ENVIRONMENTAL NOISE ASSESSMENT
for the
West Oaks Project
City of Carlsbad, California
Carlsbad Report Number: 102440327

Prepared for:

The Carlsbad West Oaks, LLC
a Delaware Limited Liability Company
2235 Encinitas Boulevard, Suite 216
Encinitas, California 92024

Prepared by:

DUDEK
605 Third Street
Encinitas, California 92024

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SUMMARY

The West Oaks Project (Project) is a multi-family residential development proposed along Palomar Airport Road in Carlsbad, California. The Project consists of 192 units comprised of one-bedroom, two-bedroom, and three-bedroom units. The Project also includes on-site parking, a recreation/leasing building, and a community pool.

Noise levels from traffic along the major roadway adjacent to the project site were analyzed for on-site noise-sensitive uses. The resultant noise levels would comply with the City's exterior noise criterion, within the "conditionally acceptable" range. Mitigation options are presented to address calculated future exterior noise levels to reduce them to acceptable levels inside buildings and on balconies. Unshielded outdoor areas between the residential buildings and Palomar Airport Road are not generally acceptable for outdoors use. The pool and club house area of the development are set back from Palomar Airport Road such that the noise levels in these outdoor use spaces are acceptable.

Noise associated with short-term (construction) activities would pose potentially significant impacts at nearby noise-sensitive receivers. Mitigation to reduce the potential for short-term significant construction noise impacts is included in the mitigation section.

Another noise concern for the site emanates from the operation of the nearby Palomar Airport. This noise report relies on the analysis and conclusions provided in a Due Diligence letter aimed at assessing the Aircraft noise from the nearby airport on the proposed site. Results from that letter are summarized and mitigation to address elevated noise levels is included. An independent full assessment of the airport noise was not conducted.

With inclusion of mitigation measures, Dudek expects that noise levels from the proposed project can be reduced from potentially significant to less than significant.

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1 INTRODUCTION

The West Oaks Project (Project) is a multi-family residential development proposed along Palomar Airport Road in Carlsbad, California. The Project consists of 192 units comprised of one-bedroom, two-bedroom, and three-bedroom units. The Project also includes on-site parking, a recreation/leasing building, and a community pool.

1.1 Purpose

The purpose of this report is to calculate and evaluate the potential noise and vibration impacts associated with implementation of the West Oaks Project (Project) relative to the City of Carlsbad significance thresholds. The report includes a quantitative analysis of Project-related noise and vibration for construction and operation.

1.2 Project Location

The approximate 12.52-acre site (including West Oaks Way) is located within the City of Carlsbad, California (City), San Diego County, California. The site is located roughly 2.1 miles east of the Pacific Ocean and is within the Coastal Zone Boundary. Specifically, the site is located approximately 0.5-mile east of Aviara Parkway, directly west of Palomar Oaks Way, and immediately south of Palomar Airport Road (Figure 2, Vicinity Map).

1.3 Project Description

The proposed project would develop 192-unit multi-family apartment homes in nine (9) separate 3-story walk-up structures. The proposed project includes a new driveway entrance and bridge at the western end of West Oaks Way as well as a new internal loop road. Surface parking will be provided in several areas within the project.

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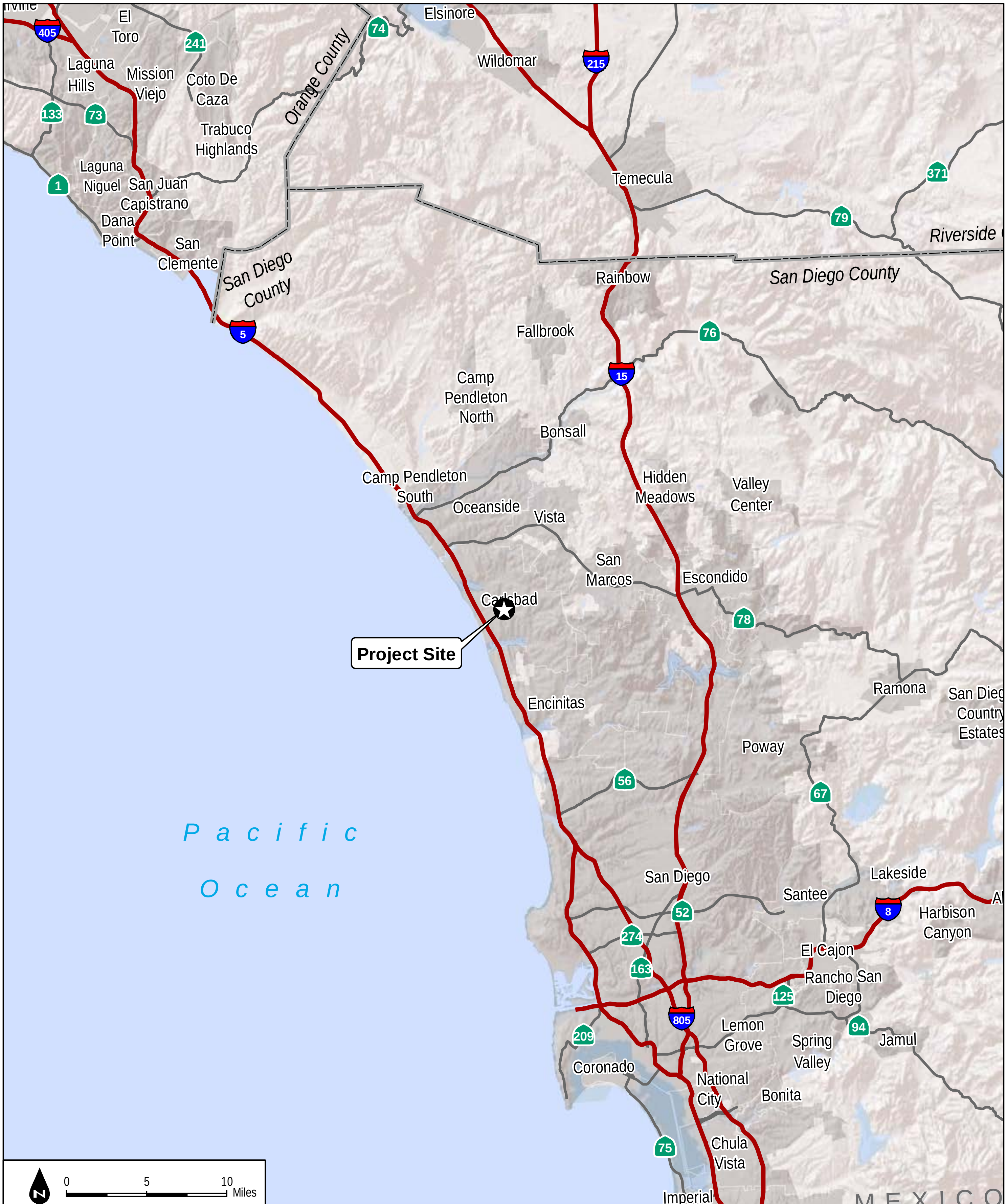

SOURCE: ESRI Basemaps (2016)

FIGURE 1

Regional Map

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Noise Quality Technical Report for the West Oaks Project

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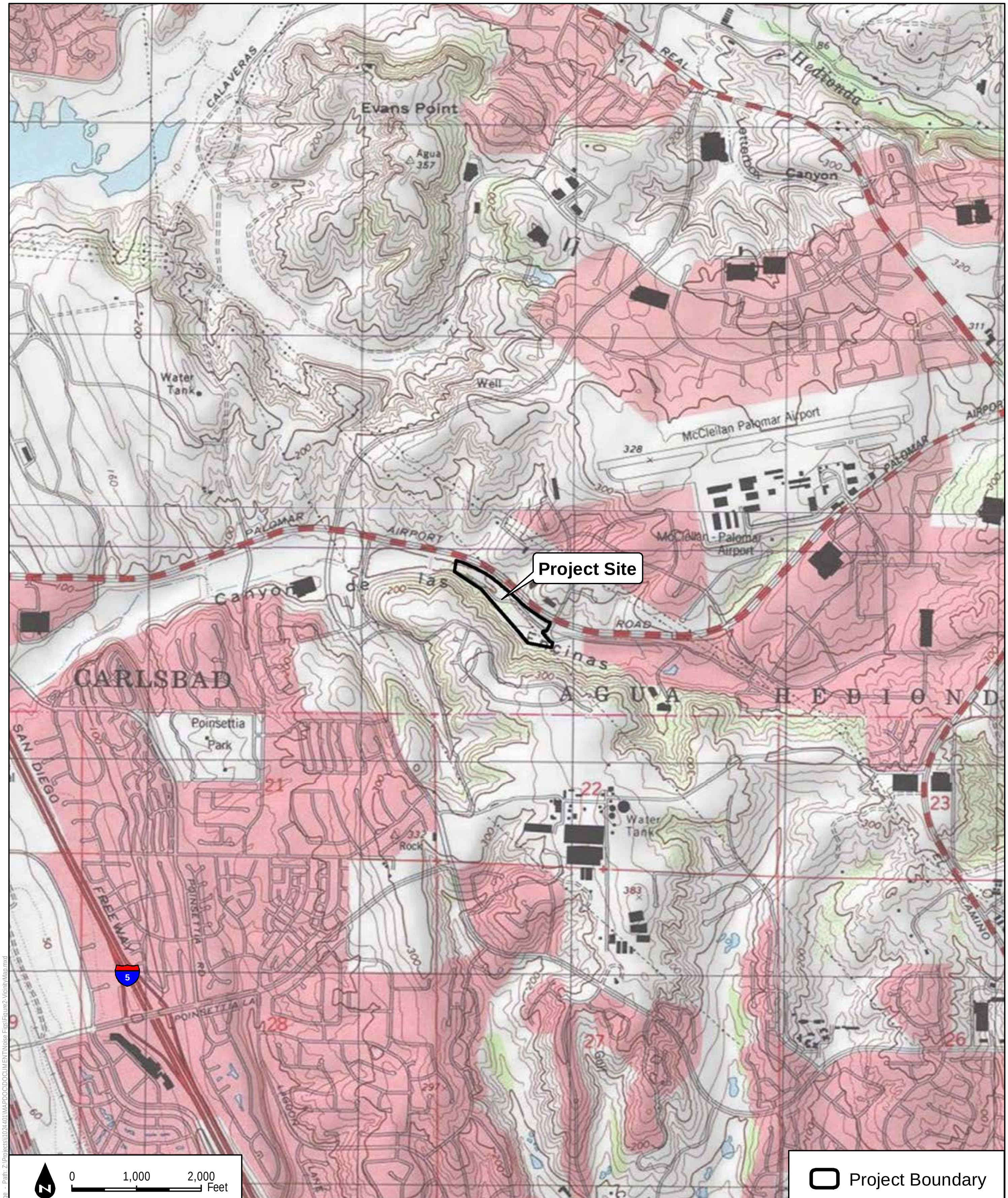

SOURCE: USGS 7.5-Minute Series Encinitas Quadrangle
Township 12S, Range 4W, Section 22

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FIGURE 2

Vicinity Map

Noise Quality Technical Report for the West Oaks Project

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2 FUNDAMENTALS OF NOISE AND VIBRATION

The following is a brief discussion of fundamental noise concepts and basic terminology.

2.1 Sound, Noise, and Acoustics

Sound propagation is a process that consists of three components: the sound source, the sound path, and the sound receiver. All three components must be present for sound to propagate. Without a source to produce sound, there is no sound. Similarly, without a medium to transmit sound pressure waves, there is no sound transmitted. Finally, sound must reach a receiver; a hearing organ, sensor, or object must be present to perceive, register, or be affected by sound or noise. In most situations, there are many different sound sources, paths, and receptors. Acoustics is the field of science that deals with the production, propagation, reception, effects, and control of sound. Noise is defined as sound that is unpleasant, unexpected, or undesired.

2.2 Sound Pressure Levels and Decibels

Loudness of sound increases with increasing amplitude. Sound pressure amplitude is measured in units of micronewton per square meter, also called micropascal. One micropascal is approximately one-hundred billionth (0.00000000001) of normal atmospheric pressure. The pressure of a very loud sound may be 200 million micropascals, or 10 million times the pressure of the weakest audible sound. Because expressing sound levels in terms of micropascal would be very cumbersome, sound pressure level in logarithmic units is used instead to describe the ratio of actual sound pressure to a reference pressure squared. These units are called Bels. To provide a finer resolution, a Bel is subdivided into 10 decibels (dB).

2.3 A-Weighted Sound Level

Sound pressure level alone is not a reliable indicator of loudness. The frequency, or pitch, of a sound also has a substantial effect on how humans will respond. Although the intensity (energy per unit area) of the sound is a purely physical quantity, the loudness, or human response, is determined by the characteristics of the human ear.

Human hearing is limited not only in the range of audible frequencies, but also in the way it perceives the sound in that range. In general, the healthy human ear is most sensitive to sounds between 1,000 and 5,000 hertz, and it perceives a sound within that range as more intense than a sound of higher or lower frequency with the same magnitude. To approximate the frequency response of the human ear, a series of sound level adjustments is usually applied to the sound measured by a sound level meter. The adjustments (referred to as a weighting network) are frequency-dependent.

The A-scale weighting network approximates the frequency response of the average young ear when listening to ordinary sounds. When people make judgments about the relative loudness or annoyance of a sound, their judgments correlate well with the A-scale sound levels of those sounds. Noise levels are typically reported in terms of A-weighted sound levels. All sound levels discussed in this report are A-weighted decibels (dBA), unless otherwise stated. Examples of typical noise levels for common indoor and outdoor activities are depicted in Table 1.

Table 1
Typical Sound Levels in the Environment and Industry

Common Outdoor Activities	Noise Level (dB)	Common Indoor Activities
—	110	Rock band
Jet fly over at 300 meters (1,000 feet)	100	—
Gas lawn mower at 1 meter (3 feet)	90	—
Diesel truck at 15 meters (50 feet), at 80 kilometers per hour (50 miles per hour)	80	Food blender at 1 meter (3 feet); garbage disposal at 1 meter (3 feet)
Noisy urban area, daytime; gas lawn mower at 30 meters (100 feet)	70	Vacuum cleaner at 3 meters (10 feet)
Commercial area; heavy traffic at 90 meters (300 feet)	60	Normal speech at 1 meter (3 feet)
Quite urban, daytime	50	Large business office; dishwasher next room
Quite urban, nighttime	40	Theater; large conference room (background)
Quite suburban, nighttime	30	Library
Quite rural, nighttime	20	Bedroom at night; concert hall (background)
—	10	Broadcast/recording studio
Lowest threshold of human hearing	0	Lowest threshold of human hearing

Source: Caltrans 2011

2.4 Human Response to Changes in Noise Levels

"It is generally accepted that the average healthy ear…can barely perceive a noise level change of 3 dB" (Caltrans 2013). A change of 5 dBA is readily perceptible, and a change of 10 dBA is perceived as twice or half as loud. A doubling of sound energy results in a 3 dBA increase in sound, which means that a doubling of sound energy (e.g., doubling the average daily numbers of traffic on a road) would result in a barely perceptible change in sound level.

2.5 Noise Descriptors

Additional units of measure have been developed to evaluate the long-term characteristics of sound. The equivalent sound level (L_{eq}) is also referred to as the time-average sound level. It is the equivalent steady-state sound level that in a stated period of time would contain the same acoustical energy as the time-varying sound level during the same time period. The 1-hour A-weighted equivalent sound level, $L_{eq}(h)$, is the energy average of the A-weighted sound levels occurring during a 1-hour period.

People are generally more sensitive and annoyed by noise occurring during the evening and nighttime hours. Thus, another noise descriptor used in community noise assessments—the community noise equivalent level (CNEL)—was introduced. The CNEL scale represents a time-weighted, 24-hour average noise level based on the A-weighted sound level. The CNEL accounts for the increased noise sensitivity during the evening hours (7 p.m. to 10 p.m.) and nighttime hours (10 p.m. to 7 a.m.) by adding 5 dBA and 10 dBA, respectively, to the average sound levels occurring during the evening and nighttime hours. Similar to CNEL, the Day Night Level (L_{dn}[1]) is the basis for the City's standards for land use compatibility for community noise (See Table 2 in Section 3).

2.6 Sound Propagation

Sound propagation (i.e., the passage of sound from a noise source to a receiver) is influenced by geometric spreading, ground absorption, atmospheric effects, and shielding by natural and/or built features. Sound levels attenuate (or diminish) at a rate of approximately 6 dBA per doubling of distance from an outdoor point source due to the geometric spreading of the sound waves. Atmospheric conditions such as humidity, temperature, and wind gradients can also temporarily alter sound levels. In general, the greater the distance the receiver is from the source, the greater the potential for variation in sound levels due to atmospheric effects. Additional sound attenuation can result from built features such as intervening walls and buildings, and by natural features such as hills and dense woods.

2.7 Groundborne Vibration Fundamentals

Groundborne vibration is a small, rapidly fluctuating motion transmitted through the ground. The strength of groundborne vibration attenuates fairly rapidly over distance. Some soil types transmit vibration quite efficiently; other types (primarily sandy soils) do not. Several basic measurement units are commonly used to describe the intensity of ground vibration. The descriptors used by the Federal Transit Administration are peak particle velocity (PPV), in units of inches per second, and velocity decibel (VdB). The calculation to determine PPV at a given distance is as follows:

$$PPV_{distance} = PPV_{ref} * (25/D)^{1.5}$$

Where:

PPV_{equip} = the peak particle velocity in inches per second of the equipment adjusted for distance

[1] L_{dn} (also known as DNL) is comparable to CNEL, except that there is no evening component: the period from 7 a.m. to 10 p.m. is classified as daytime, and no adjustment to the noise levels is made during these hours; the period from 10 p.m. to 7 a.m. is classified as nighttime and 10 decibels is added to the hourly Leqs occurring during these hours.

PPV_{ref} = the reference vibration level in inches per second at 25 feet

D = the distance from the equipment to the receiver

The vibration velocity parameter correlates well with human perception of vibration. Thus, the response of humans, buildings, and sensitive equipment to vibration is described in this section in terms of the root-mean square velocity level in VdB units relative to 1 micro-inch per second. As a point of reference, the average person can just barely perceive vibration velocity levels below 70 VdB (typically in the vertical direction). The calculation to determine the root-mean square at a given distance is as follows:

$$L_v(D) = L_v(25\text{ feet}) - 30*\log(D/25)$$

Where:

$L_v(D)$ = the vibration level at the receiver

$L_v(25\text{ feet})$ = the reference source vibration level

D = the distance from the vibration activity to the receiver

Typical background vibration levels are between 50 and 60 VdB, and the level for minor cosmetic damage to fragile buildings or blasting generally begins at 100 VdB. The Federal Transit Authority (FTA) uses a significance threshold of 80 VdB to address potential annoyance or sensitivity for the average person (FTA 2006).

3 CITY OF CARLSBAD NOISE CRITERIA

City of Carlsbad Noise Guidelines Manual

The City's Noise Guidelines Manual is primarily intended to address community noise issues related to land use. The City's General Plan Noise Element policies are summarized, the science of noise is summarized, procedures for the processing of a project are explained, preferred methods for the mitigation of noise are listed, and a preferred noise report format is presented. Additionally, typical conditions of approval are listed. The Noise Guidelines Manual does not address noise issues such as animal noise, noise from parties and loud gatherings, motor vehicle noise, or general nuisance noise, for which the best resource is the Carlsbad Municipal Code Noise Ordinance (Carlsbad Municipal Code, Chapter 8.48).

City of Carlsbad Municipal Code

Carlsbad Municipal Code Chapter 8.48 outlines regulations for limitation of hours for construction (i.e., the erection, demolition, alteration, or repair of any building or structure or the grading or excavation of land) that creates disturbing, excessive, or offensive noise. Construction can occur Monday through Friday from 7:00 a.m. to 6:00 p.m. and Saturday 8:00 a.m. to 6:00 p.m.; no work shall be conducted on Sundays or on federal holidays. Carlsbad Municipal Code Chapter 8.48 also outlines exceptions that may be granted by the City for circumstances such as emergency repairs required to protect the health and safety of the community.

Carlsbad Municipal Code Section 21.34.090 specifies that the maximum allowable exterior noise level of any use shall not exceed 65 dBA day/night average sound level (L_{dn}) as measured at the property line. If a building includes more than one use, the noise level shall not be in excess of 45 dBA L_{dn} as measured within the interior space of the neighboring establishment.

City of Carlsbad General Plan Noise Standards

The Draft Noise Element of the City's General Plan Update (City of Carlsbad 2013) includes several standards for noise.

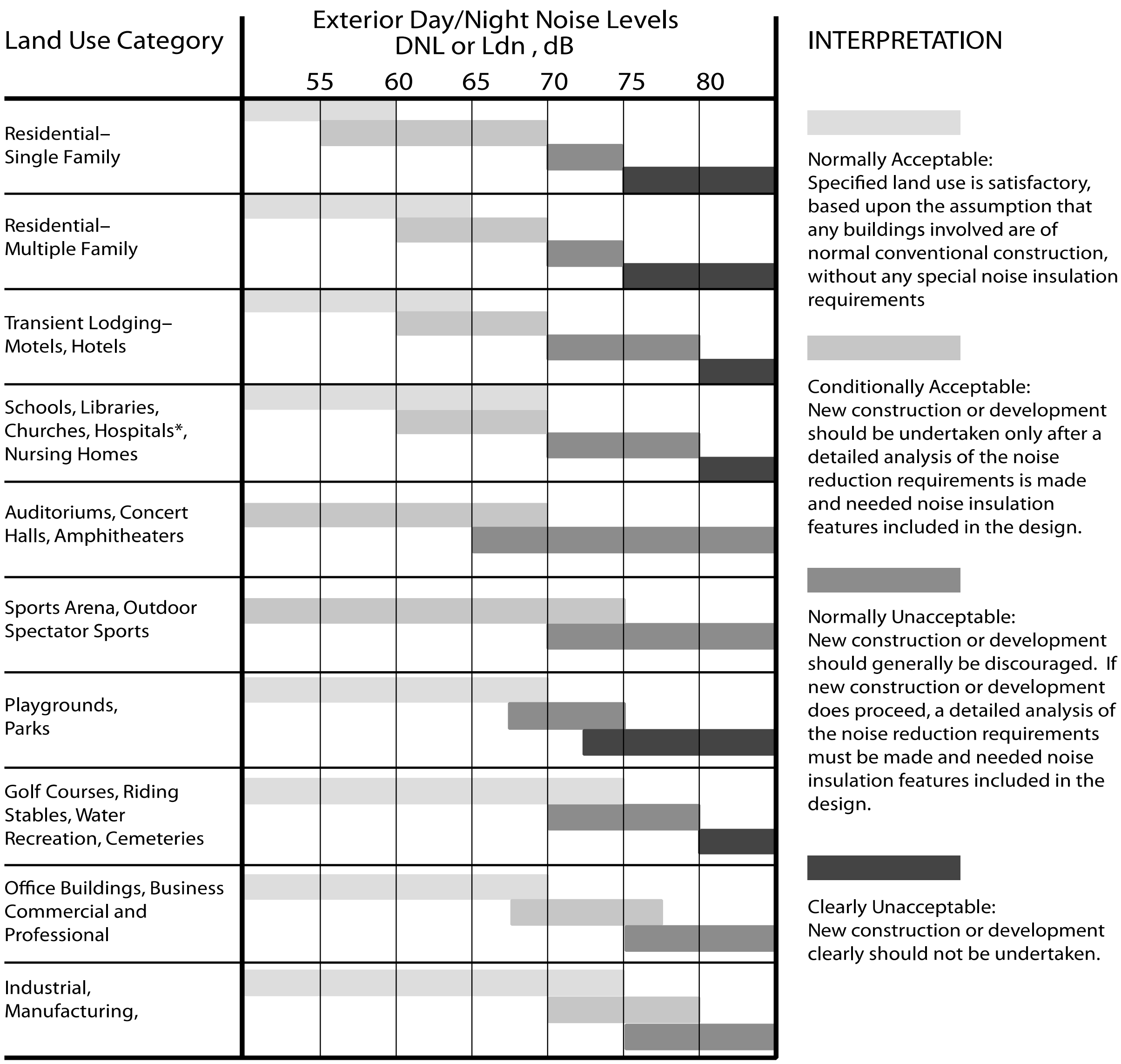
Community Noise Exposure

Table 2 (reproduced from City of Carlsbad 2015, Table 5-1) presents the community noise exposure matrix, establishing criteria the City shall use to evaluate land use compatibility based on noise emanating from all sources.

Allowable Noise Exposure

Table 3 (reproduced from City of Carlsbad 2015, Table 5-2) presents acceptable limits of noise for various land uses for both exterior and interior environments from transportation sources. Although Table 2 identifies standards to help the City establish the appropriateness of locating specific uses in noise-sensitive environments, Table 3 provides standards with which new development must comply, through noise attenuation measures including site design and construction materials. These limits are based on guidelines provided by the California Office of Planning and Research. Similarly, Table 4 provides City standards for noise from non-transportation noise sources such as industrial facilities, equipment yards, automotive servicing, and on-site equipment and machinery such as heating, ventilation, and air conditioning (HVAC) equipment. These standards apply to the noise sources themselves, as measured at the edge of the property line; noise caused by motor vehicles traveling to and from the site is exempt from noise generation standards found in Table 4.

Table 2
Land Use Compatibility for Community Noise Environments



Source: Office of Planning and Research, State of California General Plan Guidelines,
Appendix A: Guidelines for the Preparation and Content of the Noise Element of the General Plan, 1998.

*Because hospitals are often designed and constructed with high noise insulation properties, it is possible for them to be satisfactorily located in noisier areas.

Source: City of Carlsbad 2015, Table 5-1.

Table 3
Allowable Noise Exposure[1]

Land Use	Outdoor Activity[2,3] Areas (dBA CNEL)	Interior Spaces (dBA CNEL)
Residential	60[4]	45
Motels, Hotels	65	45
Hospitals, Residential Care Facilities, Schools, Libraries, Museums, Churches, Day Care Facilities	65	45
Playgrounds, Parks, Recreation Uses	65	50
Commercial and Office Uses	65	50
Industrial Uses	70	65

Notes:

1 Development proposed within the McClellan-Palomar Airport Area of Influence shall also be subject to the noise compatibility policies contained in the ALUCP.

2 For non-residential uses, where an outdoor activity area is not proposed, the standard does not apply. Where the location of outdoor activity areas is unknown, the exterior noise level standard shall be applied to the property line of the receiving use.

3 Where it is not possible to reduce noise in outdoor activity areas to the allowable maximum, levels up to 5 dB higher may be allowed provided that available exterior noise level reduction measures have been implemented and interior noise levels are in compliance with this table.

4 An exterior noise exposure level of 65 dBA CNEL is allowable for residential uses in a mixed-use project and for residential uses within the McClellan-Palomar Airport Area of Influence, pursuant to the noise compatibility policies contained in the ALUCP.

Source: City of Carlsbad, Table 5-2.

Table 4
Performance Standards for Non-Transportation Sources (As Measured at Property Line of Source/Sensitive Use)

Noise Level Descriptor	Daytime (7 A.M. to 10 P.M.)	Nighttime (10 P.M. to 7 A.M.)
Hourly L_{eq}, dB	55	45
Maximum Level, dB	75	65

Note: Each of the noise levels specified above shall be lowered by 5 dB for simple tone noises, noises consisting primarily of speech or music, or for recurring impulsive noises.

Source: City of Carlsbad, Table 5-3.

4 METHODOLOGY

Ambient noise measurements were conducted to quantify the existing daytime noise environment at locations in the project vicinity. Noise levels resulting from the proposed construction activities have been calculated using Federal Highway Administration (FHWA) Roadway Construction Noise Modeling software. The noise impact assessment used criteria established in Carlsbad noise regulations as discussed in Section 3. The noise levels associated with Palomar Airport Road were determined based on data obtained from the traffic reports (Appendix C and LLG 2020) for the proposed project. Datakustic's CadnaA sound modeling software was used to model the traffic noise from Palomar Airport Road. This software includes traffic noise modeling algorithms based on the Federal Highway Administration's Traffic Noise Model (TNM), Version 2.5 (FHWA 2004) software. The measurements were used to calibrate the model to ensure vehicle speed was approximate to expected speeds for vehicles on the road.

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5 EXISTING CONDITIONS

The ambient noise in the project vicinity is dominated by traffic along Palomar Airport Road and aircraft operations associated with Palomar Airport (i.e., take-off and landing maneuvers, as well as low altitude fly-overs). To address the existing noise environment of the project vicinity, short term noise measurements were conducted on the proposed project site. Details of those measurements are discussed in the following section which also includes the results of those measurements. Following the measurement discussion, a brief summary of the use of traffic noise modeling is included. Finally, this chapter includes a discussion of the aircraft noise due to the nearby airport.

5.1 Ambient Noise Monitoring

Traffic noise measurements were conducted at the site to determine the existing noise levels in the project vicinity. The measurements were conducted by Connor Burke, of Dudek, using a Rion NL-52 sound level meter. This sound level meter meets the current American National Standards Institute standard for a Type 1 Precision sound level meter. The sound level meter was positioned on a tripod at a height of approximately five feet above the ground and fitted with a windscreen during measurements. The instrument was calibrated prior to measurements.

The short-term noise measurements were conducted on Monday, March 13, 2017 and Thursday August 31, 2017. The measured average noise levels and the concurrent traffic volume are presented in Table 5.

Table 5
Measured Noise Levels and Traffic Volumes

Site	Description	Date/Time	L_{eq}[1]	Cars	MT[2]	HT[3]	M[4]
ST1	Approximately 100 feet from the edge of the pavement of Palomar Airport Road	3/13/2017 10:21 a.m. to 10:36 a.m.	63.1 dBA	500	4	8	0
ST1v2		08/31/2017 10:39 a.m. to 10:54 a.m.	60.4 dBA	595	14	6	0
ST2	Approximately 30 feet from the edge of the pavement of Palomar Airport Road near intersection with Palomar Oaks Way	3/13/2017 11:07 a.m. to 11:22 a.m.	63.7 dBA	510	7	8	1
ST3	Rear of Site south of West Oaks Way	3/13/2017 10:43 a.m. to 10:58 a.m.	57.6 dBA	N/A	N/A	N/A	N/A
ST4	Far Side of Palomar Airport Road, about 110 feet from road centerline	08/31/2017 11:31 a.m. to 11:46 a.m.	69.9 dBA	691	16	7	0
ST5	Lot Site Nearest to Intersection, 100 feet from road centerline	08/31/2017 11:02 a.m. to 11:17 a.m.	63.2 dBA	616	22	17	0

Notes:
1 Equivalent Continuous Sound Level (Time-Average Sound Level)
2 Medium Trucks

3 Heavy Trucks
4 Motocycles

Despite focusing on traffic noise, the measurements also included flyovers from the nearby airport. ST3 was located further from Palomar Road than were ST1 and ST2. At ST3, traffic from Palomar Airport Road remained the dominate noise source, but traffic was not visible and traffic counts could not be conducted concurrently with the measurements. Thus, traffic count data is not reported with the ST3 measurement in Table 5. The measurement was repeated at ST1 during the second site visit. ST4 and ST5 were also added during this visit.

5.2 Noise Modeling

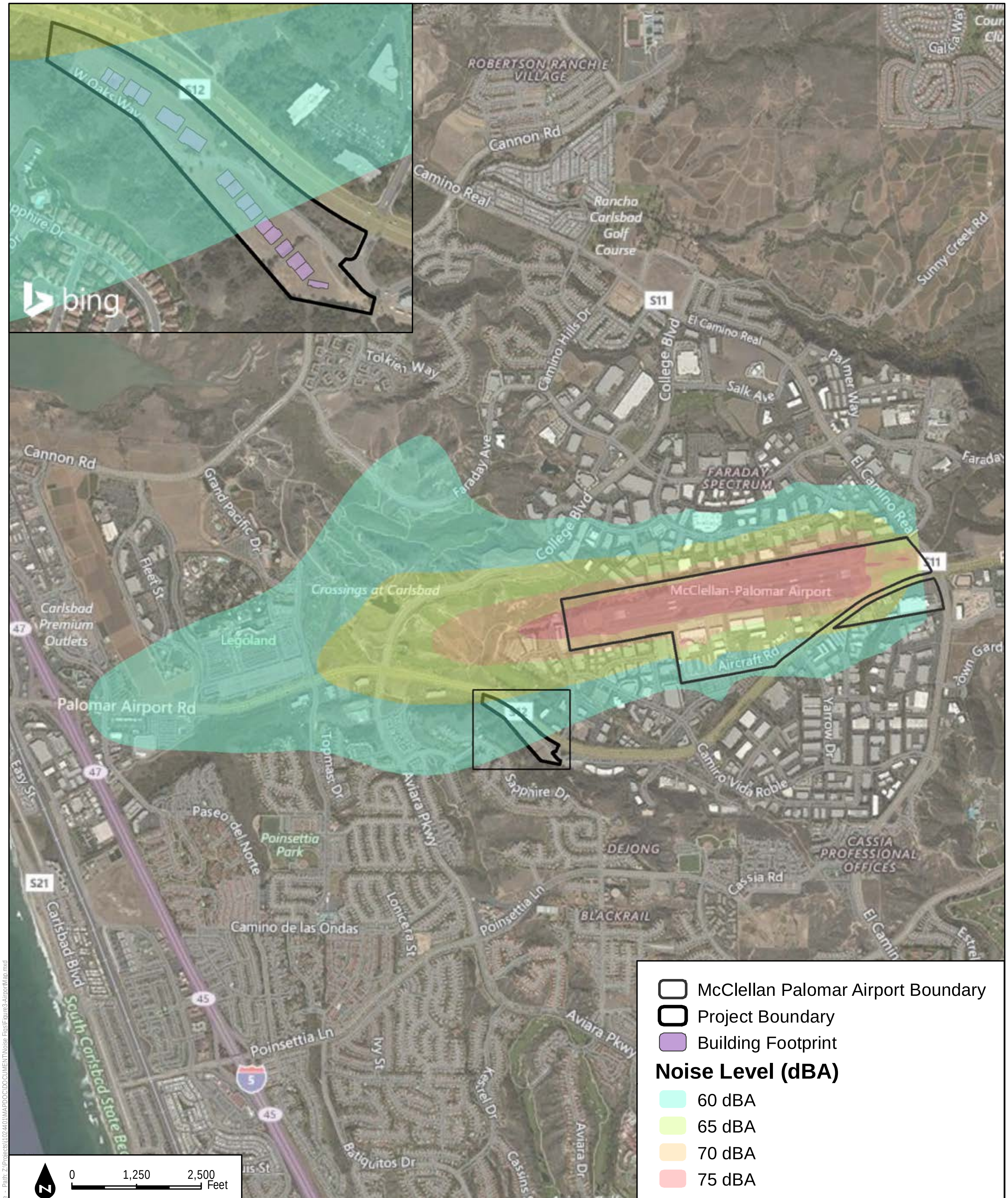
The CadnaA noise modeling software was used to model noise generated by existing and future traffic along Palomar Airport Road. The alignment of Palomar Road, number and types of vehicles on the roadway, vehicle speeds, future building locations, receiver locations, and other data were input based on sound level measurements and scaled project plans.

Based on sound level measurement results and traffic counts, the traffic noise level predicted from the model was calibrated to within approximately 4 dB of most of the measured results. Traffic speeds and vehicle mix (cars, trucks, and motorcycles) were the primary parameter altered during the calibration process. The model showed results that were within 1 dB at ST4, which provides confidence that the traffic noise model accurately represents the traffic noise in the project vicinity.

5.3 McClellan- Palomar Airport Noise

According to an “Acoustical Due Diligence Survey” (ISE 2016) conducted by ISE and dated July 26, 2016 (Revised), “the project site is located on average approximately 2,400 feet from the runway edge of McClellan Palomar Airport.” The reader is referred to Figure 3 which depicts the noise contours associated with the McClellan Palomar Airport overlain on the project site. As illustrated in Figure 3, the northern tip of the site is located within the 65 dBA CNEL contour (levels within this contour range from 61 to 65 dBA CNEL); no structures are located within the 65 dBA CNEL contour. The central 2/3 of the site is located within the 60 dBA CNEL contour (noise levels here would range from 56 to 60 dBA CNEL). The majority of the proposed structures would be located in the 60 dBA CNEL contour. The southern approximately 1/3 of the site would be located in the 55 dBA CNEL contour, about a third of the proposed structures would be located in the 55 dBA CNEL contour.

The ISE report indicates that the authors found the site to be acceptable for the residential development, after reviewing both traffic and airport noise levels for the site. The report further points out that certain special design considerations must be made in order to assure the future residential living space noise levels are acceptable.



SOURCE: Bing Maps (Accessed 2017); Fuscoe Engineering (2017)

FIGURE 3

Airport Noise Contours

Noise Quality Technical Report for the West Oaks Project

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From the ISE letter:

- Structures within the 60 dBA CNEL contour of McClellan-Palomar Airport as shown [in Figure 3] would be required to mitigate interior noise levels to comply with CCR Title 24.
- Second and third floor building areas would need to be designed to comply with CCR Title 24, especially in areas with doors and/or windows that face Palomar Airport Road.
- First floor building areas may be required to comply with CCR Title 24 depending on the extent of exterior property noise mitigation (i.e., noise walls and/or berms applied to the final design to mitigate outdoor useable space areas).
- Finally, outdoor useable space areas would need to be shielded from traffic noise along Palomar Airport Road through the use of noise walls and/or berms, or through judicious placement behind proposed development structures.

Dudek did not conduct an independent Airport Noise impact analysis.

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6 FUTURE CONDITIONS

The proposed Project would generate noise from short-term construction activities, and the site will primarily be affected by traffic noise along Palomar Airport Road. The future (year 2035) average daily traffic (ADT) based on peak-hour traffic numbers along Palomar Airport Road adjacent to the proposed project is projected to be 50,772 ADT. With traffic generated by the proposed project, that Year 2035 ADT would increase to 51,573 vehicles (Appendix C and LLG 2020).

6.1 Traffic Noise

The Project would generate a net traffic volume increase over existing volumes. Based on the LLG traffic analyses, ADT values were calculated for the scenarios analyzed in the traffic studies using the existing ADT of 44,494 vehicles and the percentage ratio of peak hour trips to ADT of 14.86% (~~refer to Appendices G-L,~~Appendix C and LLG 2020). LLG's report include an expected ADT increase of 1,152 ADT due to the project based on SANDAG (Not So) Brief Guide of Vehicular Traffic Generation Rates for the San Diego Region (April 2002).

The Existing + Project scenario was calculated by summing these two numbers; note, this is a conservative approach that does not account for trip distribution split at the project site entrance. Table 6 shows the calculated ADT numbers for those scenarios. Using the peak hour Existing traffic numbers included in the LLG reports, and the reported Carlsbad Traffic Monitoring ADT value, the average peak hour traffic was calculated to be 7.4% of ADT in the existing case. This percentage was used to calculate expected ADT values from the peak hour traffic numbers contained in the traffic reports from LLG.

Table 6
Palomar Road Average Daily Traffic Scenarios

Street	Existing	Existing + Project	Existing + Cumulative	Existing + Cumulative + Project	Year 2035	Year 2035 + Project
Palomar Airport Road	44,494	45,646	45,941	46,742	50,772	51,573

Notes: ADT = average daily traffic; CNEL = community noise equivalent level; dB = decibel(s).

The ADT values derived as discussed above were used with the calibrated CadnA traffic noise model to calculate existing and expected noise levels at the proposed building facades.

A local road default traffic hourly distribution was used for these scenarios. This default hourly percentage for 6:00 a.m. to 7:00 p.m. is about 6.4% of the ADT. For evening hours between 7:00 p.m. and 10 p.m. hourly traffic is assumed to be 2.9% of ADT. For nighttime hour from 10 p.m. to 6:00 a.m., 1% of ADT is the assumed hourly traffic. These percentages are rounded. CadnaA utilizes additional digits of precision (more decimal places) during model simulations/

calculations. The percentage of heavier vehicles (medium trucks, heavy trucks, and buses) is assumed to be 10%.

Table 7 shows the results of the model runs for the balcony areas facing the road. Under the "Receiver" column, the M numbers relate to the positions of the modeled receivers shown on Figure 4. The "L" indicates the level with L1 indicating the first floor, L2 indicating the second floor, and L3 indicating the third floor. The receiver locations were placed approximately 3 feet above the floor level to model a seated resident on the balconies, based on elevations derived from the project plan.

Table 7
Traffic Noise Model Results at Representative Receivers

Receiver	Traffic Noise (CNEL dBA)					
	Existing	*Existing + Project*	*Existing + Cumulative*	*Existing + Cumulative + Project*	*Year 2035*	*Year 2035 + Project*
M1 L1	66	66	66	67	67	67
M1 L2	67	67	67	67	67	67
M1 L3	67	67	67	67	67	67
M2 L1	67	67	67	67	67	67
M2 L2	67	67	67	67	67	67
M2 L3	67	67	67	67	67	68
M2-Alt L1	66	67	67	67	67	67
M2-Alt L2	67	67	67	67	67	67
M2-Alt L3	67	67	67	67	67	67
M3 L1	66	66	66	66	67	67
M3 L2	66	66	66	67	67	67
M3 L3	66	66	66	66	67	67
M3-Alt L1	66	66	66	66	67	67
M3-Alt L2	66	66	66	66	67	67
M3-Alt L3	66	67	67	67	67	67
M4 L1	66	66	66	66	67	67
M4 L2	66	67	67	67	67	67
M4 L3	66	66	67	67	67	67
M4-Alt L1	66	66	66	66	67	67
M4-Alt L2	66	66	66	67	67	67
M5 L1	64	64	64	64	64	64
M5 L2	64	64	64	64	65	65
M5 L3	64	65	65	65	65	65
M5-Alt L1	63	63	63	63	64	64
M5-Alt L2	64	64	64	64	64	64
M5-Alt L3	64	64	64	64	65	65
M6 L1	64	64	64	64	64	64
M6 L2	64	64	64	64	65	65

Table 7
Traffic Noise Model Results at Representative Receivers

Receiver	Traffic Noise (CNEL dBA)					
	Existing	*Existing + Project*	*Existing + Cumulative*	*Existing + Cumulative + Project*	*Year 2035*	*Year 2035 + Project*
M6 L3	64	64	64	64	65	65
M6-Alt L1	64	64	64	64	64	64
M6-Alt L2	64	64	64	64	64	64
M6-Alt L3	63	64	64	64	64	64
M7 L1	62	62	62	62	63	63
M7 L2	63	63	63	63	63	63
M7 L3	63	63	63	63	64	64
M7-Alt L1	63	63	63	63	63	63
M7-Alt L2	63	63	63	63	64	64
M7-Alt L3	63	63	63	64	64	64
M8 L1	63	63	63	63	63	63
M8 L2	63	63	63	63	64	64
M8 L3	63	63	63	63	64	64
M9 L1	63	63	63	63	63	63
M9 L2	63	63	63	63	63	63
M9 L3	63	63	63	63	63	63
M10 L1	63	63	63	63	63	63
M10 L2	63	63	63	63	63	64
M10 L3	63	63	63	63	63	63
Pool/Club House	*65*	*65*	*65*	*65*	*65*	*65*

Existing exterior noise exposure levels due to traffic on Palomar Airport Road exceed 65 dBA CNEL at M1, M2, M3, and M4 on the first, second, and third floors. All of these receivers have calculated noise levels below 70 dBA CNEL, and therefore remain in the "conditionally acceptable" range from the land use compatibility table. To address the conditional nature of the noise levels, MM-NOI-3 and MM_NOI-4 are included in the mitigation measures sections.

Further modeling was conducted to estimate the noise levels on the balconies. This modeling focused on the added noise reduction due to acoustically solid barriers (i.e., free of holes, gaps, or cracks) at the open end of the balconies. The modeled balcony receivers were assumed to be seated; thus, the receiver elevations were modeled at a height of approximately 3 feet above the 1st, 2nd, and 3rd floor levels. Barriers were assumed to extend 4 feet up from the floors on these levels.

Applying standard acoustical barrier calculations to the seated receiver, 5 dBA or more of additional noise reduction is expected. For the worst case modeled receiver at M2 L3 in the Year 2035 with project traffic scenario, the calculated CNEL is 68 dBA. With the conservative noise reduction of 5 dBA applied due to the balcony barrier, the expected traffic noise level for a seated receiver is about 63 dBA CNEL. Thus the outdoor seated areas would have noise levels below 65 dBA CNEL and thus are allowable for residential uses in a mixed-use project as stated in note 4 of Table 3 (City of Carlsbad).

With implementation of mitigation measures MM-NOI-3 and MM_NOI-4, the noise impacts from traffic can be considered less than significant for the planned outdoor use areas reviewed and the balconies of the residential units.

Another planned outdoor living space is the Pool area adjacent to the Club House. At this location, the noise levels from Palomar Airport Road are acceptable. Therefore no exterior traffic noise mitigation is required in the Pool and Club House area.

Interior spaces are a concern due to the elevated exterior noise levels identified in the traffic noise modeling. A review of the construction plans for the buildings would be required to assure the interior living spaces do not have noise levels that exceed 45 dBA CNEL, which could result from the elevated exterior noise levels. More details on required future review of construction drawings is included in the mitigation measure section.

With regard to traffic noise levels associated roadways to which the project would contribute trips, it is noteworthy that the noise level increases would not exceed 2 dBA when the project trips are added to any of the analyzed future traffic condition scenarios. This is considered a less than significant noise increase due to the project. Since less than a 2 dB increase in traffic noise has been calculated on roadways immediately adjacent to the project site, we conclude that less than a 2 dB increase in traffic noise due to the project would be expected at other residential receptors located along roads further from the project site (i.e., roads with smaller proportionate traffic contributions by the project. Therefore project-related traffic noise level increase impacts on nearby residential receptors are expected to be less than significant.

SOURCE: Bing Maps (Accessed 2017); Fuscoe Engineering (2017)

FIGURE 4

Noise Measurement and Modeling Locations

DUDEK

Noise Quality Technical Report for the West Oaks Project

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6.2 Construction Noise

Construction noise and vibration are temporary phenomena. Construction noise and vibration levels will vary from hour to hour and day to day, depending on the equipment in use, the operations being performed, and the distance between the source and receptor.

Construction is expected to include site preparation, grading, trenching, building construction, paving, and architectural coating. Construction equipment with substantially higher noise-generation characteristics (such as pile drivers, rock drills, blasting equipment) would not be necessary.

The Federal Highway Administration (FHWA) has developed the Roadway Construction Noise Model (RCNM) software, which can be used to evaluate construction noise from any major construction proposal. RCNM contains a large database of construction equipment, including noise generation level and load factor (percentage of time each piece of equipment is active on a typical construction site). Dudek used RCNM to assess construction noise impacts of the proposed project.

Construction noise is difficult to quantify because of the many variables involved, including the specific equipment types, size of equipment used, percentage of time in use, condition of each piece of equipment, and number of pieces of equipment that will actually operate on site. The construction vehicle assemblage would include standard equipment such as dozers, trackers loaders, backhoes, excavators, graders, scrappers, trenchers, lifts, paving equipment, rollers, compressors, and miscellaneous trucks. Specified and measured noise level ranges for various pieces of construction equipment at a distance of 50 feet are presented in Table 8. The noise values presented are used as reference noise data for respective equipment in RCNM. The specified noise levels at 50 feet for typical equipment would range up to 85 dBA for the type of equipment normally used for this type of project. The construction equipment is expected to be spread out over the entire site, with some equipment operating along the perimeter of the site while the rest of the equipment may be located several hundred feet further away from the noise sensitive receptors.

Table 8
Typical Construction Equipment Noise Levels

CA/T Noise Emission Reference Levels and Usage Factors					
Equipment Description	*Impact Device?*	*Acoustical Use Factor (%)*	*Spec 721.560 L_{max} @ 50ft (dBA, slow)*	*Actual Measured L_{max} @50ft (dBA, slow) samples averaged**	*Number of Actual Data Samples (Count)*
All Other Equipment > 5 HP	No	50	85	-- N/A --	0
Auger Drill Rig	No	20	85	84	36
Backhoe	No	40	80	78	372
Compactor (ground)	No	20	80	83	57
Compressor (air)	No	40	80	78	18
Crane	No	16	85	81	405

Table 8
Typical Construction Equipment Noise Levels

CA/T Noise Emission Reference Levels and Usage Factors					
Equipment Description	*Impact Device?*	*Acoustical Use Factor (%)*	*Spec 721.560 L_{max} @ 50ft (dBA, slow)*	*Actual Measured L_{max} @50ft (dBA, slow) samples averaged**	*Number of Actual Data Samples (Count)*
Dozer	No	40	85	82	55
Dump Truck	No	40	84	76	31
Excavator	No	40	85	81	170
Flat Bed Truck	No	40	84	74	4
Front End Loader	No	40	80	79	96
Generator	No	50	82	81	19
Grader	No	40	85	-- N/A --	0
Man Lift	No	20	85	75	23
Pickup Truck	No	40	55	75	1
Roller	No	20	85	80	16
Scraper	No	40	85	84	12
Tractor	No	40	84	-- N/A --	0

Source: DOT 2006.

Construction would occur during the City's allowable hours of construction activities. The Municipal Code states that construction can occur Monday through Friday from 7:00 a.m. to 6:00 p.m. and Saturday from 8:00 a.m. to 6:00 p.m.. Adherence to these construction work hours is included as a mitigation measure. The noise levels generated by construction equipment would vary greatly, depending on factors such as the type and specific model of the equipment, the operation being performed, and the condition of the equipment. The average sound level of the construction activity also depends on the amount of time that the equipment operates and the intensity of the construction during periods of activity.

The typical operating cycles for construction equipment involve one or two minutes of full power operation followed by three or four minutes at lower power settings. These expected construction conditions lead us to consider those noise levels shown in Table 9 as conservative assumptions.

The magnitude of the impact would depend on the type of construction activity, equipment, duration of the construction phase, distance between the noise source and receiver, and any intervening structures. Noise from construction equipment generally exhibits point source acoustical characteristics. A point source sound is attenuated (is reduced) at a rate of 6 decibels per doubling of distance from the source for "hard site" conditions and at 7.5 decibels per doubling of distance for "soft site" conditions. These rules apply to the propagation of sound waves with no obstacles between source and receivers, such as topography (ridges or berms) or structures.

Table 9 shows the calculated noise levels at the property line of the closest noise-sensitive receptor (i.e., the residential property lines to the southwest of the project site along Sapphire Drive) during construction phases for this project, employing the RCNM software and based on construction equipment defaults found in the air quality model CalEEMod for a project of this size and scope. The noise levels shown in Table 9 take into account operation of multiple pieces of construction equipment simultaneously for the L_{eq} results. More details from the RCNM analysis can be found in Appendix B. These noise levels are based on surveys conducted by the United States Environmental Protection Agency in 1971. In the time since 1971, regulations have been enforced to improve noise generated by certain types of construction equipment to meet worker noise exposure standards. Also because of stringent air quality emissions standards, newer, cleaner, and quieter heavy equipment is used on most construction projects in California. Thus, construction phase noise levels indicated in Table 9 represent worst-case conditions. L_{max} levels are focused on the single piece of equipment with the highest L_{max}. These L_{max} results do not account for multiple pieces of equipment producing maximum levels at the same time, since this is an unlikely occurrence. For this reason and because construction phases typical include multiple pieces of equipment operating, the calculated L_{eq} levels can be higher than the L_{max}.

Table 9
Outdoor Construction Noise Levels by Phase

Construction Phase	L_{max} (dBA)	L_{eq} (dBA)
Nearest Residential Receptor (500 feet from Project Boundary)		
Site Preparation	64	68
Grading	65	68
Trenching	65	65
Building Construction	64	65
Paving	65	66
Architectural Coatings	58	54
Typical Group of Residential Receptors (550 feet from Project Center)		
Site Preparation	63	67
Grading	64	67
Trenching	64	64
Building Construction	63	64
Paving	64	65
Architectural Coatings	57	53

As the table shows, the highest noise levels are expected to occur during the Site Preparation and Grading Phases. Construction-related noise levels could reach up to 67 dBA L_{eq} at residential property lines to the south. The Carlsbad Municipal Code provides hours for construction, but does not explicitly exempt construction from noise regulations. The code specifies 65 dBA L_{dn} as the maximum allowable exterior noise level. With the construction operations limited to the hours between 7:00 a.m. and 6:00 p.m. during weekdays and 8:00 a.m. to 6:00 p.m. on Saturdays, it is very likely that the construction noise L_{dn} will remain below 65 dBA at the residences to the south.

Despite not exceeding the Municipal Code Maximum Noise level, the construction operations still have a high likelihood of producing annoyance for the nearby residences. In order to reduce the likelihood of nuisance noise during construction, mitigation measures are included in the Mitigation Section.

6.3 Construction Vibration Impact to Off-Site Residences

The heavier pieces of construction equipment used at this site would include dozers, graders, and pavers. Ground-borne vibration information related to construction activities has been collected by the California Department of Transportation (Caltrans) (Caltrans 2004). Based on published vibration data, the anticipated construction equipment would generate a peak particle velocity of approximately 0.09 inch/second or less at a distance of 25 feet (FTA 2006). Information from Caltrans indicates that continuous vibrations with a peak particle velocity of approximately 0.1 inch/second begin to annoy people. Ground-borne vibration is typically attenuated over short distances. The closest existing residences would be approximately 500 feet or more from the construction area. At these distances, the peak particle velocity from construction would be well below 0.1 inch/second and would also be below the threshold of perceptibility. Therefore, impacts related to vibration from construction activities would be less than significant.

7 MITIGATION MEASURES

Construction noise, roadway traffic noise, and aircraft noise pose potential impacts that may be significant. To reduce these impacts to less than significant the following mitigation measures are provided. Some mitigation measures are required, while others are recommended.

Construction Noise Mitigation

Construction noise impacts pose the potential for nuisance noise impacts on nearby noise sensitive receptors. The Carlsbad Municipal Code states that construction can occur Monday through Friday from 7:00 a.m. to 6:00 p.m. and Saturday from 8:00 a.m. to 6:00 p.m.. No explicit statement of exemption for construction activities is included in the Municipal Code for construction noise. The 65 dBA L_{dn} maximum allowable exterior limit is unlikely to be exceeded, but annoyance is still a concern.

MM-NOI-1 Limit Construction Work Hours (Required)

- Noise generating construction activities associated with the project shall not occur in the period before seven a.m. or after six p.m. on weekdays, or before eight a.m., after six p.m. on Saturday, or on Sunday.
- Construction hours, allowable workdays, and the phone number of the job superintendent shall be clearly posted at all construction entrances to allow surrounding property owners to contact the job superintendent if necessary. In the event the University receives a complaint, appropriate corrective actions shall be implemented and a report of the action provided to the reporting party.

MM-NOI-2 Measures to Reduce Construction Nuisance Noise (Recommended)

Compliance with the construction schedule restrictions from the Municipal Code is required, as indicated above. Even with the adherence to the construction schedule limitations, construction noise at the closest neighboring residences may be noticeable and result in annoyance (nuisance) for neighboring residents. The following are recommended measures to help reduce potential nuisance construction noise for the noise sensitive receptors located near the site:

- All construction equipment, fixed or mobile, should be equipped with properly operating and maintained mufflers.
- Construction noise reduction methods, such as shutting off idling equipment, installing temporary acoustic barriers around stationary construction noise sources, maximizing the distance between construction equipment staging areas

and occupied residential areas, and using electric air compressors and similar power tools rather than diesel equipment, should be employed where feasible.

- During construction, stationary construction equipment should be placed such that emitted noise is directed away from or shielded from sensitive noise receivers.
- During construction, stockpiling and vehicle staging areas should be located as far as practical from noise-sensitive receptors.
- Electrically powered equipment should be used instead of pneumatic or internal combustion powered equipment, where feasible.
- Construction site and access road speed limits should be established and enforced during the construction period.
- The use of noise-producing signals, including horns, whistles, alarms, and bells, should be for safety warning purposes only.
- The on-site construction supervisor and “disturbance coordinator” should have the responsibility and authority to receive and resolve noise complaints. A clear appeal process to the owner should be established prior to construction commencement that will allow for resolution of noise problems that cannot be immediately solved by the site supervisor.
- Equipment should not be left idling unless necessary.
- The project contractor should, to the extent feasible, schedule construction activities to avoid the simultaneous operation of construction equipment so as to minimize noise levels resulting from operating several pieces of high noise level emitting equipment.

Roadway Traffic and Aircraft Noise Mitigation

Both roadway traffic from Palomar Airport Road and Airport Operations would result in potentially significant noise exposure impacts. The following mitigation measures are required in order to reduce the potential for significant noise impact from these sources.

MM-NOI-3 Interior Noise Study

To comply with the City and State's 45 dB CNEL interior noise standard, the residential dwelling units would most likely require mechanical ventilation system or air conditioning system and possibly sound-rated windows. Thus, prior to the approval of building permits, the applicant shall submit an interior noise study for approval by the City of Carlsbad Planning Department. The interior noise study would ensure compliance with the City and State's 45 dB CNEL noise standard

MM-NOI-4 Exterior Noise Barriers at Balconies

Noise barriers must be placed on all balconies that are subject to noise levels greater than 65 dB in the Year 2035 + Project model scenario (refer to Table 7). The noise barriers may be constructed of a material such as tempered glass, acrylic glass, solid metal (minimum 6 gage thickness: steel, aluminum, etc.) or any masonry material with a surface density of at least three pounds per square foot. The barriers may also be constructed using a combination of materials, such as a stucco base component topped with glass or Plexiglas, or a solid metal base topped with glass or Plexiglass. The noise barriers should have no openings or cracks.

MM-NOI-5 Elevated Noise Environment Disclaimer

Some outdoor spaces that are not considered livable outdoor areas have elevated noise levels due to both the airport operations and the adjacent Palomar Airport Road. Prospective buyers and future occupants of dwellings shall be provided the following notice:

> This property is presently located in an urban area which periodically and regularly experiences elevated noise levels. Potential sources of this noise may be automobile traffic, flying aircraft, industrial/commercial uses and general human activity in an urban environment. You may wish to consider what noise level annoyances, if any, are associated with the property before you complete your purchase and/or rental agreement and determine whether they are acceptable to you.

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APPENDIX A

Definitions

APPENDIX A
Definitions

Term	Definition
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
A-Weighted Sound Level (dBA)	The sound pressure level in decibels as measured on a sound-level meter using the A-weighted filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Community Noise Equivalent Level (CNEL)	CNEL is the A-weighted equivalent continuous sound exposure level for a 24-hour period with a 10 dB adjustment added to sound levels occurring during nighttime hours (10 p.m. to 7 a.m.) and a 5 dB adjustment added to the sound levels occurring during the evening hours (7 p.m. to 10 p.m.).
Decibel (dB)	A unit for measuring sound pressure level, equal to 10 times the logarithm to the base 10 of the ratio of the measured sound pressure squared to a reference pressure, which is 20 micropascals.
Equivalent Sound Level (L_{eq})	The sound level corresponding to a steady-state sound level and containing the same total energy as a time varying signal over a given sample period. L_{eq} is designed to average all of the loud and quiet sound levels occurring over a specific time period.

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APPENDIX B

Noise Modeling Input/Output

Report date:	3/17/2017	**Case Description:**	Site Preparation	*Calculated Lmax is the Loudest value.				
	Land Use: Residential		Daytime Baseline (dBA): 60	Evening Baseline (dBA): 60	Night Baseline (dBA): 60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Dozer	3	No	40	0	81.7	550	60.8	56.9
Tractor	4	No	40	84	0	550	63.2	59.2
						Total	**63.2**	**66.8**

Report date:	3/17/2017	**Case Description:**	Grading	*Calculated Lmax is the Loudest value.				
	Land Use: Residential		Daytime Baseline (dBA): 60	Evening Baseline (dBA): 60	Night Baseline (dBA): 60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Excavator	2	No	40	0	80.7	550	59.9	55.9
Grader	1	No	40	85	0	550	64.2	60.2
Dozer	1	No	40	0	81.7	550	60.8	56.9
Scraper	2	No	40	0	83.6	550	62.8	58.8
Tractor	2	No	40	84	0	550	63.2	59.2
						Total	**64.2**	**67.4**

Report date:	3/17/2017	**Case Description:**	Trenching	*Calculated Lmax is the Loudest value.				
	Land Use: Residential		Daytime Baseline (dBA): 60	Evening Baseline (dBA): 60	Night Baseline (dBA): 60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Excavator	1	No	40	0	80.7	550	59.9	55.9
Tractor	1	No	40	84	0	550	63.2	59.2
All Other Equipment > 5 HP	1	No	50	85	0	550	64.2	61.2
						Total	**64.2**	**64**

Report date:	3/17/2017	**Case Description:**	Building Construction	*Calculated Lmax is the Loudest value.				
	Land Use: Residential		Daytime Baseline (dBA): 60	Evening Baseline (dBA): 60	Night Baseline (dBA): 60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Man Lift	6	No	20	0	74.7	550	53.9	46.9
Tractor	3	No	40	84	0	550	63.2	59.2
						Total	**63.2**	**64.4**

Report date:	3/17/2017	**Case Description:**	Paving	*Calculated Lmax is the Loudest value.				
Description:	Land Use: Residential		Daytime Baseline (dBA): 60	Evening Baseline (dBA): 60	Night Baseline (dBA): 60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Paver	2	No	50	0	77.2	550	56.4	53.4
All Other Equipment > 5 HP	2	No	50	85	0	550	64.2	61.2
Roller	2	No	20	0	80	550	59.2	52.2
						Total	**64.2**	**65.3**

Report date:	3/16/2017	**Case Description:**	Architectural Coating	*Calculated Lmax is the Loudest value.				
	Land Use: Residential		Daytime Baseline (dBA): 60	Evening Baseline (dBA): 60	Night Baseline (dBA): 60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Compressor (air)	1	No	40		77.7	550	56.8	52.9
						Total	**56.8**	**52.9**

Report date:	3/17/2017	**Case Description:**	Site Preparation	*Calculated Lmax is the Loudest value.				
	Land Use:		Daytime Baseline (dBA):	Evening Baseline (dBA):	Night Baseline (dBA):			
	Residential		60	60	60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Dozer	3	No	40	0	81.7	500	61.7	57.7
Tractor	4	No	40	84	0	500	64	60
						Total	**64**	**67.6**

Report date:	3/17/2017	**Case Description:**	Grading	*Calculated Lmax is the Loudest value.				
	Land Use:		Daytime Baseline (dBA):	Evening Baseline (dBA):	Night Baseline (dBA):			
	Residential		60	60	60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Excavator	2	No	40	0	80.7	500	60.7	56.7
Grader	1	No	40	85	0	500	65	61
Dozer	1	No	40	0	81.7	500	61.7	57.7
Scraper	2	No	40	0	83.6	500	63.6	59.6
Tractor	2	No	40	84	0	500	64	60
						Total	**65**	**68.2**

Report date:	3/17/2017	**Case Description:**	Trenching	*Calculated Lmax is the Loudest value.				
	Land Use:		Daytime Baseline (dBA):	Evening Baseline (dBA):	Night Baseline (dBA):			
	Residential		60	60	60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Excavator	1	No	40	0	80.7	500	60.7	56.7
Tractor	1	No	40	84	0	500	64	60
All Other Equipment > 5 HP	1	No	50	85	0	500	65	62
						Total	**65**	**64.9**

Report date:	3/17/2017	**Case Description:**	Building Construction	*Calculated Lmax is the Loudest value.				
	Land Use:		Daytime Baseline (dBA):	Evening Baseline (dBA):	Night Baseline (dBA):			
	Residential		60	60	60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Man Lift	6	No	20	0	74.7	500	54.7	47.7
Tractor	3	No	40	84	0	500	64	60
						Total	**64**	**65.3**

Report date:	3/17/2017	**Case Description:**	Paving	*Calculated Lmax is the Loudest value.				
Description:	Land Use:		Daytime Baseline (dBA):	Evening Baseline (dBA):	Night Baseline (dBA):			
	Residential		60	60	60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Paver	2	No	50	0	77.2	500	57.2	54.2
All Other Equipment > 5 HP	2	No	50	85	0	500	65	62
Roller	2	No	20	0	80	500	60	53
						Total	**65**	**66.1**

Report date:	3/16/2017	**Case Description:**	Architectural Coating	*Calculated Lmax is the Loudest value.				
	Land Use:		Daytime Baseline (dBA):	Evening Baseline (dBA):	Night Baseline (dBA):			
	Residential		60	60	60			
Equipment Name	# of Devices	Impact Device	Usage(%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Calculated Lmax* (dBA)	Calculated Leq (dBA)
Compressor (air)	1	No	40		77.7	500	57.7	53.7
						Total	**57.7**	**53.7**

APPENDIX C

Supplemental LOS Analysis

LINSCOTT
LAW &
GREENSPAN
engineers

SUPPLEMENTAL LEVEL OF SERVICE ANALYSIS

WEST OAKS

Carlsbad, California
October 28, 2020

LLG Ref. 3-16-2672

Prepared by:
Roman Lopez
Transportation Planner II

Under the Supervision of:
Chris Mendiara
Associate Principal

Linscott, Law &
Greenspan, Engineers
4542 Ruffner Street
Suite 100
San Diego, CA 92111
858.300.8800 T
858.300.8810 F
www.llgengineers.com

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SUPPLEMENTAL LEVEL OF SERVICE ANALYSIS

WEST OAKS

Carlsbad, California
October 28, 2020

1.0 INTRODUCTION

1.1 Project Description

The Project site is west of Palomar Oaks Way, south of Palomar Airport Road, and proposes to develop 192 multi-family residential units both north and south of West Oaks Way. West Oaks Way is a local road terminating in a cul-de-sac west of Palomar Oaks Way that is constructed but not open to traffic, with a gate and temporary barrier erected at its intersection with Palomar Oaks Way.

Project access is proposed via West Oaks Way from Palomar Oaks Way. A roundabout control is proposed for the project access intersection at West Oaks Way/ Palomar Oaks Way. Onsite pedestrian and bicycle circulation is proposed to connect with the existing pedestrian sidewalk on the south side of Palomar Airport Road at both the east and west ends of West Oaks Way. At the west end of West Oaks Way, a new emergency vehicular access bridge to Palomar Airport Road is proposed which will provide bicycle and pedestrian connectivity at the west end of the site. Bicycle racks and lockers are also proposed.

Figure 1–1 shows the vicinity map. ***Figure 1–2*** shows a more detailed Project area map. ***Figure 1–3*** shows the Project site plan.

1.2 Project Analysis

The auto LOS analysis is provided here for informational purposes only relative to transportation, though in support of other technical analyses required by CEQA (e.g., air quality). For roadway segment analysis, capacity is evaluated using the City of Carlsbad Roadway Capacity Tables. Intersection and roadway segment LOS are evaluated based on the most recent version of the *Highway Capacity Manual* (HCM) methodology.

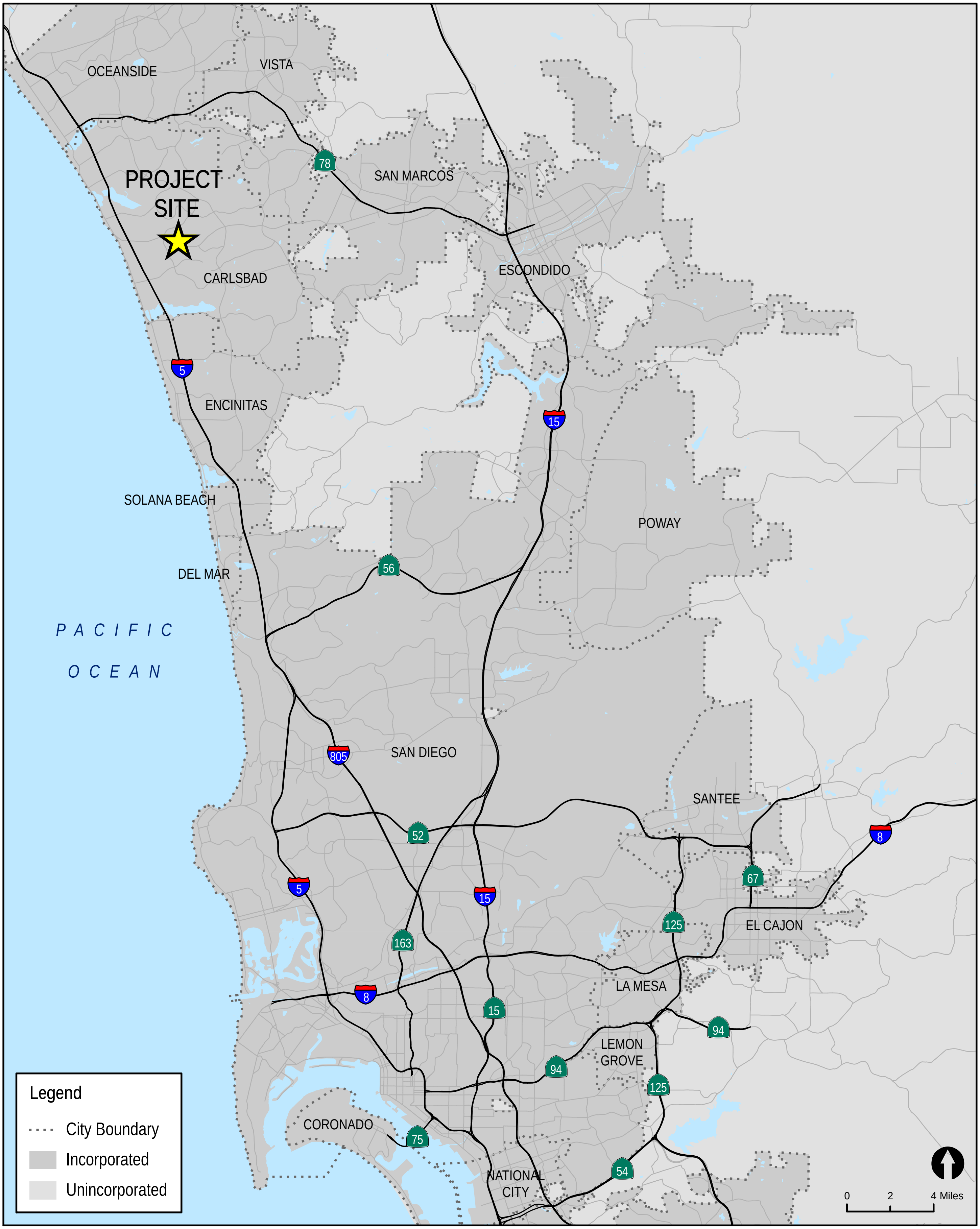

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Figure 1-1

Vicinity Map

WEST OAKS PROPERTY

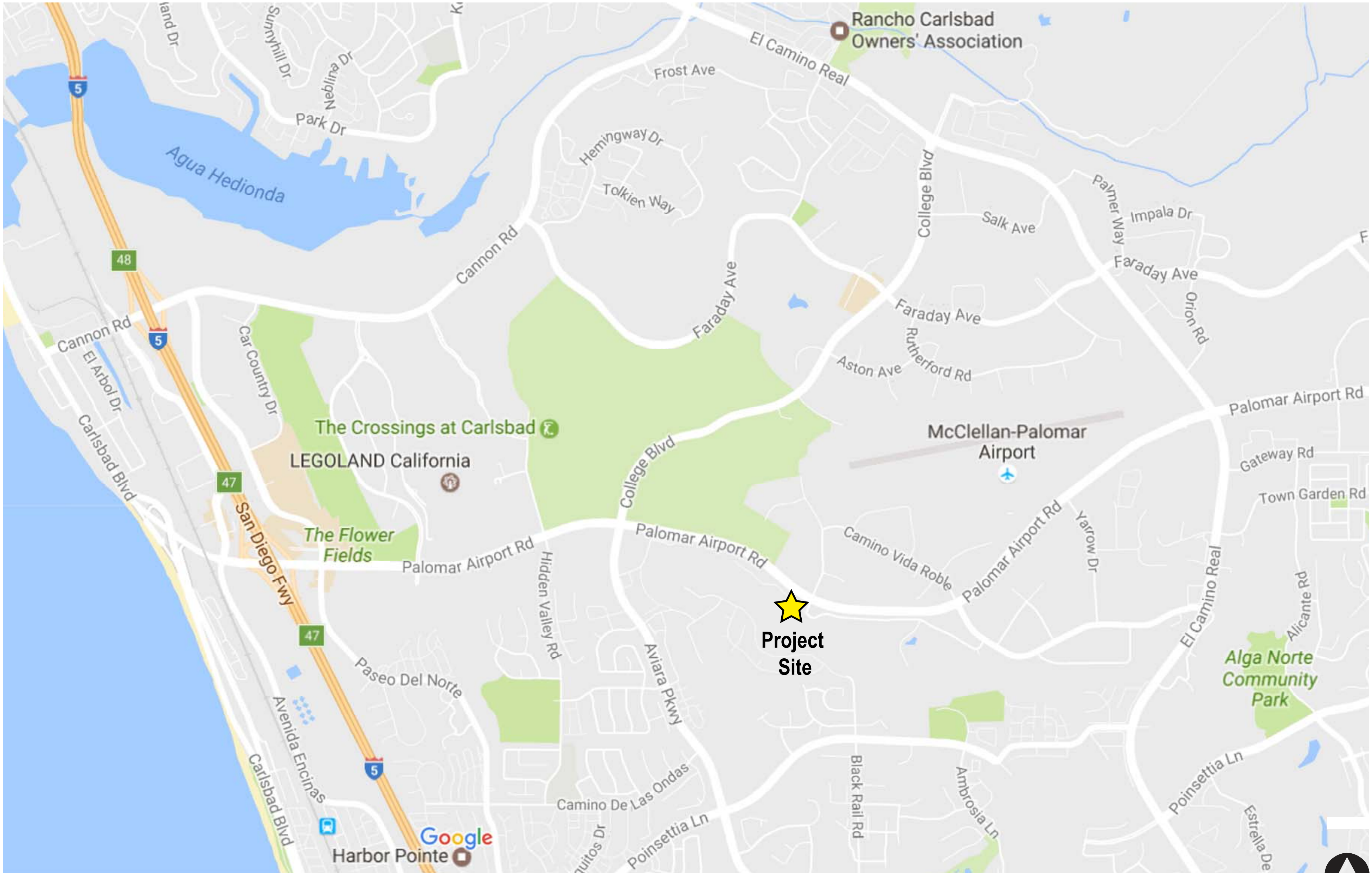

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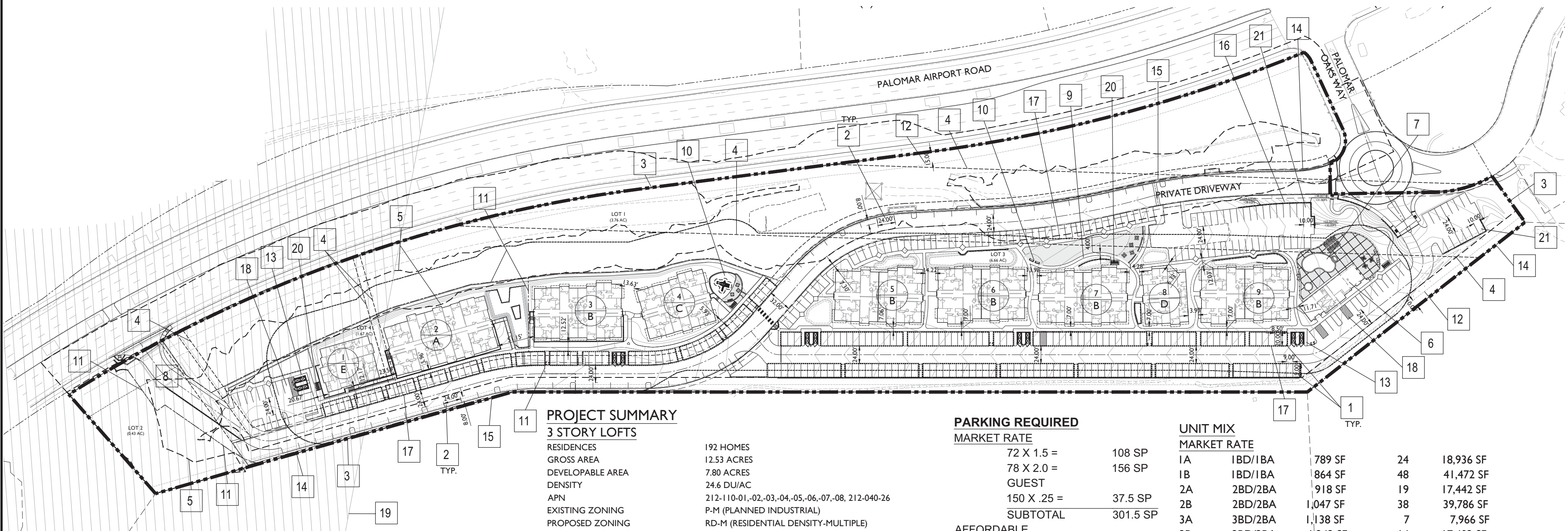
Figure 1-2

Project Area Map

WEST OAKS PROPERTY



PROJECT SUMMARY

3 STORY LOFTS

RESIDENCES	192 HOMES
GROSS AREA	12.53 ACRES
DEVELOPABLE AREA	7.80 ACRES
DENSITY	24.6 DU/AC
APN	212-110-01,-02,-03,-04,-05,-06,-07,-08, 212-040-26
EXISTING ZONING	P-M (PLANNED INDUSTRIAL)
PROPOSED ZONING	RD-M (RESIDENTIAL DENSITY-MULTIPLE)
EXISTING LAND USE	PI (PLANNED INDUSTRIAL)
PROPOSED LAND USE	R-30 (RESIDENTIAL)
LOCAL COASTAL PROGRAM	MELLO II SEGMENT
LOTS PROPOSED	4 LOTS
UNDEVELOPABLE AREA	4.73 AC
PARKING	384 SPACES
BLDG COVERAGE	12.8%
LANSCAPE AREA	23%
STORAGE	18,000 CUBIC FEET
WATER & SEWER DISTRICT	CARLSBAD MUNICIPAL WATER DISTRICT
SCHOOL DISTRICT	CARLSBAD UNIFIED SCHOOL DISTRICT
DRAINAGE DISCHARGE	73 CFS
MASTER DRAINAGE BASIN	ENCINAS

LEGAL DESCRIPTION:

LOTS 1 THROUGH 7 OF CARLSBAD TRACT NO. 82-04 PALOMAR OAKS. IN THE CITY OF CARLSBAD, COUNTY OF SAN DIEGO, STATE OF CALIFORNIA, ACCORDING TO MAP THEREOF NO. 11358, FILED IN THE OFFICE OF THE COUNTY RECORDER OF SAN DIEGO COUNTY, OCTOBER 23, 1985.

IN ADDITION, THAT PORTION OF THAT CERTAIN PARCEL OF LAND SHOWN AND DESIGNATED AS "DESCRIPTION NO. 3, 78.07 ACRES" ON RECORD OF SURVEY MAP NO. 5715, FILED IN THE OFFICE OF THE COUNTY RECORDER OF SAN DIEGO COUNTY, DECEMBER 19, 1960, BEING A PORTION OF LOT "G" OF THE RANCHO AGUA HEDIONDA, IN THE CITY OF CARLSBAD, COUNTY OF SAN DIEGO, STATE OF CALIFORNIA, ACCORDING TO MAP NO. 823, FILED IN THE OFFICE OF THE COUNTY RECORDER OF SAN DIEGO COUNTY, NOVEMBER 16 1896.

PARKING REQUIRED

MARKET RATE		
	72 X 1.5 =	108 SP
	78 X 2.0 =	156 SP
	GUEST	
	150 X .25 =	37.5 SP
	SUBTOTAL	301.5 SP
AFFORDABLE		
	24 X 1.5 =	36 SP
	18 X 2.0 =	36 SP
	GUEST	
	42 X .25 =	10.5 SP
	SUBTOTAL	82.5 SP
TOTAL REQUIRED		384 SP
		(192 COVERED)

PARKING PROVIDED

MARKET RATE		
	PERPENDICULAR	285 SP
	PARALLEL	16 SP
	SUBTOTAL	301 SP
AFFORDABLE		
	PERPENDICULAR	54 SP
	PARALLEL	29 SP
	SUBTOTAL	83 SP*
TOTAL		384 SP
		(203 COVERED)

*AFFORDABLE CONCESSION:
42 SP < 150' WALKING DISTANCE
41 SP > 300' WALKING DISTANCE

UNIT MIX

MARKET RATE				
1A	1BD/1BA	789 SF	24	18,936 SF
1B	1BD/1BA	864 SF	48	41,472 SF
2A	2BD/2BA	918 SF	19	17,442 SF
2B	2BD/2BA	1,047 SF	38	39,786 SF
3A	3BD/2BA	1,138 SF	7	7,966 SF
3B	3BD/2BA	1,243 SF	14	17,402 SF
	SUBTOTAL		150	143,004 SF
AFFORDABLE				
	1BD/1BA	550 SF	24	13,200 SF
	2BD/2BA	750 SF	12	9,000 SF
	3BD/2BA	1,020 SF	6	6,120 SF
	SUBTOTAL		42	28,320 SF
TOTAL			192	171,324 SF

BUILDING MIX / COVERAGE AREA

			GROSS SF	OCC. / CONST.
BLDG A	10,235 GSF	1	10,235 GSF	R-2/ VA
BLDG B	8,652 GSF	5	43,260 GSF	R-2 / VA
BLDG C	6,564 GSF	1	6,564 GSF	R-2 / VA
BLDG D	4,291 GSF	1	8,582 GSF	R-2 / VA
BLDG E	4,291 GSF	1	8,582 GSF	R-2 / VA
LEASING	2,705 GSF	1	2,705 GSF	B / VB
TOTAL		11	71,346 GSF	

TRASH ENCLOSURES

1 BIN/10 DU = 20 BINS FOR 200 DU
4 BINS PER ENCLOSURE = 5 TOTAL TRASH ENCLOSURES

LEGEND

BUILDING NUMBER — 7
BUILDING TYPE — B

SITE PLAN KEYNOTES

1	TYP. PARKING STALL(9' X 19' or 8.5' X 20')	11	LOT LINE
2	PARALLEL PARKING STALL(8' X 24')	12	SETBACK LINE
3	PROPERTY LINE	13	TRASH ENCLOSURE
4	SDG&E EASEMENT	14	SITE FENCE
5	RIPARIAN BUFFER	15	EXISTING RETAINING WALL
6	REC / LEASING BUILDING	16	PROPOSED RETAINING WALL
7	POOL	17	CARPORTS
8	EMERGENCY ACCESS	18	ACCESSIBLE PARKING STALL
9	HARDSCAPE PATHWAYS	19	AIRPORT SAFETY ZONE
10	REC AREA	20	BIKE RACK
		21	10' WIDE STALL NEXT TO WALLS

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Figure 1-3

Site Plan

WEST OAKS PROPERTY

2.0 ANALYSIS APPROACH & METHODOLOGY

This analysis based on auto delay and capacity is provided for informational purposes relative to transportation though to support other technical analyses required by CEQA (e.g., air quality). No determinations of significance relative to transportation are made based on this analysis. Traffic analysis for CEQA purposes using vehicle miles traveled (VMT) was conducted by Fehr & Peers and is provided under separate cover.

2.1 Study Area

The study area for Auto LOS analysis was determined per the SANTEC/ITE Guidelines for Traffic Impact Studies in the San Diego Region. Per SANTEC/ITE Guidelines, the study area must include:

- All local roadway segments (including all State surface routes), intersections, and mainline freeway locations where the proposed project will add 50 or more peak hour trips in either direction to the existing roadway traffic.
- All freeway entrance and exit ramps where the proposed project will add 20 or more peak hour trips.

Based on the Project's trip generation and distribution (*Section 4.0*), the following locations are included in the Project study area for Auto LOS Analysis:

<u>*Intersections*</u>

- Palomar Airport Road / Palomar Oaks Way
- Palomar Oaks Way / West Oaks Way

<u>*Street Segments*</u>

Palomar Oaks Way

- Palomar Airport Road to West Oaks Way

2.2 Signalized Intersection Methodology

Signalized intersections were analyzed under AM and PM peak hour conditions. Average vehicle delay was determined utilizing the methodology found in Chapter 19 of the *Highway Capacity Manual 6th Edition (HCM 6),* with the assistance of the *Synchro 10* computer software. The delay values (represented in seconds) are presented for the pre-and-post Project conditions. A more detailed explanation of the methodology is attached in ***Appendix B***.

2.3 Unsignalized Intersection Methodology

Unsignalized intersections were analyzed under AM and PM peak hour conditions. Average vehicle delay was determined based upon the procedures found in Chapter 20 and Chapter 21 of the *HCM 6* with the assistance of the *Synchro 10* computer software. A more detailed explanation of the methodology is also attached in *Appendix B.*

2.4 Roadway Segment Methodology

The City of Carlsbad has historically evaluated street segment LOS by evaluating the volume-to-capacity ratio for peak hour traffic for each direction of travel.

The City has updated the capacity table utilized for the "Volume/Capacity", or "V/C" method with development of the recent *City of Carlsbad Segment LOS Capacity Threshold* table. ***Appendix A*** contains the City of Carlsbad Segment LOS Capacity Threshold table.

3.0 EXISTING CONDITIONS

This section presents existing transportation conditions for street system components identified for analysis.

3.1 Existing Street Network

The following is a description of the major roadways within the study area. ***Figure 3–1*** illustrates existing conditions in the study area in terms of traffic lanes and intersection controls.

Palomar Airport Road is classified as an Arterial Street on the *City of Carlsbad Mobility Element*. Within the study area, Palomar Airport Road is a six-lane divided roadway with Class II bicycle lanes in both directions of travel. The posted speed limit is 35 to 55 mph. On-street parking is not allowed.

Palomar Oaks Way is classified as a Local/Neighborhood Street on the *City of Carlsbad Mobility Element*. Palomar Oaks Way is a private street open to public circulation, and currently constructed as a two-lane undivided roadway. On-street parking is prohibited and there are no bicycle lanes or bus stops.

West Oaks Way is classified as a Local/Neighborhood Street the *City of Carlsbad Mobility Element*. West Oaks Way is constructed as a two-lane undivided roadway but is currently gated and not open to general traffic.

3.2 Existing Traffic Volumes

AM/PM peak hour intersection counts at all study area intersections were commissioned on Wednesday, November 30, 2016 while schools in the area were in session. Peak hour roadway segments volumes were derived from these counts as needed. As noted above, West Oaks Way is constructed but not open to traffic and Palomar Oaks Way / West Oaks Way is not an existing operational intersection. Existing trips on Palomar Oaks Way for analysis of "with Project" scenarios were taken from the count conducted at the adjacent intersection.

Figure 3–2 shows the Existing Traffic Volumes. ***Appendix C*** contains the unadjusted count sheets.

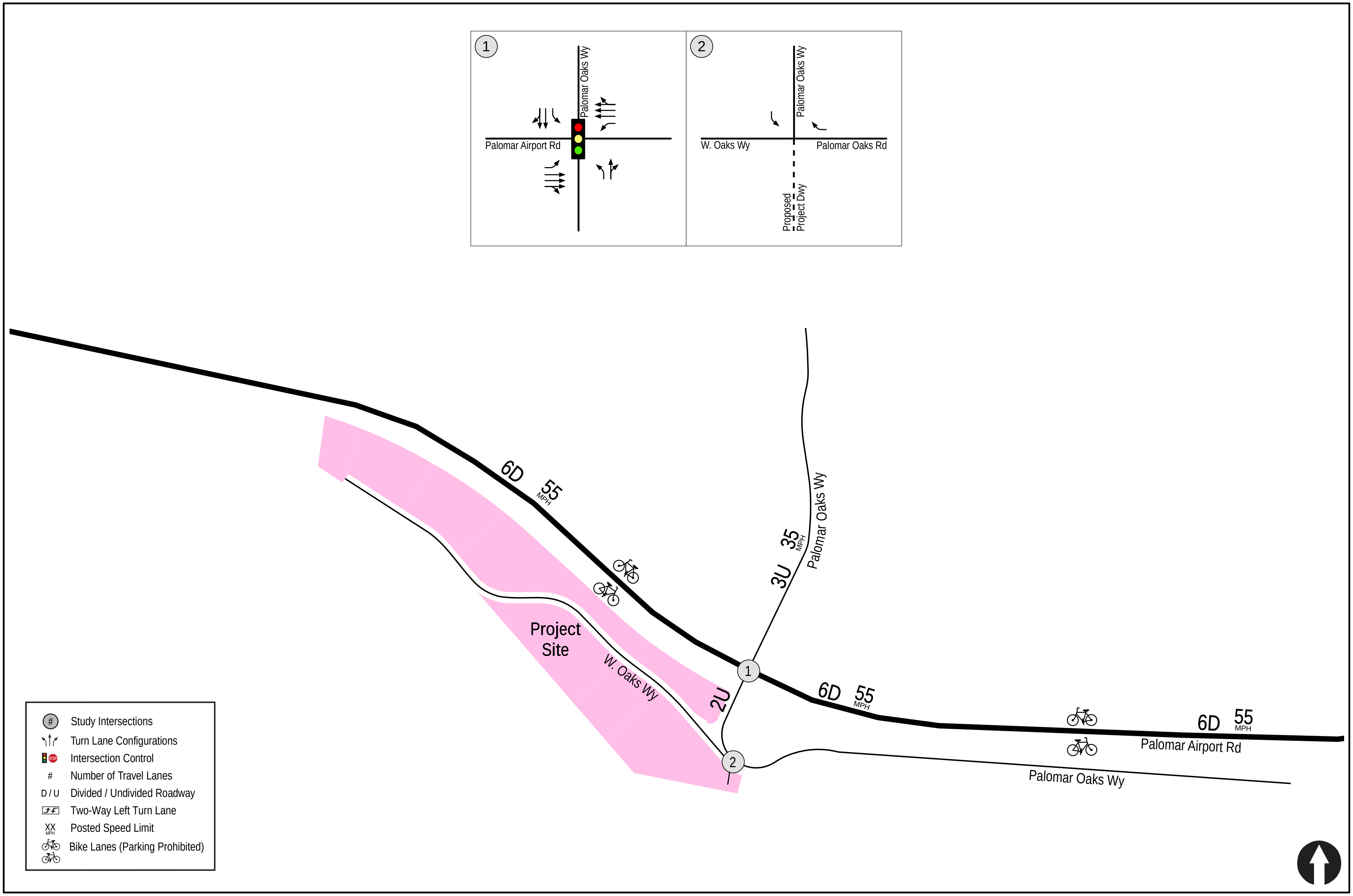

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Figure 3-1

Existing Conditions Diagram

WEST OAKS PROPERTY

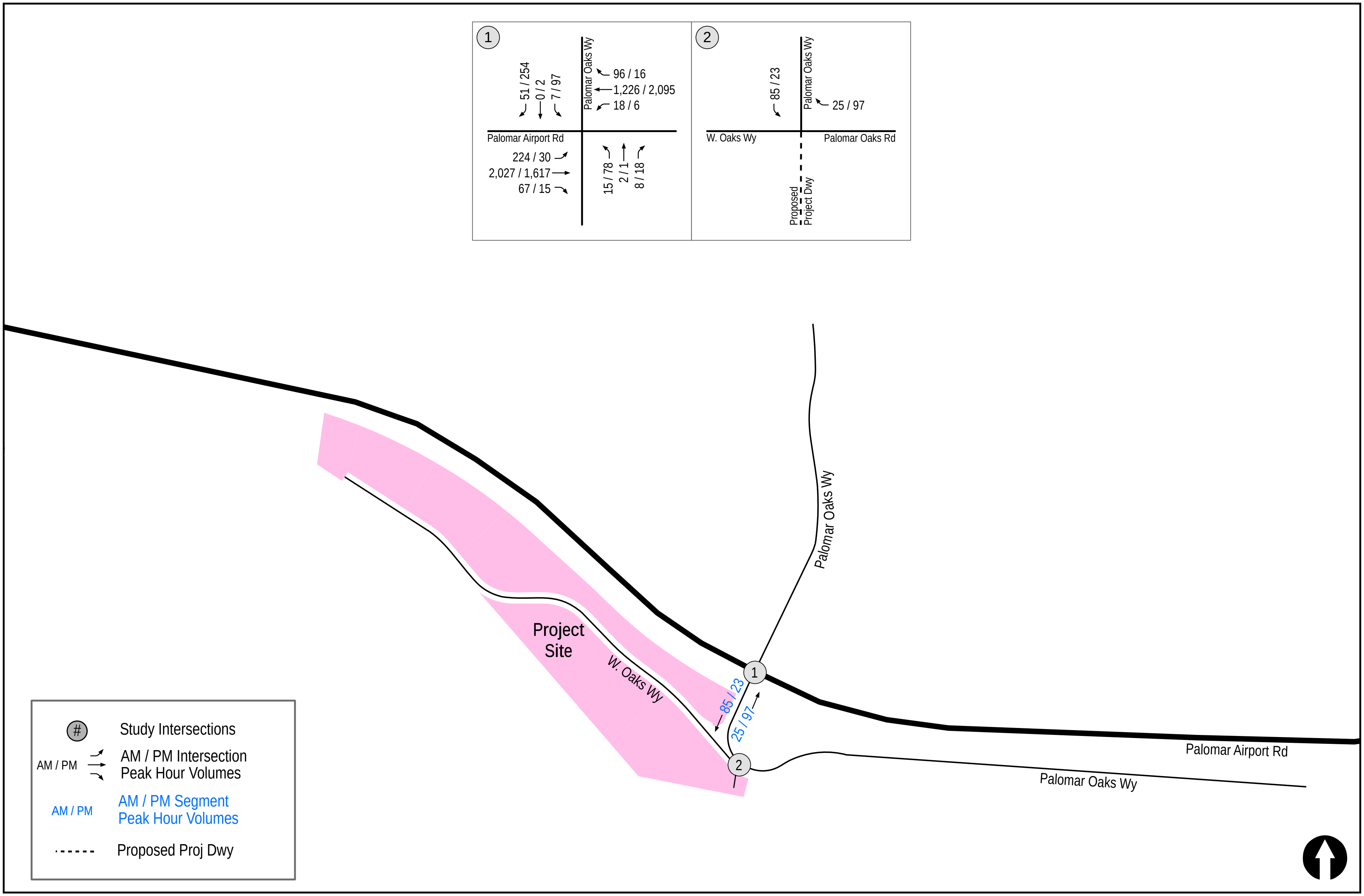

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Figure 3-2

Existing Traffic Volumes

WEST OAKS PROPERTY

4.0 PROPOSED PROJECT

4.1 Trip Generation

The Project proposes the construction of 192 multi-family residential dwelling units. Trip generation estimates for the proposed project were based on the SANDAG's *Brief Guide of Vehicular Traffic Generation Rates for the San Diego Region* (April 2002). Based on the Project's density, the SANDAG "Apartment" rate for multi-family units more than 20 DU/ acre was used.

Table 4–1 tabulates the Project traffic generation. The Project is calculated to generate 1,152 ADT with 18 inbound / 74 outbound trips during the AM peak hour and 73 inbound / 31 outbound trips during the PM peak hour.

TABLE 4–1
PROJECT TRIP GENERATION SUMMARY

Land Use	Quantity	Daily Driveway Trips (ADT)		AM Peak Hour					PM Peak Hour				
		Rate	Volume	Rate	In:Out Split	Volume In	Volume Out	Volume Total	Rate	In:Out Split	Volume In	Volume Out	Volume Total
Apartment [a]	192 DU	6/DU	1,152	8%	20:80	18	74	92	9%	70:30	73	31	104

Source: *SANDAG (Not So) Brief Guide of Vehicular Traffic Generation Rates for the San Diego Region (April 2002).*

Footnotes:

a. Apartment rate applied to "any multi-family units more than 20 units/acre".

General Notes:

1. ADT = Average Daily Trips

4.2 Trip Distribution

Project traffic was distributed to the street system based on discussions with City staff, using existing traffic counts and other factors such as project access, the proximity of the project to Interstate 5, and potential recreation and retail opportunities.

4.3 Trip Assignment

The Project traffic generation in *Table 4–1* was assigned to the street system based on the trip distribution presented in ***Figure 4–1.*** The resulting assignment of AM/PM peak hour Project volumes is shown on ***Figure 4–2***. Existing + Project traffic volumes are presented on ***Figure 4–3***.

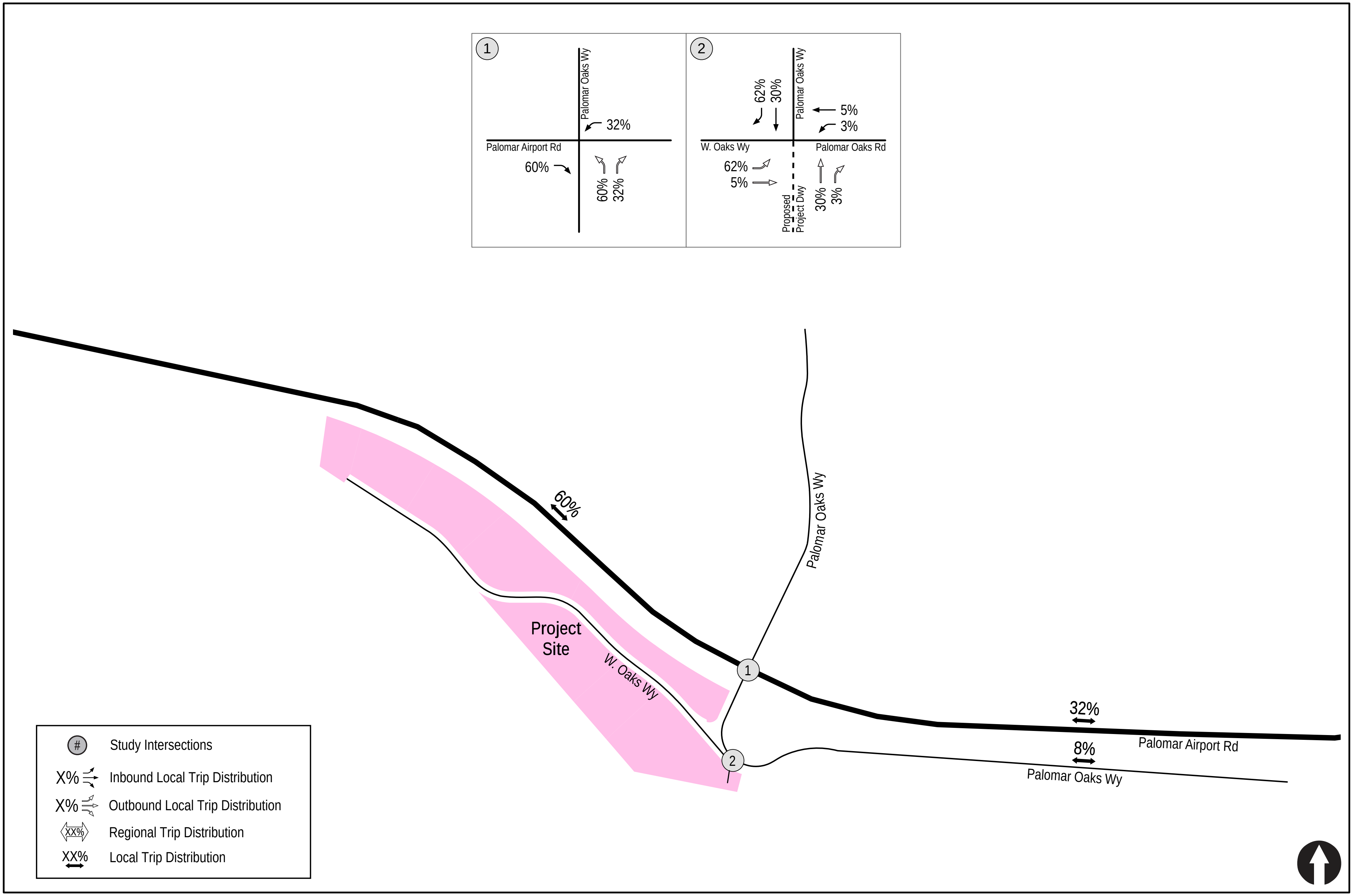

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Figure 4-1

Project Traffic Distribution

WEST OAKS PROPERTY

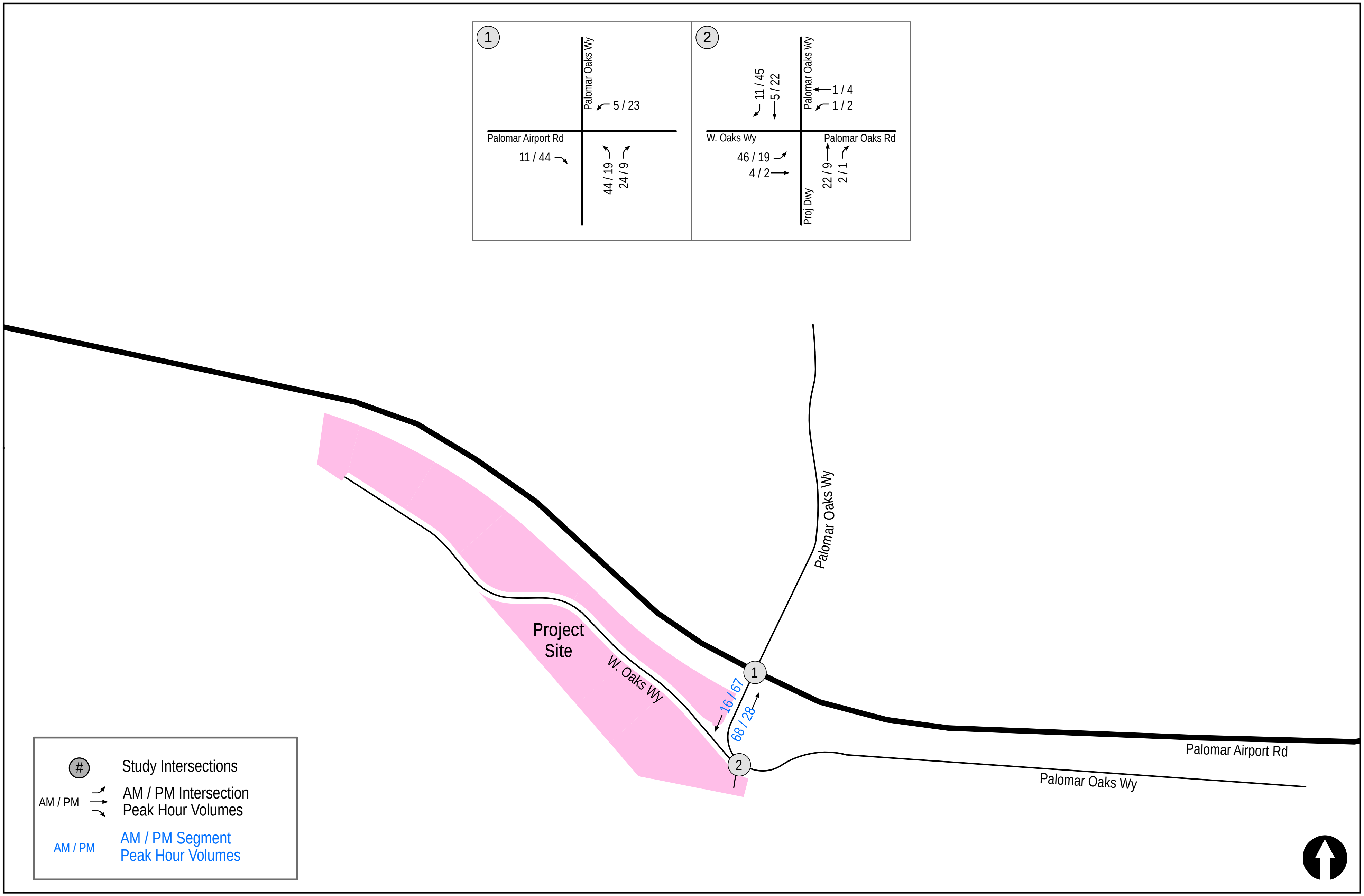

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Figure 4-2

Project Traffic Volumes

WEST OAKS PROPERTY

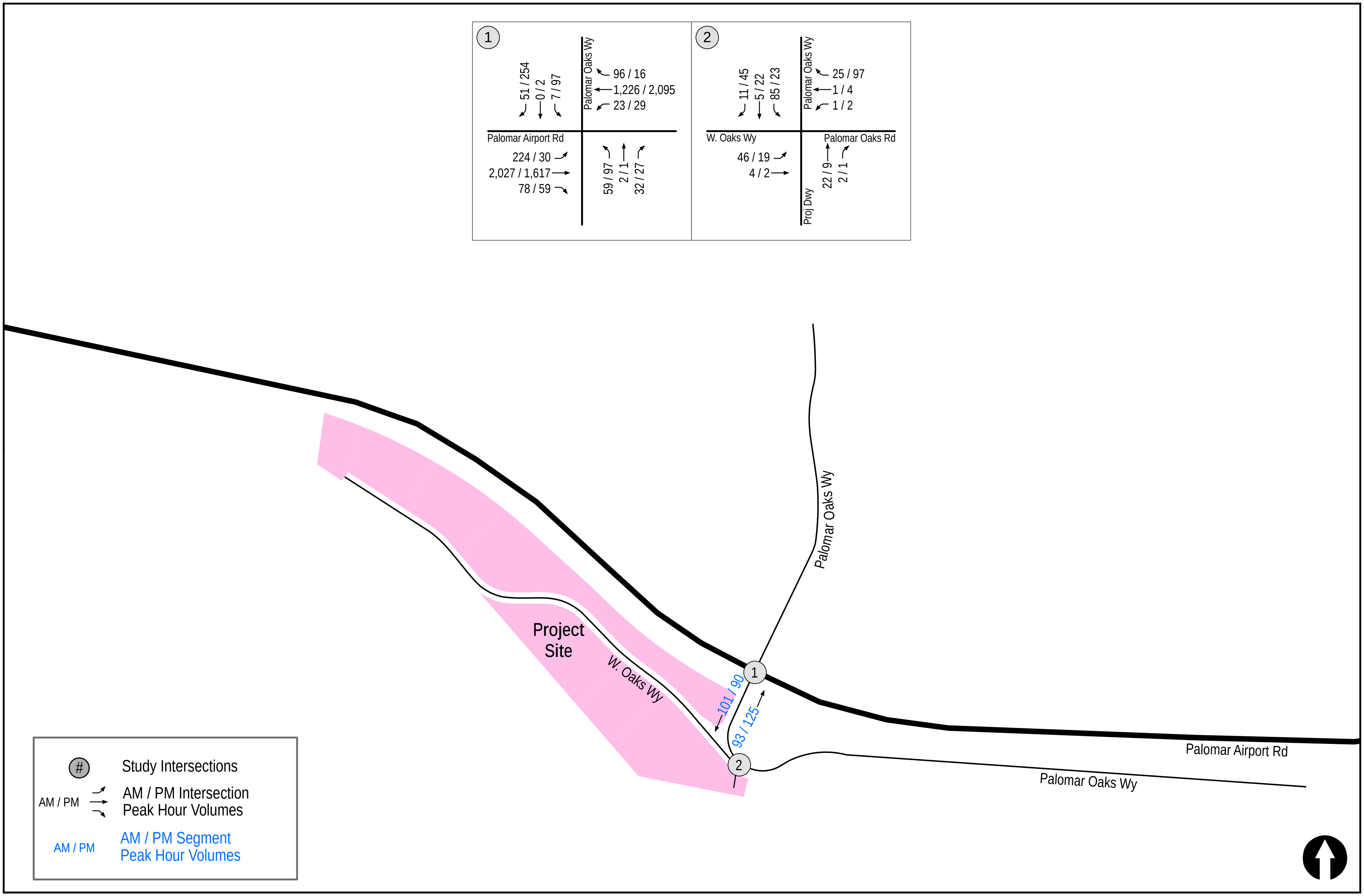

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Figure 4-3

Existing + Project Traffic Volumes

WEST OAKS PROPERTY

5.0 CUMULATIVE CONDITIONS

5.1 Cumulative Projects

To determine Near-Term (Existing + Cumulative) conditions, LLG coordinated with the City of Carlsbad to identify approved or pending projects that will add traffic to the Project study area in the near-term (Project opening day) condition. The following thirteen (13) cumulative projects were identified for inclusion in Near-Term conditions. ***Table 5–1*** lists and describes each cumulative project.

Figure 5–1 shows the total cumulative projects peak hour traffic volumes. ***Figure 5–2*** shows the peak hour traffic volumes for the "Existing + Cumulative Projects" scenario. ***Figure 5–3*** shows the peak hour traffic volumes for the "Existing + Cumulative Projects + Project" scenario.

Individual cumulative project assignments completed by LLG based on available information, as well as supporting information, including cumulative project trip generation and distribution, where available, is included in ***Appendix D***.

TABLE 5–1
CUMULATIVE PROJECTS LIST

Project Name	Description
Robertson Ranch West Village	308 single-family and 322 multi-family dwelling units, 9 acres commercial, 5 acres community facilities
Cantarini Ranch [a, b]	105 single-family and 81 multi-family dwelling units
Holly Springs [a, b]	43 single family dwelling units
Encinas Creek Apartments [a, b]	127 apartments
Quarry Creek	119 single family, 537 multi-family dwelling units
Dos Colinas [a, b]	228 retirement community units, 8 congregate care units, 29 multi-family dwelling units
Bressi Ranch Hotels	239 business hotel rooms
La Costa Town Square	284,400 sf of community shopping center, 129 condo dwelling units, 64 single family dwelling units, 55,000 sf office
Westin Hotel & Timeshare	71 hotel units and 36 timeshare units
Uptown Bressi	90,267 sf commercial buildings and 125 residential units
Aviara Apartments	329-unit apartment complex
Legoland Hotel Phase 2	250-room resort hotel
Marja Acres [a]	252 condos, 46 senior units, 6,000 sf retail, 4,000 sf restaurant

Footnotes:

a. Cumulative project was evaluated and is not expected to contribute a measurable number of trips to the Project study area.

b. Cumulative project requires construction of College Boulevard extension between Cannon Road and El Camino Real.

5.2 Network Conditions

No improvements or changes to study area street facilities are assumed for Near-Term (Existing + Cumulative) conditions. Some of the cumulative projects listed above will require the construction of the planned College Boulevard extension between Cannon Road and El Camino Real. This planned network improvement is located approximately three miles from the Project study area and is anticipated to primarily affect local traffic patterns in the vicinity of College Boulevard, El Camino Real, and Cannon Road. The College Boulevard extension is not expected to have a notable effect on traffic patterns within the study area.

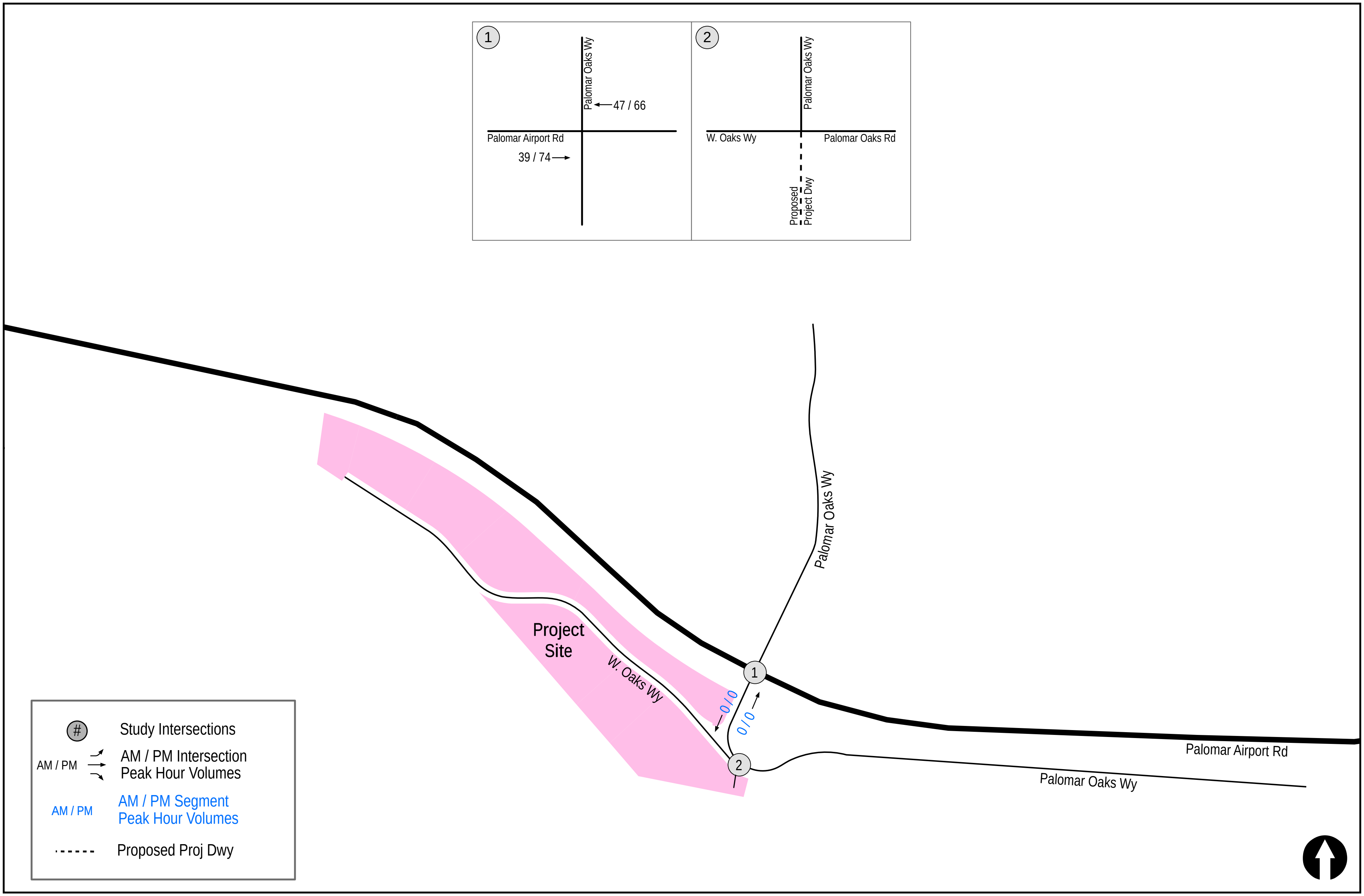

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Figure 5-1

Cumulative Projects Traffic Volumes

WEST OAKS PROPERTY

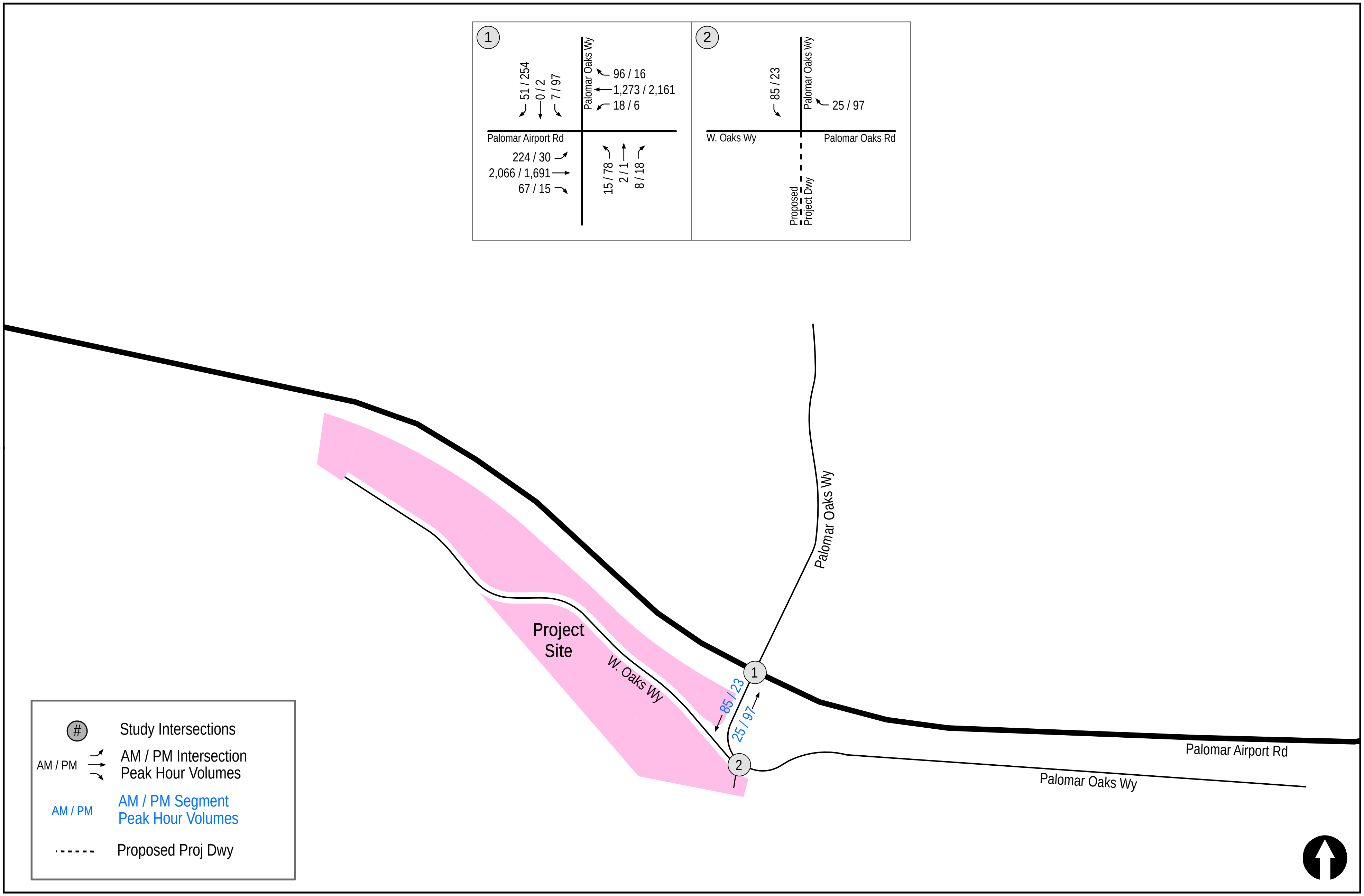

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Figure 5-2

Existing + Cumulative Projects Traffic Volumes

WEST OAKS PROPERTY

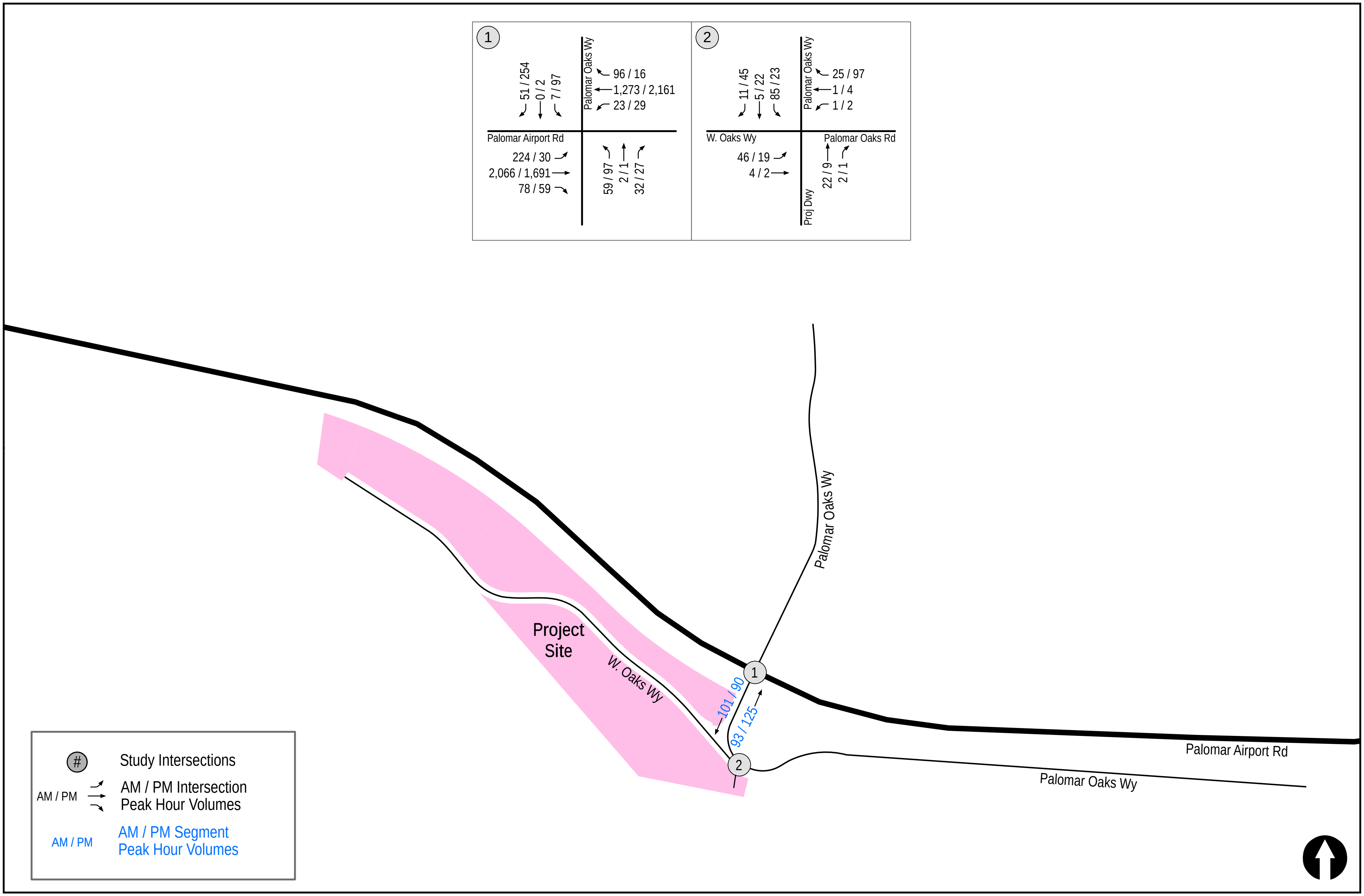

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Figure 5-3

Existing + Cumulative Projects + Project Traffic Volumes

WEST OAKS PROPERTY

6.0 YEAR 2035 CONDITIONS

6.1 Year 2035 Traffic Volumes

Year 2035 traffic volumes along the Palomar Airport Road corridor were forecasted based on the SANDAG Series 12 Traffic Forecast Model developed by Fehr & Peers for use in the Agua Hedionda South Shore Specific Plan traffic study. LLG confirmed with City staff that this model generally contains the most up to date land use forecast within the City of Carlsbad. As the study area for the Agua Hedionda South Shore Specific Plan overlaps with the Project, Year 2035 peak hour volumes were taken directly from the Transportation Impact Analysis, also prepared by Fehr & Peers. These volumes exclude the proposed Agua Hedionda plan itself, which was rejected by ballot measure within the City of Carlsbad. Year 2035 volumes on West Oaks Way and Palomar Oaks Way, south of Palomar Airport Road, were not included in the Agua Hedionda South Shore Specific Plan. These were estimated based on regional growth along Palomar Airport, applied to existing volumes on West Oaks Way.

Figure 6–1 shows the Year 2035 traffic volumes and ***Figure 6–2*** shows the Year 2035 + Project traffic volumes.

Appendix E contains the excerpts from the Fehr & Peers study depicting Year 2035 traffic volumes.

6.2 Year 2035 Roadway Network

The City's planned circulation system includes the following roadway improvements that are expected to be completed by the Year 2035. Although they are not within the Project study area and do not affect the intersection or roadway geometry of study area facilities, they are noted for the broader effect on forecasted traffic volumes for Year 2035.

- College Boulevard Extension – connect roadway from El Camino Real to Cannon Road
- Poinsettia Lane Extension – connect roadway between Cassia Road and El Camino Real
- El Camino Real Widening at Cannon Road – widen intersection to include three northbound through lanes and a separate northbound right-turn lane

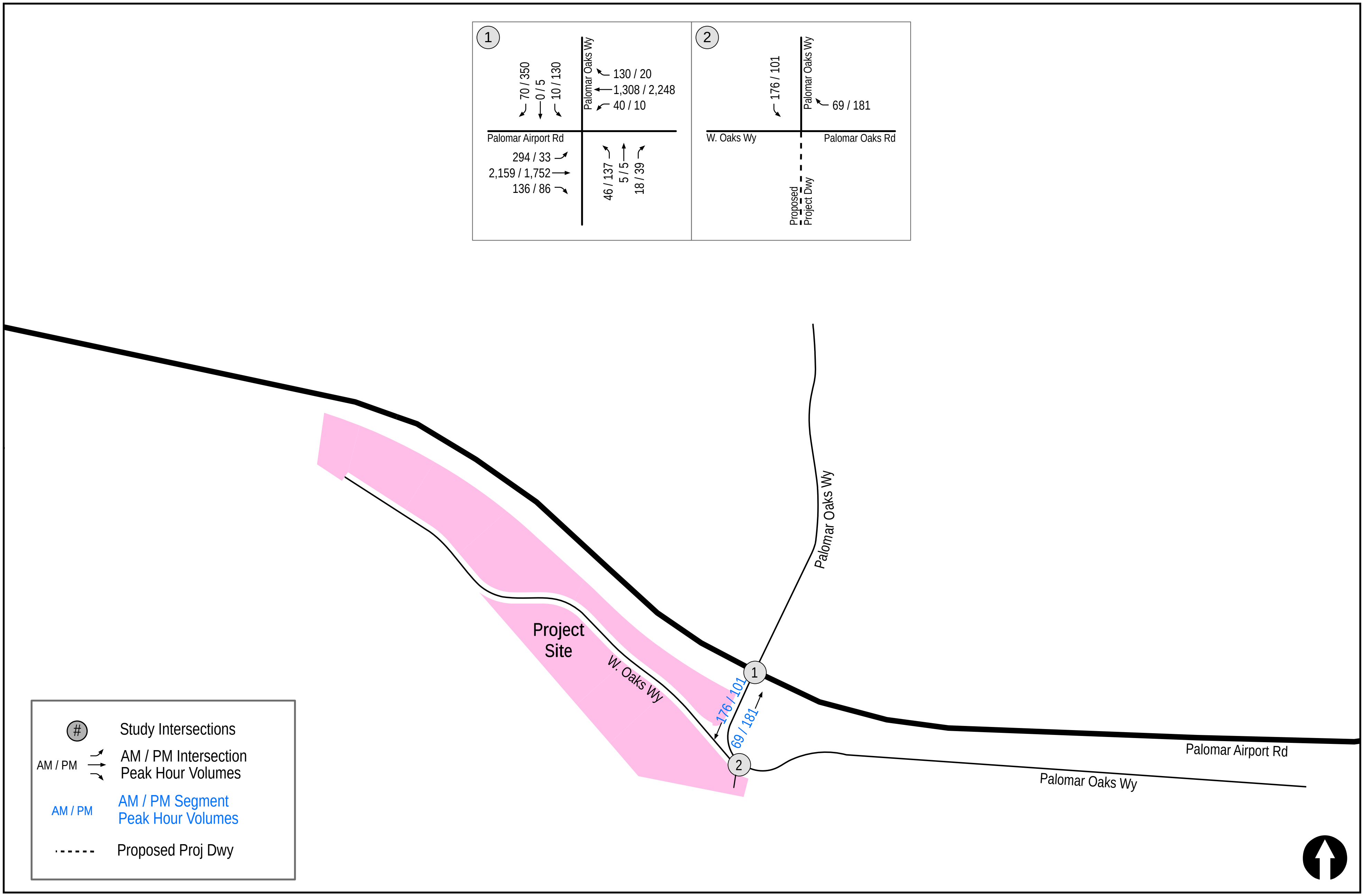

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Figure 6-1

Year 2035 Traffic Volumes

WEST OAKS PROPERTY

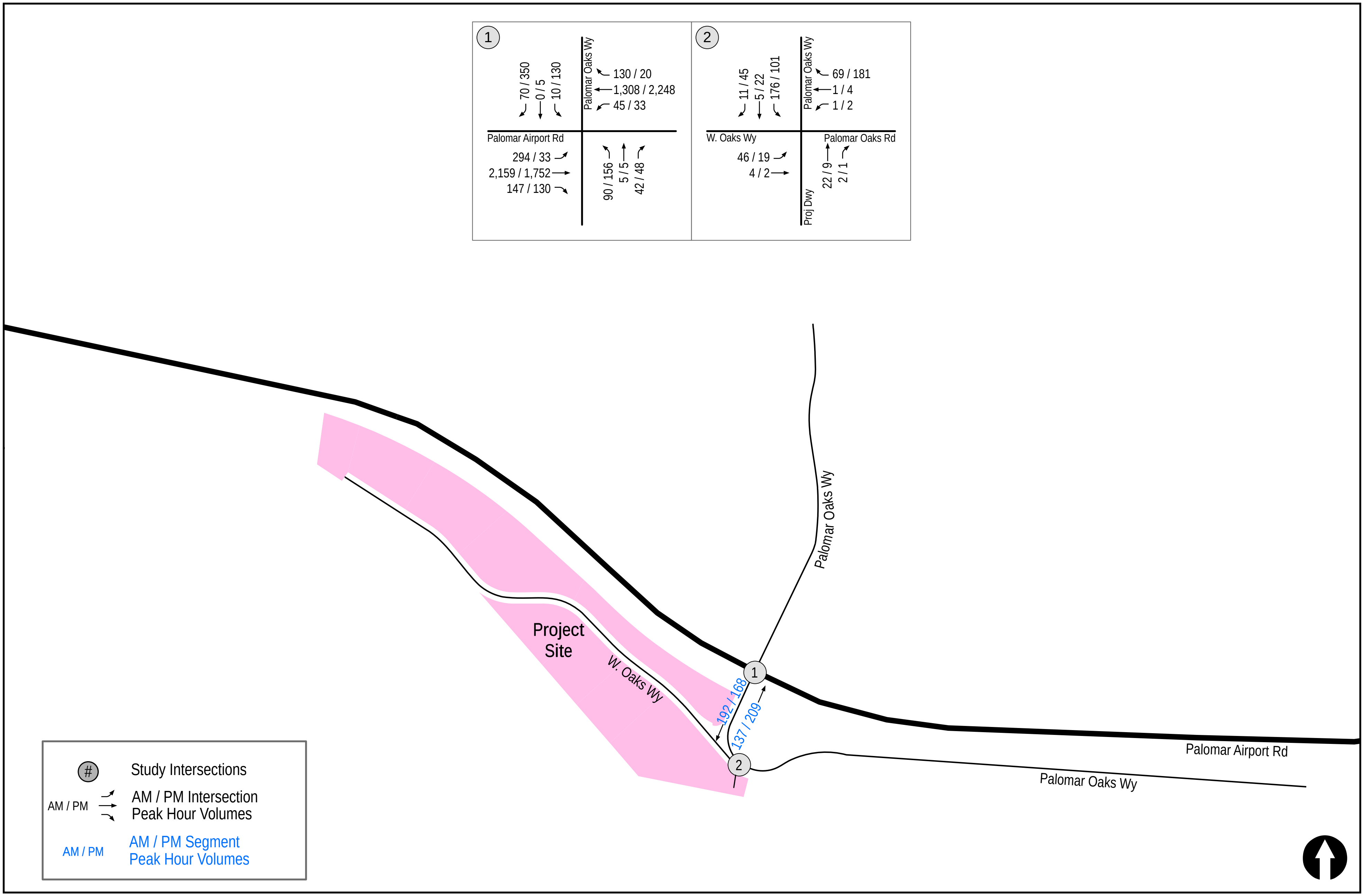

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Figure 6-2

Year 2035 + Project Traffic Volumes

WEST OAKS PROPERTY

7.0 AUTO ANALYSIS PER SANTEC/ITE GUIDELINES (CEQA)

7.1 Background

Based on the approach and methodologies described in *Section 2.0* for the CEQA analysis, the following is an evaluation of the one (1) signalized intersection, one (1) unsignalized intersection, and the one (1) street segment. This analysis is provided for informational purposes only to support other technical studies required by CEQA. West Oaks Way is constructed but gated and not open to traffic. Therefore there are no conflicting turning movements or delay at Palomar Oaks Way / West Oaks Way prior to the Project's opening. This location is evaluated for "with Project" scenarios only.

7.2 Analysis of Existing Conditions

7.2.1 *Signalized and Unsignalized Intersection Analysis*

Table 7–1 shows the results of the intersection capacity analyses conducted for the study intersections under Existing and Existing + Project conditions during the AM and PM peak hours.

Appendix F contains the intersection analysis worksheets for the Existing scenario. ***Appendix G*** contains the intersection analysis worksheets for the Existing + Project scenario.

TABLE 7–1
EXISTING CONDITIONS
INTERSECTION ANALYSIS

Intersection	Control Type	Peak Hour	Existing	Existing + Project	
			Delay[a]	Delay	Δ[b]
1. Palomar Airport Road/ Palomar Oaks Way	Signal	AM	9.3	11.8	2.5
		PM	16.9	18.3	1.4
2. Palomar Oaks Way/ West Oaks Way	Roundabout	AM	—[c]	3.3	—
		PM	—[c]	3.3	—

Footnotes:

a. Average delay expressed in seconds per vehicle.

b. Δ denotes Project induced delay increase.

c. Intersection does not exist without Project. West Oaks Way is constructed but not open to traffic.

SIGNALIZED Delay	SIGNALIZED LOS	UNSIGNALIZED Delay	UNSIGNALIZED LOS
0.0 ≤ 10.0	A	0.0 ≤ 10.0	A
10.1 to 20.0	B	10.1 to 15.0	B
20.1 to 35.0	C	15.1 to 25.0	C
35.1 to 55.0	D	25.1 to 35.0	D
55.1 to 80.0	E	35.1 to 50.0	E
≥ 80.1	F	≥ 50.1	F

7.2.2 *Roadway Segment Analysis*

***Table** 7–2* summarizes the street segment operations under Existing and Existing + Project conditions.

As shown in *Table 7–2,* with the addition of Project traffic Palomar Oaks Way is calculated to continue to operate at acceptable LOS D or better.

Appendix F and *Appendix G* also show peak hour roadway segment volumes for an expanded area used to support other technical studies required by CEQA.

TABLE 7–2
EXISTING CONDITIONS
SEGMENT ANALYSIS

Segment	Capacity [a]	Dir.	Peak Hour	Existing			Existing + Project			
				Volume	LOS[b]	V/C[c]	Volume	LOS	V/C	Δ[d]
Palomar Oaks Way										
Palomar Airport Road to West Oaks Way	560	SB	AM	85	C	0.152	101	C	0.180	0.028
			PM	23	A	0.041	90	C	0.161	0.120
		NB	AM	25	C	0.045	93	C	0.166	0.121
			PM	97	C	0.173	125	D	0.223	0.050

Footnotes:

a. Hourly two-way capacities based on City of Carlsbad Segment LOS Capacity Thresholds.
b. Level of Service
c. Volume to Capacity
d. Δ denotes project induced V/C increase.

LOS	Peak Hour Volume
A	N/A
B	N/A
C	<110
D	<450
E	<560
F	>560

7.3 Analysis of Cumulative Conditions

7.3.1 *Signalized and Unsignalized Intersection Analysis*

Table 7–3 reports the Existing + Cumulative and Existing + Cumulative Projects + Project intersection operations during the AM and PM peak hours.

Appendix H contains the intersection analysis worksheets for the Existing + Cumulative Projects scenario. ***Appendix I*** contains the intersection analysis worksheets for the Existing + Cumulative Projects + Project scenario.

TABLE 7–3
CUMULATIVE CONDITIONS
INTERSECTION ANALYSIS

Intersection	Control Type	Peak Hour	Existing + Cumulative Projects	Existing + Cumulative Projects + Project	
			Delay[a]	Delay	Δ[b]
1. Palomar Airport Road/ Palomar Oaks Way	Signal	AM PM	9.4 17.3	11.9 18.9	2.5 1.6
2. Palomar Oaks Way/ West Oaks Way	Roundabout	AM PM	—[c] —[c]	3.3 3.3	— —

Footnotes:

a. Average delay expressed in seconds per vehicle.
b. Δ denotes Project induced delay increase.
c. Intersection does not exist without Project. West Oaks Way is constructed but not open to traffic.

SIGNALIZED Delay	SIGNALIZED LOS	UNSIGNALIZED Delay	UNSIGNALIZED LOS
0.0 ≤ 10.0	A	0.0 ≤ 10.0	A
10.1 to 20.0	B	10.1 to 15.0	B
20.1 to 35.0	C	15.1 to 25.0	C
35.1 to 55.0	D	25.1 to 35.0	D
55.1 to 80.0	E	35.1 to 50.0	E
≥ 80.1	F	≥ 50.1	F

7.3.2 *Roadway Segment Analysis*

Table 7–4 summarizes the street segment operations under Existing + Cumulative and Existing + Cumulative + Project conditions.

As shown in *Table 7–4,* with the addition of Project traffic Palomar Oaks Way is calculated to continue to operate at acceptable LOS D or better during peak hours.

Appendix H and *Appendix I* also show peak hour roadway segment volumes for an expanded area to support other technical studies required by CEQA.

TABLE 7–4
CUMULATIVE CONDITIONS
SEGMENT ANALYSIS

Segment	Capacity[a]	Dir.	Peak Hour	Existing + Cumulative Projects			Existing + Cumulative Projects + Project			
				Volume	LOS[b]	V/C[c]	Volume	LOS	V/C	Δ[d]
Palomar Oaks Way										
Palomar Airport Road to West Oaks Way	560	SB	AM	85	C	0.152	101	C	0.180	0.028
			PM	23	C	0.041	90	C	0.161	0.120
		NB	AM	25	C	0.045	93	C	0.166	0.121
			PM	97	C	0.173	125	D	0.223	0.050

Footnotes:

a. Hourly two-way capacities based on City of Carlsbad Segment LOS Capacity Thresholds.
b. Level of Service
c. Volume to Capacity.
d. Δ denotes project induced V/C increase.

LOS	Peak Hour Volume
A	N/A
B	N/A
C	<110
D	<450
E	<560
F	>560

7.4 Analysis of Year 2035 Conditions

7.4.1 *Signalized and Unsignalized Intersection Analysis*

Table 7–5 reports the Year 2035 and Year 2035 + Project intersection operations during the AM and PM peak hours.

Appendix J contains the intersection analysis worksheets for the Year 2035 scenario. ***Appendix K*** contains the intersection analysis worksheets for the Year 2035 + Project scenario.

TABLE 7–5
YEAR 2035 CONDITIONS
INTERSECTION ANALYSIS

Intersection	Control Type	Peak Hour	Year 2035	Year 2035 + Project	
			Delay[a]	Delay	Δ[b]
1. Palomar Airport Road/ Palomar Oaks Way	Signal	AM PM	13.5 27.0	16.4 30.4	2.9 3.4
2. Palomar Oaks Way/ West Oaks Way	Roundabout	AM PM	—[c] —[c]	3.7 3.8	— —

Footnotes:

a. Average delay expressed in seconds per vehicle.
b. Δ denotes Project induced delay increase.
c. Intersection does not exist without Project. West Oaks Way is constructed but not open to traffic.

SIGNALIZED Delay	SIGNALIZED LOS	UNSIGNALIZED Delay	UNSIGNALIZED LOS
0.0 ≤ 10.0	A	0.0 ≤ 10.0	A
10.1 to 20.0	B	10.1 to 15.0	B
20.1 to 35.0	C	15.1 to 25.0	C
35.1 to 55.0	D	25.1 to 35.0	D
55.1 to 80.0	E	35.1 to 50.0	E
≥ 80.1	F	≥ 50.1	F

7.4.2 *Roadway Segment Analysis*

Table 7–6 summarizes the street segment operations under Year 2035 and Year 2035 + Project conditions.

As shown in *Table 7–6,* with the addition of Project traffic Palomar Oaks Way is calculated to continue to operate at acceptable LOS D.

Appendix J and *Appendix K* also show peak hour roadway segment volumes for an expanded area to support other technical studies required by CEQA.

TABLE 7–6
YEAR 2035 CONDITIONS
SEGMENT ANALYSIS

Segment	Capacity [a]	Dir.	Peak Hour	Year 2035			Year 2035 + Project			
				Volume	LOS[b]	V/C[c]	Volume	LOS	V/C	Δ[d]
Palomar Oaks Way										
Palomar Airport Road to West Oaks Way	560	SB	AM	176	D	0.314	192	D	0.343	0.029
			PM	101	C	0.180	168	D	0.300	0.120
		NB	AM	69	C	0.123	137	D	0.245	0.122
			PM	181	D	0.323	209	D	0.373	0.050

Footnotes:

a. Hourly two-way capacities based on City of Carlsbad Segment LOS Capacity Thresholds.
b. Level of Service
c. Volume to Capacity.
d. Δ denotes project induced V/C increase.

LOS	Peak Hour Volume
A	N/A
B	N/A
C	<110
D	<450
E	<560
F	>560

8.0 PROJECT ACCESS ALTERNATIVE

8.1 Roundabout (Proposed)

Project access will be via W. Oaks Way, which is the existing west leg of the Palomar Oaks Way/ W. Oaks Way unsignalized tee-intersection. Currently, this west leg is closed via a physical barricade, and the balance of the intersection functions as a defacto curve. The Project proposes to control the tee-intersection with a roundabout. This would be a one-lane roundabout with an approximate inscribed diameter of 100'. Each of the four legs would provide a single lane entry, with design speeds of 25 MPH. A second Project access driveway will form the south leg of the intersection. ***Table 8–1*** restates the near-term and long-term "plus Project" results from *Table 7–3* and *Table 7–5* with the proposed roundabout control.

TABLE 8–1
"PLUS PROJECT" INTERSECTION OPERATIONS
PROPOSED ROUNDABOUT CONTROL

Intersection	Control Type	Peak Hour	Existing + Cumulative + Project		Year 2035 + Project	
			Delay [a]	LOS [b]	Delay	LOS
2. Palomar Oaks Way/ West Oaks Way [c]	Roundabout	AM PM	3.3 3.3	A A	3.7 3.8	A A

Footnotes:

a. Average delay expressed in seconds per vehicle.

b. Level of Service.

c. Intersection does not exist without Project. West Oaks Way is constructed but not open to traffic.

UNSIGNALIZED

DELAY/LOS THRESHOLDS

Delay	LOS
0.0 ≤ 10.0	A
10.1 to 15.0	B
15.1 to 25.0	C
25.1 to 35.0	D
35.1 to 50.0	E
≥ 50.1	F

Based on these results, no queuing issues would occur with peak southbound traffic from Palomar Airport Road to Palomar Oaks Way. The maximum AM southbound volumes would be 192 vehicles in one hour (Year 2035 + Project), which averages 3.2 vehicles/minute.

Installation of a roundabout at this intersection provides a range of benefits and is consistent with the goals and policies of the City of Carlsbad Mobility Element, which suggests the use of "innovative design solutions" such as roundabouts to meet mobility, efficiency, connectivity, and safety goals of the transportation system. As compared to the all-way stop-control alternative, discussed below, a roundabout minimizes both overall vehicular delay and prevents unnecessary stops for vehicles on Palomar Oaks Way. This may reduce noise and air quality impacts and fuel consumption by reducing the number of acceleration/deceleration cycles and as such is consistent with the City's Climate Action Plan. The roundabout also provides positive geometric features to manage vehicle speeds as they transition from the higher speed arterial on Palomar Airport Road to the lower speed Palomar Oaks Way.

8.2 All-Way Stop Control (Alternative)

All-way stop-control at Palomar Oaks Way / West Oaks Way was considered as an alternative to the roundabout, although the minor street volumes from the Project would not meet minimum volume warrants. However, the primary movements through the intersection are to/from the adjacent north and east legs, and providing stops signs only on the Project driveways (west and south legs) would be unconventional and not recommended. All-way stop-control of the intersection control would provide a single lane at each approach. ***Table 8–2*** shows a summary of the all-way stop control operations for the same "plus Project" conditions shown above in *Table 8–1* for the roundabout alternative.

TABLE 8–2
"PLUS PROJECT" INTERSECTION OPERATIONS
ALTERNATIVE ALL-WAY STOP CONTROL

Intersection	Control Type	Peak Hour	Existing + Cumulative + Project		Year 2035 + Project	
			Delay [a]	LOS [b]	Delay	LOS
2. Palomar Oaks Way/ West Oaks Way [c]	AWSC [d]	AM PM	7.7 7.3	A A	8.4 8.2	A A

Footnotes:

a. Average delay expressed in seconds per vehicle.
b. Level of Service.
c. Intersection does not exist without Project. West Oaks Way is constructed but not open to traffic.
d. AWSC – All-Way Stop Control.

UNSIGNALIZED

DELAY/LOS THRESHOLDS

Delay	LOS
0.0 ≤ 10.0	A
10.1 to 15.0	B
15.1 to 25.0	C
25.1 to 35.0	D
35.1 to 50.0	E
≥ 50.1	F

This table shows that the all-way stop control alternative would also provide a Level of Service of A during both peak hours in both the near-term and long-term conditions with Project traffic volumes. All-way stop control LOS calculations are shown in ***Appendix L.***

8.3 Summary

The Project proposes to serve the Palomar Oaks Way/ West Oaks Way intersection with a roundabout. This results in LOS A operations during peak hours for both near-term and long-term "plus Project" volumes conditions. The proposed roundabout assumes an inscribed diameter of approximately 100-feet. Splitters and lane deflection would be required on each leg, which would result in crosswalks being set back on these legs from the circulatory roadway. Bicycle circulation through the roundabout would occur in the circulatory roadway with bicyclists needing to "take the lane" through the circulatory roadway.

The alternative intersection control evaluated is a conventional all-way stop-control. This allows for a smaller intersection footprint as compared to the roundabout, and provides positive stop control on all approaches for each vehicle. This intersection control also results in LOS A operations during both peak hours for both near-term and long-term "plus Project" volumes conditions. No queuing issues would occur during the AM peak hour with southbound entering vehicles from Palomar Airport Road stopping at Palomar Oaks Way. Pedestrians will have ADA-compliant service at the intersection curb returns, and bicycles will circulate within the roadway. This control type would not meet minimum volume warrants, but would still be recommended as compared to only providing stop-control on the adjacent driveway legs.

End of Report

LINSCOTT
LAW &
GREENSPAN
engineers

TECHNICAL APPENDICES
WEST OAKS
Carlsbad, California
October 28, 2020

LLG Ref. 3-16-2672

**Linscott, Law &
Greenspan, Engineers**
4542 Ruffner Street
Suite 100
San Diego, CA 92111
858.300.8800 T
858.300.8810 F
www.llgengineers.com

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APPENDIX A

CITY OF CARLSBAD SEGMENT LOS CAPACITY THRESHOLD TABLE

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City of Carlsbad Segment LOS Capacity Threshold

Segment Capacity Threshold for Arterial Streets

Hourly Volume in Peak Direction

Lanes	Speed Limit	Median	B	C	D	E
1	35	Undivided	**	180	590	740
	35	Divided	**	190	630	780
2	35	Divided	**	520	1390	1540
	45	Divided	**	600	1560	1760
	50	Divided	**	850	1690	1820
	55	Divided	**	1050	1800	1890
3	35	Divided	**	680	2230	2540
	45	Divided	**	2040	2660	2700
	50	Divided	**	2360	2760	2800
	55	Divided	390	2600	2870	2900
4	45	Divided	**	2780	3560	3620

Hourly Volume in Both Direction

Lanes	Speed Limit	Median	B	C	D	E
2	35	Undivided	**	340	1100	1380
	35	Divided	**	360	1170	1450
4	35	Divided	**	970	2580	2860
	45	Divided	**	1120	2890	3260
	50	Divided	**	1580	3130	3380
	55	Divided	**	1950	3340	3500
5	55	Divided	**	3395	4343	4455
6	35	Divided	**	1260	4130	4720
	50	Divided	**	4380	5120	5180
	55	Divided	730	4820	5320	5360
7	45	Divided	**	4483	5785	5878

Annual Average Daily Traffic

Lanes	Speed Limit	Median	B	C	D	E
2	35	Undivided	**	4200	13700	17200
	35	Divided	**	4400	14600	18100
4	35	Divided	**	12100	32200	35800
	45	Divided	**	13900	36200	40800
	50	Divided	**	19700	39200	42200
	55	Divided	**	24400	41700	43800
6	35	Divided	**	15800	51700	59000
	50	Divided	**	54700	63900	64800
	55	Divided	9100	60200	66500	67000

Segment Capacity Threshold for Industrial Streets

Hourly Volume in Peak Direction

Lanes	Speed Limit	Median	B	C	D	E
1	25	Undivided	**	110	450	560
	25	Divided	**	140	610	720
	35	Undivided	**	180	590	740
	35	Divided	**	190	630	780
	40	Undivided	**	216	708	888
	40	Divided	**	228	756	936

Hourly Volume in Both Direction

Lanes	Speed Limit	Median	B	C	D	E
2	25	Undivided	**	200	800	990
	25	Divided	**	250	1080	1270
	35	Undivided	**	340	1100	1380
	35	Divided	**	360	1170	1450
	40	Undivided	**	408	1320	1656
	40	Divided	**	432	1404	1740

Annual Average Daily Traffic

Lanes	Speed Limit	Median	B	C	D	E
2	25	Undivided	**	2200	8900	11000
	25	Divided	**	2800	12000	14100
	35	Undivided	**	4200	13700	17200
	35	Divided	**	4400	14600	18100
	40	Undivided	**	5040	16440	20640
	40	Divided	**	5280	17520	21720

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APPENDIX B

INTERSECTION ANALYSIS METHODOLOGY

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HIGHWAY CAPACITY 6th EDITION MANUAL
LEVEL OF SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

In the Highway Capacity Manual 6th Edition (HCM 6), Level of Service for signalized intersections is defined in terms of delay. Delay is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. Specifically, Level of Service criteria are stated in terms of the average control delay per vehicle for a 15-minute analysis period. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay.

Delay is a complex measure, and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group or approach in question.

LEVEL OF SERVICE	CONTROLLED DELAY PER VEHICLE (SEC)		
A		≤	10.0
B	10.1	to	20.0
C	20.1	to	35.0
D	35.1	to	55.0
E	55.1	to	80.0
F		>	80.0

Level of Service A describes operations with very low delay, (i.e. less than 10.0 seconds per vehicle). This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

Level of Service B describes operations with delay in the range of 10.1 to 20.0 seconds per vehicle. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than for LOS A, causing higher levels of average delay.

Level of Service C describes operations with delay in the range of 20.1 to 35.0 seconds per vehicle. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear in the level. The number of vehicles stopping is significant at this level, although many still pass through the intersections without stopping.

Level of Service D describes operations with delay in the range of 35.1 to 55.0 seconds per vehicle. At Level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

Level of Service E describes operations with delay in the range of 55.1 to 80.0 seconds per vehicle. This is considered to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.

Level of Service F describes operations with delay in excess of 80.0 seconds per vehicle. This is considered to be unacceptable to most drivers. This condition often occurs with over-saturation (i.e. when arrival flow rates exceed the capacity of the intersection). It may also occur at high v/c ratios below 1.00 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

HIGHWAY CAPACITY 6th EDITION MANUAL
LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

In the Highway Capacity Manual 6th Edition (HCM 6), Level of Service for unsignalized intersections is determined by the computed or measured control delay and is defined for each minor movement. Level of Service is not defined for the intersection as a whole. Delay is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. The criteria are given in the following the table, and are based on the average control delay for any particular minor movement.

LEVEL OF SERVICE	AVERAGE CONTROL DELAY SEC/VEH			EXPECTED DELAY TO MINOR STREET TRAFFIC
A	0.0	≤	10.0	Little or no delay
B	10.1	to	15.0	Short traffic delays
C	15.1	to	25.0	Average traffic delays
D	25.1	to	35.0	Long traffic delays
E	35.1	to	50.0	Very long traffic delays
F		>	50.0	Severe congestion

Level of Service F exists when there are insufficient gaps of suitable size to allow a side street demand to safely cross through a major street traffic stream. This Level of Service is generally evident from extremely long control delays experienced by side-street traffic and by queuing on the minor-street approaches. The method, however, is based on a constant critical gap size; that is, the critical gap remains constant no matter how long the side-street motorist waits. LOS F may also appear in the form on side-street vehicles selecting smaller-than-usual gaps. In such cases, safety may be a problem, and some disruption to the major traffic stream may result. It is important to note that LOS F may not always result in long queues but may result in adjustments to normal gap acceptance behavior, which are more difficult to observe in the field than queuing.

In most cases at Two-Way Stop Controlled (TWSC) intersections, the critical movement is the minor-street left-turn movement. As such, the minor-street left-turn movement can generally be considered the primary factor affecting overall intersection performance. The lower threshold for LOS F is set at 50 seconds of delay per vehicle. There are many instances, particularly in urban areas, in which the delay equations will predict delays of 50 seconds (LOS F) or more for minor-street movements under very low volume conditions on the minor street (less than 25 vehicle/hour). Since the first term of the equation is a function only of the capacity, the LOS F threshold of 50 sec/vehicle is reached with a movement capacity of approximately 85 vehicle/hour or less.

This procedure assumes random arrivals on the major street. For a typical four-lane arterial with average daily traffic volumes in the range of 15,000 to 20,000 vehicles per day (peak hour, 1,500 to 2,000 vehicle/hour), the delay equation used in the TWSC capacity analysis procedure will predict 50 seconds of delay or more (LOS F) for many urban TWSC intersections that allow minor-street left-turn movements. **The LOS F threshold will be reached regardless of the volume of minor-street left-turn traffic.** Not-withstanding this fact, most low-volume minor-street approaches would not meet any of the volume or delay warrants for signalization of the *Manual on Uniform Traffic Control Devices* (MUTCD) since the warrants define an asymptote at 100 vehicle/hour on the minor approach. As a result, many public agencies that use the HCM 6 Level of Service thresholds to determine the design adequacy of TWSC intersections may be forced to eliminate the minor-street left-turn movement, even when the movement may not present any operational problem, such as the formation of long queues on the minor street or driveway approach.

APPENDIX C

EXISTING TRAFFIC COUNT SHEETS

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Linscott Law & Greenspan engineers

Turn Count Summary

Accurate Video Counts Inc
info@accuratevideocounts.com
(619) 987-5136

AVC

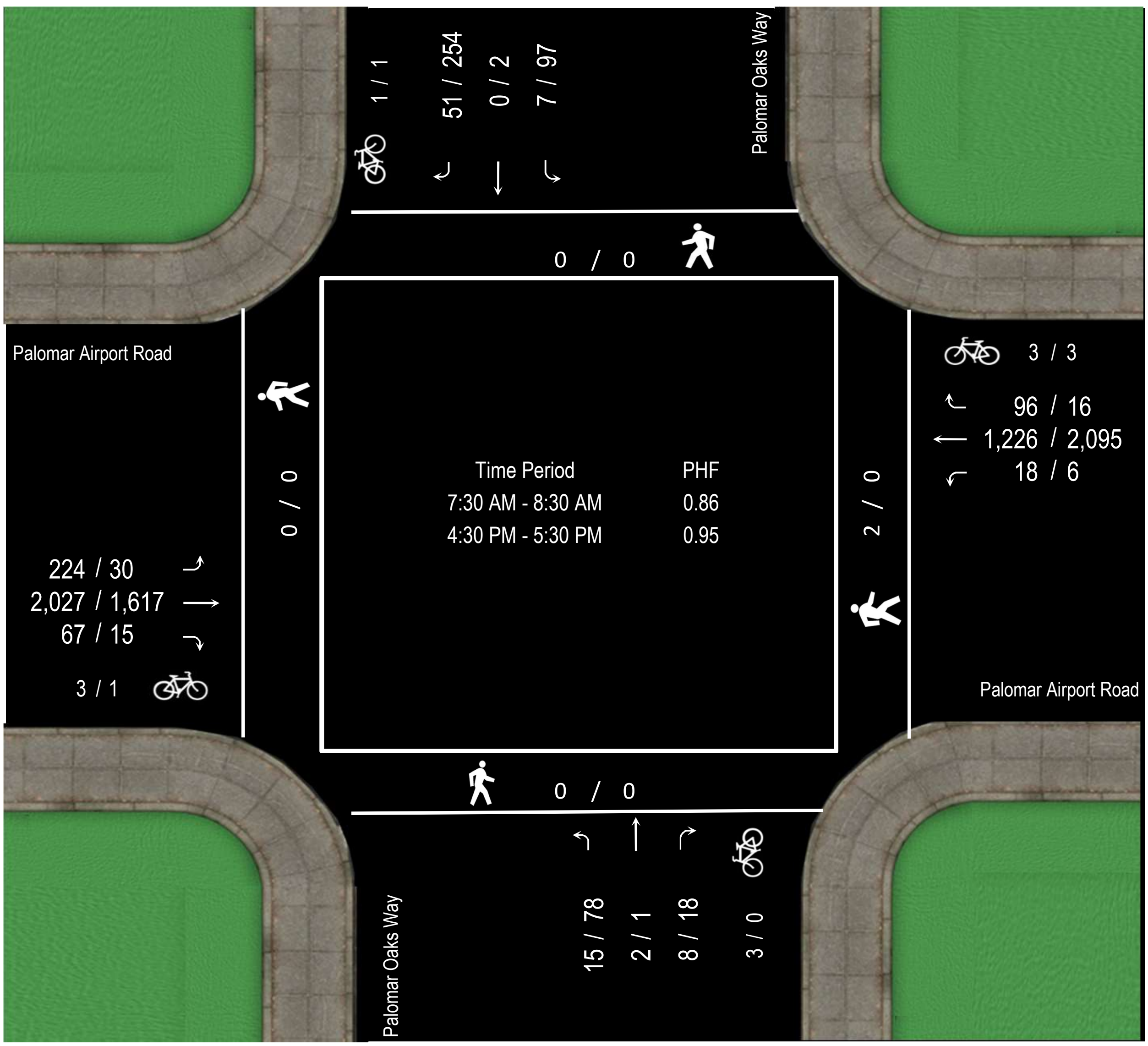
Location: Palomar Airport Road @ Palomar Oaks Way

Date of Count: *Wednesday, November 30, 2016*

Analysts: *LV/CD*

Weather: *Sunny*

AVC Proj No: *16-0598*



LINSCOTT LAW & GREENSPAN engineers

Vehicular Count

Accurate Video Counts Inc
info@accuratevideocounts.com
(619) 987-5136

AVC

Location: Palomar Airport Road @ Palomar Oaks Way

AM Period (7:00 AM - 9:00 AM)

	Southbound			Westbound			Northbound			Eastbound			TOTAL
	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	
7:00 AM	7	0	4	16	234	6	3	1	4	10	274	41	600
7:15 AM	9	0	1	21	234	3	3	1	1	10	369	46	698
7:30 AM	8	0	2	19	279	3	2	0	5	10	460	44	832
7:45 AM	12	0	2	28	334	9	1	1	4	21	601	79	1,092
8:00 AM	20	0	2	24	299	3	3	1	4	19	515	56	946
8:15 AM	11	0	1	25	314	3	2	0	2	17	451	45	871
8:30 AM	12	0	5	25	280	3	2	1	1	8	438	53	828
8:45 AM	8	2	5	22	312	2	1	2	3	11	401	45	814
Total	87	2	22	180	2,286	32	17	7	24	106	3,509	409	6,681

AM Intersection Peak Hour : **7:30 AM - 8:30 AM** Intersection PHF : **0.86**

	Southbound			Westbound			Northbound			Eastbound			TOTAL
	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	
Volume	51	0	7	96	1,226	18	8	2	15	67	2,027	224	3,741
PHF	0.64	#####	0.88	0.86	0.92	0.50	0.67	0.50	0.75	0.80	0.84	0.71	0.86
Movement PHF		0.66			0.90			0.78			0.83		0.86

PM Period (4:00 PM - 6:00 PM)

	Southbound			Westbound			Northbound			Eastbound			TOTAL
	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	
4:00 PM	69	0	22	3	470	1	4	0	18	3	390	12	992
4:15 PM	49	2	13	4	457	1	3	2	9	3	332	13	888
4:30 PM	70	0	23	4	533	2	7	0	16	3	410	8	1,076
4:45 PM	63	2	19	6	476	3	3	1	20	3	428	9	1,033
5:00 PM	90	0	32	4	554	1	7	0	24	6	390	9	1,117
5:15 PM	31	0	23	2	532	0	1	0	18	3	389	4	1,003
5:30 PM	30	0	16	0	396	1	4	0	11	1	340	5	804
5:45 PM	24	0	9	1	380	3	1	0	12	2	314	6	752
Total	426	4	157	24	3,798	12	30	3	128	24	2,993	66	7,665

PM Intersection Peak Hour : **4:30 PM - 5:30 PM** Intersection PHF : **0.95**

	Southbound			Westbound			Northbound			Eastbound			TOTAL
	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	
Volume	254	2	97	16	2095	6	18	1	78	15	1617	30	4229
PHF	0.71	0.25	0.758	0.667	0.945	0.5	0.643	0.25	0.813	0.625	0.945	0.833	0.95
Movement PHF		0.72			0.95			0.78			0.94		0.95

APPENDIX D

CUMULATIVE PROJECTS TRAFFIC VOLUMES AND INFORMATION

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INTERSECTION	DIRECTION	TOTAL CUMULATIVE						Agua Hedionda NT Projects [1]						Westin Hotel LLG #2418					
		Ram	Rpm	Tam	Tpm	Lam	Lpm	Ram	Rpm	Tam	Tpm	Lam	Lpm	Ram	Rpm	Tam	Tpm	Lam	Lpm
7 Palomar Airport Rd / Palomar Oaks Way	Sb	0	0	0	0	0	0												
	Wb	0	0	47	66	0	0			26	25					3	4		
	Nb	0	0	0	0	0	0												
	Eb	0	0	39	74	0	0			18	28					2	4		
8 Palomar Oaks Way / W Oaks Way	Sb	0	0	0	0	0	0			0	0					0	0		
	Wb	0	0	0	0	0	0												
	Nb	0	0	0	0	0	0			0	0					0	0		
	Eb	0	0	0	0	0	0												

1. Includes the following developments
Robertson Ranch
Cantarini Ranch
Holly Springs
Quarry Creek
Dos Colinas
North 40
Bressi Ranch Hotels
La Costa Town Square

INTERSECTION	DIRECTION	Uptown Bressi						Legoland Hotel 2						Marja Acres					
		Ram	**R**pm	**T**am	**T**pm	**L**am	**L**pm	**R**am	**R**pm	**T**am	**T**pm	**L**am	**L**pm	**R**am	**R**pm	**T**am	**T**pm	**L**am	**L**pm
7 Palomar Airport Rd / Palomar Oaks Way	**S**b							0	0	0	0	0	0						
	Wb			15	34			0	0	3	3	0	0						
	Nb							0	0	0	0	0	0						
	Eb			17	38			0	0	2	4	0	0						

No trips to study area

INTERSECTION	DIRECTION	Uptown Bressi						Legoland Hotel 2						Marja Acres					
		Ram	**R**pm	**T**am	**T**pm	**L**am	**L**pm	**R**am	**R**pm	**T**am	**T**pm	**L**am	**L**pm	**R**am	**R**pm	**T**am	**T**pm	**L**am	**L**pm
8 Palomar Oaks Way / W Oaks Way	**S**b			0	0					0	0								
	Wb																		
	Nb			0	0					0	0								
	Eb																		

1. Includes the following developments
Robertson Ranch
Cantarini Ranch
Holly Springs
Quarry Creek
Dos Colinas
North 40
Bressi Ranch Hotels
La Costa Town Square

4 PROJECT DESCRIPTION

Merlin Entertainment Group operates LEGOLAND California and LEGOLAND Hotel in the City of Carlsbad. Merlin Entertainment Group is proposing to construct a 250 room hotel on the existing parking lot adjacent to the Sea Life Aquarium. The project site plan is provided in **Figure 4-1a** and **Figure 4-1b.**

Parking for the new LEGOLAND Hotel will be provided in a dedicated parking lot located within the existing ADA parking lot. The existing ADA parking lot will be relocated. A detailed assessment of existing hotel parking demand determined sufficient capacity is available to meet the future demand of the new hotel. Details of the parking assessment is provided in Chapter 9 of this report. Access to the new hotel will be provided either through the main park gates from LEGOLAND Drive or through the hotel access road off The Crossings. Parking and circulation patterns for the new hotel are illustrated in **Figure 4-2**.

4.1 Trip Generation

To determine the trips forecast to be generated by the proposed hotel land use, SANDAG trip generations rates (April 2002) were utilized in accordance with SANTEC/ITE Traffic Study Guidelines. **Table 4-1** represents the trip generation rates used for the proposed hotel and summarizes the forecast generated by the proposed project.

As shown on Table 4-1, a typical 250 room resort hotel is forecast to generate approximately 2,000 daily trips, which includes approximately 100 AM peak hour trips and approximately 140 PM peak hour trips.

TABLE 4-1: FORECAST PROJECT GENERATED TRIPS

	Daily Trips	AM Peak Hour (7:30 to 8:30)			PM Peak Hour (4:15-5:15)		
		Total	Inbound	Outbound	Total	Inbound	Outbound
Trip Rates							
Resort Hotel	8/Room	5%	60%	40%	7%	40%	60%
Forecast Trips							
250 Room Resort Hotel	2,000	100	60	40	140	56	84

Source: *SANDAG "Not so Brief Guide" – April 2002*

It should be noted that co-locating the hotel on site with the theme park will result in lower trip generation rates than similar resort hotels in the Carlsbad area. Guests of the LEGOLAND Hotel choose to stay at the resort for the convenience and LEGOLAND experience. Therefore, most visitors do not leave the hotel or park during the day to travel to other destinations. The presence of the hotel also reduces the number of park trips as those who would typically choose to stay at other hotels in the area choose to stay at the LEGOLAND Hotel instead.

Legoland Hotel 2

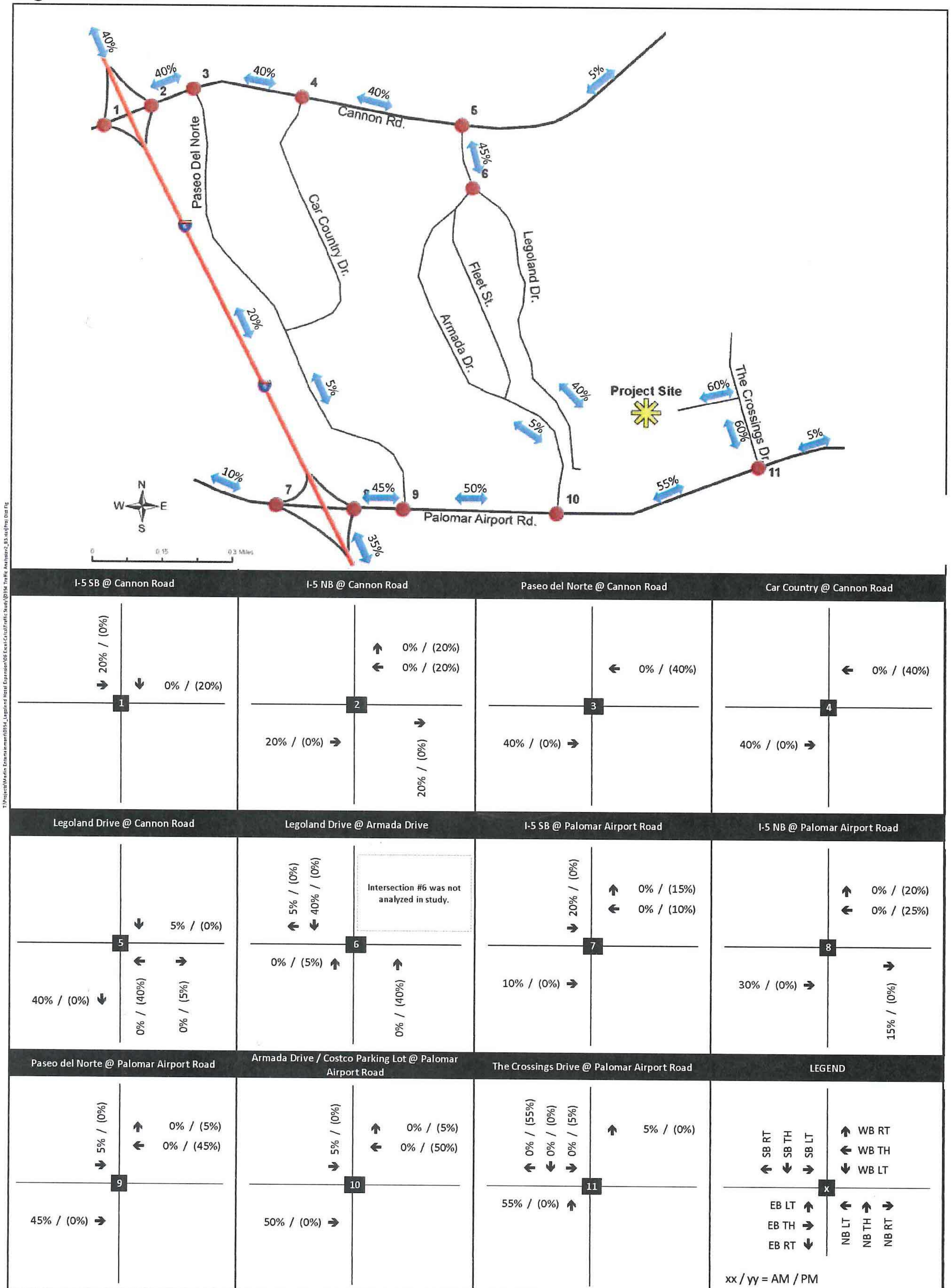


Figure 4-3
Project Trip Distribution

TABLE 3-1

Project Trip Generation Table

PROPOSED RESIDENTIAL

Use	Amount	Trip Rate*	ADT	AM						PM					
				Peak %	Vol.	In %	Out%	In	Out	Peak %	Vol.	In %	Out%	In	Out
Condominiums	125 DU	8 /DU	**1,000**	8%	**80**	20%	80%	**16**	**64**	10%	**100**	70%	30%	**70**	**30**

*Sandag Traffic Generation Rates, April 2002

<u>Note:</u>
DU= Dwelling Unit
ADT = Average Daily Traffic

PROPOSED RETAIL

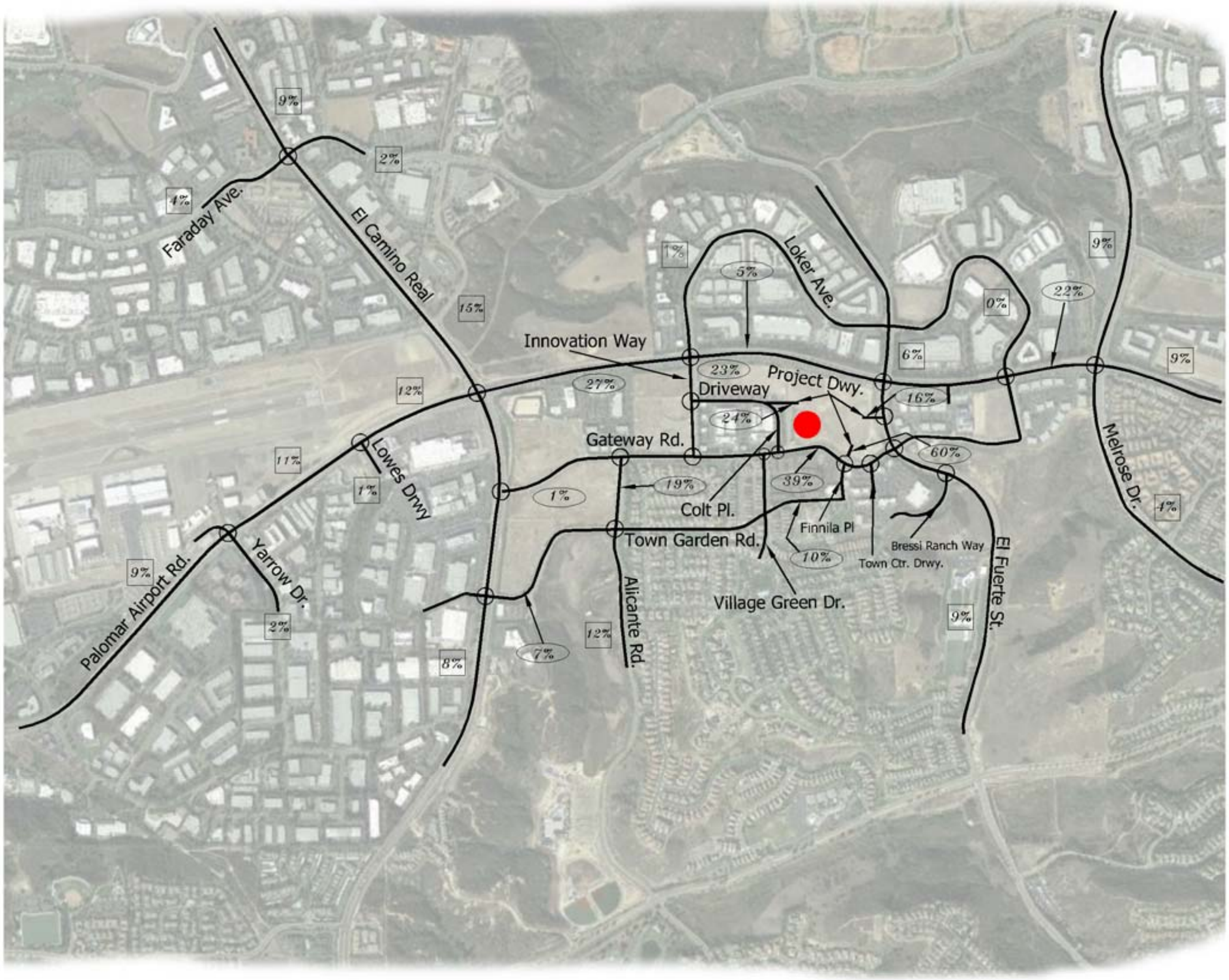
Use	Amount	Trip Rate*	ADT	AM						PM					
				Peak %	Vol.	In %	Out%	In	Out	Peak %	Vol.	In %	Out%	In	Out
Community Shopping Center	100,174 KSF	80 /KSF	**8,014**	4%	**321**	60%	40%	**192**	**128**	10%	**801**	50%	50%	**401**	**401**
Retail Total			**8,014**		**321**			**192**	**128**		**801**			**401**	**401**

*Sandag Traffic Generation Rates, April 2002

<u>Note:</u>
KSF=1,000 Square Feet

COMBINED TRIP GENERATION

Project	ADT	AM				PM			
		Vol.		In	Out	Vol.		In	Out
TOTAL PROPOSED RESIDENTIAL	**1,000**	**80**		**16**	**64**	**100**		**70**	**30**
TOTAL PROPOSED RETAIL	**8,014**	**321**		**192**	**128**	**801**		**401**	**401**
COMBINED TOTAL	**9,014**	**401**		**208**	**192**	**901**		**471**	**431**



#% = Cordon Count Adds to 85% External Trips. 15% Internal to Bressi Ranch Planned Industrial and Mixed Use.

#% = Project Only Internal Percentages within Cordon, do not add to 85%

● = Project Site

FIGURE 3-2

Project Distribution Percentages

FIGURE 3-3

Project Only Average Daily Traffic

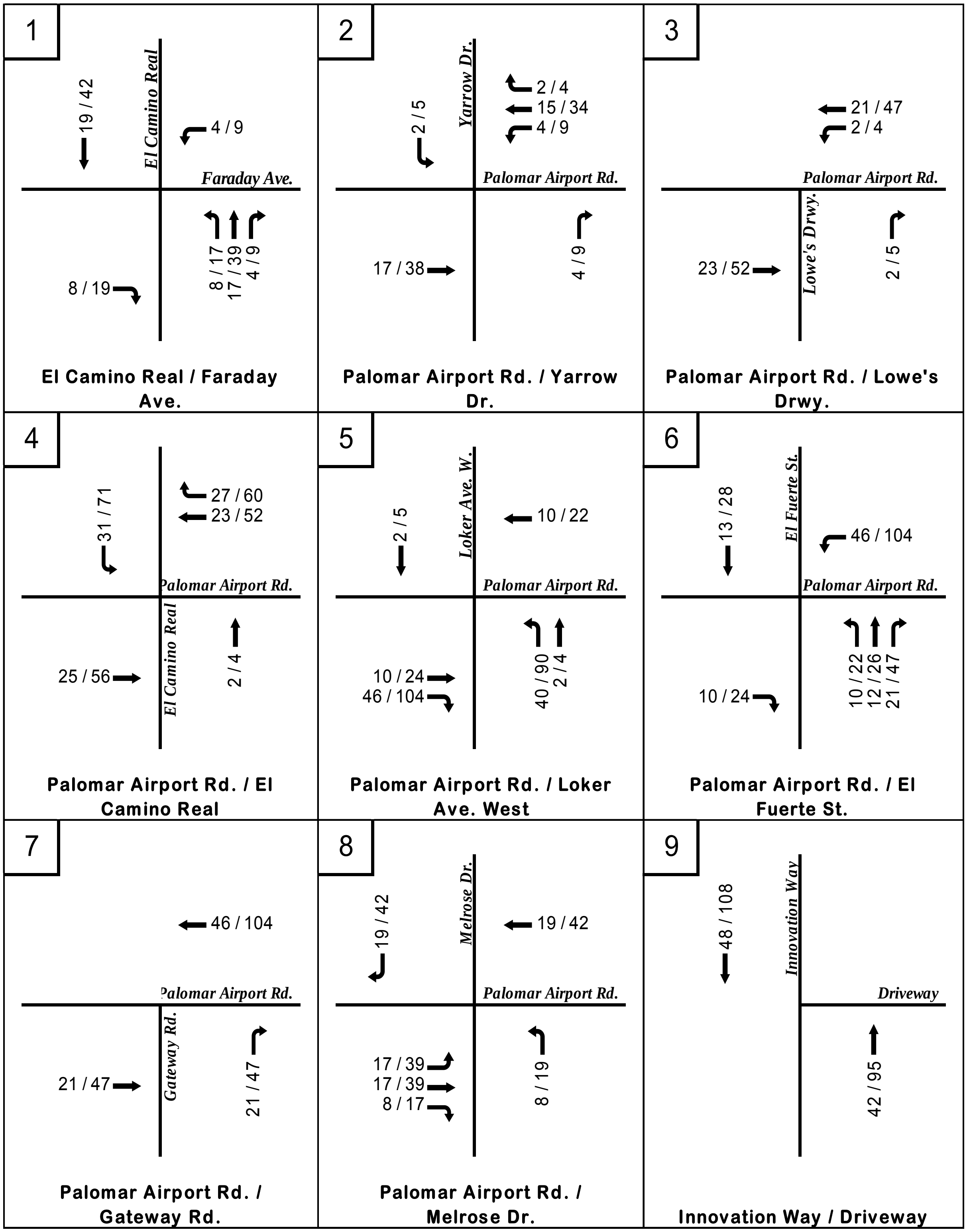


FIGURE 3-4

Project Only AM / PM Peak Hour Traffic

APPENDIX E

YEAR 2035 TRAFFIC VOLUME DATA

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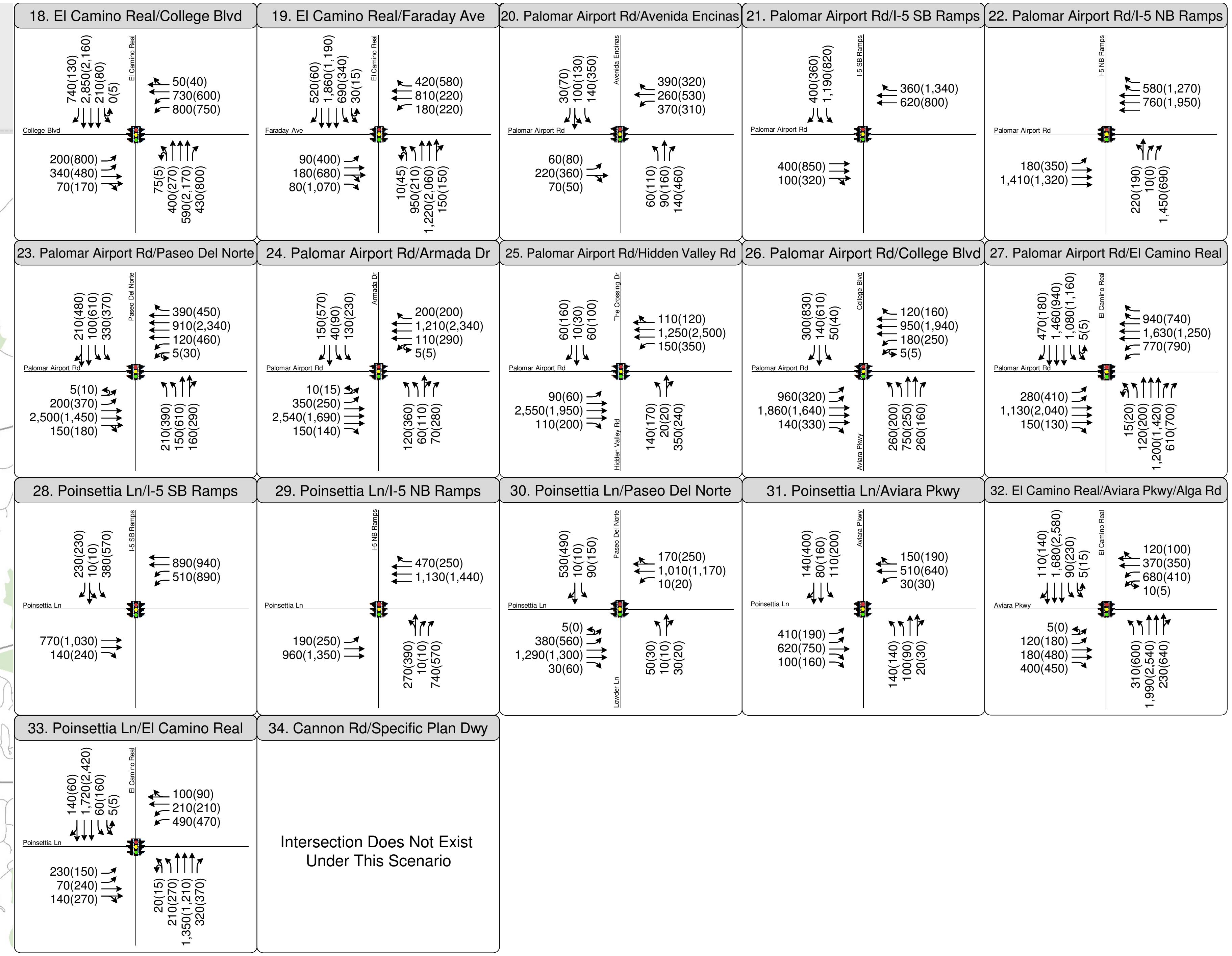

Figure 13
Peak Hour Traffic Volumes and Lane Configurations
2035 No Specific Plan Conditions

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APPENDIX F

HCM ANALYSIS WORKSHEETS – EXISTING

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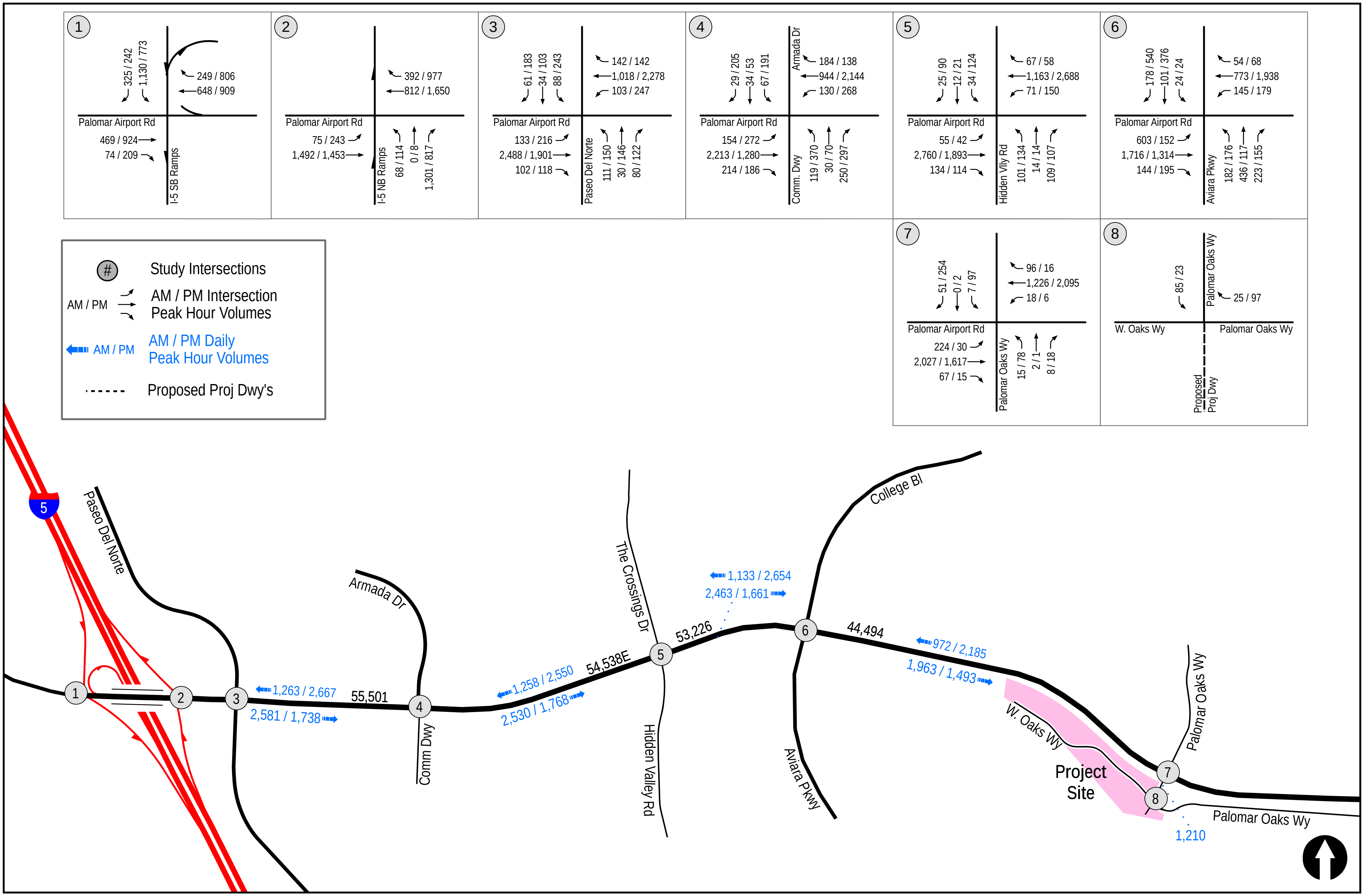
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	224	2027	67	18	1226	96	15	2	8	7	0	51
Future Volume (veh/h)	224	2027	67	18	1226	96	15	2	8	7	0	51
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	255	2303	76	20	1393	109	17	2	9	8	0	58
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	311	3632	119	41	2722	213	144	19	86	187	115	103
Arrive On Green	0.17	0.72	0.72	0.02	0.56	0.56	0.06	0.06	0.06	0.06	0.00	0.06
Sat Flow, veh/h	1781	5078	167	1781	4829	378	1345	296	1334	1404	1777	1585
Grp Volume(v), veh/h	255	1541	838	20	982	520	17	0	11	8	0	58
Grp Sat Flow(s),veh/h/ln	1781	1702	1840	1781	1702	1802	1345	0	1630	1404	1777	1585
Q Serve(g_s), s	9.5	16.1	16.3	0.8	12.1	12.1	0.9	0.0	0.4	0.4	0.0	2.4
Cycle Q Clear(g_c), s	9.5	16.1	16.3	0.8	12.1	12.1	3.3	0.0	0.4	0.8	0.0	2.4
Prop In Lane	1.00		0.09	1.00		0.21	1.00		0.82	1.00		1.00
Lane Grp Cap(c), veh/h	311	2435	1316	41	1919	1016	144	0	105	187	115	103
V/C Ratio(X)	0.82	0.63	0.64	0.49	0.51	0.51	0.12	0.00	0.10	0.04	0.00	0.57
Avail Cap(c_a), veh/h	663	3124	1689	143	2130	1128	412	0	430	467	469	419
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	27.2	5.1	5.1	33.1	9.2	9.2	32.7	0.0	30.2	30.6	0.0	31.1
Incr Delay (d2), s/veh	5.3	0.3	0.5	8.6	0.2	0.4	0.4	0.0	0.4	0.1	0.0	4.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.3	3.7	4.1	0.4	3.8	4.1	0.3	0.0	0.2	0.1	0.0	1.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.6	5.4	5.6	41.7	9.4	9.6	33.1	0.0	30.6	30.7	0.0	35.9
LnGrp LOS	C	A	A	D	A	A	C	A	C	C	A	D
Approach Vol, veh/h		2634			1522			28			66	
Approach Delay, s/veh		8.1			9.9			32.1			35.3	
Approach LOS		A			A			C			D	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	6.1	53.5		8.9	16.5	43.1		8.9				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.5	62.9		18.1	25.5	42.9		18.1				
Max Q Clear Time (g_c+I1), s	2.8	18.3		4.4	11.5	14.1		5.3				
Green Ext Time (p_c), s	0.0	30.7		0.2	0.6	13.1		0.0				

Intersection Summary			
HCM 6th Ctrl Delay			9.3
HCM 6th LOS			A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	1617	15	6	2095	16	78	1	18	97	2	254
Future Volume (veh/h)	30	1617	15	6	2095	16	78	1	18	97	2	254
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	34	1838	17	7	2381	18	89	1	20	110	2	289
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	57	3242	30	16	3129	24	130	17	335	372	391	349
Arrive On Green	0.03	0.62	0.62	0.01	0.60	0.60	0.22	0.22	0.22	0.22	0.22	0.22
Sat Flow, veh/h	1781	5217	48	1781	5228	39	1088	76	1521	1391	1777	1585
Grp Volume(v), veh/h	34	1199	656	7	1550	849	89	0	21	110	2	289
Grp Sat Flow(s),veh/h/ln	1781	1702	1862	1781	1702	1863	1088	0	1597	1391	1777	1585
Q Serve(g_s), s	1.7	18.6	18.6	0.4	30.3	30.4	4.2	0.0	0.9	6.1	0.1	15.7
Cycle Q Clear(g_c), s	1.7	18.6	18.6	0.4	30.3	30.4	19.9	0.0	0.9	7.1	0.1	15.7
Prop In Lane	1.00		0.03	1.00		0.02	1.00		0.95	1.00		1.00
Lane Grp Cap(c), veh/h	57	2115	1157	16	2038	1115	130	0	352	372	391	349
V/C Ratio(X)	0.60	0.57	0.57	0.44	0.76	0.76	0.68	0.00	0.06	0.30	0.01	0.83
Avail Cap(c_a), veh/h	128	2317	1267	101	2264	1239	130	0	352	372	391	349
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	43.2	10.0	10.0	44.6	13.4	13.4	44.0	0.0	27.8	30.6	27.5	33.6
Incr Delay (d2), s/veh	9.8	0.3	0.5	18.0	1.4	2.6	13.8	0.0	0.1	0.4	0.0	15.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	6.2	6.9	0.2	10.6	12.0	2.5	0.0	0.4	2.1	0.0	7.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	53.0	10.3	10.5	62.6	14.8	15.9	57.8	0.0	27.9	31.1	27.5	48.7
LnGrp LOS	D	B	B	E	B	B	E	A	C	C	C	D
Approach Vol, veh/h		1889			2406			110			401	
Approach Delay, s/veh		11.1			15.3			52.1			43.8	
Approach LOS		B			B			D			D	
Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	5.3	60.7		24.4	7.4	58.6		24.4				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.1	61.5		19.9	6.5	60.1		19.9				
Max Q Clear Time (g_c+I1), s	2.4	20.6		17.7	3.7	32.4		21.9				
Green Ext Time (p_c), s	0.0	20.5		0.5	0.0	21.7		0.0				
Intersection Summary												
HCM 6th Ctrl Delay			16.9									
HCM 6th LOS			B									



LINSCOTT LAW & GREENSPAN engineers

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Date: 08/16/17

Figure 3-2

Existing Traffic Volumes

WEST OAKS PROPERTY

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APPENDIX G

HCM ANALYSIS WORKSHEETS – EXISTING + PROJECT

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	224	2027	78	23	1226	96	59	2	32	7	0	51
Future Volume (veh/h)	224	2027	78	23	1226	96	59	2	32	7	0	51
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	255	2303	89	26	1393	109	67	2	36	8	0	58
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	307	3447	133	50	2602	204	197	9	165	215	193	172
Arrive On Green	0.17	0.68	0.68	0.03	0.54	0.54	0.11	0.11	0.11	0.11	0.00	0.11
Sat Flow, veh/h	1781	5046	194	1781	4829	378	1345	84	1514	1370	1777	1585
Grp Volume(v), veh/h	255	1550	842	26	982	520	67	0	38	8	0	58
Grp Sat Flow(s),veh/h/ln	1781	1702	1835	1781	1702	1802	1345	0	1598	1370	1777	1585
Q Serve(g_s), s	10.4	19.8	20.1	1.1	14.0	14.0	3.6	0.0	1.6	0.4	0.0	2.5
Cycle Q Clear(g_c), s	10.4	19.8	20.1	1.1	14.0	14.0	6.2	0.0	1.6	2.0	0.0	2.5
Prop In Lane	1.00		0.11	1.00		0.21	1.00		0.95	1.00		1.00
Lane Grp Cap(c), veh/h	307	2326	1254	50	1834	971	197	0	174	215	193	172
V/C Ratio(X)	0.83	0.67	0.67	0.52	0.54	0.54	0.34	0.00	0.22	0.04	0.00	0.34
Avail Cap(c_a), veh/h	606	2858	1541	131	1949	1032	376	0	386	397	429	383
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	30.0	6.9	6.9	35.9	11.2	11.2	33.7	0.0	30.5	31.4	0.0	30.9
Incr Delay (d2), s/veh	5.8	0.4	0.8	8.3	0.3	0.5	1.0	0.0	0.6	0.1	0.0	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.8	5.4	6.1	0.6	4.7	5.0	1.2	0.0	0.6	0.1	0.0	1.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	35.8	7.3	7.8	44.2	11.4	11.7	34.8	0.0	31.1	31.5	0.0	32.0
LnGrp LOS	D	A	A	D	B	B	C	A	C	C	A	C
Approach Vol, veh/h		2647			1528			105			66	
Approach Delay, s/veh		10.2			12.1			33.4			32.0	
Approach LOS		B			B			C			C	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	6.6	55.7		12.6	17.4	44.9		12.6				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.5	62.9		18.1	25.5	42.9		18.1				
Max Q Clear Time (g_c+I1), s	3.1	22.1		4.5	12.4	16.0		8.2				
Green Ext Time (p_c), s	0.0	29.1		0.2	0.6	12.7		0.2				

Intersection Summary			
HCM 6th Ctrl Delay			11.8
HCM 6th LOS			B

Intersection	
Intersection Delay, s/veh	3.3
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	54	29	26	109
Demand Flow Rate, veh/h	55	30	26	111
Vehicles Circulating, veh/h	100	75	149	2
Vehicles Exiting, veh/h	13	100	6	103
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	3.3	3.1	3.3	3.3
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	55	30	26	111
Cap Entry Lane, veh/h	1246	1278	1185	1377
Entry HV Adj Factor	0.980	0.966	0.982	0.981
Flow Entry, veh/h	54	29	26	109
Cap Entry, veh/h	1222	1235	1164	1351
V/C Ratio	0.044	0.023	0.022	0.081
Control Delay, s/veh	3.3	3.1	3.3	3.3
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	1617	59	29	2095	16	97	1	27	97	2	254
Future Volume (veh/h)	30	1617	59	29	2095	16	97	1	27	97	2	254
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	34	1838	67	33	2381	18	110	1	31	110	2	289
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	57	3030	110	56	3129	24	130	11	340	361	391	349
Arrive On Green	0.03	0.60	0.60	0.03	0.60	0.60	0.22	0.22	0.22	0.22	0.22	0.22
Sat Flow, veh/h	1781	5057	184	1781	5228	39	1088	50	1543	1377	1777	1585
Grp Volume(v), veh/h	34	1237	668	33	1550	849	110	0	32	110	2	289
Grp Sat Flow(s),veh/h/ln	1781	1702	1837	1781	1702	1863	1088	0	1593	1377	1777	1585
Q Serve(g_s), s	1.7	20.7	20.7	1.7	30.3	30.4	4.2	0.0	1.4	6.2	0.1	15.7
Cycle Q Clear(g_c), s	1.7	20.7	20.7	1.7	30.3	30.4	19.9	0.0	1.4	7.7	0.1	15.7
Prop In Lane	1.00		0.10	1.00		0.02	1.00		0.97	1.00		1.00
Lane Grp Cap(c), veh/h	57	2040	1101	56	2038	1115	130	0	351	361	391	349
V/C Ratio(X)	0.60	0.61	0.61	0.59	0.76	0.76	0.85	0.00	0.09	0.30	0.01	0.83
Avail Cap(c_a), veh/h	128	2317	1250	101	2264	1239	130	0	351	361	391	349
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	43.2	11.4	11.4	43.2	13.4	13.4	44.2	0.0	28.0	31.1	27.5	33.6
Incr Delay (d2), s/veh	9.8	0.4	0.7	9.7	1.4	2.6	37.3	0.0	0.1	0.5	0.0	15.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	7.1	7.8	0.9	10.6	12.0	3.8	0.0	0.6	2.1	0.0	7.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	53.0	11.8	12.1	53.0	14.8	15.9	81.5	0.0	28.1	31.6	27.5	48.7
LnGrp LOS	D	B	B	D	B	B	F	A	C	C	C	D
Approach Vol, veh/h		1939			2432			142			401	
Approach Delay, s/veh		12.6			15.7			69.5			43.9	
Approach LOS		B			B			E			D	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	7.3	58.6		24.4	7.4	58.6		24.4
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	5.1	61.5		19.9	6.5	60.1		19.9
Max Q Clear Time (g_c+I1), s	3.7	22.7		17.7	3.7	32.4		21.9
Green Ext Time (p_c), s	0.0	20.8		0.5	0.0	21.7		0.0

Intersection Summary	
HCM 6th Ctrl Delay	18.3
HCM 6th LOS	B

Intersection	
Intersection Delay, s/veh	3.3
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	23	111	11	98
Demand Flow Rate, veh/h	23	113	11	100
Vehicles Circulating, veh/h	51	31	48	6
Vehicles Exiting, veh/h	54	28	26	138
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	2.9	3.4	2.9	3.3
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	23	113	11	100
Cap Entry Lane, veh/h	1310	1337	1314	1371
Entry HV Adj Factor	0.998	0.982	0.982	0.975
Flow Entry, veh/h	23	111	11	98
Cap Entry, veh/h	1308	1312	1290	1338
V/C Ratio	0.018	0.085	0.008	0.073
Control Delay, s/veh	2.9	3.4	2.9	3.3
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0

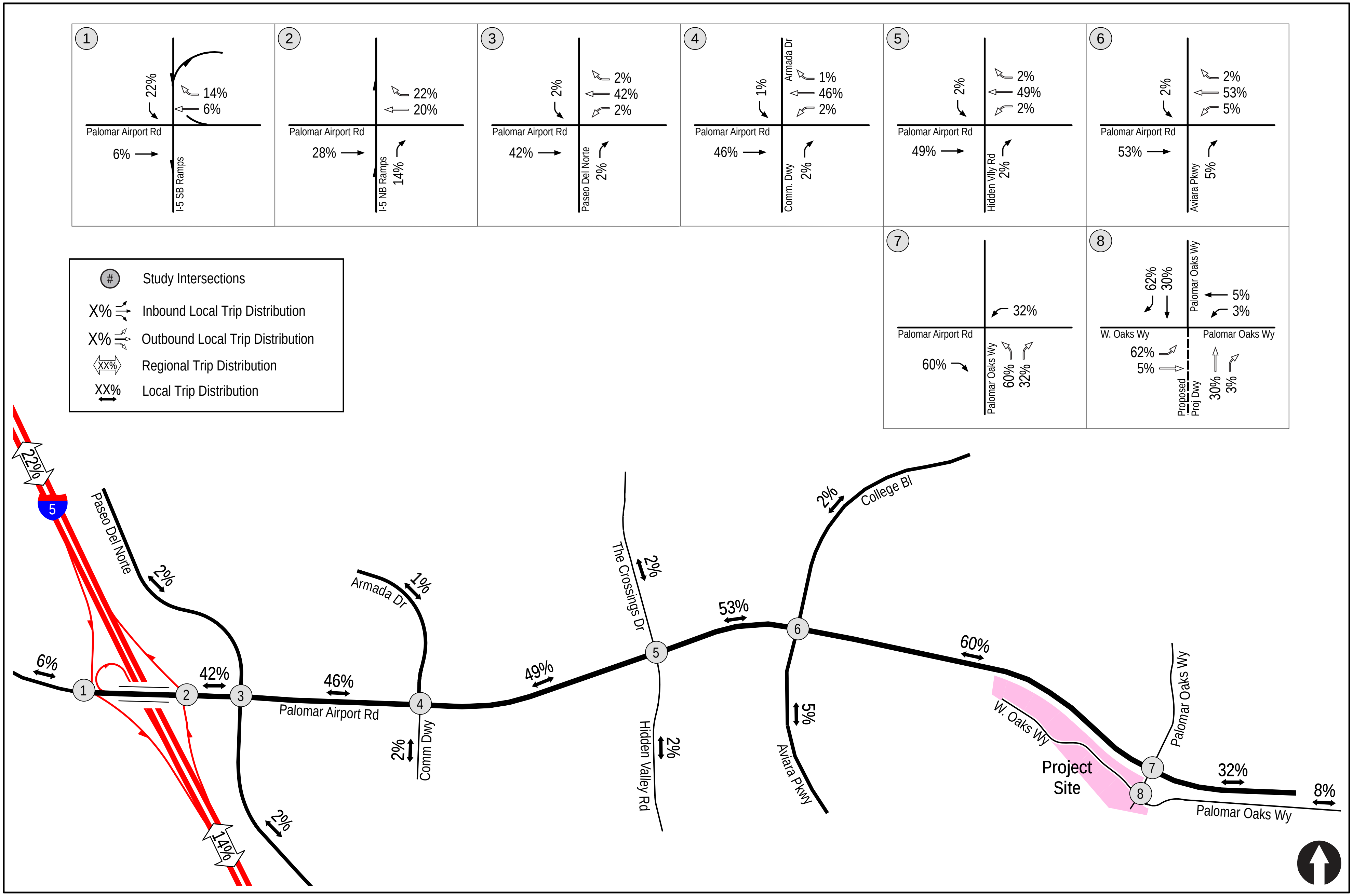

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Figure 8-1

Project Traffic Distribution

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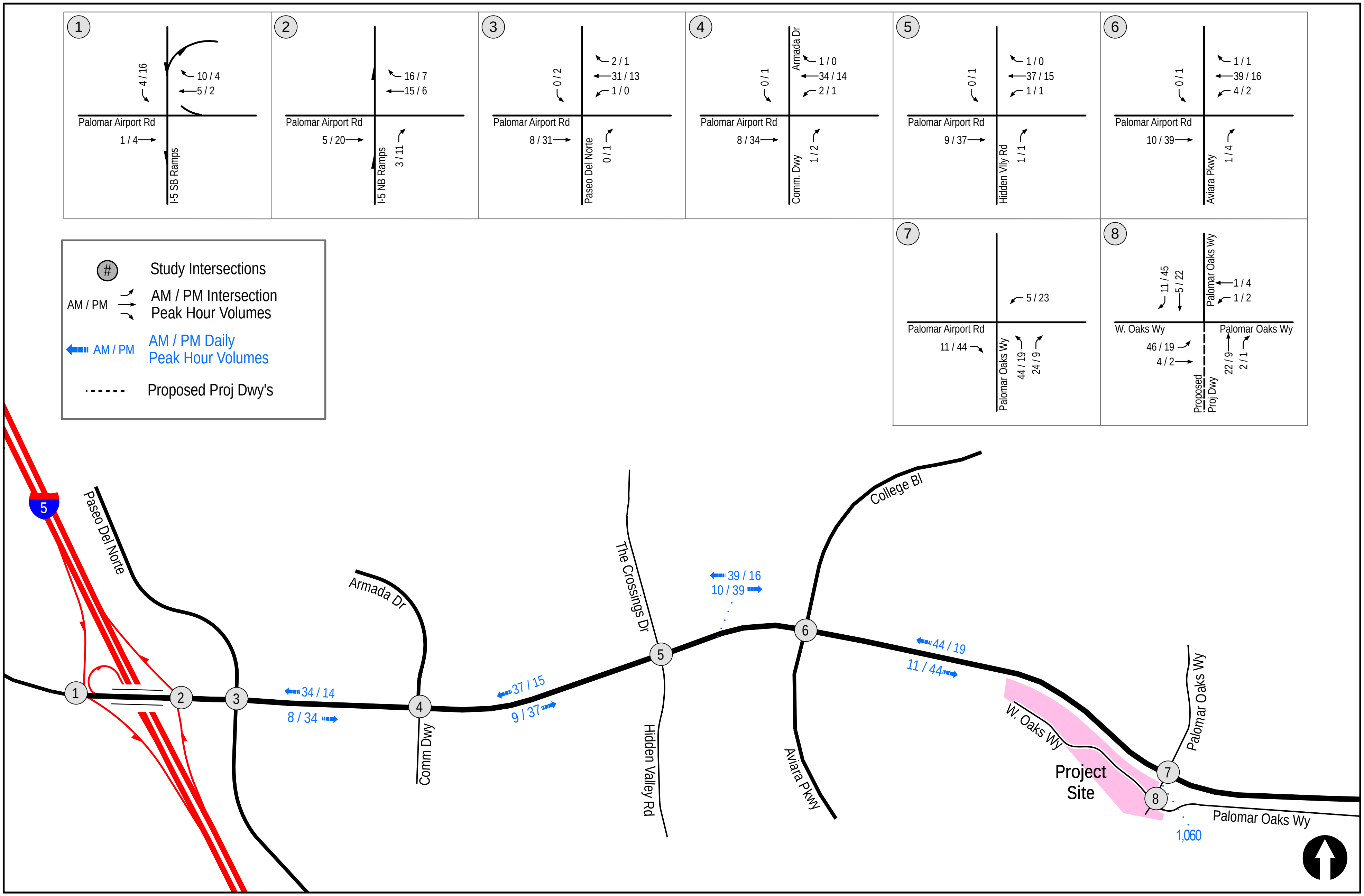

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Figure 8-2

Project Traffic Volumes

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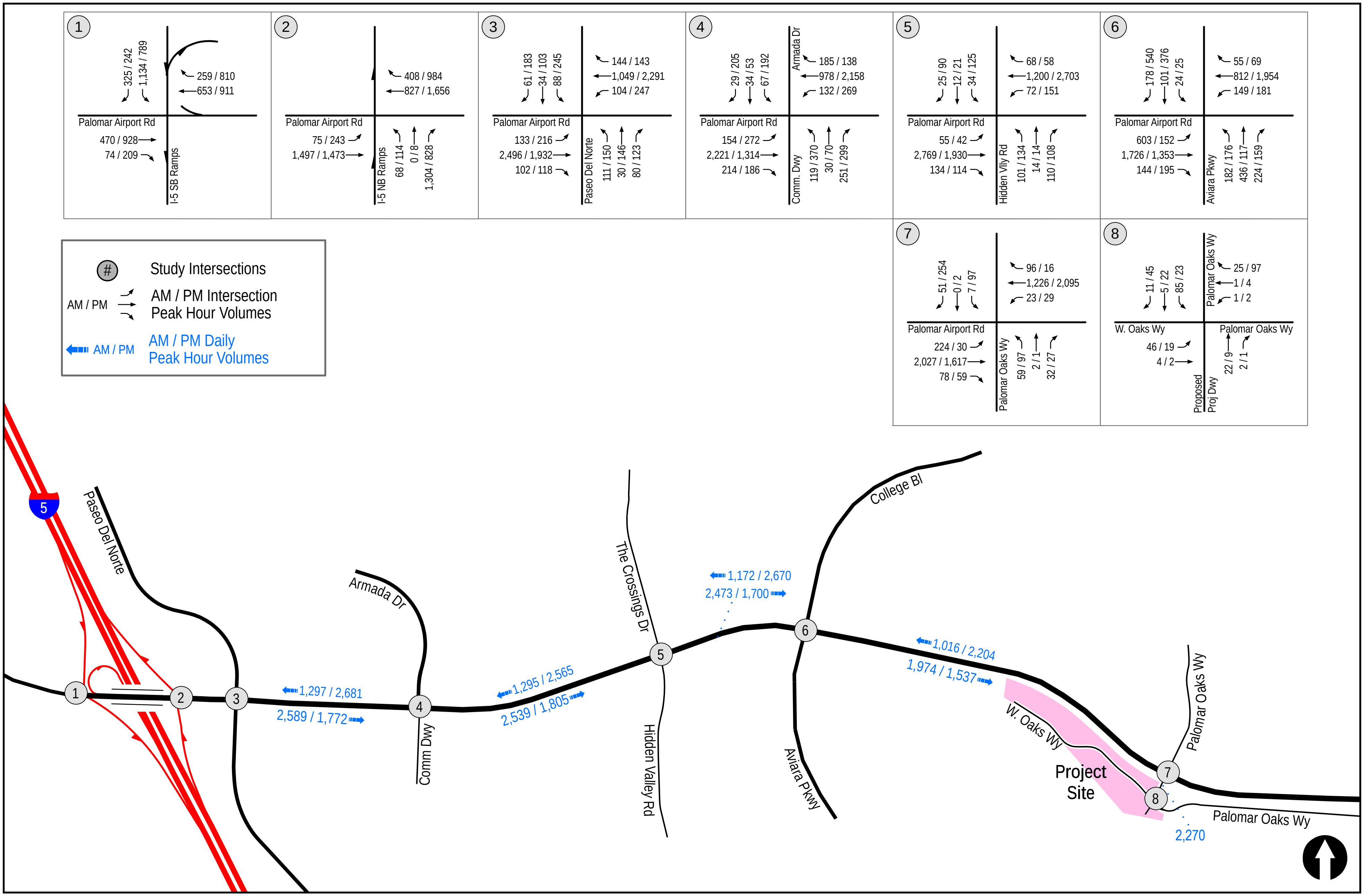

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Figure 8-3

Existing + Project Traffic Volumes

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APPENDIX H

HCM ANALYSIS WORKSHEETS – EXISTING + CUMULATIVE PROJECTS

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	224	2064	67	18	1270	96	15	2	8	7	0	51
Future Volume (veh/h)	224	2064	67	18	1270	96	15	2	8	7	0	51
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	255	2345	76	20	1443	109	17	2	9	8	0	58
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	310	3650	118	41	2747	207	143	19	86	185	115	102
Arrive On Green	0.17	0.72	0.72	0.02	0.57	0.57	0.06	0.06	0.06	0.06	0.00	0.06
Sat Flow, veh/h	1781	5081	164	1781	4843	366	1345	296	1334	1404	1777	1585
Grp Volume(v), veh/h	255	1567	854	20	1014	538	17	0	11	8	0	58
Grp Sat Flow(s),veh/h/ln	1781	1702	1841	1781	1702	1805	1345	0	1630	1404	1777	1585
Q Serve(g_s), s	9.6	16.7	16.9	0.8	12.8	12.8	0.9	0.0	0.4	0.4	0.0	2.5
Cycle Q Clear(g_c), s	9.6	16.7	16.9	0.8	12.8	12.8	3.3	0.0	0.4	0.8	0.0	2.5
Prop In Lane	1.00		0.09	1.00		0.20	1.00		0.82	1.00		1.00
Lane Grp Cap(c), veh/h	310	2446	1323	41	1931	1024	143	0	105	185	115	102
V/C Ratio(X)	0.82	0.64	0.65	0.49	0.53	0.53	0.12	0.00	0.10	0.04	0.00	0.57
Avail Cap(c_a), veh/h	652	3075	1663	141	2097	1112	405	0	424	459	462	412
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	27.7	5.1	5.1	33.6	9.3	9.3	33.2	0.0	30.7	31.1	0.0	31.6
Incr Delay (d2), s/veh	5.4	0.3	0.6	8.7	0.2	0.4	0.4	0.0	0.4	0.1	0.0	4.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.4	3.8	4.3	0.4	4.0	4.3	0.3	0.0	0.2	0.1	0.0	1.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	33.1	5.4	5.7	42.3	9.5	9.7	33.6	0.0	31.1	31.1	0.0	36.4
LnGrp LOS	C	A	A	D	A	A	C	A	C	C	A	D
Approach Vol, veh/h		2676			1572			28			66	
Approach Delay, s/veh		8.2			10.0			32.6			35.8	
Approach LOS		A			A			C			D	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	6.1	54.5		9.0	16.6	44.0		9.0				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.5	62.9		18.1	25.5	42.9		18.1				
Max Q Clear Time (g_c+I1), s	2.8	18.9		4.5	11.6	14.8		5.3				
Green Ext Time (p_c), s	0.0	31.1		0.2	0.6	13.5		0.0				

Intersection Summary			
HCM 6th Ctrl Delay			9.4
HCM 6th LOS			A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	1687	15	6	2158	16	78	1	18	97	2	254
Future Volume (veh/h)	30	1687	15	6	2158	16	78	1	18	97	2	254
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	34	1917	17	7	2452	18	89	1	20	110	2	289
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	56	3268	29	16	3155	23	125	17	331	367	386	345
Arrive On Green	0.03	0.63	0.63	0.01	0.60	0.60	0.22	0.22	0.22	0.22	0.22	0.22
Sat Flow, veh/h	1781	5220	46	1781	5229	38	1088	76	1521	1391	1777	1585
Grp Volume(v), veh/h	34	1250	684	7	1595	875	89	0	21	110	2	289
Grp Sat Flow(s),veh/h/ln	1781	1702	1862	1781	1702	1863	1088	0	1597	1391	1777	1585
Q Serve(g_s), s	1.7	19.9	19.9	0.4	32.0	32.1	3.9	0.0	1.0	6.2	0.1	16.0
Cycle Q Clear(g_c), s	1.7	19.9	19.9	0.4	32.0	32.1	19.9	0.0	1.0	7.2	0.1	16.0
Prop In Lane	1.00		0.02	1.00		0.02	1.00		0.95	1.00		1.00
Lane Grp Cap(c), veh/h	56	2131	1166	16	2054	1124	125	0	347	367	386	345
V/C Ratio(X)	0.60	0.59	0.59	0.44	0.78	0.78	0.71	0.00	0.06	0.30	0.01	0.84
Avail Cap(c_a), veh/h	127	2288	1251	99	2236	1224	125	0	347	367	386	345
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	43.7	10.1	10.1	45.1	13.5	13.6	44.7	0.0	28.4	31.2	28.0	34.3
Incr Delay (d2), s/veh	10.0	0.3	0.6	18.1	1.7	3.0	16.9	0.0	0.1	0.5	0.0	16.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	6.6	7.4	0.2	11.3	12.8	2.6	0.0	0.4	2.1	0.0	7.6
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	53.7	10.5	10.7	63.2	15.2	16.6	61.6	0.0	28.5	31.7	28.1	50.8
LnGrp LOS	D	B	B	E	B	B	E	A	C	C	C	D
Approach Vol, veh/h		1968			2477			110			401	
Approach Delay, s/veh		11.3			15.8			55.3			45.4	
Approach LOS		B			B			E			D	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	5.3	61.8		24.4	7.4	59.7		24.4				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.1	61.5		19.9	6.5	60.1		19.9				
Max Q Clear Time (g_c+I1), s	2.4	21.9		18.0	3.7	34.1		21.9				
Green Ext Time (p_c), s	0.0	21.4		0.4	0.0	21.1		0.0				

Intersection Summary			
HCM 6th Ctrl Delay			17.3
HCM 6th LOS			B

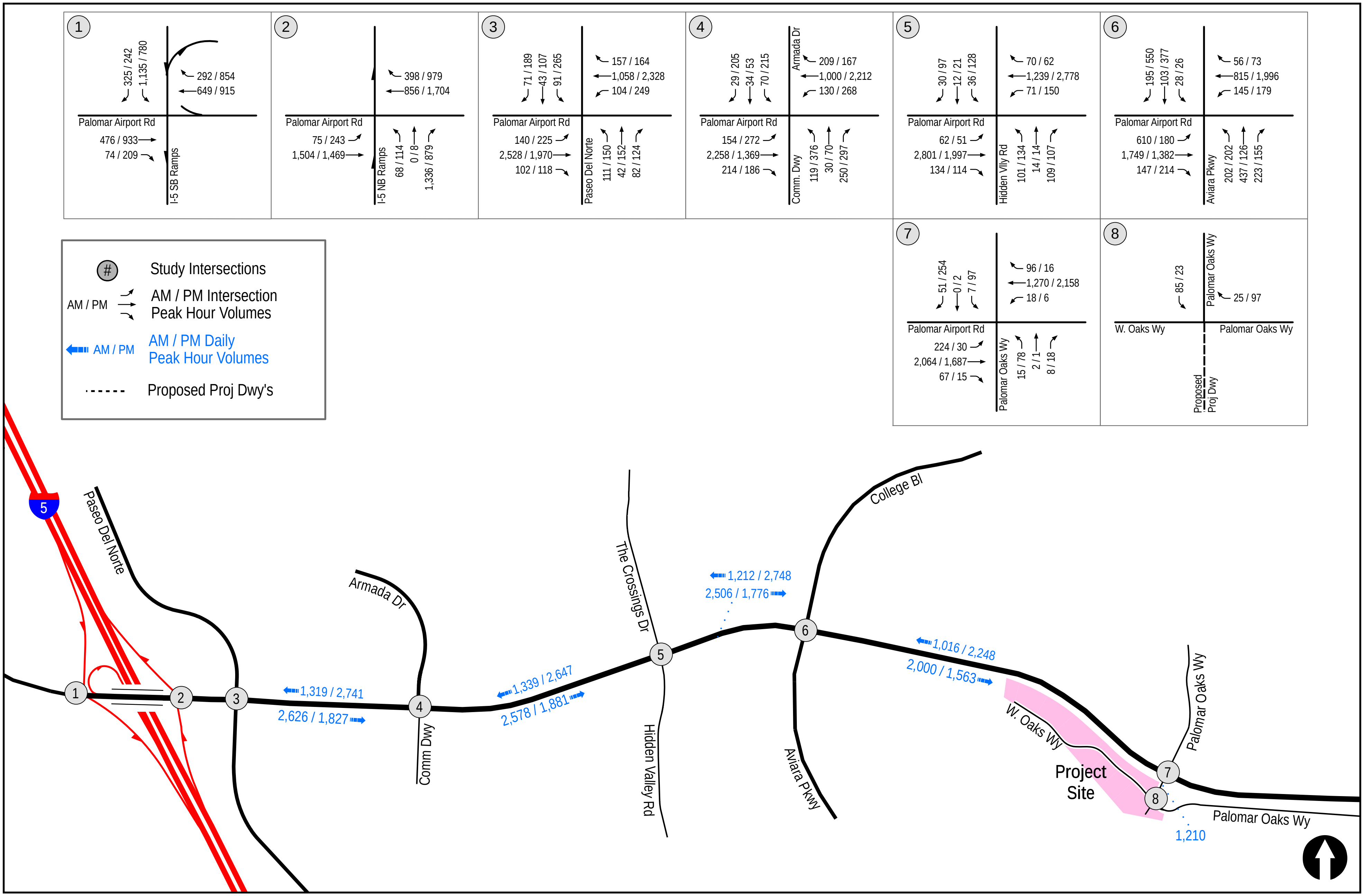

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Figure 7-1

Existing + Cumulative Projects Traffic Volumes

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APPENDIX I

HCM ANALYSIS WORKSHEETS – EXISTING + CUMULATIVE PROJECTS + PROJECT

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	224	2064	78	23	1270	96	59	2	32	7	0	51
Future Volume (veh/h)	224	2064	78	23	1270	96	59	2	32	7	0	51
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	255	2345	89	26	1443	109	67	2	36	8	0	58
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	306	3464	131	50	2625	198	195	9	164	214	193	172
Arrive On Green	0.17	0.69	0.69	0.03	0.54	0.54	0.11	0.11	0.11	0.11	0.00	0.11
Sat Flow, veh/h	1781	5050	191	1781	4843	366	1345	84	1514	1370	1777	1585
Grp Volume(v), veh/h	255	1577	857	26	1014	538	67	0	38	8	0	58
Grp Sat Flow(s),veh/h/ln	1781	1702	1836	1781	1702	1805	1345	0	1598	1370	1777	1585
Q Serve(g_s), s	10.5	20.6	20.9	1.1	14.8	14.8	3.7	0.0	1.7	0.4	0.0	2.6
Cycle Q Clear(g_c), s	10.5	20.6	20.9	1.1	14.8	14.8	6.3	0.0	1.7	2.1	0.0	2.6
Prop In Lane	1.00		0.10	1.00		0.20	1.00		0.95	1.00		1.00
Lane Grp Cap(c), veh/h	306	2335	1260	50	1845	978	195	0	173	214	193	172
V/C Ratio(X)	0.83	0.68	0.68	0.53	0.55	0.55	0.34	0.00	0.22	0.04	0.00	0.34
Avail Cap(c_a), veh/h	598	2818	1520	129	1922	1019	370	0	381	391	423	378
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	30.4	7.0	7.0	36.4	11.3	11.3	34.2	0.0	30.9	31.9	0.0	31.3
Incr Delay (d2), s/veh	5.9	0.5	1.0	8.4	0.3	0.6	1.0	0.0	0.6	0.1	0.0	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.8	5.7	6.4	0.6	5.0	5.3	1.2	0.0	0.6	0.1	0.0	1.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	36.3	7.5	8.0	44.8	11.7	11.9	35.3	0.0	31.6	31.9	0.0	32.5
LnGrp LOS	D	A	A	D	B	B	D	A	C	C	A	C
Approach Vol, veh/h		2689			1578			105			66	
Approach Delay, s/veh		10.4			12.3			33.9			32.4	
Approach LOS		B			B			C			C	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	6.6	56.6		12.7	17.6	45.7		12.7				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.5	62.9		18.1	25.5	42.9		18.1				
Max Q Clear Time (g_c+I1), s	3.1	22.9		4.6	12.5	16.8		8.3				
Green Ext Time (p_c), s	0.0	29.2		0.2	0.6	13.0		0.2				

Intersection Summary			
HCM 6th Ctrl Delay			11.9
HCM 6th LOS			B

Intersection	
Intersection Delay, s/veh	3.3
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	54	29	26	109
Demand Flow Rate, veh/h	55	30	26	111
Vehicles Circulating, veh/h	100	75	149	2
Vehicles Exiting, veh/h	13	100	6	103
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	3.3	3.1	3.3	3.3
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	55	30	26	111
Cap Entry Lane, veh/h	1246	1278	1185	1377
Entry HV Adj Factor	0.980	0.966	0.982	0.981
Flow Entry, veh/h	54	29	26	109
Cap Entry, veh/h	1222	1235	1164	1351
V/C Ratio	0.044	0.023	0.022	0.081
Control Delay, s/veh	3.3	3.1	3.3	3.3
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱		↰	↑↑↱		↰	↱		↰	↑↱	
Traffic Volume (veh/h)	30	1687	59	29	2158	16	97	1	27	97	2	254
Future Volume (veh/h)	30	1687	59	29	2158	16	97	1	27	97	2	254
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	34	1917	67	33	2452	18	110	1	31	110	2	289
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	56	3060	107	55	3155	23	125	11	336	356	386	345
Arrive On Green	0.03	0.60	0.60	0.03	0.60	0.60	0.22	0.22	0.22	0.22	0.22	0.22
Sat Flow, veh/h	1781	5066	177	1781	5229	38	1088	50	1543	1377	1777	1585
Grp Volume(v), veh/h	34	1287	697	33	1595	875	110	0	32	110	2	289
Grp Sat Flow(s),veh/h/ln	1781	1702	1839	1781	1702	1863	1088	0	1593	1377	1777	1585
Q Serve(g_s), s	1.7	22.0	22.1	1.7	32.0	32.1	3.9	0.0	1.5	6.3	0.1	16.0
Cycle Q Clear(g_c), s	1.7	22.0	22.1	1.7	32.0	32.1	19.9	0.0	1.5	7.8	0.1	16.0
Prop In Lane	1.00		0.10	1.00		0.02	1.00		0.97	1.00		1.00
Lane Grp Cap(c), veh/h	56	2056	1110	55	2054	1124	125	0	346	356	386	345
V/C Ratio(X)	0.60	0.63	0.63	0.60	0.78	0.78	0.88	0.00	0.09	0.31	0.01	0.84
Avail Cap(c_a), veh/h	127	2288	1236	99	2236	1224	125	0	346	356	386	345
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	43.7	11.5	11.6	43.8	13.5	13.6	44.9	0.0	28.6	31.7	28.0	34.3
Incr Delay (d2), s/veh	10.0	0.5	0.9	9.9	1.7	3.0	45.3	0.0	0.1	0.5	0.0	16.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	7.6	8.3	0.9	11.3	12.8	4.1	0.0	0.6	2.1	0.0	7.6
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	53.7	12.0	12.4	53.7	15.2	16.6	90.3	0.0	28.7	32.2	28.1	50.8
LnGrp LOS	D	B	B	D	B	B	F	A	C	C	C	D
Approach Vol, veh/h		2018			2503			142			401	
Approach Delay, s/veh		12.8			16.2			76.4			45.6	
Approach LOS		B			B			E			D	

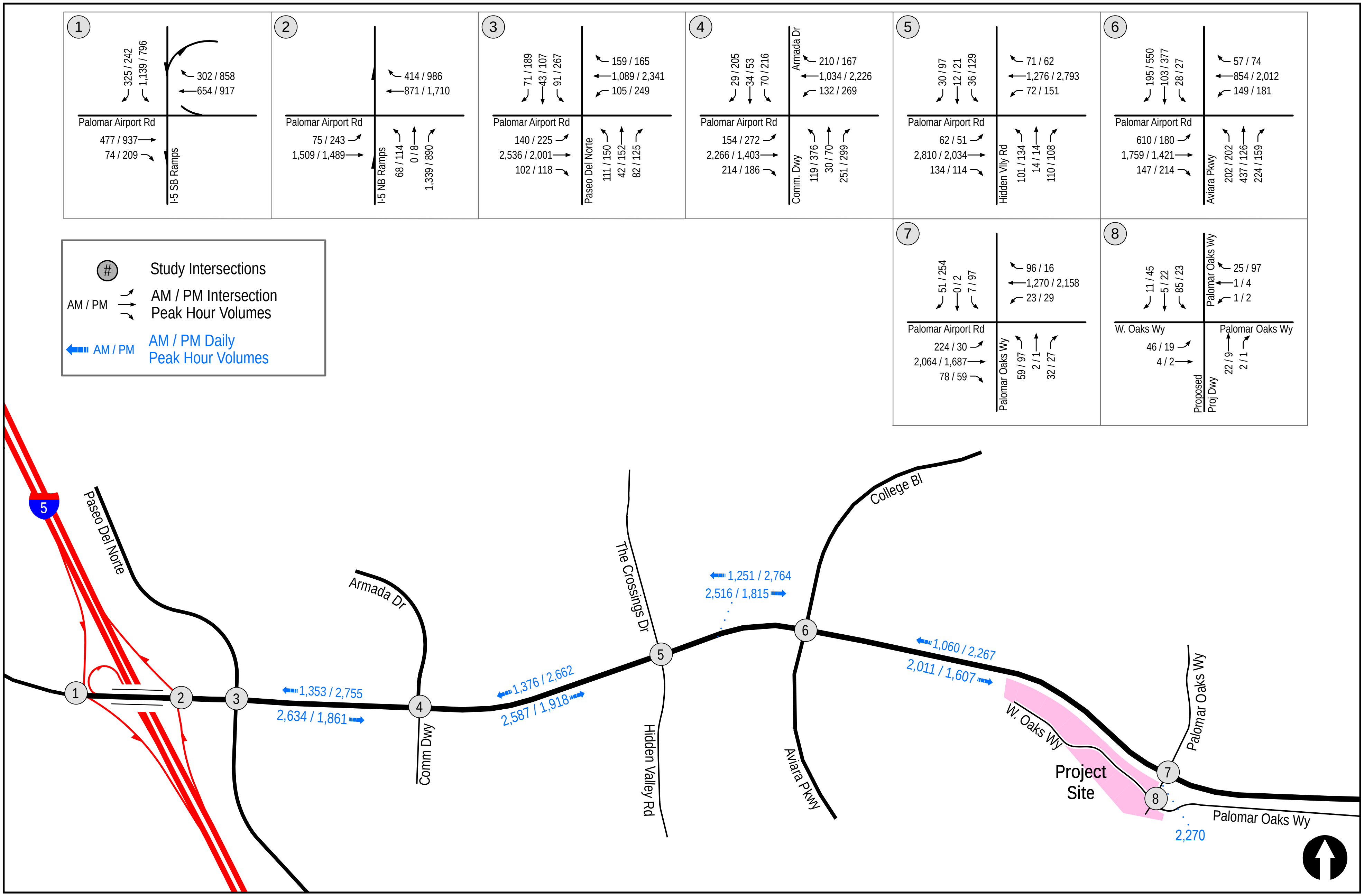
Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	7.3	59.8		24.4	7.4	59.7		24.4				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.1	61.5		19.9	6.5	60.1		19.9				
Max Q Clear Time (g_c+I1), s	3.7	24.1		18.0	3.7	34.1		21.9				
Green Ext Time (p_c), s	0.0	21.6		0.4	0.0	21.1		0.0				

Intersection Summary			
HCM 6th Ctrl Delay			18.9
HCM 6th LOS			B

Intersection	
Intersection Delay, s/veh	3.3
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	23	111	11	98
Demand Flow Rate, veh/h	23	113	11	100
Vehicles Circulating, veh/h	51	31	48	6
Vehicles Exiting, veh/h	54	28	26	138
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	2.9	3.4	2.9	3.3
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	23	113	11	100
Cap Entry Lane, veh/h	1310	1337	1314	1371
Entry HV Adj Factor	0.998	0.982	0.982	0.975
Flow Entry, veh/h	23	111	11	98
Cap Entry, veh/h	1308	1312	1290	1338
V/C Ratio	0.018	0.085	0.008	0.073
Control Delay, s/veh	2.9	3.4	2.9	3.3
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0



LINSCOTT LAW & GREENSPAN engineers

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Figure 8-4

Existing + Project + Cumulative Projects Traffic Volumes

WEST OAKS PROPERTY

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APPENDIX J

HCM ANALYSIS WORKSHEETS – YEAR 2035

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	294	2159	136	40	1308	130	46	5	18	10	0	70
Future Volume (veh/h)	294	2159	136	40	1308	130	46	5	18	10	0	70
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	320	2347	148	43	1422	141	50	5	20	11	0	76
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
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	372	3362	210	69	2430	241	172	35	138	219	188	168
Arrive On Green	0.21	0.68	0.68	0.04	0.51	0.51	0.11	0.11	0.11	0.11	0.00	0.11
Sat Flow, veh/h	1781	4913	307	1781	4722	468	1323	327	1308	1386	1777	1585
Grp Volume(v), veh/h	320	1619	876	43	1025	538	50	0	25	11	0	76
Grp Sat Flow(s),veh/h/ln	1781	1702	1815	1781	1702	1786	1323	0	1635	1386	1777	1585
Q Serve(g_s), s	13.7	22.6	23.2	1.9	16.5	16.5	2.9	0.0	1.1	0.6	0.0	3.6
Cycle Q Clear(g_c), s	13.7	22.6	23.2	1.9	16.5	16.5	6.5	0.0	1.1	1.7	0.0	3.6
Prop In Lane	1.00		0.17	1.00		0.26	1.00		0.80	1.00		1.00
Lane Grp Cap(c), veh/h	372	2330	1242	69	1752	919	172	0	173	219	188	168
V/C Ratio(X)	0.86	0.69	0.71	0.62	0.59	0.59	0.29	0.00	0.14	0.05	0.00	0.45
Avail Cap(c_a), veh/h	644	2715	1448	124	1752	919	335	0	375	390	408	364
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	30.1	7.5	7.6	37.3	13.3	13.3	36.2	0.0	32.0	32.8	0.0	33.1
Incr Delay (d2), s/veh	5.9	0.6	1.3	8.9	0.5	1.0	0.9	0.0	0.4	0.1	0.0	1.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.3	6.4	7.3	1.0	5.8	6.2	1.0	0.0	0.4	0.2	0.0	1.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	36.1	8.1	8.9	46.2	13.8	14.3	37.1	0.0	32.4	32.9	0.0	35.0
LnGrp LOS	D	A	A	D	B	B	D	A	C	C	A	D
Approach Vol, veh/h		2815			1606			75			87	
Approach Delay, s/veh		11.5			14.8			35.5			34.8	
Approach LOS		B			B			D			C	

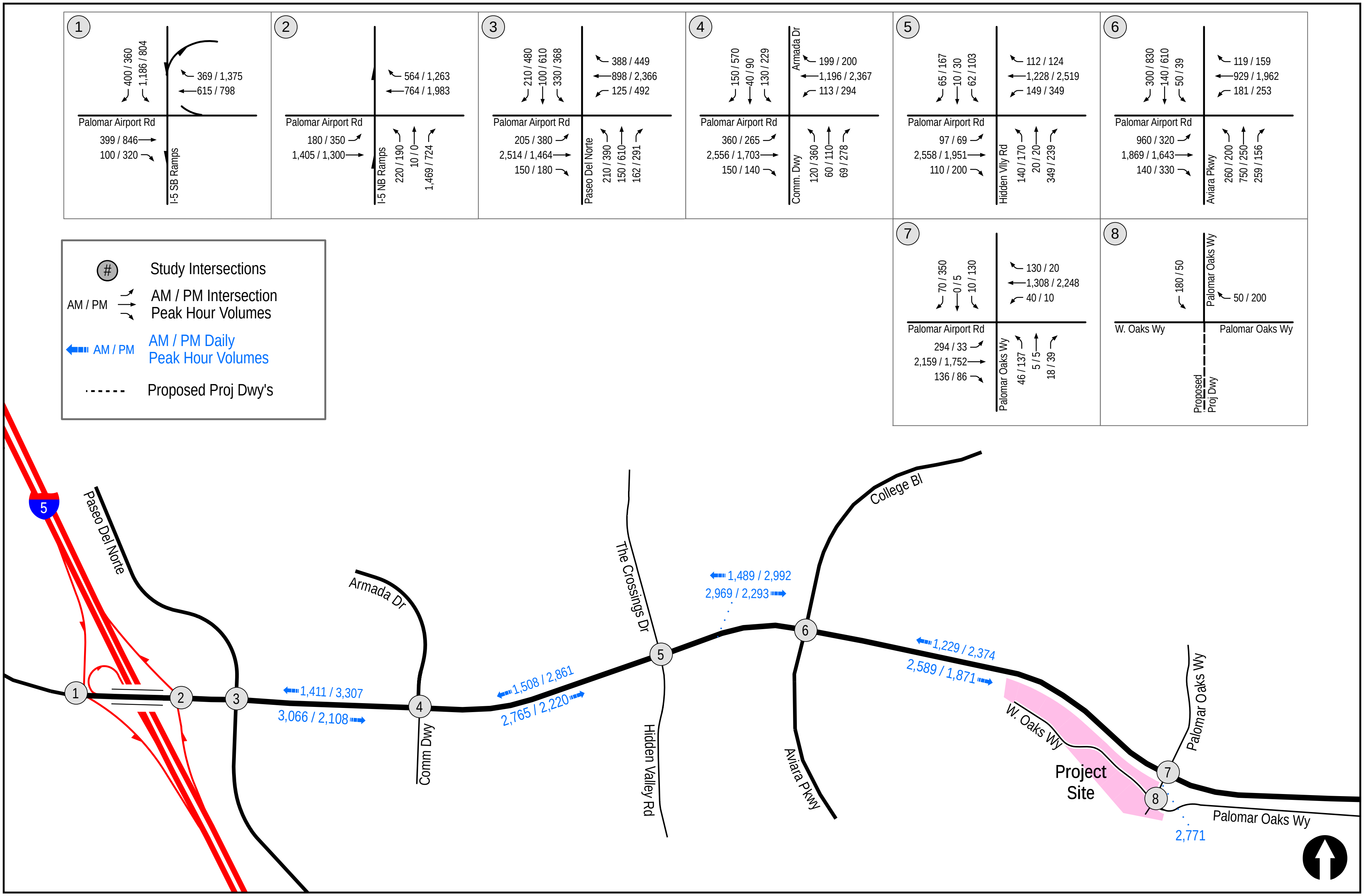
Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	7.6	58.5		12.8	21.0	45.1		12.8
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	5.5	62.9		18.1	28.5	39.9		18.1
Max Q Clear Time (g_c+I1), s	3.9	25.2		5.6	15.7	18.5		8.5
Green Ext Time (p_c), s	0.0	28.8		0.3	0.8	11.7		0.1

Intersection Summary	
HCM 6th Ctrl Delay	13.5
HCM 6th LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	33	1752	86	10	2248	20	137	5	39	130	5	350
Future Volume (veh/h)	33	1752	86	10	2248	20	137	5	39	130	5	350
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	36	1904	93	11	2443	22	149	5	42	141	5	380
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
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	57	2799	136	24	2830	25	135	49	411	433	507	452
Arrive On Green	0.03	0.56	0.56	0.01	0.54	0.54	0.29	0.29	0.29	0.29	0.29	0.29
Sat Flow, veh/h	1781	4988	243	1781	5219	47	998	171	1440	1359	1777	1585
Grp Volume(v), veh/h	36	1298	699	11	1592	873	149	0	47	141	5	380
Grp Sat Flow(s),veh/h/ln	1781	1702	1827	1781	1702	1862	998	0	1611	1359	1777	1585
Q Serve(g_s), s	1.9	26.1	26.2	0.6	38.7	38.9	5.8	0.0	2.1	8.2	0.2	21.7
Cycle Q Clear(g_c), s	1.9	26.1	26.2	0.6	38.7	38.9	27.5	0.0	2.1	10.3	0.2	21.7
Prop In Lane	1.00		0.13	1.00		0.03	1.00		0.89	1.00		1.00
Lane Grp Cap(c), veh/h	57	1910	1025	24	1846	1010	135	0	460	433	507	452
V/C Ratio(X)	0.63	0.68	0.68	0.47	0.86	0.86	1.11	0.00	0.10	0.33	0.01	0.84
Avail Cap(c_a), veh/h	98	1910	1025	94	1897	1038	135	0	460	433	507	452
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	46.1	15.0	15.0	47.2	19.0	19.0	46.9	0.0	25.3	29.1	24.7	32.4
Incr Delay (d2), s/veh	10.9	1.0	1.9	13.7	4.3	7.6	108.7	0.0	0.1	0.4	0.0	13.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	9.5	10.5	0.3	15.1	17.5	7.3	0.0	0.8	2.7	0.1	9.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	56.9	16.0	16.9	60.8	23.2	26.6	155.6	0.0	25.4	29.5	24.7	45.6
LnGrp LOS	E	B	B	E	C	C	F	A	C	C	C	D
Approach Vol, veh/h		2033			2476			196			526	
Approach Delay, s/veh		17.0			24.6			124.4			41.1	
Approach LOS		B			C			F			D	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	5.8	58.6		32.0	7.6	56.7		32.0				
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5				
Max Green Setting (Gmax), s	5.1	53.9		27.5	5.3	53.7		27.5				
Max Q Clear Time (g_c+I1), s	2.6	28.2		23.7	3.9	40.9		29.5				
Green Ext Time (p_c), s	0.0	17.2		1.1	0.0	11.3		0.0				

Intersection Summary			
HCM 6th Ctrl Delay			27.0
HCM 6th LOS			C



LINSCOTT LAW & GREENSPAN engineers

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Figure 10-1

Year 2035 Traffic Volumes

West Oaks Property

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APPENDIX K

HCM ANALYSIS WORKSHEETS – YEAR 2035 + PROJECT

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	294	2159	147	45	1308	130	90	5	42	10	0	70
Future Volume (veh/h)	294	2159	147	45	1308	130	90	5	42	10	0	70
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	320	2347	160	49	1422	141	98	5	46	11	0	76
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
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	368	3218	217	72	2326	231	215	22	205	238	251	224
Arrive On Green	0.21	0.66	0.66	0.04	0.49	0.49	0.14	0.14	0.14	0.14	0.00	0.14
Sat Flow, veh/h	1781	4886	329	1781	4722	468	1323	158	1451	1354	1777	1585
Grp Volume(v), veh/h	320	1627	880	49	1025	538	98	0	51	11	0	76
Grp Sat Flow(s),veh/h/ln	1781	1702	1811	1781	1702	1786	1323	0	1609	1354	1777	1585
Q Serve(g_s), s	14.7	26.4	27.3	2.3	18.5	18.5	6.1	0.0	2.4	0.6	0.0	3.7
Cycle Q Clear(g_c), s	14.7	26.4	27.3	2.3	18.5	18.5	9.8	0.0	2.4	3.0	0.0	3.7
Prop In Lane	1.00		0.18	1.00		0.26	1.00		0.90	1.00		1.00
Lane Grp Cap(c), veh/h	368	2242	1193	72	1677	880	215	0	228	238	251	224
V/C Ratio(X)	0.87	0.73	0.74	0.68	0.61	0.61	0.46	0.00	0.22	0.05	0.00	0.34
Avail Cap(c_a), veh/h	600	2531	1346	116	1677	880	311	0	344	337	380	339
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	32.5	9.4	9.6	40.1	15.6	15.6	37.2	0.0	32.2	33.5	0.0	32.8
Incr Delay (d2), s/veh	7.8	0.9	1.9	10.7	0.7	1.2	1.5	0.0	0.5	0.1	0.0	0.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.9	8.3	9.4	1.2	6.8	7.3	2.0	0.0	0.9	0.2	0.0	1.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	40.3	10.4	11.5	50.8	16.2	16.8	38.7	0.0	32.7	33.6	0.0	33.6
LnGrp LOS	D	B	B	D	B	B	D	A	C	C	A	C
Approach Vol, veh/h		2827			1612			149			87	
Approach Delay, s/veh		14.1			17.5			36.6			33.6	
Approach LOS		B			B			D			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	7.9	60.2		16.5	22.0	46.2		16.5
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	5.5	62.9		18.1	28.5	39.9		18.1
Max Q Clear Time (g_c+I1), s	4.3	29.3		5.7	16.7	20.5		11.8
Green Ext Time (p_c), s	0.0	26.4		0.3	0.8	11.1		0.3

Intersection Summary	
HCM 6th Ctrl Delay	16.4
HCM 6th LOS	B

Intersection	
Intersection Delay, s/veh	3.7
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	54	77	26	208
Demand Flow Rate, veh/h	55	78	26	212
Vehicles Circulating, veh/h	201	75	250	2
Vehicles Exiting, veh/h	13	201	6	151
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	3.7	3.3	3.6	3.9
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	55	78	26	212
Cap Entry Lane, veh/h	1124	1278	1069	1377
Entry HV Adj Factor	0.980	0.987	0.982	0.981
Flow Entry, veh/h	54	77	26	208
Cap Entry, veh/h	1102	1262	1050	1350
V/C Ratio	0.049	0.061	0.024	0.154
Control Delay, s/veh	3.7	3.3	3.6	3.9
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	33	1752	130	33	2248	20	156	5	48	130	5	350
Future Volume (veh/h)	33	1752	130	33	2248	20	156	5	48	130	5	350
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	36	1904	141	36	2443	22	170	5	52	141	5	380
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
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	57	2493	184	57	2681	24	174	44	462	465	561	500
Arrive On Green	0.03	0.51	0.51	0.03	0.51	0.51	0.32	0.32	0.32	0.32	0.32	0.32
Sat Flow, veh/h	1781	4852	358	1781	5219	47	998	141	1466	1346	1777	1585
Grp Volume(v), veh/h	36	1334	711	36	1592	873	170	0	57	141	5	380
Grp Sat Flow(s),veh/h/ln	1781	1702	1806	1781	1702	1862	998	0	1607	1346	1777	1585
Q Serve(g_s), s	1.9	30.5	30.8	1.9	41.6	41.7	9.7	0.0	2.4	8.1	0.2	21.0
Cycle Q Clear(g_c), s	1.9	30.5	30.8	1.9	41.6	41.7	30.7	0.0	2.4	10.5	0.2	21.0
Prop In Lane	1.00		0.20	1.00		0.03	1.00		0.91	1.00		1.00
Lane Grp Cap(c), veh/h	57	1749	928	57	1749	957	174	0	507	465	561	500
V/C Ratio(X)	0.63	0.76	0.77	0.63	0.91	0.91	0.98	0.00	0.11	0.30	0.01	0.76
Avail Cap(c_a), veh/h	97	1774	941	93	1767	966	174	0	507	465	561	500
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	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	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	46.5	18.9	19.0	46.5	21.6	21.7	45.8	0.0	23.6	27.4	22.9	30.0
Incr Delay (d2), s/veh	11.0	2.0	3.8	11.0	7.5	12.6	62.1	0.0	0.1	0.4	0.0	6.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	11.7	13.0	1.0	17.2	20.2	7.1	0.0	0.9	2.6	0.1	8.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	57.5	20.9	22.8	57.5	29.1	34.2	108.0	0.0	23.7	27.7	22.9	36.7
LnGrp LOS	E	C	C	E	C	C	F	A	C	C	C	D
Approach Vol, veh/h		2081			2501			227			526	
Approach Delay, s/veh		22.2			31.3			86.8			34.1	
Approach LOS		C			C			F			C	

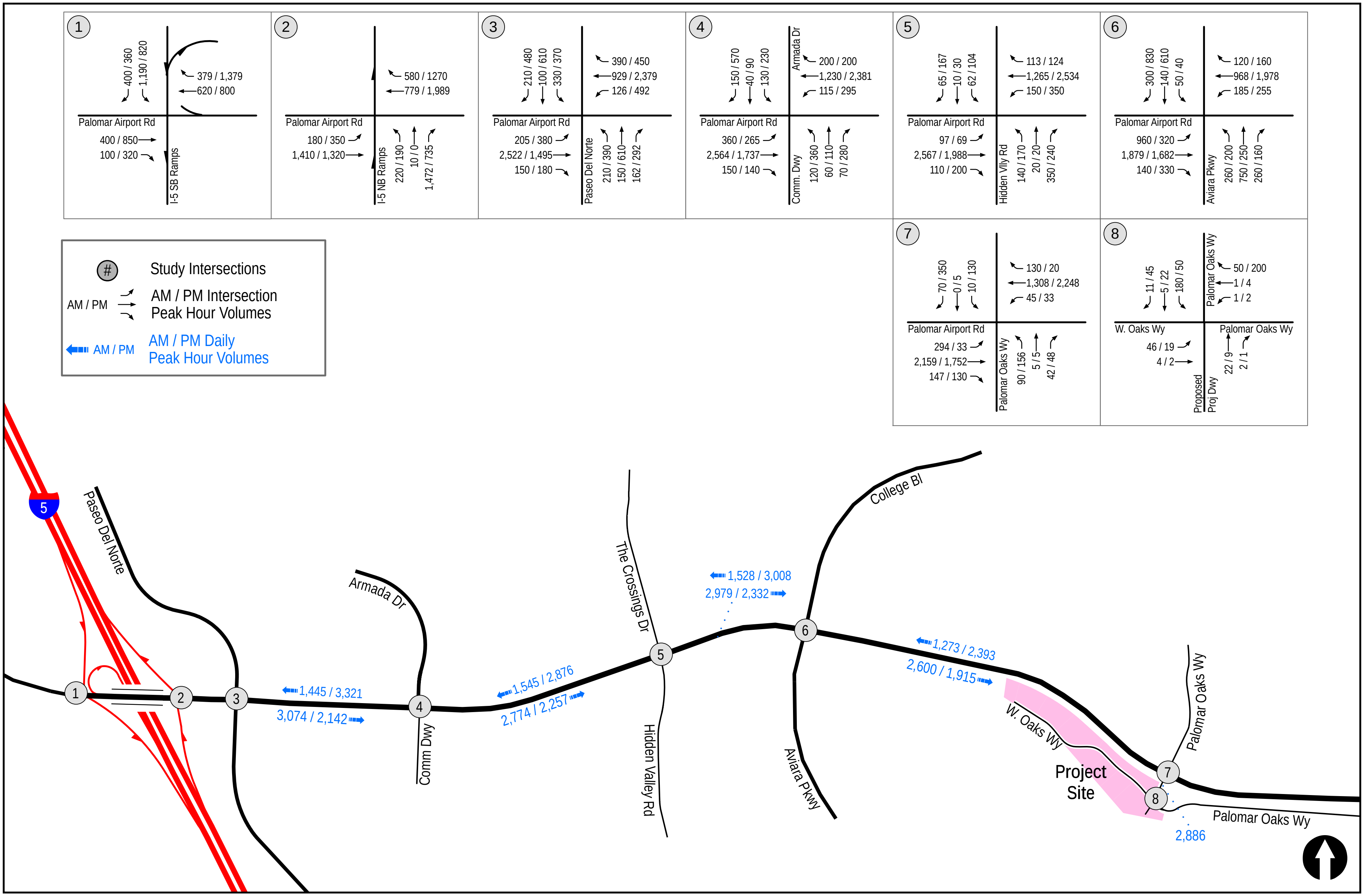
Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	7.6	54.5		35.2	7.6	54.5		35.2
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5		4.5
Max Green Setting (Gmax), s	5.1	50.7		30.7	5.3	50.5		30.7
Max Q Clear Time (g_c+I1), s	3.9	32.8		23.0	3.9	43.7		32.7
Green Ext Time (p_c), s	0.0	13.5		1.9	0.0	6.2		0.0

Intersection Summary			
HCM 6th Ctrl Delay			30.4
HCM 6th LOS			C

Intersection	
Intersection Delay, s/veh	3.8
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	23	203	11	183
Demand Flow Rate, veh/h	23	207	11	186
Vehicles Circulating, veh/h	138	31	135	6
Vehicles Exiting, veh/h	54	115	26	232
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	3.2	4.0	3.1	3.8
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	23	207	11	186
Cap Entry Lane, veh/h	1199	1337	1202	1371
Entry HV Adj Factor	0.998	0.980	0.982	0.981
Flow Entry, veh/h	23	203	11	183
Cap Entry, veh/h	1197	1311	1181	1346
V/C Ratio	0.019	0.155	0.009	0.136
Control Delay, s/veh	3.2	4.0	3.1	3.8
LOS	A	A	A	A
95th %tile Queue, veh	0	1	0	0



Linscott Law & Greenspan engineers

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Date: 08/16/17

Figure 10-2

Year 2035 + Project Traffic Volumes

West Oaks Property

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APPENDIX L

HCM ANALYSIS WORKSHEETS – ALL-WAY STOP ACCESS ALTERNATIVE

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Intersection	
Intersection Delay, s/veh	7.7
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	46	4	0	1	1	25	0	22	2	85	5	11
Future Vol, veh/h	46	4	0	1	1	25	0	22	2	85	5	11
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	50	4	0	1	1	27	0	24	2	92	5	12
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	7.8	6.9	7.3	7.9
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	0%	92%	4%	84%
Vol Thru, %	92%	8%	4%	5%
Vol Right, %	8%	0%	93%	11%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	24	50	27	101
LT Vol	0	46	1	85
Through Vol	22	4	1	5
RT Vol	2	0	25	11
Lane Flow Rate	26	54	29	110
Geometry Grp	1	1	1	1
Degree of Util (X)	0.03	0.066	0.03	0.128
Departure Headway (Hd)	4.113	4.377	3.663	4.201
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	861	809	960	849
Service Time	2.183	2.453	1.751	2.25
HCM Lane V/C Ratio	0.03	0.067	0.03	0.13
HCM Control Delay	7.3	7.8	6.9	7.9
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0.1	0.2	0.1	0.4

Intersection	
Intersection Delay, s/veh	7.3
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	19	2	0	2	4	97	0	9	1	23	22	45
Future Vol, veh/h	19	2	0	2	4	97	0	9	1	23	22	45
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	21	2	0	2	4	105	0	10	1	25	24	49
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	7.6	7.1	7.3	7.4
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	0%	90%	2%	26%
Vol Thru, %	90%	10%	4%	24%
Vol Right, %	10%	0%	94%	50%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	10	21	103	90
LT Vol	0	19	2	23
Through Vol	9	2	4	22
RT Vol	1	0	97	45
Lane Flow Rate	11	23	112	98
Geometry Grp	1	1	1	1
Degree of Util (X)	0.013	0.028	0.111	0.107
Departure Headway (Hd)	4.185	4.393	3.579	3.927
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	849	810	993	909
Service Time	2.24	2.448	1.631	1.966
HCM Lane V/C Ratio	0.013	0.028	0.113	0.108
HCM Control Delay	7.3	7.6	7.1	7.4
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0	0.1	0.4	0.4

Intersection	
Intersection Delay, s/veh	8.4
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	46	4	0	1	1	69	0	22	2	176	5	11
Future Vol, veh/h	46	4	0	1	1	69	0	22	2	176	5	11
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	50	4	0	1	1	75	0	24	2	191	5	12
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	8.1	7.3	7.6	8.9
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	0%	92%	1%	92%
Vol Thru, %	92%	8%	1%	3%
Vol Right, %	8%	0%	97%	6%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	24	50	71	192
LT Vol	0	46	1	176
Through Vol	22	4	1	5
RT Vol	2	0	69	11
Lane Flow Rate	26	54	77	209
Geometry Grp	1	1	1	1
Degree of Util (X)	0.032	0.072	0.085	0.251
Departure Headway (Hd)	4.403	4.746	3.964	4.331
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	816	759	908	818
Service Time	2.415	2.75	1.969	2.416
HCM Lane V/C Ratio	0.032	0.071	0.085	0.256
HCM Control Delay	7.6	8.1	7.3	8.9
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0.1	0.2	0.3	1

Intersection	
Intersection Delay, s/veh	8.2
Intersection LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	19	2	0	2	4	181	0	9	1	101	22	45
Future Vol, veh/h	19	2	0	2	4	181	0	9	1	101	22	45
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	21	2	0	2	4	197	0	10	1	110	24	49
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	7.9	7.9	7.6	8.6
HCM LOS	A	A	A	A

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	0%	90%	1%	60%
Vol Thru, %	90%	10%	2%	13%
Vol Right, %	10%	0%	97%	27%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	10	21	187	168
LT Vol	0	19	2	101
Through Vol	9	2	4	22
RT Vol	1	0	181	45
Lane Flow Rate	11	23	203	183
Geometry Grp	1	1	1	1
Degree of Util (X)	0.014	0.03	0.216	0.218
Departure Headway (Hd)	4.542	4.763	3.831	4.294
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	790	755	941	824
Service Time	2.558	2.771	1.834	2.384
HCM Lane V/C Ratio	0.014	0.03	0.216	0.222
HCM Control Delay	7.6	7.9	7.9	8.6
HCM Lane LOS	A	A	A	A
HCM 95th-tile Q	0	0.1	0.8	0.8