flow (perm)	0	5085	1583	1770	3539	0	0	0	0	1522	4700	1583
Satd. Flow (RTOR)			446									158
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	0	804	446	228	761	0	0	0	0	228	141	261
Shared Lane Traffic (%)										50%		
Lane Group Flow (vph)	0	804	446	228	761	0	0	0	0	114	255	261
Turn Type		NA	Perm	Prot	NA					Perm	NA	Perm
Protected Phases		2		1	2 1						4 12	
Permitted Phases			2							4 12		4 12
Total Split (s)		26.0	26.0	24.0								
Total Lost Time (s)		6.0	6.0	4.0								
Act Effct Green (s)		20.1	20.1	26.2	50.4					21.6	21.6	21.6
Actuated g/C Ratio		0.24	0.24	0.31	0.60					0.26	0.26	0.26
v/c Ratio		0.66	0.62	0.41	0.36					0.29	0.21	0.50
Control Delay		32.4	7.4	6.9	3.9					26.8	24.5	14.0
Queue Delay		0.1	0.0	0.9	0.8					0.0	0.0	0.0
Total Delay		32.6	7.4	7.8	4.7					26.8	24.5	14.0
LOS		C	A	A	A					C	C	B
Approach Delay		23.6			5.4						20.6	
Approach LOS		C			A						C	
Queue Length 50th (ft)		141	0	7	0					55	41	43
Queue Length 95th (ft)		200	80	m75	232					106	62	109
Internal Link Dist (ft)		766			244			320			664	
Turn Bay Length (ft)			150									350
Base Capacity (vph)		1224	719	556	2134					563	1740	685
Starvation Cap Reductn		0	0	143	984					0	0	0
Spillback Cap Reductn		38	0	0	0					0	0	0
Storage Cap Reductn		0	0	0	0					0	0	0
Reduced v/c Ratio		0.68	0.62	0.55	0.66					0.20	0.15	0.38

Intersection Summary

Cycle Length: 90	
Actuated Cycle Length: 83.5	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.71	
Intersection Signal Delay: 16.6	Intersection LOS: B
Intersection Capacity Utilization 55.0%	ICU Level of Service B

Volume  
5: WB Frontage Rd & Sunset Rd

2045 PM Peak Hour  
02/11/2020

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	300	650	0	0	680	120	230	200	240	0	0	0
Future Volume (vph)	300	650	0	0	680	120	230	200	240	0	0	0
Satd. Flow (prot)	1770	3539	0	0	5085	1583	1522	4719	1583	0	0	0
Flt Permitted	0.950						0.950	0.982				
Satd. Flow (perm)	1770	3539	0	0	5085	1583	1522	4719	1583	0	0	0
Satd. Flow (RTOR)						224			163			
Confl. Peds. (#/hr)												
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Adj. Flow (vph)	326	707	0	0	739	130	250	217	261	0	0	0
Shared Lane Traffic (%)							50%					
Lane Group Flow (vph)	326	707	0	0	739	130	125	342	261	0	0	0
Turn Type	Prot	NA			NA	Perm	Perm	NA	Perm			
Protected Phases	5	6 5			6			8 16				
Permitted Phases						6	8 16		8 16			
Total Split (s)	27.0				23.0	23.0						
Total Lost Time (s)	5.5				6.0	6.0						
Act Effct Green (s)	24.8	47.4			17.1	17.1	24.0	24.0	24.0			
Actuated g/C Ratio	0.30	0.57			0.20	0.20	0.29	0.29	0.29			
v/c Ratio	0.62	0.35			0.71	0.26	0.29	0.25	0.46			
Control Delay	10.6	3.1			36.1	1.2	24.5	23.0	11.9			
Queue Delay	5.2	0.4			0.0	0.0	0.0	0.0	0.0			
Total Delay	15.9	3.6			36.2	1.2	24.5	23.0	11.9			
LOS	B	A			D	A	C	C	B			
Approach Delay		7.5			30.9			19.3				
Approach LOS		A			C			B				
Queue Length 50th (ft)	173	0			134	0	59	53	39			
Queue Length 95th (ft)	290	126			191	0	108	75	99			
Internal Link Dist (ft)		244			1409			1117			318	
Turn Bay Length (ft)						150			350			
Base Capacity (vph)	525	2009			1040	502	523	1621	651			
Starvation Cap Reductn	139	781			0	0	0	0	0			
Spillback Cap Reductn	0	0			6	0	7	12	0			
Storage Cap Reductn	0	0			0	0	0	0	0			
Reduced v/c Ratio	0.84	0.58			0.71	0.26	0.24	0.21	0.40			

Intersection Summary

Cycle Length: 90	
Actuated Cycle Length: 83.5	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.71	
Intersection Signal Delay: 18.5	Intersection LOS: B
Intersection Capacity Utilization 55.0%	ICU Level of Service B

Intersection						
Int Delay, s/veh	6.4					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗			↕↕	↗
Traffic Vol, veh/h	0	300	0	0	140	60
Future Vol, veh/h	0	300	0	0	140	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	100
Veh in Median Storage, #	0	-	-	16974	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	326	0	0	152	65

Major/Minor	Minor2		Major2	
Conflicting Flow All	-	76	-	0
Stage 1	-	-	-	-
Stage 2	-	-	-	-
Critical Hdwy	-	6.94	-	-
Critical Hdwy Stg 1	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-
Follow-up Hdwy	-	3.32	-	-
Pot Cap-1 Maneuver	0	970	-	-
Stage 1	0	-	-	-
Stage 2	0	-	-	-
Platoon blocked, %			-	-
Mov Cap-1 Maneuver	-	970	-	-
Mov Cap-2 Maneuver	-	-	-	-
Stage 1	-	-	-	-
Stage 2	-	-	-	-

Approach	EB	SB
HCM Control Delay, s	10.6	0
HCM LOS	B	

Minor Lane/Major Mvmt	EBLn1	SBT	SBR
Capacity (veh/h)	970	-	-
HCM Lane V/C Ratio	0.336	-	-
HCM Control Delay (s)	10.6	-	-
HCM Lane LOS	B	-	-
HCM 95th %tile Q(veh)	1.5	-	-

Intersection						
Int Delay, s/veh	2.6					
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↗			↕↕	↗
Traffic Vol, veh/h	0	140	0	0	400	40
Future Vol, veh/h	0	140	0	0	400	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	100
Veh in Median Storage, #	0	-	-	16974	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	152	0	0	435	43

Major/Minor	Minor2		Major2	
Conflicting Flow All	-	218	-	0
Stage 1	-	-	-	-
Stage 2	-	-	-	-
Critical Hdwy	-	6.94	-	-
Critical Hdwy Stg 1	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-
Follow-up Hdwy	-	3.32	-	-
Pot Cap-1 Maneuver	0	786	-	-
Stage 1	0	-	-	-
Stage 2	0	-	-	-
Platoon blocked, %			-	-
Mov Cap-1 Maneuver	-	786	-	-
Mov Cap-2 Maneuver	-	-	-	-
Stage 1	-	-	-	-
Stage 2	-	-	-	-

Approach	EB	SB
HCM Control Delay, s	10.7	0
HCM LOS	B	

Minor Lane/Major Mvmt	EBLn1	SBT	SBR
Capacity (veh/h)	786	-	-
HCM Lane V/C Ratio	0.194	-	-
HCM Control Delay (s)	10.7	-	-
HCM Lane LOS	B	-	-
HCM 95th %tile Q(veh)	0.7	-	-

HCM 6th Signalized Intersection Summary  
8: Sunset Rd & River Rd

2045 PM Peak Hour  
02/11/2020



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑	↑	↑	↑↑	↑	↑
Traffic Volume (veh/h)	520	300	500	660	400	490
Future Volume (veh/h)	520	300	500	660	400	490
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No			No	No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	565	326	543	717	435	533
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	641	712	634	2164	479	991
Arrive On Green	0.18	0.18	0.36	0.61	0.27	0.27
Sat Flow, veh/h	3647	1585	1781	3647	1781	1585
Grp Volume(v), veh/h	565	326	543	717	435	533
Grp Sat Flow(s),veh/h/ln	1777	1585	1781	1777	1781	1585
Q Serve(g_s), s	13.9	12.8	25.4	8.9	21.3	0.0
Cycle Q Clear(g_c), s	13.9	12.8	25.4	8.9	21.3	0.0
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	641	712	634	2164	479	991
V/C Ratio(X)	0.88	0.46	0.86	0.33	0.91	0.54
Avail Cap(c_a), veh/h	652	717	634	2164	505	1014
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.93	0.93
Uniform Delay (d), s/veh	35.9	17.2	26.8	8.6	31.8	9.5
Incr Delay (d2), s/veh	16.0	2.1	11.2	0.4	18.6	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	11.8	12.2	18.0	5.8	16.7	9.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	51.9	19.3	38.0	9.0	50.4	10.0
LnGrp LOS	D	B	D	A	D	B
Approach Vol, veh/h	891			1260	968	
Approach Delay, s/veh	40.0			21.5	28.2	
Approach LOS	D			C	C	
Timer - Assigned Phs		2	3	4		8
Phs Duration (G+Y+Rc), s		29.7	37.5	22.7		60.3
Change Period (Y+Rc), s		5.5	5.5	6.5		5.5
Max Green Setting (Gmax), s		25.5	30.5	16.5		53.5
Max Q Clear Time (g_c+I1), s		23.3	27.4	15.9		10.9
Green Ext Time (p_c), s		0.9	0.6	0.3		5.9
<b>Intersection Summary</b>						
HCM 6th Ctrl Delay			28.9			
HCM 6th LOS			C			

Appendix E  
2045 Signal Warrant Analysis

## Signal Warrant Assessment

Based on 2009 Edition of the MUTCD

Project #: 24312  
 Project Name: Sunset Rd DCR  
 Analyst: LMW  
 Date: 1/29/2020  
 Intersection: Sunset Rd/Main Dwy  
 Scenario: 2045 Traffic Projections

Volume Adjustment Factor = 1.0  
 North-South Approach = Major  
 East-West Approach = Minor  
 Major Street Thru Lanes = 2  
 Minor Street Thru Lanes = 1  
 Speed > 40 mph? No  
 Population < 10,000? No  
 Warrant Factor 100%  
 Peak Hour or Daily Count? Peak Hour

### Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Highest	Yes	Yes
#2	Four-Hour	Yes	Yes
#3	Peak Hour	Yes	Yes

*\*This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.*

Select Type Of Major Street Approach From Dropdown Menu

Rural Major Collector

Select Type Of Minor Street Approach From Dropdown Menu

Rural Minor Collector

Note: traffic volume profile for weekday (if weekend is desired, tab "vol profile" needs to be adjusted)

Hour		Major Street		Minor Street		Major St.	Minor St.
Begin	End	NB	SB	EB	WB	Adj. Factor	Adj. Factor
7:15 PM	8:15 PM	900	1230	0	160	1.00	1.00
2nd Highest Hour		803	1098	0	127	0.89	0.79
3rd Highest Hour		697	952	0	120	0.77	0.75
4th Highest Hour		687	939	0	106	0.76	0.66
5th Highest Hour		610	833	0	99	0.68	0.62
6th Highest Hour		600	820	0	91	0.67	0.57
7th Highest Hour		581	794	0	90	0.65	0.56
8th Highest Hour		532	727	0	84	0.59	0.52
9th Highest Hour		503	688	0	84	0.56	0.52
10th Highest Hour		484	661	0	82	0.54	0.51
11th Highest Hour		474	648	0	73	0.53	0.46
12th Highest Hour		474	648	0	70	0.53	0.44
13th Highest Hour		465	635	0	57	0.52	0.36
14th Highest Hour		387	529	0	55	0.43	0.35
15th Highest Hour		377	516	0	52	0.42	0.33
16th Highest Hour		271	370	0	51	0.30	0.32
17th Highest Hour		271	370	0	30	0.30	0.19
18th Highest Hour		184	251	0	30	0.20	0.19
19th Highest Hour		116	159	0	12	0.13	0.07
20th Highest Hour		97	132	0	9	0.11	0.06
21st Highest Hour		48	66	0	6	0.05	0.04
22nd Highest Hour		39	53	0	1	0.04	0.01
23rd Highest Hour		39	53	0	1	0.04	0.01
24th Highest Hour		29	40	0	1	0.03	0.01

Data Input

Traffic Volumes					
Hour		Major Street		Minor Street	
Begin	End	NB	SB	EB	WB
7:15 PM	8:15 PM	900	1230	0	160
2nd Highest Hour		803	1098	0	127
3rd Highest Hour		697	952	0	120
4th Highest Hour		687	939	0	106
5th Highest Hour		610	833	0	99
6th Highest Hour		600	820	0	91
7th Highest Hour		581	794	0	90
8th Highest Hour		532	727	0	84
9th Highest Hour		503	688	0	84
10th Highest Hour		484	661	0	82
11th Highest Hour		474	648	0	73
12th Highest Hour		474	648	0	70
13th Highest Hour		465	635	0	57
14th Highest Hour		387	529	0	55
15th Highest Hour		377	516	0	52
16th Highest Hour		271	370	0	51
17th Highest Hour		271	370	0	30
18th Highest Hour		184	251	0	30
19th Highest Hour		116	159	0	12
20th Highest Hour		97	132	0	9
21st Highest Hour		48	66	0	6
22nd Highest Hour		39	53	0	1
23rd Highest Hour		39	53	0	1
24th Highest Hour		29	40	0	1

100% Warrant Met  
70% Warrant Met

Number of lanes for moving traffic on each approach (Major Street) 2  
 Number of lanes for moving traffic on each approach (Minor Street) 1  
 Warrant Factor 100%  
 Row Index for VLOOKUP 2

Calculations												
Combined Major Street	Higher Minor Street	Major Plus Minor	Hourly Rank	Condition A				Condition B				
				100%	80%	70%	56%	100%	80%	70%	56%	
2130	160	2290	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
1901	127	2028	2	N	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
1649	120	1769	3	N	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
1626	106	1732	4	N	N	Yes	Yes	Yes	Yes	Yes	Yes	
1443	99	1542	5	N	N	N	Yes	Yes	Yes	Yes	Yes	
1420	91	1511	6	N	N	N	Yes	Yes	Yes	Yes	Yes	
1374	90	1464	7	N	N	N	Yes	Yes	Yes	Yes	Yes	
1260	84	1343	8	N	N	N	Yes	Yes	Yes	Yes	Yes	
1191	84	1275	9	N	N	N	Yes	Yes	Yes	Yes	Yes	
1145	82	1227	10	N	N	N	N	Yes	Yes	Yes	Yes	
1122	73	1196	11	N	N	N	N	N	Yes	Yes	Yes	
1122	70	1193	12	N	N	N	N	N	Yes	Yes	Yes	
1099	57	1156	13	N	N	N	N	N	N	Yes	Yes	
916	55	971	14	N	N	N	N	N	N	Yes	Yes	
893	52	946	15	N	N	N	N	N	N	Yes	Yes	
641	51	692	16	N	N	N	N	N	N	N	Yes	
641	30	671	17	N	N	N	N	N	N	N	N	
435	30	465	18	N	N	N	N	N	N	N	N	
275	12	287	19	N	N	N	N	N	N	N	N	
229	9	238	20	N	N	N	N	N	N	N	N	
115	6	120	21	N	N	N	N	N	N	N	N	
92	1	93	22	N	N	N	N	N	N	N	N	
92	1	93	22	N	N	N	N	N	N	N	N	
69	1	70	24	N	N	N	N	N	N	N	N	
				1	3	4	9	10	12	15	16	

Warrant Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition is Met	Threshold	Condition for Warrant Factor Met?	Signal Warrant Met?
100%	A	600	150	1	8	No	Yes
	B	900	75	10	8	Yes	
80%	A	480	120	3	8	No	No
	B	720	60	12	8	Yes	
70%	A	420	105	4	8	No	Yes
	B	630	53	15	8	Yes	
56%	A	336	84	9	8	Yes	Yes
	B	504	42	16	8	Yes	

Is Warrant #1 met based on the applicable warrant factor?

Yes

Vehicles per hour on major street (100% Volume) 600  
 Vehicles per hour on major street (80% Volume) 480  
 Vehicles per hour on major street (70% Volume) 420  
 Vehicles per hour on major street (56% Volume) 336  
 Vehicles per hour on higher-volume minor-street approach (100% Volume) 150  
 Vehicles per hour on higher-volume minor-street approach (80% Volume) 120  
 Vehicles per hour on higher-volume minor-street approach (70% Volume) 105  
 Vehicles per hour on higher-volume minor-street approach (56% Volume) 84  
 Vehicles per hour on major street (100% Volume) 900  
 Vehicles per hour on major street (80% Volume) 720  
 Vehicles per hour on major street (70% Volume) 630  
 Vehicles per hour on major street (56% Volume) 504  
 Vehicles per hour on higher-volume minor-street approach (100% Volume) 75  
 Vehicles per hour on higher-volume minor-street approach (80% Volume) 60  
 Vehicles per hour on higher-volume minor-street approach (70% Volume) 53  
 Vehicles per hour on higher-volume minor-street approach (56% Volume) 42

Traffic Volumes						Calculations			
Hour		Major Street		Minor Street		Combined Major Street	Higher Minor Street	Threshold	Is Threshold Met?
Begin	End	NB	SB	EB	WB				
7:15 PM	8:15 PM	900	1230	0	160	2130	160	80	Yes
2nd Highest Hour		803	1098	0	127	1901	127	80	Yes
3rd Highest Hour		697	952	0	120	1649	120	80	Yes
4th Highest Hour		687	939	0	106	1626	106	80	Yes
5th Highest Hour		610	833	0	99	1443	99	80	Yes
6th Highest Hour		600	820	0	91	1420	91	80	Yes
7th Highest Hour		581	794	0	90	1374	90	81	Yes
8th Highest Hour		532	727	0	84	1260	84	94	No
9th Highest Hour		503	688	0	84	1191	84	104	No
10th Highest Hour		484	661	0	82	1145	82	112	No
11th Highest Hour		474	648	0	73	1122	73	117	No
12th Highest Hour		474	648	0	70	1122	70	117	No
13th Highest Hour		465	635	0	57	1099	57	121	No
14th Highest Hour		387	529	0	55	916	55	169	No
15th Highest Hour		377	516	0	52	893	52	176	No
16th Highest Hour		271	370	0	51	641	51	271	No
17th Highest Hour		271	370	0	30	641	30	271	No
18th Highest Hour		184	251	0	30	435	30	372	No
19th Highest Hour		116	159	0	12	275	12	465	No
20th Highest Hour		97	132	0	9	229	9	494	No
21st Highest Hour		48	66	0	6	115	6	571	No
22nd Highest Hour		39	53	0	1	92	1	587	No
23rd Highest Hour		39	53	0	1	92	1	587	No
24th Highest Hour		29	40	0	1	69	1	604	No

7

Number of lanes for moving traffic on each approach (Major Street) 2  
 Number of lanes for moving traffic on each approach (Minor Street) 1  
 Warrant Factor 100%  
 Row Index for VLOOKUP 2

**Lookup Table**

Index	Major Street	Minor Street	Break Point	x <sup>2</sup>	x	c	alt
1	1	1	1100	0.00025	0.70119	549.643	80
2	2 or more	1	1380	0.00025	0.75657	654.704	80
3	2 or more	2 or more	1290	0.00032	0.99411	875.600	115
4	1	2 or more	1190	0.00028	0.80531	669.814	115
5	1	1	780	0.00042	0.75589	394.893	60
6	2 or more	1	980	0.00040	0.81250	473.690	60
7	2 or more	2 or more	890	0.00046	1.01643	620.143	80
8	1	2 or more	790	0.00041	0.82464	476.500	80

70% Factor 100% Factor

**Is Warrant #2 met based on the applicable warrant factor?**

**Yes**

## Signal Warrant Assessment

Based on 2009 Edition of the MUTCD

Project #: 24312  
 Project Name: Sunset Rd DCR  
 Analyst: LMW  
 Date: 1/29/2020  
 Intersection: Sunset Road/River Road  
 Scenario: 2045 Traffic Projections

Volume Adjustment Factor = 1.0  
 North-South Approach = Minor  
 East-West Approach = Major  
 Major Street Thru Lanes = 2  
 Minor Street Thru Lanes = 2  
 Speed > 40 mph? No  
 Population < 10,000? No  
 Warrant Factor 100%  
 Peak Hour or Daily Count? Peak Hour

### Warrant Summary

Warrant	Name	Analyzed?	Met?
#1	Eight-Highest	Yes	Yes
#2	Four-Hour	Yes	Yes
#3	Peak Hour	Yes	Yes

*\*This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.*

Select Type Of Major Street Approach From Dropdown Menu

Urban Minor Arterial

Select Type Of Minor Street Approach From Dropdown Menu

Rural Major Collector

Note: traffic volume profile for weekday (if weekend is desired, tab "vol profile" needs to be adjusted)

Hour		Major Street		Minor Street		Major St.	Minor St.
Begin	End	EB	WB	NB	SB	Adj. Factor	Adj. Factor
7:15 PM	8:15 PM	1250	1030	900	0	1.00	1.00
2nd Highest Hour		1183	975	803	0	0.95	0.89
3rd Highest Hour		1167	961	697	0	0.93	0.77
4th Highest Hour		1117	920	687	0	0.89	0.76
5th Highest Hour		1100	906	610	0	0.88	0.68
6th Highest Hour		1100	906	600	0	0.88	0.67
7th Highest Hour		1050	865	581	0	0.84	0.65
8th Highest Hour		1033	851	532	0	0.83	0.59
9th Highest Hour		1000	824	503	0	0.80	0.56
10th Highest Hour		933	769	484	0	0.75	0.54
11th Highest Hour		900	742	474	0	0.72	0.53
12th Highest Hour		883	728	474	0	0.71	0.53
13th Highest Hour		850	700	465	0	0.68	0.52
14th Highest Hour		733	604	387	0	0.59	0.43
15th Highest Hour		583	481	377	0	0.47	0.42
16th Highest Hour		550	453	271	0	0.44	0.30
17th Highest Hour		383	316	271	0	0.31	0.30
18th Highest Hour		317	261	184	0	0.25	0.20
19th Highest Hour		167	137	116	0	0.13	0.13
20th Highest Hour		117	96	97	0	0.09	0.11
21st Highest Hour		100	82	48	0	0.08	0.05
22nd Highest Hour		67	55	39	0	0.05	0.04
23rd Highest Hour		33	27	39	0	0.03	0.04
24th Highest Hour		33	27	29	0	0.03	0.03

Data Input

Traffic Volumes					
Hour		Major Street		Minor Street	
Begin	End	EB	WB	NB	SB
7:15 PM	8:15 PM	1250	1030	900	0
2nd Highest Hour		1183	975	803	0
3rd Highest Hour		1167	961	697	0
4th Highest Hour		1117	920	687	0
5th Highest Hour		1100	906	610	0
6th Highest Hour		1100	906	600	0
7th Highest Hour		1050	865	581	0
8th Highest Hour		1033	851	532	0
9th Highest Hour		1000	824	503	0
10th Highest Hour		933	769	484	0
11th Highest Hour		900	742	474	0
12th Highest Hour		883	728	474	0
13th Highest Hour		850	700	465	0
14th Highest Hour		733	604	387	0
15th Highest Hour		583	481	377	0
16th Highest Hour		550	453	271	0
17th Highest Hour		383	316	271	0
18th Highest Hour		317	261	184	0
19th Highest Hour		167	137	116	0
20th Highest Hour		117	96	97	0
21st Highest Hour		100	82	48	0
22nd Highest Hour		67	55	39	0
23rd Highest Hour		33	27	39	0
24th Highest Hour		33	27	29	0

100% Warrant Met  
70% Warrant Met

Number of lanes for moving traffic on each approach (Major Street) 2  
 Number of lanes for moving traffic on each approach (Minor Street) 2  
 Warrant Factor 100%  
 Row Index for VLOOKUP 3

Calculations												
Combined Major Street	Higher Minor Street	Major Plus Minor	Hourly Rank	Condition A				Condition B				
				100%	80%	70%	56%	100%	80%	70%	56%	
2280	900	3180	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2158	803	2962	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2128	697	2825	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2037	687	2724	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2006	610	2616	5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2006	600	2606	6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1915	581	2496	7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1885	532	2417	8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1824	503	2327	9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1702	484	2186	10	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1642	474	2116	11	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1611	474	2085	12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1550	465	2015	13	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1338	387	1725	14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1064	377	1441	15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1003	271	1274	16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
699	271	970	17	Yes	Yes	Yes	Yes	N	N	N	Yes	Yes
578	184	761	18	N	Yes	Yes	Yes	N	N	N	N	Yes
304	116	420	19	N	N	N	N	N	N	N	N	N
213	97	310	20	N	N	N	N	N	N	N	N	N
182	82	231	21	N	N	N	N	N	N	N	N	N
122	39	160	22	N	N	N	N	N	N	N	N	N
61	39	100	23	N	N	N	N	N	N	N	N	N
61	29	90	24	N	N	N	N	N	N	N	N	N
				17	18	18	18	16	16	17	18	

Warrant Summary

Warrant Factor	Condition	Major Street Requirement	Minor Street Requirement	Hours That Condition is Met	Threshold	Condition for Warrant Factor Met?	Signal Warrant Met?
100%	A	600	200	17	8	Yes	Yes
	B	900	100	16	8	Yes	Yes
80%	A	480	160	18	8	Yes	Yes
	B	720	80	16	8	Yes	Yes
70%	A	420	140	18	8	Yes	Yes
	B	630	70	17	8	Yes	Yes
56%	A	336	112	18	8	Yes	Yes
	B	504	56	18	8	Yes	Yes

Is Warrant #1 met based on the applicable warrant factor?

Yes

Vehicles per hour on major street (100% Volume) 600  
 Vehicles per hour on major street (80% Volume) 480  
 Vehicles per hour on major street (70% Volume) 420  
 Vehicles per hour on major street (56% Volume) 336  
 Vehicles per hour on higher-volume minor-street approach (100% Volume) 200  
 Vehicles per hour on higher-volume minor-street approach (80% Volume) 160  
 Vehicles per hour on higher-volume minor-street approach (70% Volume) 140  
 Vehicles per hour on higher-volume minor-street approach (56% Volume) 112  
 Vehicles per hour on major street (100% Volume) 900  
 Vehicles per hour on major street (80% Volume) 720  
 Vehicles per hour on major street (70% Volume) 630  
 Vehicles per hour on major street (56% Volume) 504  
 Vehicles per hour on higher-volume minor-street approach (100% Volume) 100  
 Vehicles per hour on higher-volume minor-street approach (80% Volume) 80  
 Vehicles per hour on higher-volume minor-street approach (70% Volume) 70  
 Vehicles per hour on higher-volume minor-street approach (56% Volume) 56

Traffic Volumes						Calculations			
Hour		Major Street		Minor Street		Combined Major Street	Higher Minor Street	Threshold	Is Threshold Met?
Begin	End	EB	WB	NB	SB				
7:15 PM	8:15 PM	1250	1030	900	0	2280	900	115	Yes
2nd Highest Hour		1183	975	803	0	2158	803	115	Yes
3rd Highest Hour		1167	961	697	0	2128	697	115	Yes
4th Highest Hour		1117	920	687	0	2037	687	115	Yes
5th Highest Hour		1100	906	610	0	2006	610	115	Yes
6th Highest Hour		1100	906	600	0	2006	600	115	Yes
7th Highest Hour		1050	865	581	0	1915	581	115	Yes
8th Highest Hour		1033	851	532	0	1885	532	115	Yes
9th Highest Hour		1000	824	503	0	1824	503	115	Yes
10th Highest Hour		933	769	484	0	1702	484	115	Yes
11th Highest Hour		900	742	474	0	1642	474	115	Yes
12th Highest Hour		883	728	474	0	1611	474	115	Yes
13th Highest Hour		850	700	465	0	1550	465	115	Yes
14th Highest Hour		733	604	387	0	1338	387	115	Yes
15th Highest Hour		583	481	377	0	1064	377	177	Yes
16th Highest Hour		550	453	271	0	1003	271	197	Yes
17th Highest Hour		383	316	271	0	699	271	335	No
18th Highest Hour		317	261	184	0	578	184	407	No
19th Highest Hour		167	137	116	0	304	116	603	No
20th Highest Hour		117	96	97	0	213	97	678	No
21st Highest Hour		100	82	48	0	182	48	705	No
22nd Highest Hour		67	55	39	0	122	39	759	No
23rd Highest Hour		33	27	39	0	61	39	816	No
24th Highest Hour		33	27	29	0	61	29	816	No

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Number of lanes for moving traffic on each approach (Major Street) 2  
 Number of lanes for moving traffic on each approach (Minor Street) 2  
 Warrant Factor 100%  
 Row Index for VLOOKUP 3

**Lookup Table**

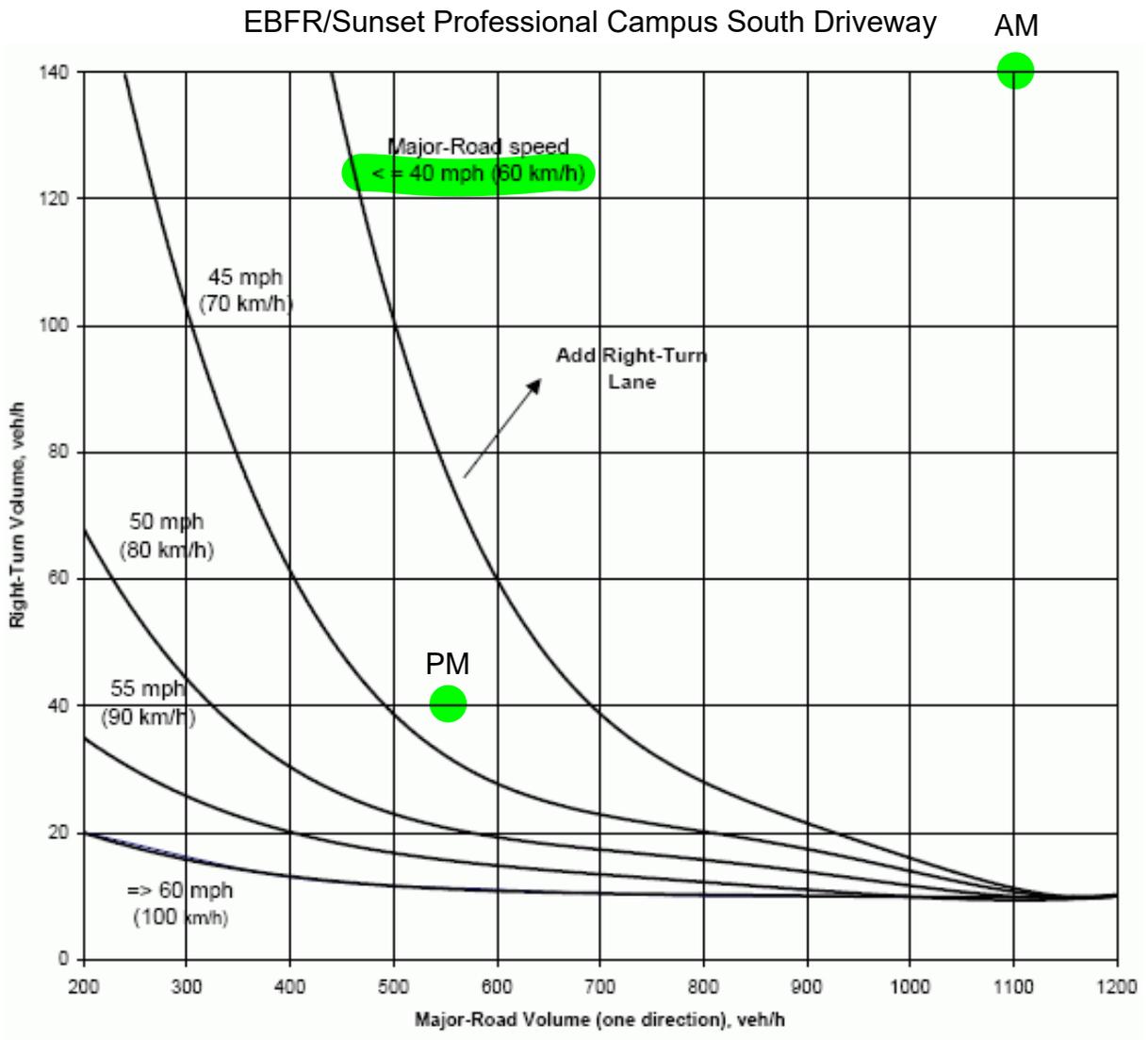
Index	Major Street	Minor Street	Break Point	x <sup>2</sup>	x	c	alt
1	1	1	1100	0.00025	0.70119	549.643	80
2	2 or more	1	1380	0.00025	0.75657	654.704	80
3	2 or more	2 or more	1290	0.00032	0.99411	875.600	115
4	1	2 or more	1190	0.00028	0.80531	669.814	115
5	1	1	780	0.00042	0.75589	394.893	60
6	2 or more	1	980	0.00040	0.81250	473.690	60
7	2 or more	2 or more	890	0.00046	1.01643	620.143	80
8	1	2 or more	790	0.00041	0.82464	476.500	80

70% Factor 100% Factor

**Is Warrant #2 met based on the applicable warrant factor?**

**Yes**

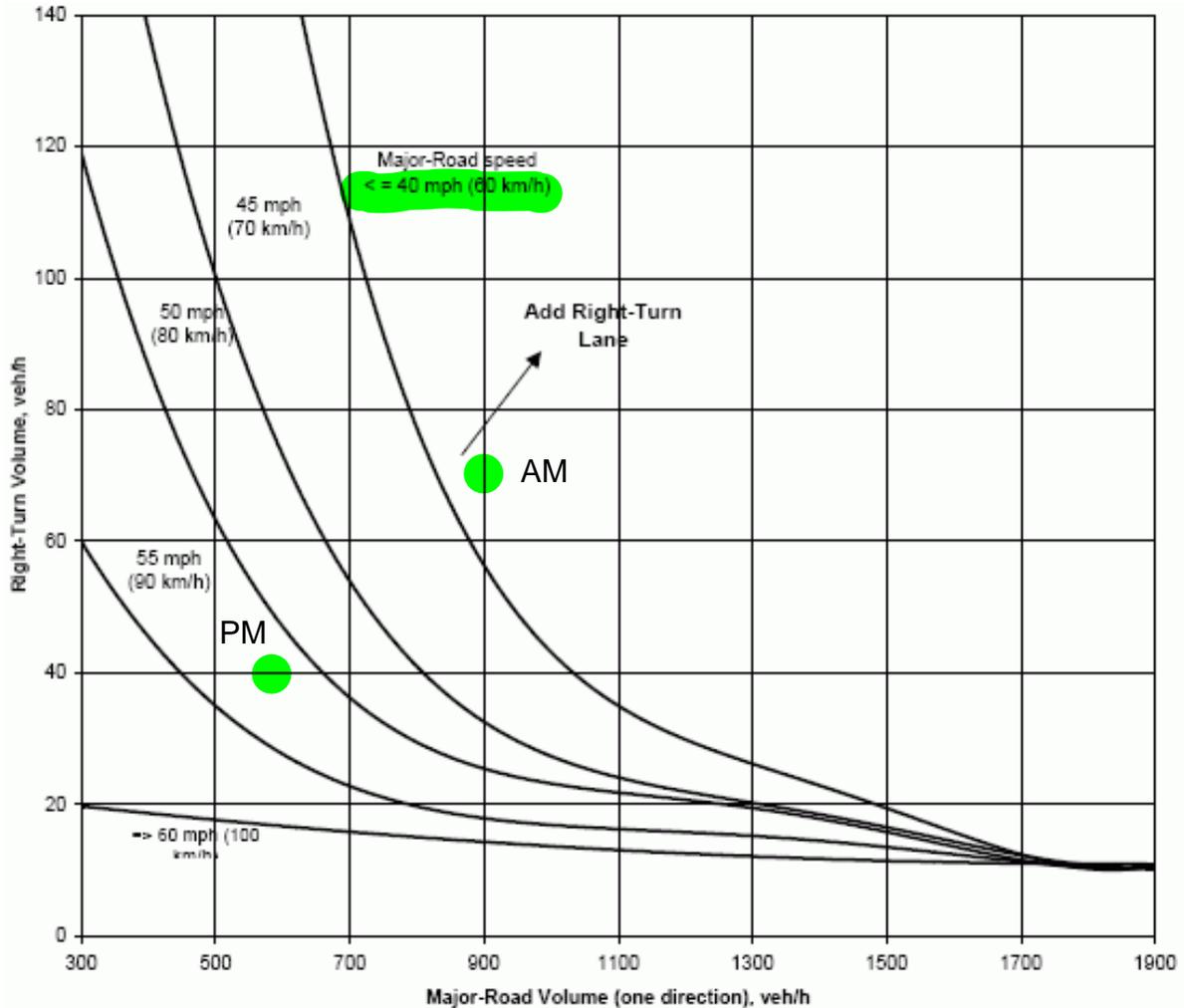
Appendix F  
2045 Right Turn Lane  
Warrant Analysis



**Figure 5-2 – Right Turn Lane Guidelines for Two-Lane Roadway<sup>14</sup>**

<sup>14</sup> Source: MoDOT. Engineering Policy Guide. Sheet 940.9.8 “Right Turn Lane Guidelines for Two-Lane Roadways,” 2007.

Sunset Road/Sunset Professional Campus Main Driveway



Note: Existing roadway constraints may restrict the ability or need to install turning lanes. Traffic Engineering may require a traffic engineering analysis to support alternative recommendations for the installation of turning lanes.

**Figure 5-3 – Right Turn Guidelines for Four-Lane Roadways<sup>15</sup>**

5.3.1 Total Turn Lane Length

A separate turning lane consists of a taper plus a full width auxiliary lane. The design of turn lanes is primarily based on the speed at which drivers turn into the lane, the speed to which drivers must reduce in order to turn into the driveway, and the required vehicular storage length. Other special considerations include the volume of trucks that will use the turning lane and the steepness of an ascending or descending grade.

The Pima County Department of Transportation (PCDOT) and the City of Tucson Department of Transportation (TDOT) provide design guidelines for minimum

<sup>15</sup> Source: MoDOT. Engineering Policy Guide. Sheet 940.9.9 “Right Turn Lane Guidelines for Four-Lane Roadways.” 2007.

## 245 TURN LANE WARRANTS

The intent of this document is to offer guidance to warrant the installation of dedicated left or right turn lanes on state routes, whether during new construction, major reconstruction, or in the course of the encroachment permitting process. **The primary determining factors to warrant an exclusive turn lane shall be: (a) the combination of through traffic volume and turning traffic volume, (b) the posted roadway speed, and (c) the number of through lanes on the roadway.** Note: Dual right- or left-turn lanes should be considered when the turning volume exceeds 300 vehicles per hour. In addition to the criteria presented in the tables below, other factors should be taken into consideration when performing a warrant study such as: shoulder width, percentage of trucks, sight distance, highway grade, horizontal and vertical curvature and crash history.

### Right-Turn Lane Warrants

#### Sunset Road/EBFR

Peak Hour Traffic Volume on the Highway in Advancing Direction	Minimum Peak Hour Right-turn Traffic Volume				
	# of thru lanes per direction				
	1		2		3
	< 45 MPH Posted Speed	≥ 45 MPH Posted Speed	< 45 MPH Posted Speed	≥ 45 MPH Posted Speed	All Speeds
≤ 200					
201 – 300	-	30	-	-	-
PM 301 – 400	-	19	-	55	-
401 – 500	85	14	-	30	-
AM 501 – 600	58	12	140	25	-
601 – 700	27	9	80	18	-
701 – 800	20	8	53	15	-
801 – 900	12	7	40	12	-
901 – 1000	9	6	30	11	-
1001 – 1100	8	5	23	9	18
1101 – 1200	7	5	18	8	16
1201 – 1300	6	4	14	8	15
1301 – 1400	6	4	11	6	12
1400+	5	3	8	6	10

## 245 TURN LANE WARRANTS

The intent of this document is to offer guidance to warrant the installation of dedicated left or right turn lanes on state routes, whether during new construction, major reconstruction, or in the course of the encroachment permitting process. **The primary determining factors to warrant an exclusive turn lane shall be: (a) the combination of through traffic volume and turning traffic volume, (b) the posted roadway speed, and (c) the number of through lanes on the roadway.** Note: Dual right- or left-turn lanes should be considered when the turning volume exceeds 300 vehicles per hour. In addition to the criteria presented in the tables below, other factors should be taken into consideration when performing a warrant study such as: shoulder width, percentage of trucks, sight distance, highway grade, horizontal and vertical curvature and crash history.

### Right-Turn Lane Warrants

#### Sunset Road/WBFR

Peak Hour Traffic Volume on the Highway in Advancing Direction	Minimum Peak Hour Right-turn Traffic Volume				
	# of thru lanes per direction				
	1		2		3
	< 45 MPH Posted Speed	≥ 45 MPH Posted Speed	< 45 MPH Posted Speed	≥ 45 MPH Posted Speed	All Speeds
≤ 200					
201 – 300	-	30	-	-	-
301 – 400	-	19	-	55	-
401 – 500	85	14	-	30	-
501 – 600	58	12	140	25	-
601 – 700	27	9	80	18	-
701 – 800	20	8	53	15	-
801 – 900	12	7	40	12	-
901 – 1000	9	6	30	11	-
1001 – 1100	8	5	23	9	18
1101 – 1200	7	5	18	8	16
1201 – 1300	6	4	14	8	15
1301 – 1400	6	4	11	6	12
1400+	5	3	8	6	10

AM/PM

## 245 TURN LANE WARRANTS

The intent of this document is to offer guidance to warrant the installation of dedicated left or right turn lanes on state routes, whether during new construction, major reconstruction, or in the course of the encroachment permitting process. **The primary determining factors to warrant an exclusive turn lane shall be: (a) the combination of through traffic volume and turning traffic volume, (b) the posted roadway speed, and (c) the number of through lanes on the roadway.** Note: Dual right- or left-turn lanes should be considered when the turning volume exceeds 300 vehicles per hour. In addition to the criteria presented in the tables below, other factors should be taken into consideration when performing a warrant study such as: shoulder width, percentage of trucks, sight distance, highway grade, horizontal and vertical curvature and crash history.

### Right-Turn Lane Warrants

#### EBFR/Sunset Professional Campus West Driveway

Peak Hour Traffic Volume on the Highway in Advancing Direction	Minimum Peak Hour Right-turn Traffic Volume					
	# of thru lanes per direction					
	1		2		3	
	< 45 MPH Posted Speed	≥ 45 MPH Posted Speed	< 45 MPH Posted Speed	≥ 45 MPH Posted Speed	All Speeds	
PM	< 200			0		
	201 – 300	-	30	-	-	
	301 – 400	-	19	55	-	
	401 – 500	85	14	30	-	
AM	501 – 600	58	12	140	25	
	601 – 700	27	9	80	18	
	701 – 800	20	8	53	15	
	801 – 900	12	7	40	12	
	901 – 1000	9	6	30	11	
	1001 – 1100	8	5	23	9	18
	1101 – 1200	7	5	18	8	16
	1201 – 1300	6	4	14	8	15
	1301 – 1400	6	4	11	6	12
	1400+	5	3	8	6	10

## 245 TURN LANE WARRANTS

The intent of this document is to offer guidance to warrant the installation of dedicated left or right turn lanes on state routes, whether during new construction, major reconstruction, or in the course of the encroachment permitting process. **The primary determining factors to warrant an exclusive turn lane shall be: (a) the combination of through traffic volume and turning traffic volume, (b) the posted roadway speed, and (c) the number of through lanes on the roadway.** Note: Dual right- or left-turn lanes should be considered when the turning volume exceeds 300 vehicles per hour. In addition to the criteria presented in the tables below, other factors should be taken into consideration when performing a warrant study such as: shoulder width, percentage of trucks, sight distance, highway grade, horizontal and vertical curvature and crash history.

### Right-Turn Lane Warrants

#### EBFR/Sunset Professional Campus East Driveway

Peak Hour Traffic Volume on the Highway in Advancing Direction	Minimum Peak Hour Right-turn Traffic Volume				
	# of thru lanes per direction				
	1		2		3
	< 45 MPH Posted Speed	≥ 45 MPH Posted Speed	< 45 MPH Posted Speed	≥ 45 MPH Posted Speed	All Speeds
≤ 200					
AM 201 – 300	-	30	-	-	-
301 – 400	-	19	-	55	-
PM 401 – 500	85	14	-	30	-
501 – 600	58	12	140	25	-
601 – 700	27	9	80	18	-
701 – 800	20	8	53	15	-
801 – 900	12	7	40	12	-
901 – 1000	9	6	30	11	-
1001 – 1100	8	5	23	9	18
1101 – 1200	7	5	18	8	16
1201 – 1300	6	4	14	8	15
1301 – 1400	6	4	11	6	12
1400+	5	3	8	6	10