LAGAE RANCH PA-7

FOCUSED TRAFFIC IMPACT ANALYSIS

REVISED: MAY 3, 2019

JOB NUMBER: 17665C

RICK

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Lagae Ranch PA-7

Focused Traffic Impact Analysis

Revised: May 3, 2019

Prepared for:

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Prepared by:

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Job Number 17665-C

EXECUTIVE SUMMARY

Lagae Ranch PA-7

Focused Traffic Impact Analysis

Revised: May 3, 2019

INTRODUCTION

The following study has been prepared to determine the future intersection improvement needs associated with the proposed change in land use from 75,000 square-feet of church use to 190 multi-family residential dwelling units in Planning Area 7 (PA-7) of the Lagae Ranch Planned Development located in the City of Castle Pines, Colorado.

PROJECT DESCRIPTION

The project proposes to construct 190 multi-family residential units on the 15.86-acre PA-7 site within the Lagae Ranch Planned Development. The PA-7 site was approved for non-residential use, with 75,000 square-feet of church use previously proposed.

Access to the PA-7 site is proposed to be provided from two driveways along Lagae Road. Full access is proposed at both driveway intersections, which would be one-way-stop controlled on the driveway approaches of the two intersections. Lagae Road would remain uncontrolled through the two proposed project driveway intersections.

PROJECT TRAFFIC VOLUMES

The proposed project trip generation was calculated based on the ITE *Trip Generation* (10th Edition, 2017) rate for Apartments (ITE land use code 220). The project is estimated to generate approximately 1,391 trips per day, which include approximately 87 trips during the AM peak hour and approximately 106 trips during the PM peak hour.

TRAFFIC IMPACT ANALYSIS RESULTS

The following intersections were assessed as part of this analysis:

1. Lagae Road / Castle Pines Parkway (existing)
2. Lagae Road / PA-7 Northerly Site Access (future with project)
3. Lagae Road / PA-7 Southerly Site Access (future with project)
4. Lagae Road / Happy Canyon Road (existing)

The project area intersections were analyzed for the following analysis scenarios:

- Existing Conditions: This scenario reflects the conditions on the ground today with the traffic volume data obtained in mid-February 2019.

- Horizon Year 2040 With Project Conditions: The Horizon Year 2040 scenario reflects the long-range future traffic conditions with the buildout of the City of Castle Pines Comprehensive Plan plus the traffic generated by the proposed project.

The results of the level of service (LOS) analysis showed that under existing conditions, the existing study intersections currently operate at an acceptable LOS D or better during the peak hours.

The Horizon Year 2040 Project Buildout Conditions analysis results showed that the study intersections are forecast to operate at an acceptable LOS D or better during the peak hours with the planned future improvements and recommended improvements.

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INTRODUCTION

The following study has been prepared to determine the future intersection improvement needs associated with the proposed change in land use from 75,000 square-feet of church use to 190 multi-family residential dwelling units in Planning Area 7 (PA-7) of the Lagae Ranch Planned Development located in the City of Castle Pines, Colorado. **Exhibit 1** shows the project vicinity map.

Project Description

The project proposes to construct 190 multi-family residential units on the 15.86-acre PA-7 site within the Lagae Ranch Planned Development. The PA-7 site was previously approved for non-residential use, with 75,000 square-feet of church use previously proposed.

Access to the PA-7 site is proposed to be provided from two driveways along Lagae Road. Full access is proposed at both driveway intersections, which would be one-way-stop controlled on the driveway approaches of the two intersections. Lagae Road would remain uncontrolled through the two proposed project driveway intersections. **Exhibit 2** shows the proposed project site plan.

Study Area

The project study area was determined based on consultation with City staff and the Traffic Impact Study Criteria (Appendix B) from the *Douglas County Roadway Design and Construction Standards*, which require that the study area should extend to locations where project-generated traffic would represent 5 percent or more of a roadway's peak hour capacity. Based on this requirement, the study area consists of the following intersections:

1. Lagae Road / Castle Pines Parkway (existing)
2. Lagae Road / PA-7 Northerly Site Access (future with project)
3. Lagae Road / PA-7 Southerly Site Access (future with project)
4. Lagae Road / Happy Canyon Road (existing)

Exhibit 3 illustrates the location of the project and the project study area.

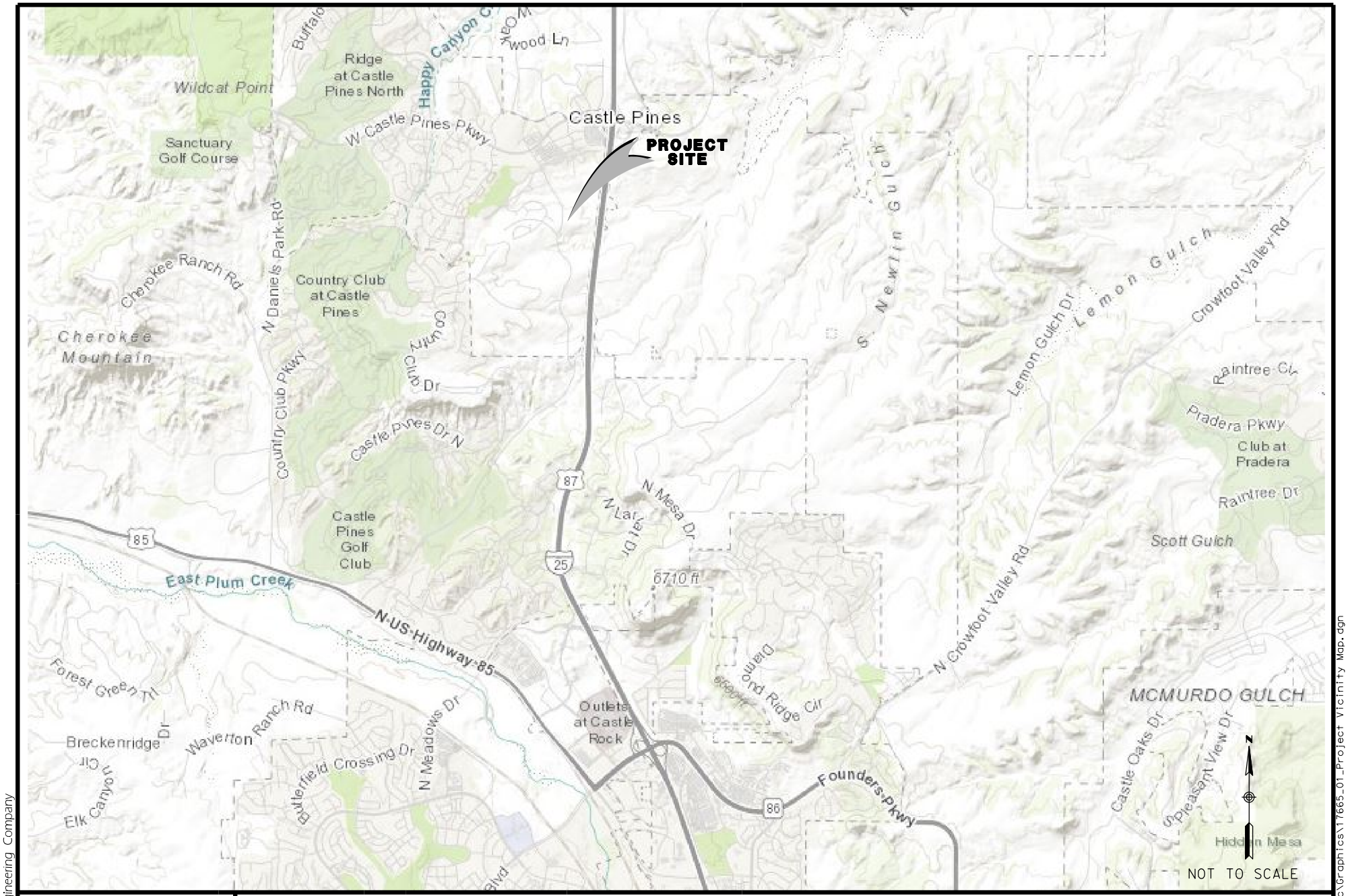

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EXHIBIT 1

PROJECT VICINITY MAP

LAGAE RANCH PLANNING AREA 7

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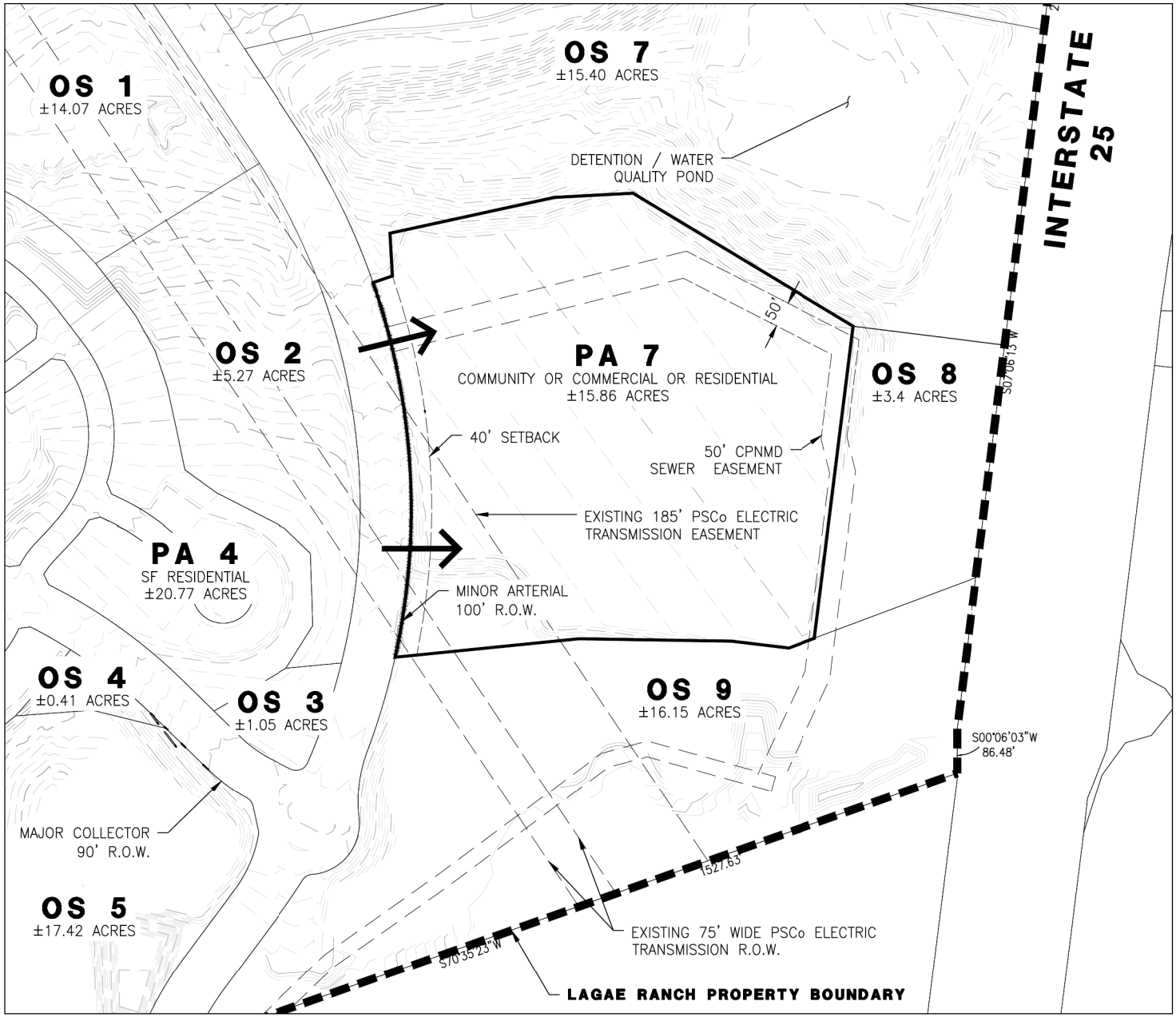

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EXHIBIT 2

PROJECT SITE PLAN

LAGAE RANCH PLANNING AREA 7

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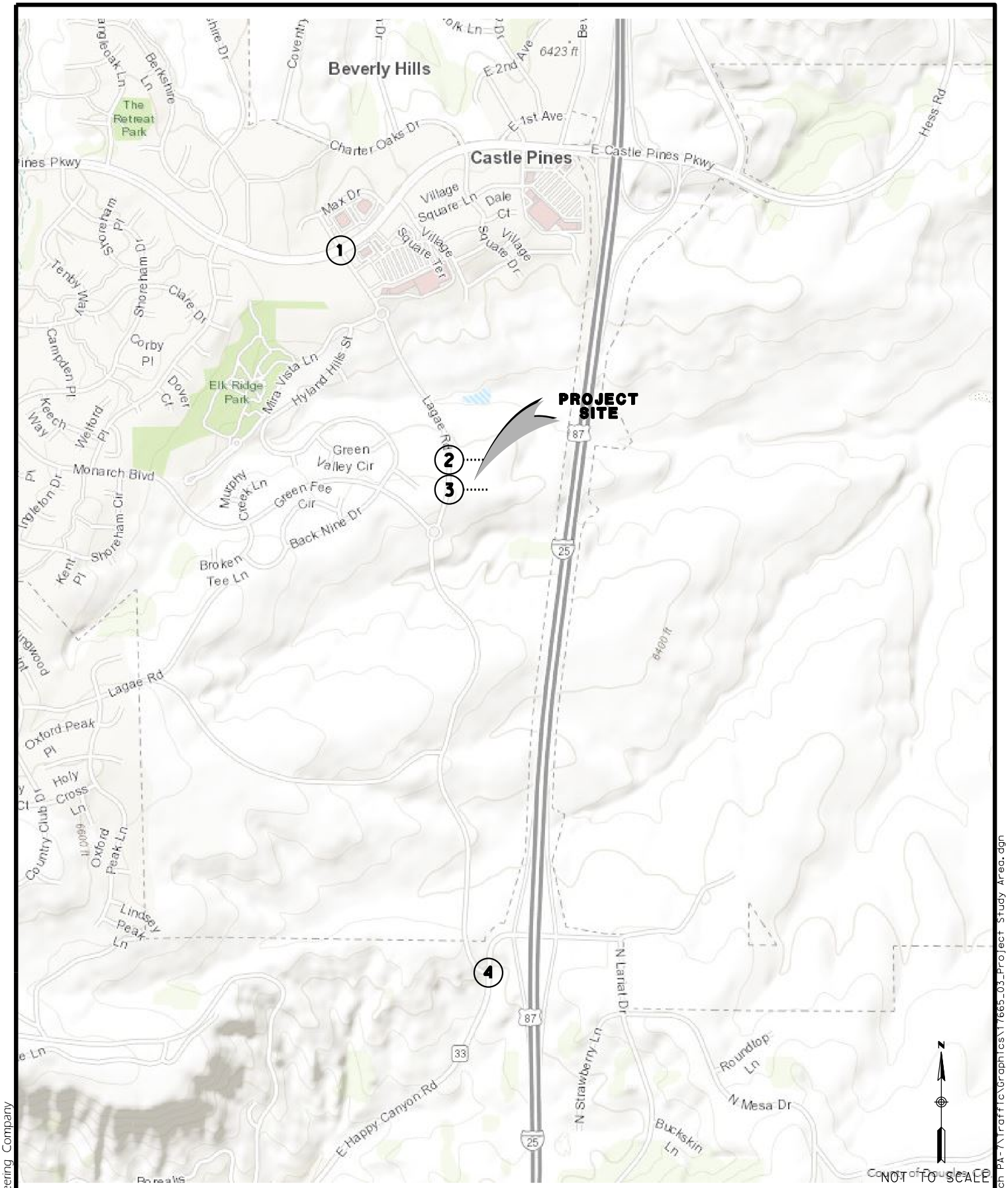

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EXHIBIT 3

PROJECT STUDY AREA

LAGAE RANCH PLANNING AREA 7

LEGEND

(X) = STUDY INTERSECTION

····· = PROPOSED ACCESS

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ANALYSIS APPROACH AND METHODOLOGY

This section summarizes the analysis approach and methodology used to evaluate the study intersections associated with the proposed project.

Analysis Scenarios

The following scenarios are evaluated in this traffic study:

- Existing Conditions: This scenario reflects the conditions on the ground today with the traffic volume data obtained in mid-February 2019.

- Horizon Year 2040 Project Buildout Conditions: The Horizon Year 2040 Project Buildout scenario reflects the long-range future traffic conditions with the buildout of the City of Castle Pines Comprehensive Plan including the Castle Pines Town Center, the Canyons and Lagae Ranch developments, based on the proposed change in land use for the PA-7 site.

Methodology

Intersection LOS Analysis

Levels of service (LOS) were determined at the study area intersections for the weekday AM and PM peak hours. The weekday AM intersection analysis evaluates LOS during the hour with the highest vehicular traffic between 7:00 AM and 9:00 AM. The weekday PM intersection analysis evaluates LOS during the hour with the highest vehicular traffic between 4:00 PM and 6:00 PM.

Intersection operations were analyzed with Synchro 10 software (Trafficware) utilizing the methodologies outlined in the *Highway Capacity Manual 6th Edition (HCM 6)*. Synchro reports delays, which correspond to a particular LOS, to describe the overall operation of an intersection.

LOS provides a quick overview of how well an intersection is performing. The City of Castle Pines has a design objective of LOS D or better for intersection operations, per the Traffic Impact Study Criteria (Appendix B) from the *Douglas County Roadway Design and Construction Standards.* The criteria for the LOS grade designations are provided in **Table 1**.

Table 1
LOS Criteria for Intersections

LOS	Control Delay (sec/veh)		Description
	Signalized Intersections	Unsignalized Intersections	
A	≤10	≤10	Operations with very low delay and most vehicles do not stop.
B	>10 and ≤20	>10 and ≤15	Operations with good progression but with some restricted movements.
C	>20 and ≤35	>15 and ≤25	Operations where a significant number of vehicles are stopping with some backup and light congestion.
D	>35 and ≤55	>25 and ≤35	Operations where congestion is noticeable, longer delays occur, and many vehicles stop. The proportion of vehicles not stopping declines.
E	>55 and ≤80	>35 and ≤50	Operations where there is significant delay, extensive queuing, and poor progression.
F	>80	>50	Operations that are unacceptable to most drivers, when the arrival rates exceed the capacity of the intersection.

Source: *Highway Capacity Manual 6th Edition (HCM 6).*

EXISTING CONDITIONS

This section summarizes the existing roadway network, peak hour and daily traffic volumes, and operations at the study area intersections.

Roadway Network

Castle Pines Parkway is currently built as a four-lane roadway from Forest Park Drive to the I-25 freeway, and is classified as an Arterial Road per the *City of Castle Pines Transportation Master Plan* (April 2017). On-street parking is not permitted and the posted speed limit is 40 miles per hour (mph). Class II bike lanes are currently provided along Castle Pines Parkway in both directions of travel west of the DCS Montessori Charter School. East of the DCS Montessori Charter School, Castle Pines Parkway functions as a Class III bike route to the I-25 interchange.

Lagae Road is currently built as a four-lane roadway from Castle Pines Parkway to the recently constructed Chase Lane located approximately one-half mile south of Monarch Boulevard. South of Chase Lane, Lagae Road is currently built as a two-lane roadway to Happy Canyon Road. The *City of Castle Pines Transportation Master Plan* (April 2017) classifies Lagae Road as a Collector Road. The posted speed limit is 30 mph just south of Castle Pines Parkway, and is posted at 35 mph south of Hyland Hills Drive to Happy Canyon Road. On-street parking is not permitted. Class II bike lanes are currently provided in both directions of travel along Lagae Road between Castle Pines Parkway and Chase Lane.

Happy Canyon Road, which is located outside the Castle Pines City limits, is currently built as a two-lane roadway and is classified as a two-lane Minor Arterial per the *Douglas County 2030 Transportation Plan* (November 2009). The posted speed limit is 35 mph and on-street parking is not permitted. There are currently no bicycle facilities along Happy Canyon Road.

Exhibit 4 illustrates the lane geometrics at the existing study intersections.

Traffic Volumes

Intersection turning movement counts were collected on Thursday, February 21, 2019 for the AM peak period (7:00 AM to 9:00 AM) and PM peak period (4:00 PM to 6:00 PM) at the two existing study intersections. Daily traffic counts were also collected on Thursday, February 21, 2019 over a 24-hour period on Lagae Road in front of the Lagae Ranch PA-7 project site.

The existing average daily traffic (ADT) counts that were collected along Lagae Road in front of the project site show that the PM peak hour currently occurs between 3:00 PM and 4:00 PM. However, the two project access intersections on Lagae Road were only analyzed under Horizon Year 2040 conditions, and the 2040 PM peak hour volumes were developed based on the growth from 2030 to 2040 per the DRCOG Regional Transportation Model. The growth was applied to the 2030 background traffic volumes from the Final *Lagae Ranch Traffic Impact Analysis* (FHU, September 2013). The 2030 background volumes on Lagae Road from the 2013 TIA were based on the typical PM commute peak hour that occurs between 4:00 PM and 6:00 PM.

Exhibit 5 illustrates the existing study area peak hour and daily traffic volumes. **Appendix A** contains the count data sheets.

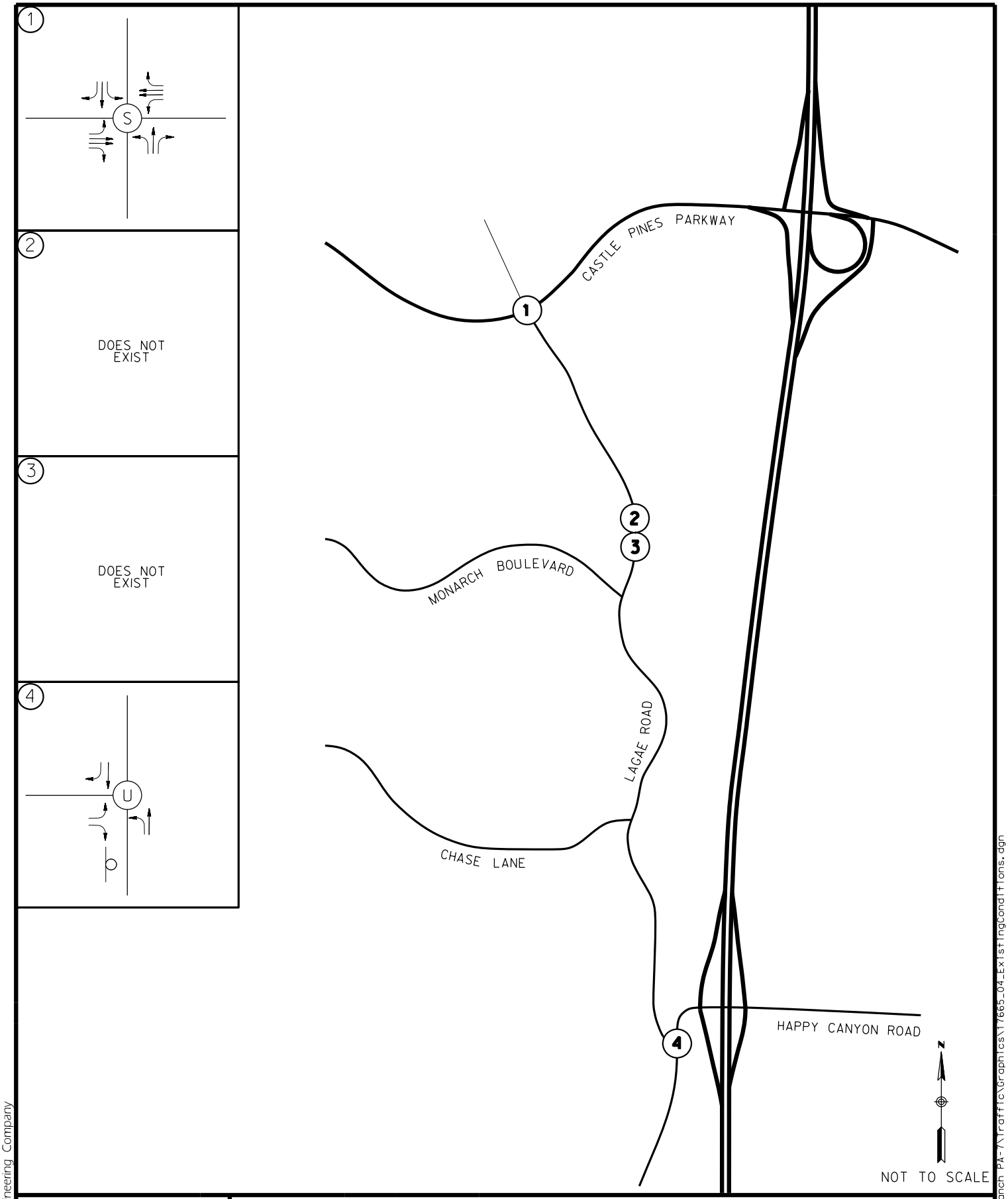

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EXHIBIT 4

EXISTING LANE GEOMETRICS

LAGAE RANCH PLANNING AREA 7

LEGEND

- (U) = UNSIGNALIZED
- (S) = SIGNALIZED
- → = EXISTING LANE
- O = STOP SIGN

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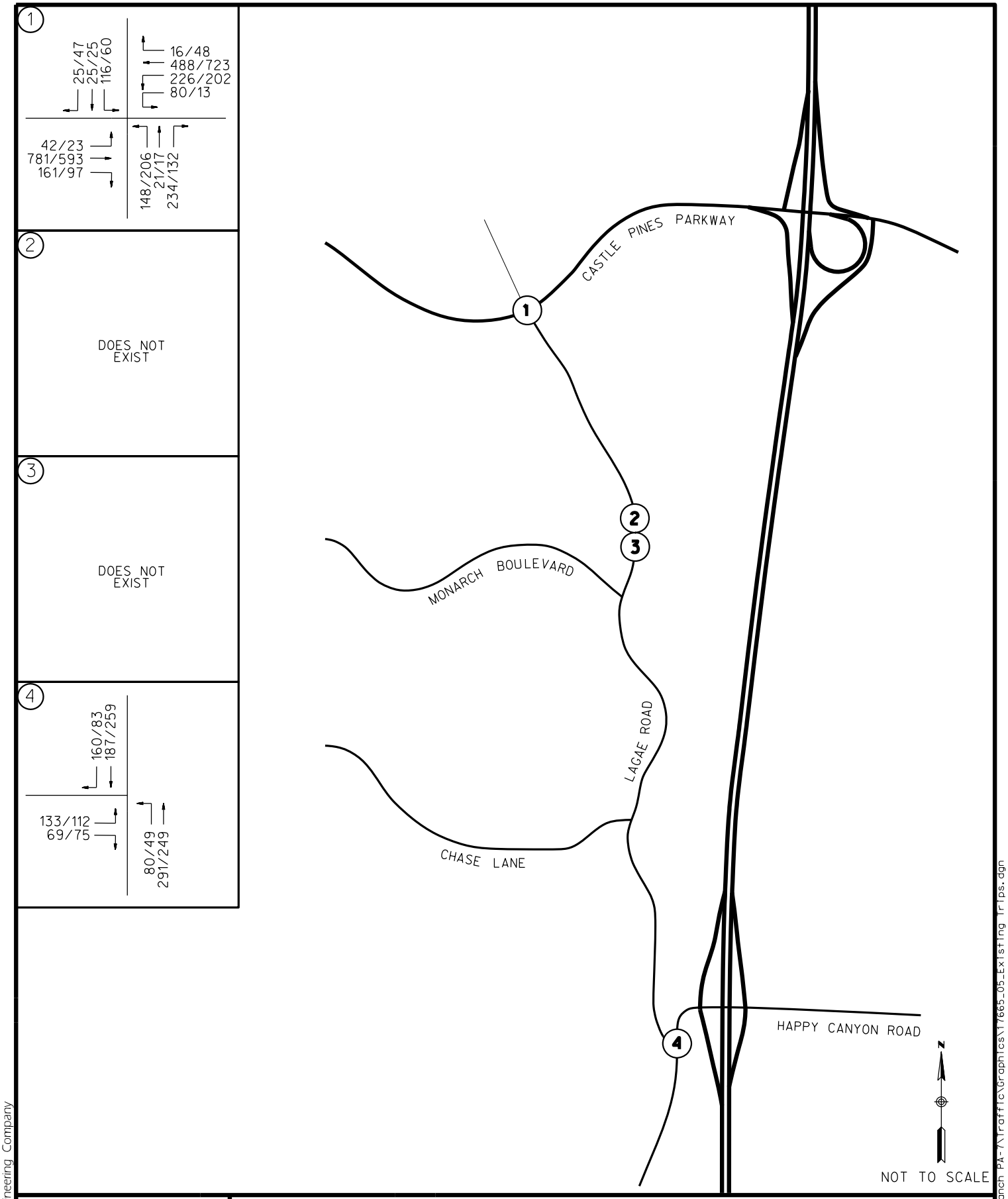

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EXHIBIT 5

EXISTING TRAFFIC VOLUMES

LAGAE RANCH PLANNING AREA 7

LEGEND

XX/XX = AM/PM PEAK HOUR VOLUMES

(X) = STUDY INTERSECTION

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Intersection Analysis

Table 2 displays the LOS analysis results for the existing study intersection under Existing Conditions. **Appendix B** contains the intersection LOS worksheets.

As shown in the table, the existing study intersections currently operate at an acceptable LOS D or better during both the AM and PM peak hours.

Table 2
Existing Peak Hour Intersection LOS Summary

#	Intersection	Traffic Control	Peak Hour	Delay [(a)]	LOS [(b)]
1	Lagae Road / Castle Pines Parkway	Signal	AM	18.1	B
			PM	12.2	B
4	Lagae Road / Happy Canyon Road	OWSC	AM	25.7	D
			PM	20.1	C

Notes:
OWSC = One-Way Stop Controlled ("T" intersection)
[(a)] Delays are reported as the average control delay for the entire intersection at signalized intersections, and the worst movement delay is reported for one/two-way-stop controlled intersections.
[(b)] LOS calculations are based on the methodology outlined in the *Highway Capacity Manual* 6th Edition (HCM 6) and performed using Synchro 10.

PROJECT TRAFFIC

This section describes the forecast trip generation, trip distribution, and assignment of trips on the adjacent roadway network.

Project Trip Generation

Trip generation rates published by the Institute of Transportation Engineers (ITE) *Trip Generation Manual* (10th Edition, 2017) were applied to the proposed project to determine the traffic generation characteristics of the site.

Table 3 summarizes the weekday trip generation for the project site. As shown in the table, the proposed project would generate approximately 1,391 daily trips, including 87 AM peak hour trips (20 inbound / 67 outbound) and 106 PM peak hour trips (67 inbound / 39 outbound).

The previously approved church use for the PA-7 site would generate approximately 683 daily trips, including 42 AM peak hour trips and 41 PM peak hour trips. The proposed 190 multi-family units would result in a net increase of 708 daily trips, including a net increase of 45 AM peak hour trips and 65 PM peak hour trips, over the previously approved church use.

Project Trip Distribution

The project trip distribution was developed based on the Final *Lagae Ranch Traffic Impact Analysis* (FHU, September 2013), which was revised at the direction of City staff. **Exhibit 6** displays the trip distribution patterns for the proposed project.

Project Trip Assignment

Based on the project trip distribution and trip generation, daily and AM/PM and peak hour project trips were assigned to the study area intersections. **Exhibit 7** displays the trip assignment for the proposed project.

Table 3
Project Trip Generation Summary

Land Use	Quantity	Trip Rate	ADT	AM Peak Hour							PM Peak Hour						
				% of ADT	In : Out Split			Volumes			% of ADT	In : Out Split			Volumes		
								In	Out	Total					In	Out	Total
Trips Generated																	
Multifamily Homes [a]	190 Units	7.32 / Unit	1,391	[a]	23%	:	77%	20	67	87	[a]	63%	:	37%	67	39	106
TOTAL TRIPS			**1,391**					**20**	**67**	**87**					**67**	**39**	**106**

Footnotes:

a. Source: ITE Trip Generation Manual 10th Edition, 2017. Multifamily Homes (Land Use Code 220): AM Peak Hour rate = 0.46/Unit, PM Peak Hour rate = 0.56/Unit.

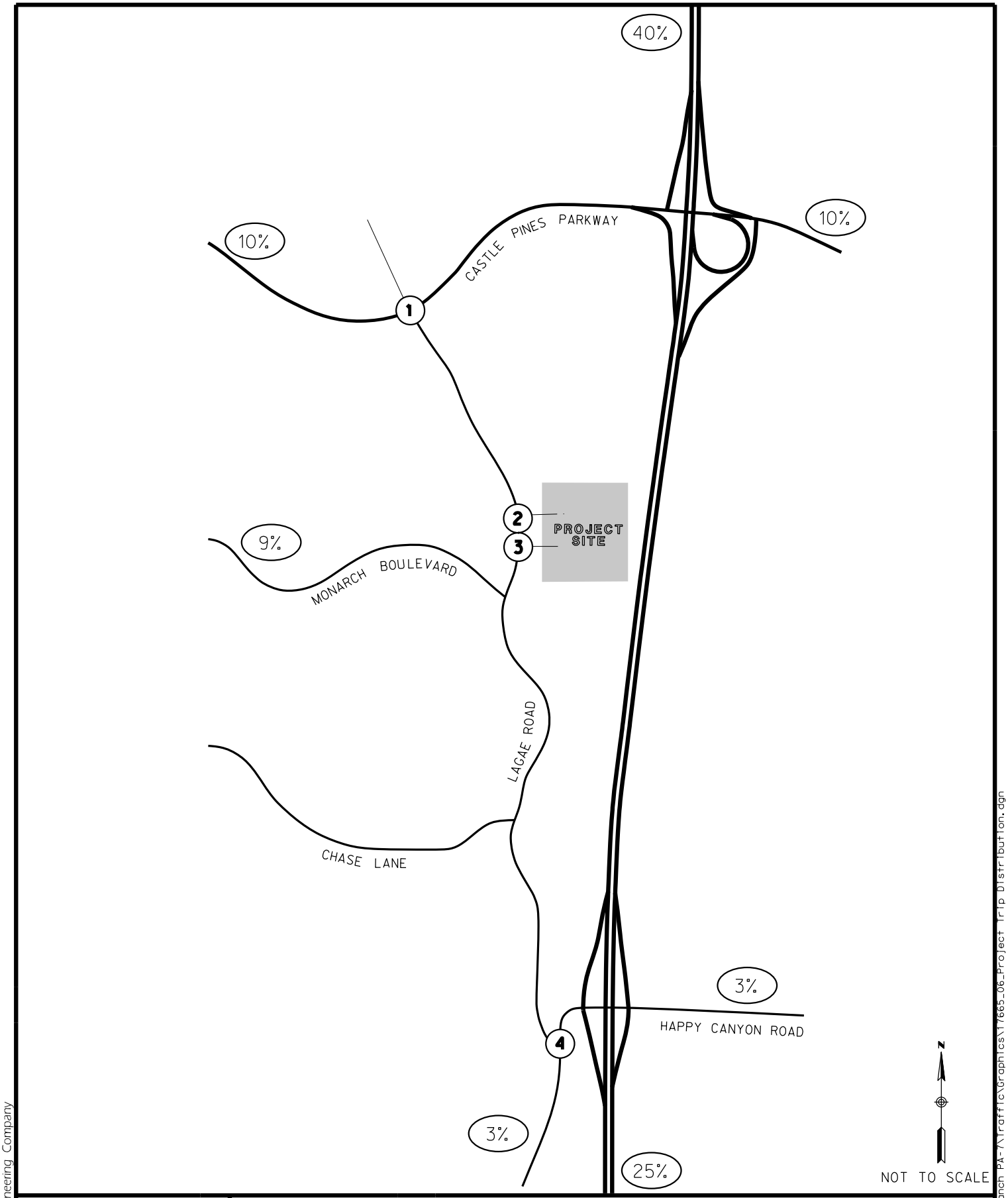

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EXHIBIT 6

PROJECT DISTRIBUTION

LAGAE RANCH PLANNING AREA 7

LEGEND

XX% = DISTRIBUTION PERCENTAGE

(X) = STUDY INTERSECTION

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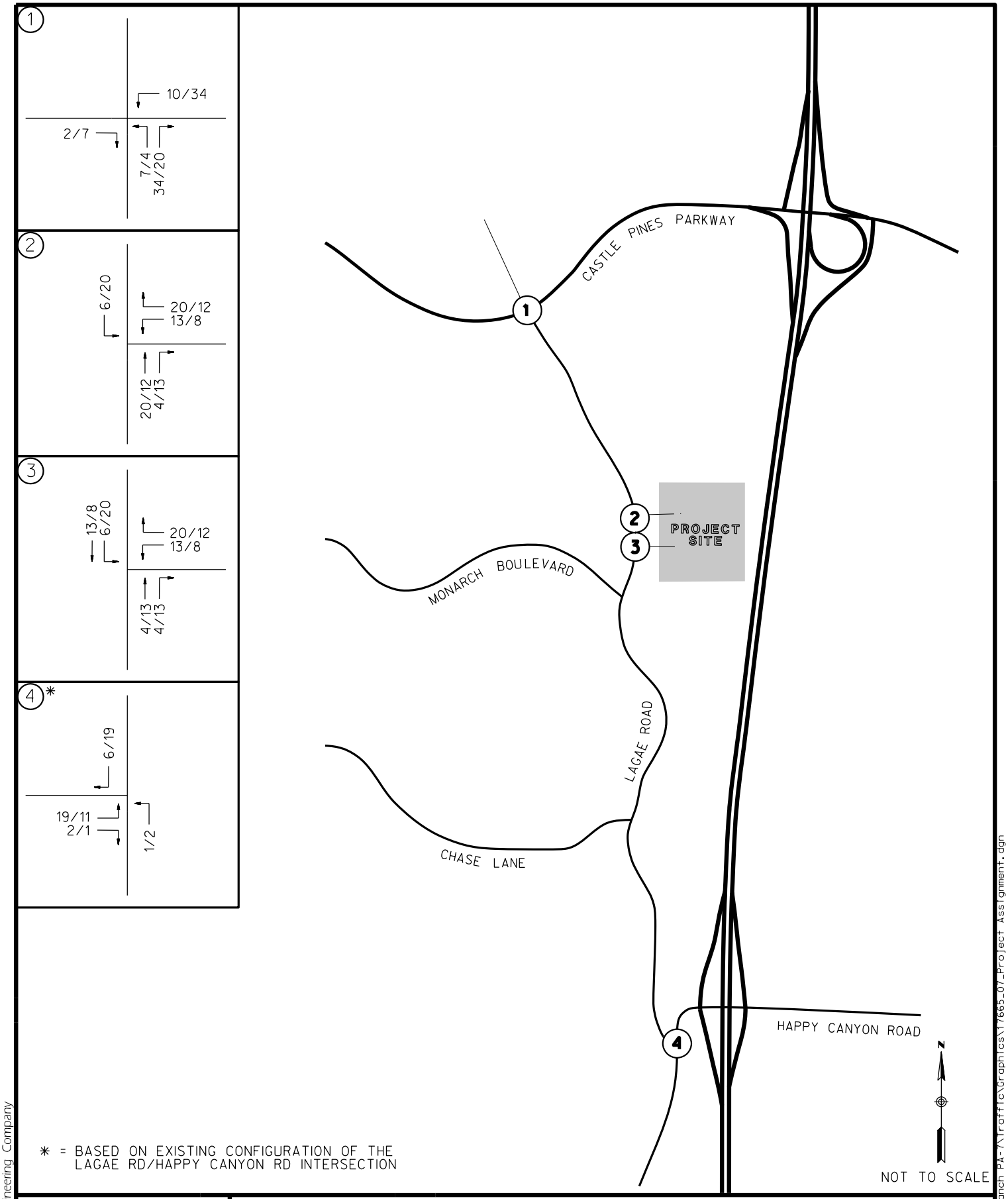

* = BASED ON EXISTING CONFIGURATION OF THE LAGAE RD/HAPPY CANYON RD INTERSECTION

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EXHIBIT 7

PROJECT TRIP ASSIGNMENT

LAGAE RANCH PLANNING AREA 7

LEGEND

XX/XX = AM/PM PEAK HOUR VOLUMES

(X) = STUDY INTERSECTION

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HORIZON YEAR 2040 PROJECT BUILDOUT CONDITIONS

This section provides a summary of long-range future operations at the existing study intersection plus the two proposed project access points along Lagae Road. The Horizon Year 2040 scenario reflects the buildout of the City of Castle Pines Comprehensive Plan including the Castle Pines Town Center, the Canyons development, the Lagae Ranch development, and the proposed change in land use for the PA-7 site.

Traffic Volumes

Horizon Year 2040 traffic volumes were developed from the Year 2030 background traffic volumes that were used in the Final *Lagae Ranch Traffic Impact Analysis* (FHU, September 2013). The forecast growth from 2030 to 2040 was calculated based on the DRCOG Regional Transportation Model. Annual growth rates were calculated for Castle Pines Parkway and Happy Canyon Road based on the growth in the DRCOG model volume from 2020 to 2040, which are shown below:

- Castle Pines Parkway: 0.63% per year
- Happy Canyon Road: 2.12% per year

Lagae Road between Castle Pines Parkway and Happy Canyon Road is not included in the DRCOG Regional Transportation Model. The annual growth rate that was calculated for Happy Canyon Road was also applied to Lagae Road to reflect a higher forecast growth on Lagae Road versus Castle Pines Parkway.

The following growth factors were then calculated from the annual growth rates shown above and applied to the 2030 background traffic volumes from the Final *Lagae Ranch Traffic Impact Analysis* to reflect the growth from 2030 to 2040:

- Castle Pines Parkway: 1.063
- Lagae Road: 1.212
- Happy Canyon Road: 1.212

The next steps consisted of adding the Lagae Ranch project buildout trips to the Year 2040 background traffic volumes, removing the PA-7 church trips, then adding the trips generated by the proposed PA-7 multi-family units to derive the Horizon Year 2040 Project Buildout volumes.

Exhibit 8 illustrates the Horizon Year 2040 Project Buildout traffic volumes at the study area intersections.

Roadway and Intersection Improvements

The Horizon Year 2040 roadway network includes the completion of all roadway improvements that were recommended in the *Douglas County 2030 Transportation Plan.* The Horizon Year 2040 Project Buildout roadway network also includes the recommended mitigation measures that were identified and analyzed in the Final *Lagae Ranch Traffic Impact Analysis* (FHU, September 2013).

The Final *Lagae Ranch Traffic Impact Analysis* (FHU, September 2013) indicates that a two-lane roundabout is planned to be constructed at the Lagae Road / Happy Canyon Road intersection after completion of the Castle Pines Town Center Phase 1 development. However, to be consistent with the analysis performed for the Final *Lagae Ranch Traffic Impact Analysis,* the Lagae Road / Happy Canyon Road intersection was also analyzed as a signalized intersection for the Horizon Year 2040 analysis.

The forecast growth in background traffic from the year 2030 to the year 2040 would result in additional improvements needed at the Lagae Road / Happy Canyon Road intersection than what were recommended as either a roundabout or as a signalized intersection in the *Lagae Ranch Traffic Impact Analysis* (FHU, September 2013) and the *Castle Pines Town Center Traffic Impact Analysis* (FHU, December 2011) for Year 2030 operations at the intersection.

Exhibit 9 illustrates the intersection improvements that would be needed under Horizon Year 2040 Project Buildout conditions for all study intersections to operate at an acceptable LOS D or better.

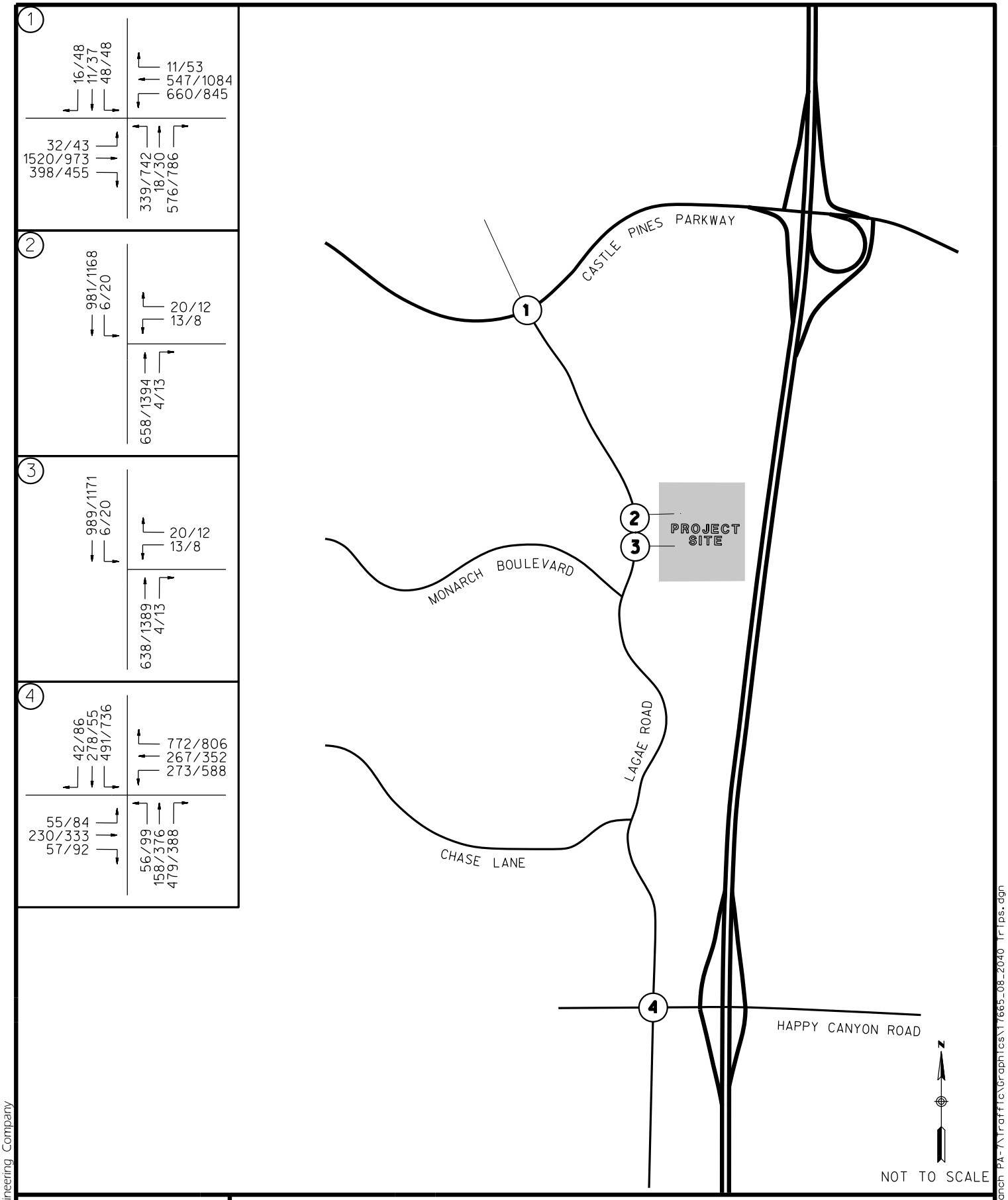

EXHIBIT 8

HORIZON YEAR 2040 PROJECT BUILDOUT
TRAFFIC VOLUMES

LAGAE RANCH PLANNING AREA 7

LEGEND

XX/XX = AM/PM PEAK HOUR VOLUMES

(X) = STUDY INTERSECTION

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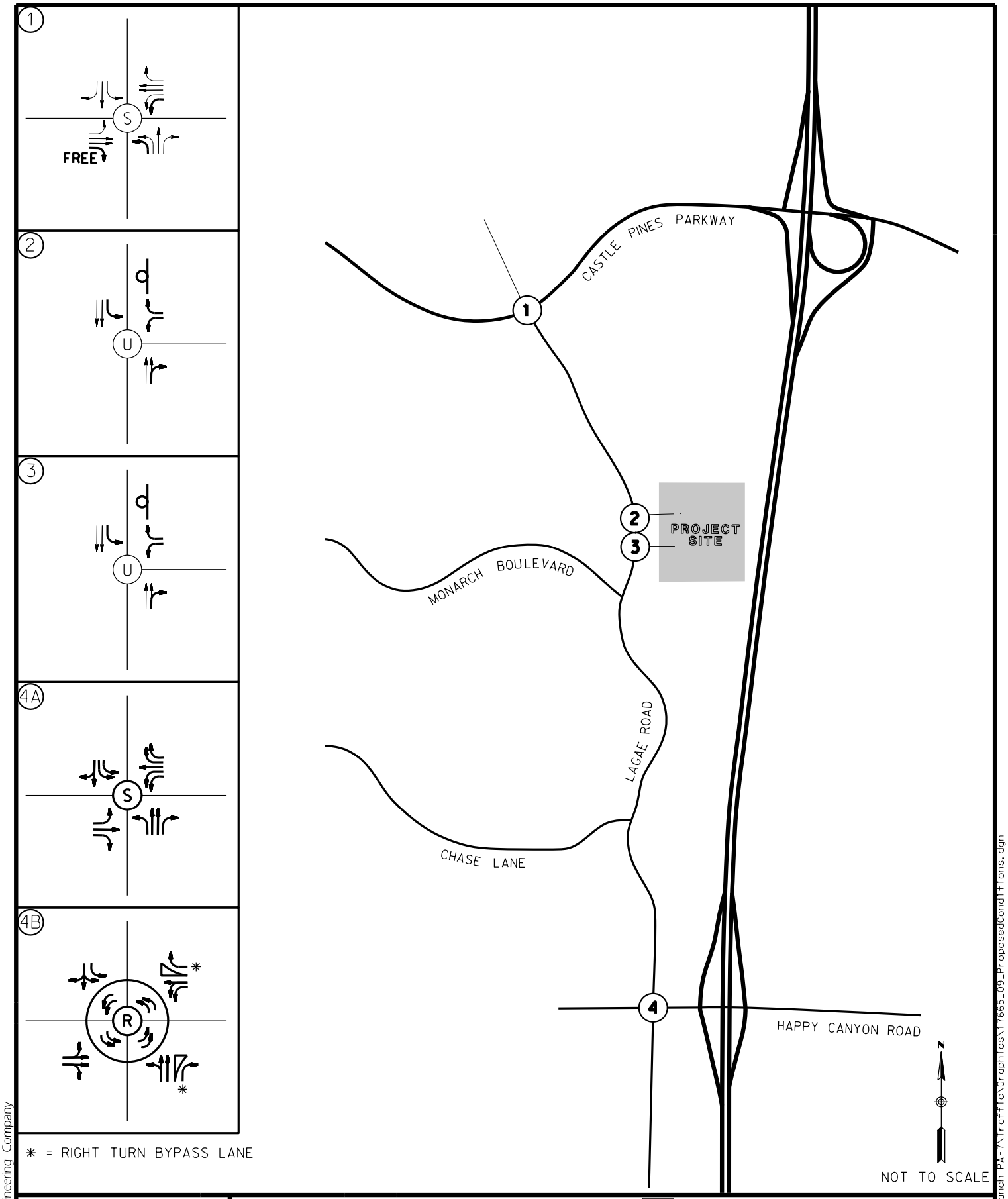

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EXHIBIT 9

HORIZON YEAR 2040 PROJECT BUILDOUT
INTERSECTION IMPROVEMENTS

LAGAE RANCH PLANNING AREA 7

LEGEND

- (U) = UNSIGNALIZED
- (S) = SIGNALIZED
- (R) = ROUNDABOUT
- → = EXISTING LANE
- ➡ = IMPROVEMENT
- —O— = STOP SIGN

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Intersection Analysis

Table 4 displays the LOS analysis results for the study intersections under the Horizon Year 2040 Project Buildout scenario. **Appendix B** contains the intersection LOS worksheets.

As shown in the table, the study intersections are forecast to operate at an acceptable LOS D or better during the peak hours with the proposed change in land use for the Lagae Ranch PA-7 site.

Table 4
Horizon Year 2040 Project Buildout Peak Hour Intersection LOS Summary

#	Intersection	Traffic Control	Peak Hour	Delay [(a)]	LOS [(b)]
1	Castle Pines Parkway / Lagae Road	Signal	AM	49.4	D
			PM	54.2	D
2	Lagae Road / Northerly Site Access	OWSC	AM	17.4	C
			PM	34.4	D
3	Lagae Road / Southerly Site Access	OWSC	AM	17.1	C
			PM	34.4	D
4	Lagae Road / Happy Canyon Road	Signal	AM	32.8	C
			PM	54.2	D
		Roundabout	AM	6.9	A
			PM	27.5	D

Notes:
OWSC = One-Way Stop Controlled
[(a)] Delays are reported as the average control delay for the entire intersection at signalized intersections, and the worst movement delay is reported for one/two-way-stop controlled intersections.
[(b)] LOS calculations for the signalized and stop-controlled intersections are based on the methodology outlined in the *Highway Capacity Manual* 6th Edition (HCM 6) and performed using Synchro 10. The SIDRA software program was used to calculate LOS for the Lagae Road / Happy Canyon Road intersection as a roundabout based on the HCM methodology for roundabout operations.

RECOMMENDED IMPROVEMENTS

Based on the findings of the analysis, the Year 2030 improvements that were recommended in the *Lagae Ranch Traffic Impact Analysis* (FHU, September 2013) for the Lagae Road / Castle Pines Parkway intersection will continue to provide acceptable LOS operations through the year 2040 with the buildout of the Lagae Ranch, Castle Pines Town Center, and Canyons developments, with the proposed change in land use for Lagae Ranch PA-7.

The findings of the Horizon Year 2040 Project Buildout analysis showed that the forecast growth in background traffic from the year 2030 to the year 2040 would result in additional improvements needed at the Lagae Road / Happy Canyon Road intersection than what were recommended as either a roundabout or as a signalized intersection in the *Lagae Ranch Traffic Impact Analysis* (FHU, September 2013) and the *Castle Pines Town Center Traffic Impact Analysis* (FHU, December 2011) for Year 2030 operations at the intersection.

The following lane geometrics and roadway improvements are recommended for the two PA-7 project access intersections to provide acceptable LOS operations under Horizon Year 2040 Project Buildout conditions:

Recommended Intersection Improvements

Lagae Road / Northerly Site Access

Westbound Approach (Driveway: assumed 15 mph speed)

- Stop-controlled with full access
- One left-turn lane with a minimum storage length of 70’ (deceleration + taper length does not apply to driveways)
- One right-turn lane

Southbound Approach (Lagae Road: posted 35 mph speed)

- One left-turn lane with a total length of 270’ (includes 50’ for storage, 120’ for deceleration, and 100’ taper length)
- Two through lanes

Northbound Approach

- One through lane
- One shared through/right-turn lane

Lagae Road / Southerly Site Access

Westbound Approach (Driveway: assumed 15 mph speed)

- Stop-controlled with full access
- One left-turn lane a minimum storage length of 50’ (deceleration + taper length does not apply to driveways)
- One right-turn lane

Southbound Approach (Lagae Road: posted 35 mph speed)

- One left-turn lane with a total length of 270' (includes 50' for storage, 120' for deceleration, and 100' taper length)
- Two through lanes

Northbound Approach

- One through lane
- One shared through/right-turn lane

The recommended storage lengths are based on the queuing analysis results as described on the next page. The recommended deceleration and taper lengths were calculated based on the posted speed limit on Lagae Road (35 mph) and on Table 9-7 and Table 9-10 of the Colorado Department of Transportation (CDOT) *Roadway Design Guide 2018*.

Recommended Roadway Improvements

North and South Legs (both intersections)

- Remove existing raised median on Lagae Road from 100 feet north of the Northerly Site Access to 100 feet south of the Southerly Site Access, and restripe roadway to provide a center two-way left-turn lane. The two-way left-turn lane would function as a refuge lane for left-turning traffic exiting the site onto Lagae Road, and is needed to provide an acceptable delay and LOS at the two project access intersections.

Queuing Analysis With Recommended Improvements

A queuing analysis was performed for the two project access intersections during the peak hours under Horizon Year 2040 Project Buildout conditions to determine the storage length needs of the left-turn and right-turn lanes with the recommended improvements. The SimTraffic traffic simulation application within Synchro was utilized to perform the queuing analysis for the study intersections. Synchro assumes 25 feet per vehicle to calculate queue length, and the reported 95th percentile queue lengths are used in this queuing analysis. **Appendix C** contains the SimTraffic queuing analysis worksheets.

The results of the queuing analysis showed the following minimum storage lengths would be needed for the two project access intersections:

Lagae Road / Northerly Site Access

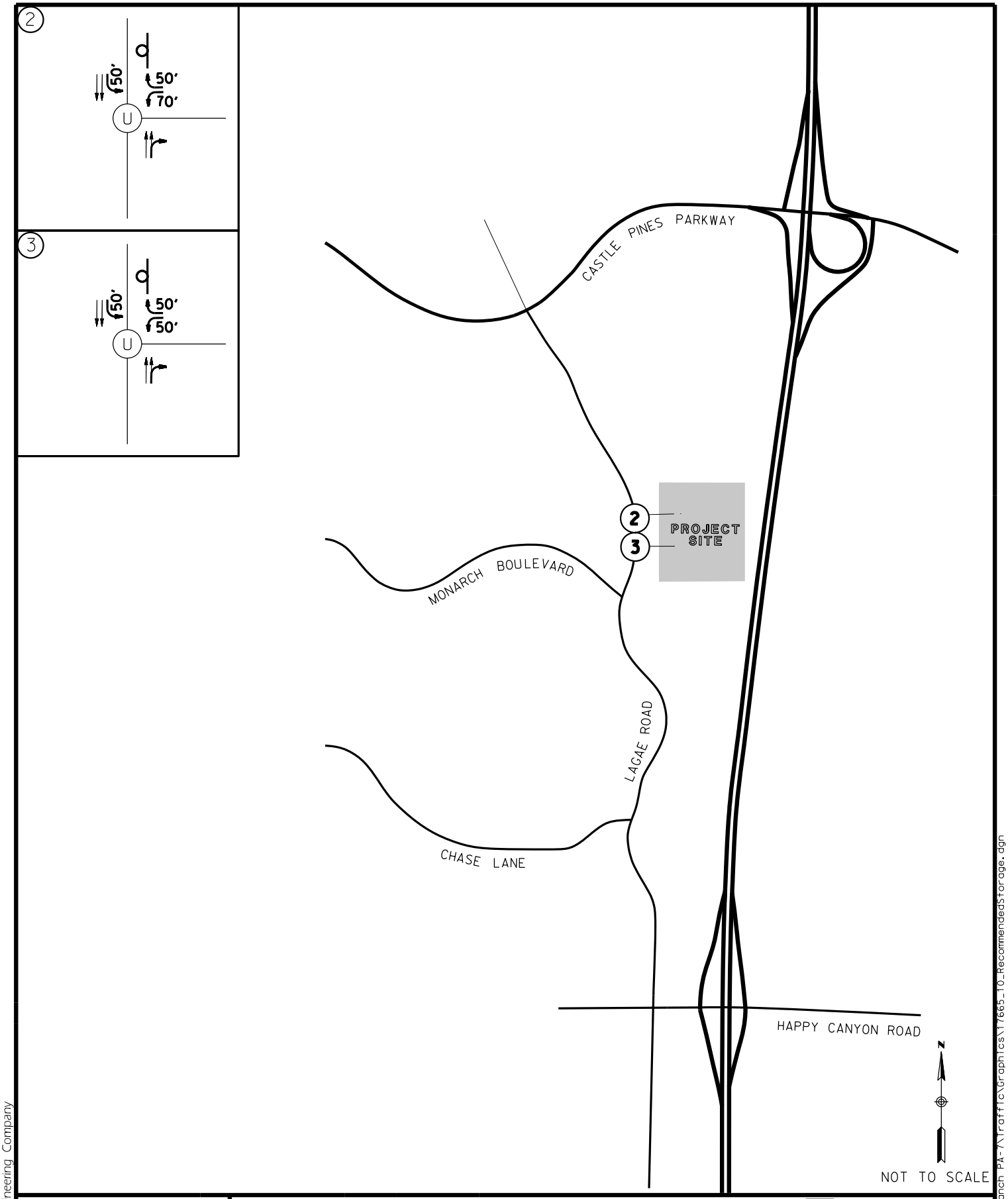
- Southbound Left-Turn Lane: 50 feet (PM 95% queue length of 40 feet)
- Westbound Left-Turn Lane: 70 feet (PM 95% queue length of 62 feet)
- Westbound Right-Turn Lane: 50 feet (PM 95% queue length of 36 feet)

Lagae Road / Southerly Site Access

- Southbound Left-Turn Lane: 50 feet (PM 95% queue length of 39 feet)
- Westbound Left-Turn Lane: 50 feet (PM 95% queue length of 48 feet)
- Westbound Right-Turn Lane: 50 feet (AM 95% queue length of 42 feet)

A minimum storage length of 50 feet is recommended for turn lanes where the 95th percentile queue lengths are less than 50 feet.

Exhibit 10 illustrates the recommended improvements and storage lengths of the turn lanes at the two PA-7 project access intersections.



RICK™ ENGINEERING COMPANY

EXHIBIT 10

HORIZON YEAR 2040 PROJECT BUILDOUT RECOMMENDED IMPROVEMENTS AND STORAGE LENGTHS

LAGAE RANCH PLANNING AREA 7

LEGEND

- (U) = UNSIGNALIZED
- XX' = STORAGE LENGTH
- = EXISTING LANE
- = IMPROVEMENT
- = STOP SIGN

T:\17665C_Lagae Ranch PA-7\Traffic\Graphics\17665_10_RecommendedStorage.dgn
T:\17665C_Lagae Ranch PA-7\Traffic\Graphics\PDF\2019-0430\SD CorpStds 2005.dscript
30-APR-2019 12:17

SUMMARY AND CONCLUSIONS

This focused traffic impact analysis evaluated the traffic conditions associated with the proposed change in land use from 75,000 square-feet of church use to 190 multi-family residential dwelling units in Planning Area 7 (PA-7) of the Lagae Ranch Planned Development located in the City of Castle Pines, Colorado.

New traffic counts were collected and the existing study intersection of Lagae Road / Castle Pines Parkway was evaluated to determine the existing traffic operations. The results of the analysis showed that the Lagae Road / Castle Pines Parkway intersection currently operates at an acceptable LOS B during the peak hours.

The Horizon Year 2040 Project Buildout scenario includes the forecast traffic generated by the buildout of the City of Castle Pines Comprehensive Plan, including the Castle Pines Town Center, the Lagae Ranch development, and the proposed change in land use for the PA-7 site.

The results of the Horizon Year 2040 Project Buildout analysis showed that with future improvements at the Lagae Road / Castle Pines Parkway and Lagae Road / Happy Canyon Road intersections, both intersections are forecast to operate at an acceptable LOS D or better during the peak hours.

The two project access intersections are forecast to operate at LOS D or better during the peak hours with the recommended intersection and roadway improvements. Queuing was also evaluated for the project access intersections to determine the minimum storage lengths that would be needed for the turn lanes. Recommendations were made for the minimum required storage lengths for each turn lane at the two project access intersections.

APPENDIX A

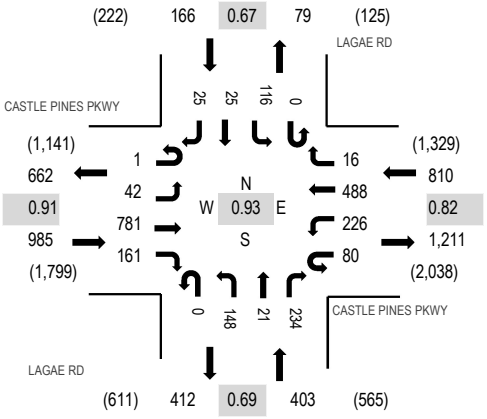
TRAFFIC VOLUME DATA

All Traffic Data Services Inc.

(303) 216-2439
www.alltrafficdata.net

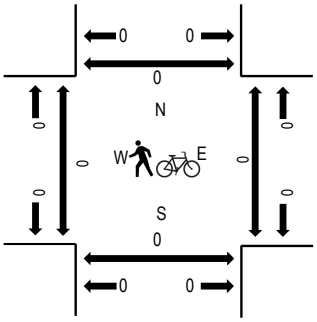
Location: 1 LAGAE RD & CASTLE PINES PKWY AM
Date: Thursday, February 21, 2019
Peak Hour: 07:30 AM - 08:30 AM
Peak 15-Minutes: 07:45 AM - 08:00 AM

Peak Hour - All Vehicles



Note: Total study counts contained in parentheses.

Peak Hour - Pedestrians/Bicycles on Crosswalk



Traffic Counts

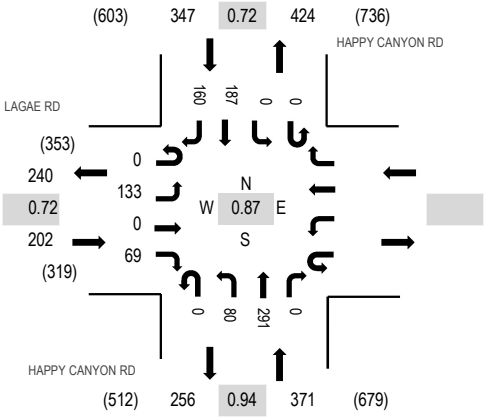
Interval Start Time	CASTLE PINES PKWY Eastbound				CASTLE PINES PKWY Westbound				LAGAE RD Northbound				LAGAE RD Southbound					Rolling Hour	Pedestrian Crossings			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	Total		West	East	South	North
7:00 AM	0	3	179	13	0	21	136	0	0	22	3	18	0	2	0	3	400	2,014	0	0	0	0
7:15 AM	0	9	192	23	0	44	88	1	0	30	1	17	0	7	3	3	418	2,174	0	0	0	0
7:30 AM	1	12	185	65	2	77	109	3	0	33	4	52	0	9	4	5	561	2,364	0	0	0	0
7:45 AM	0	10	195	65	3	75	104	5	0	44	5	96	0	18	9	6	635	2,215	0	0	0	0
8:00 AM	0	13	166	16	31	28	122	3	0	46	11	59	0	53	4	8	560	1,901	0	0	0	0
8:15 AM	0	7	235	15	44	46	153	5	0	25	1	27	0	36	8	6	608		0	0	0	0
8:30 AM	0	6	204	25	6	26	79	3	0	16	3	18	0	21	1	4	412		0	0	0	0
8:45 AM	0	4	142	14	0	29	77	9	0	14	4	16	0	5	0	7	321		0	0	0	0
Count Total	1	64	1,498	236	86	346	868	29	0	230	32	303	0	151	29	42	3,915		0	0	0	0
Peak Hour	1	42	781	161	80	226	488	16	0	148	21	234	0	116	25	25	2,364		0	0	0	0

All Traffic Data Services Inc.

(303) 216-2439
www.alltrafficdata.net

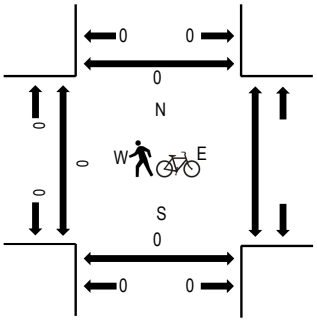
Location: 2 HAPPY CANYON RD & LAGAE RD AM
Date: Thursday, February 21, 2019
Peak Hour: 07:15 AM - 08:15 AM
Peak 15-Minutes: 07:45 AM - 08:00 AM

Peak Hour - All Vehicles



Note: Total study counts contained in parentheses.

Peak Hour - Pedestrians/Bicycles on Crosswalk



Traffic Counts

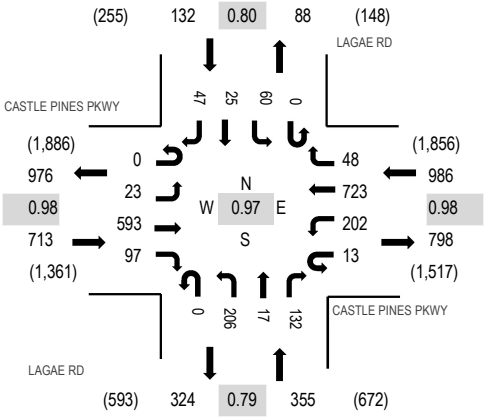
Interval Start Time	LAGAE RD Eastbound				Westbound				HAPPY CANYON RD Northbound				HAPPY CANYON RD Southbound				Total	Rolling Hour	Pedestrian Crossings			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right			West	East	South	North
7:00 AM	0	21	0	7					0	27	55	0	0	0	53	7	170	879	0		0	0
7:15 AM	0	23	0	6					0	24	64	0	0	0	47	26	190	920	0		0	0
7:30 AM	0	25	0	22					0	23	65	0	0	0	46	74	255	912	0		0	0
7:45 AM	0	46	0	27					0	14	85	0	0	0	51	41	264	833	0		0	0
8:00 AM	0	39	0	14					0	19	77	0	0	0	43	19	211	722	0		0	0
8:15 AM	0	20	0	18					0	20	62	0	0	0	49	13	182		0		0	0
8:30 AM	0	13	0	15					0	8	78	0	0	0	51	11	176		0		0	0
8:45 AM	0	16	0	7					0	11	47	0	0	0	56	16	153		0		0	0
Count Total	0	203	0	116					0	146	533	0	0	0	396	207	1,601		0		0	0
Peak Hour	0	133	0	69					0	80	291	0	0	0	187	160	920		0		0	0

All Traffic Data Services Inc.

(303) 216-2439
www.alltrafficdata.net

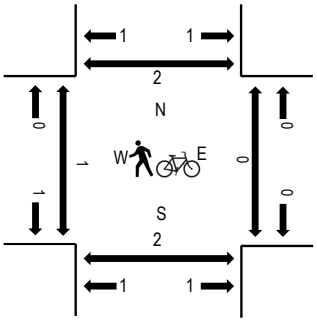
Location: 1 LAGAE RD & CASTLE PINES PKWY PM
Date: Thursday, February 21, 2019
Peak Hour: 04:15 PM - 05:15 PM
Peak 15-Minutes: 04:30 PM - 04:45 PM

Peak Hour - All Vehicles



Note: Total study counts contained in parentheses.

Peak Hour - Pedestrians/Bicycles on Crosswalk



Traffic Counts

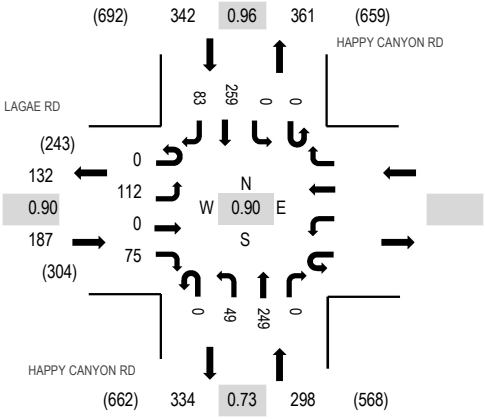
Interval Start Time	CASTLE PINES PKWY Eastbound				CASTLE PINES PKWY Westbound				LAGAE RD Northbound				LAGAE RD Southbound					Rolling Hour	Pedestrian Crossings			
	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	U-Turn	Left	Thru	Right	Total		West	East	South	North
4:00 PM	0	8	135	34	2	47	127	6	0	76	3	40	0	16	3	10	507	2,136	0	1	0	0
4:15 PM	0	6	148	27	1	63	167	12	0	37	9	35	0	9	6	12	532	2,186	1	0	1	0
4:30 PM	0	4	158	20	5	40	189	15	0	57	3	29	0	25	9	10	564	2,138	0	0	0	0
4:45 PM	0	7	141	23	4	57	174	7	0	55	3	28	0	12	5	17	533	2,059	0	0	1	2
5:00 PM	0	6	146	27	3	42	193	14	0	57	2	40	0	14	5	8	557	2,008	0	0	0	0
5:15 PM	0	1	135	12	2	44	175	6	0	45	4	24	0	13	7	16	484		0	0	0	0
5:30 PM	0	5	150	13	3	44	172	7	0	45	2	19	0	14	6	5	485		0	0	0	0
5:45 PM	0	6	131	18	1	39	187	8	0	40	4	15	0	19	2	12	482		0	0	0	0
Count Total	0	43	1,144	174	21	376	1,384	75	0	412	30	230	0	122	43	90	4,144		1	1	2	2
Peak Hour	0	23	593	97	13	202	723	48	0	206	17	132	0	60	25	47	2,186		1	0	2	2

All Traffic Data Services Inc.

(303) 216-2439
www.alltrafficdata.net

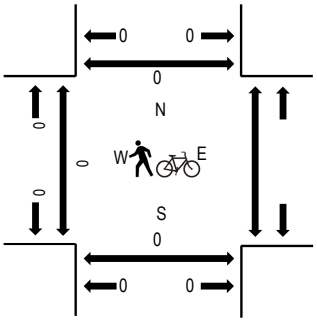
Location: 2 HAPPY CANYON RD & LAGAE RD PM
Date: Thursday, February 21, 2019
Peak Hour: 04:00 PM - 05:00 PM
Peak 15-Minutes: 04:00 PM - 04:15 PM

Peak Hour - All Vehicles



Note: Total study counts contained in parentheses.

Peak Hour - Pedestrians/Bicycles on Crosswalk



Traffic Counts

Interval Start Time	LAGAE RD Eastbound U-Turn	Left	Thru	Right	Westbound U-Turn	Left	Thru	Right	HAPPY CANYON RD Northbound U-Turn	Left	Thru	Right	HAPPY CANYON RD Southbound U-Turn	Left	Thru	Right	Total	Rolling Hour	Pedestrian Crossings West	East	South	North
4:00 PM	0	38	0	13					0	15	87	0	0	0	57	19	229	827	0		0	0
4:15 PM	0	29	0	18					0	10	60	0	0	0	70	22	209	792	0		0	0
4:30 PM	0	27	0	25					0	12	52	0	0	0	70	18	204	768	0		0	0
4:45 PM	0	18	0	19					0	12	50	0	0	0	62	24	185	756	0		0	0
5:00 PM	0	11	0	18					0	9	69	0	0	0	70	17	194	737	0		0	0
5:15 PM	0	21	0	12					0	8	60	0	0	0	61	23	185		0		0	0
5:30 PM	0	11	0	15					0	3	69	0	0	0	73	21	192		0		0	0
5:45 PM	0	15	0	14					0	10	42	0	0	0	65	20	166		0		0	0
Count Total	0	170	0	134					0	79	489	0	0	0	528	164	1,564		0		0	0
Peak Hour	0	112	0	75					0	49	249	0	0	0	259	83	827		0		0	0

All Traffic Data Services
www.alltrafficdata.net

Site Code: 3
Station ID:
LAGAE RD S.O. MONARCH BLVD

Start Time	21-Feb-19 Thu	NB	SB							Total
12:00 AM		0	2							2
01:00		0	1							1
02:00		0	0							0
03:00		0	1							1
04:00		4	1							5
05:00		5	8							13
06:00		85	25							110
07:00		**374**	**162**							**536**
08:00		140	144							284
09:00		91	74							165
10:00		90	76							166
11:00		79	99							178
12:00 PM		101	85							186
01:00		95	103							198
02:00		144	90							234
03:00		**196**	**307**							**503**
04:00		129	202							331
05:00		101	171							272
06:00		89	109							198
07:00		31	76							107
08:00		31	47							78
09:00		23	34							57
10:00		1	9							10
11:00		2	2							4
Total		1811	1828							3639
Percent		49.8%	50.2%							
AM Peak	-	07:00	07:00	-	-	-	-	-	-	07:00
Vol.	-	374	162	-	-	-	-	-	-	536
PM Peak	-	15:00	15:00	-	-	-	-	-	-	15:00
Vol.	-	196	307	-	-	-	-	-	-	503
Grand Total		1811	1828							3639
Percent		49.8%	50.2%							
ADT		ADT 3,639		AADT 3,639						

APPENDIX B

INTERSECTION LOS WORKSHEETS

EXISTING CONDITIONS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	42	781	161	306	488	16	148	21	234	116	25	25
Future Volume (veh/h)	42	781	161	306	488	16	148	21	234	116	25	25
Number	5	2	12	1	6	16	3	8	18	7	4	14
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
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	46	858	177	373	595	20	214	30	339	173	37	37
Adj No. of Lanes	1	2	1	1	2	1	1	1	1	1	1	1
Peak Hour Factor	0.91	0.91	0.91	0.82	0.82	0.82	0.69	0.69	0.69	0.67	0.67	0.67
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	395	1294	579	468	2073	928	443	509	433	365	509	433
Arrive On Green	0.37	0.37	0.37	0.16	0.59	0.59	0.27	0.27	0.27	0.27	0.27	0.27
Sat Flow, veh/h	804	3539	1583	1774	3539	1583	1320	1863	1583	1009	1863	1583
Grp Volume(v), veh/h	46	858	177	373	595	20	214	30	339	173	37	37
Grp Sat Flow(s),veh/h/ln	804	1770	1583	1774	1770	1583	1320	1863	1583	1009	1863	1583
Q Serve(g_s), s	2.7	14.4	5.7	8.5	5.9	0.4	10.2	0.8	14.1	10.9	1.0	1.2
Cycle Q Clear(g_c), s	2.7	14.4	5.7	8.5	5.9	0.4	11.2	0.8	14.1	11.7	1.0	1.2
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	395	1294	579	468	2073	928	443	509	433	365	509	433
V/C Ratio(X)	0.12	0.66	0.31	0.80	0.29	0.02	0.48	0.06	0.78	0.47	0.07	0.09
Avail Cap(c_a), veh/h	476	1649	738	612	2715	1215	835	1062	903	665	1062	903
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	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.2	18.9	16.1	13.2	7.3	6.2	23.3	19.1	23.9	23.4	19.1	19.2
Incr Delay (d2), s/veh	0.1	0.7	0.3	5.5	0.1	0.0	0.8	0.0	3.1	1.0	0.1	0.1
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	0.6	7.2	2.5	4.8	2.9	0.2	3.8	0.4	6.5	3.1	0.5	0.5
LnGrp Delay(d),s/veh	15.3	19.5	16.4	18.8	7.4	6.2	24.1	19.1	27.0	24.3	19.2	19.3
LnGrp LOS	B	B	B	B	A	A	C	B	C	C	B	B
Approach Vol, veh/h		1081			988			583			247	
Approach Delay, s/veh		18.8			11.7			25.5			22.8	
Approach LOS		B			B			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	15.6	31.0		24.4		46.6		24.4
Change Period (Y+Rc), s	4.5	5.0		5.0		5.0		5.0
Max Green Setting (Gmax), s	16.9	33.1		40.5		54.5		40.5
Max Q Clear Time (g_c+I1), s	10.5	16.4		13.7		7.9		16.1
Green Ext Time (p_c), s	0.6	9.6		3.4		15.2		3.4

Intersection Summary	
HCM 6th Ctrl Delay	18.1
HCM 6th LOS	B

Intersection	
Int Delay, s/veh	5.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	133	69	80	291	187	160
Future Vol, veh/h	133	69	80	291	187	160
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	60	0	50	-	-	50
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	72	72	94	94	72	72
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	185	96	85	310	260	222

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	740	260	482	0	-	0
Stage 1	260	-	-	-	-	-
Stage 2	480	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	384	779	1081	-	-	-
Stage 1	783	-	-	-	-	-
Stage 2	622	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	354	779	1081	-	-	-
Mov Cap-2 Maneuver	354	-	-	-	-	-
Stage 1	721	-	-	-	-	-
Stage 2	622	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	20.4	1.9	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1081	-	354	779	-	-
HCM Lane V/C Ratio	0.079	-	0.522	0.123	-	-
HCM Control Delay (s)	8.6	-	25.7	10.3	-	-
HCM Lane LOS	A	-	D	B	-	-
HCM 95th %tile Q(veh)	0.3	-	2.9	0.4	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	23	593	97	215	723	48	206	17	132	60	25	47
Future Volume (veh/h)	23	593	97	215	723	48	206	17	132	60	25	47
Number	5	2	12	1	6	16	3	8	18	7	4	14
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
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	23	605	99	219	738	49	261	22	167	75	31	59
Adj No. of Lanes	1	2	1	1	2	1	1	1	1	1	1	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.79	0.79	0.79	0.80	0.80	0.80
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	376	1269	568	482	1926	861	472	511	435	447	511	435
Arrive On Green	0.36	0.36	0.36	0.10	0.54	0.54	0.27	0.27	0.27	0.27	0.27	0.27
Sat Flow, veh/h	685	3539	1583	1774	3539	1583	1301	1863	1583	1189	1863	1583
Grp Volume(v), veh/h	23	605	99	219	738	49	261	22	167	75	31	59
Grp Sat Flow(s),veh/h/ln	685	1770	1583	1774	1770	1583	1301	1863	1583	1189	1863	1583
Q Serve(g_s), s	1.2	7.3	2.4	3.9	6.6	0.8	10.2	0.5	4.7	2.7	0.7	1.5
Cycle Q Clear(g_c), s	1.2	7.3	2.4	3.9	6.6	0.8	10.9	0.5	4.7	3.2	0.7	1.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	376	1269	568	482	1926	861	472	511	435	447	511	435
V/C Ratio(X)	0.06	0.48	0.17	0.45	0.38	0.06	0.55	0.04	0.38	0.17	0.06	0.14
Avail Cap(c_a), veh/h	547	2150	962	507	2856	1278	1070	1368	1163	994	1368	1163
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	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	11.7	13.7	12.1	9.0	7.2	5.9	18.8	14.7	16.2	15.9	14.8	15.1
Incr Delay (d2), s/veh	0.1	0.3	0.1	0.7	0.1	0.0	1.0	0.0	0.6	0.2	0.0	0.1
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	0.2	3.6	1.0	2.0	3.2	0.3	3.8	0.2	2.1	0.9	0.4	0.7
LnGrp Delay(d),s/veh	11.8	14.0	12.2	9.7	7.4	5.9	19.8	14.7	16.8	16.0	14.8	15.2
LnGrp LOS	B	B	B	A	A	A	B	B	B	B	B	B
Approach Vol, veh/h		727			1006			450			165	
Approach Delay, s/veh		13.7			7.8			18.4			15.5	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	10.2	24.8		20.1		35.0		20.1
Change Period (Y+Rc), s	4.5	5.0		5.0		5.0		5.0
Max Green Setting (Gmax), s	6.5	33.5		40.5		44.5		40.5
Max Q Clear Time (g_c+I1), s	5.9	9.3		5.2		8.6		12.9
Green Ext Time (p_c), s	0.0	10.5		2.3		12.1		2.3

Intersection Summary	
HCM 6th Ctrl Delay	12.2
HCM 6th LOS	B

Intersection	
Int Delay, s/veh	4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	112	75	49	249	259	83
Future Vol, veh/h	112	75	49	249	259	83
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	60	0	50	-	-	50
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	73	73	96	96
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	124	83	67	341	270	86

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	745	270	356	0	-	0
Stage 1	270	-	-	-	-	-
Stage 2	475	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	382	769	1203	-	-	-
Stage 1	775	-	-	-	-	-
Stage 2	626	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	361	769	1203	-	-	-
Mov Cap-2 Maneuver	361	-	-	-	-	-
Stage 1	732	-	-	-	-	-
Stage 2	626	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	16.2	1.3	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1203	-	361	769	-	-
HCM Lane V/C Ratio	0.056	-	0.345	0.108	-	-
HCM Control Delay (s)	8.2	-	20.1	10.3	-	-
HCM Lane LOS	A	-	C	B	-	-
HCM 95th %tile Q(veh)	0.2	-	1.5	0.4	-	-

HORIZON YEAR 2040 PROJECT BUILDOUT

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	32	1520	398	660	547	11	339	18	576	48	11	16
Future Volume (veh/h)	32	1520	398	660	547	11	339	18	576	48	11	16
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	1600	0	695	576	12	357	19	0	51	12	17
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	868	1728		719	735	328	389	203		81	78	66
Arrive On Green	0.49	0.49	0.00	0.21	0.21	0.21	0.11	0.11	0.00	0.05	0.04	0.04
Sat Flow, veh/h	1781	3554	1585	3456	3554	1585	3456	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	34	1600	0	695	576	12	357	19	0	51	12	17
Grp Sat Flow(s),veh/h/ln	1781	1777	1585	1728	1777	1585	1728	1870	1585	1781	1870	1585
Q Serve(g_s), s	1.2	48.6	0.0	23.0	17.7	0.6	11.8	1.1	0.0	3.2	0.7	0.5
Cycle Q Clear(g_c), s	1.2	48.6	0.0	23.0	17.7	0.6	11.8	1.1	0.0	3.2	0.7	0.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	868	1728		719	735	328	389	203		81	78	66
V/C Ratio(X)	0.04	0.93		0.97	0.78	0.04	0.92	0.09		0.63	0.15	0.26
Avail Cap(c_a), veh/h	868	1786		719	2309	1030	389	673		139	608	515
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	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.5	27.7	0.0	45.3	43.3	26.1	50.7	46.3	0.0	54.1	53.4	9.2
Incr Delay (d2), s/veh	0.0	8.7	0.0	25.6	1.9	0.0	26.2	0.2	0.0	7.7	0.9	2.0
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	0.5	21.2	0.0	12.1	7.8	0.3	6.5	0.5	0.0	1.6	0.4	0.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	15.5	36.4	0.0	70.9	45.2	26.1	76.8	46.5	0.0	61.8	54.3	11.3
LnGrp LOS	B	D		E	D	C	E	D		E	D	B
Approach Vol, veh/h		1634	A		1283			376	A		80	
Approach Delay, s/veh		35.9			58.9			75.3			49.9	
Approach LOS		D			E			E			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	28.0	61.1	17.0	9.3	60.3	28.9	9.3	17.0
Change Period (Y+Rc), s	4.0	5.0	4.0	4.5	4.0	5.0	4.0	4.5
Max Green Setting (Gmax), s	24.0	58.0	13.0	37.5	7.0	75.0	9.0	41.5
Max Q Clear Time (g_c+I1), s	25.0	50.6	13.8	2.7	3.2	19.7	5.2	3.1
Green Ext Time (p_c), s	0.0	5.6	0.0	0.1	0.0	4.2	0.0	0.1

Intersection Summary	
HCM 6th Ctrl Delay	49.4
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	0.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	13	20	658	4	6	981
Future Vol, veh/h	13	20	658	4	6	981
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	-	-	50	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	14	21	693	4	6	1033

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1224	349	0	0	697	0
Stage 1	695	-	-	-	-	-
Stage 2	529	-	-	-	-	-
Critical Hdwy	6.84	6.94	-	-	4.14	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	-	-	2.22	-
Pot Cap-1 Maneuver	171	647	-	-	895	-
Stage 1	456	-	-	-	-	-
Stage 2	555	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	170	647	-	-	895	-
Mov Cap-2 Maneuver	304	-	-	-	-	-
Stage 1	456	-	-	-	-	-
Stage 2	551	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13.4	0	0.1
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	304	647	895	-
HCM Lane V/C Ratio	-	-	0.045	0.033	0.007	-
HCM Control Delay (s)	-	-	17.4	10.8	9.1	-
HCM Lane LOS	-	-	C	B	A	-
HCM 95th %tile Q(veh)	-	-	0.1	0.1	0	-

Intersection	
Int Delay, s/veh	0.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	13	20	638	4	6	989
Future Vol, veh/h	13	20	638	4	6	989
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	-	-	50	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	14	21	672	4	6	1041

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1207	338	0	0	676	0
Stage 1	674	-	-	-	-	-
Stage 2	533	-	-	-	-	-
Critical Hdwy	6.84	6.94	-	-	4.14	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	-	-	2.22	-
Pot Cap-1 Maneuver	176	658	-	-	911	-
Stage 1	468	-	-	-	-	-
Stage 2	553	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	175	658	-	-	911	-
Mov Cap-2 Maneuver	310	-	-	-	-	-
Stage 1	468	-	-	-	-	-
Stage 2	549	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13.2	0	0.1
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	310	658	911	-
HCM Lane V/C Ratio	-	-	0.044	0.032	0.007	-
HCM Control Delay (s)	-	-	17.1	10.7	9	-
HCM Lane LOS	-	-	C	B	A	-
HCM 95th %tile Q(veh)	-	-	0.1	0.1	0	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	55	230	57	273	267	772	56	158	479	491	278	42
Future Volume (veh/h)	55	230	57	273	267	772	56	158	479	491	278	42
Number	7	4	14	3	8	18	5	2	12	1	6	16
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
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	58	242	60	287	281	813	59	166	504	517	293	44
Adj No. of Lanes	1	1	1	2	1	2	1	2	1	2	1	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	79	440	374	361	552	1306	80	837	541	593	576	86
Arrive On Green	0.04	0.24	0.24	0.10	0.30	0.30	0.05	0.24	0.24	0.17	0.36	0.36
Sat Flow, veh/h	1774	1863	1583	3442	1863	2787	1774	3539	1583	3442	1583	238
Grp Volume(v), veh/h	58	242	60	287	281	813	59	166	504	517	0	337
Grp Sat Flow(s),veh/h/ln	1774	1863	1583	1721	1863	1393	1774	1770	1583	1721	0	1821
Q Serve(g_s), s	2.6	9.4	2.5	6.7	10.2	17.9	2.7	3.1	19.4	12.0	0.0	11.9
Cycle Q Clear(g_c), s	2.6	9.4	2.5	6.7	10.2	17.9	2.7	3.1	19.4	12.0	0.0	11.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		0.13
Lane Grp Cap(c), veh/h	79	440	374	361	552	1306	80	837	541	593	0	662
V/C Ratio(X)	0.73	0.55	0.16	0.80	0.51	0.62	0.74	0.20	0.93	0.87	0.00	0.51
Avail Cap(c_a), veh/h	156	613	521	361	645	1445	110	837	541	608	0	662
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	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	38.7	27.5	24.8	35.8	23.9	16.3	38.7	25.1	26.1	33.1	0.0	20.4
Incr Delay (d2), s/veh	12.1	1.1	0.2	11.7	0.7	0.7	15.2	0.1	23.3	12.9	0.0	0.6
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	1.6	4.9	1.1	3.8	5.3	7.0	1.7	1.5	14.4	6.7	0.0	6.0
LnGrp Delay(d),s/veh	50.8	28.5	25.0	47.5	24.6	17.0	53.9	25.2	49.4	46.0	0.0	21.0
LnGrp LOS	D	C	C	D	C	B	D	C	D	D		C
Approach Vol, veh/h		360			1381			729			854	
Approach Delay, s/veh		31.6			24.9			44.2			36.2	
Approach LOS		C			C			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	18.6	25.4	13.1	24.9	8.2	35.8	8.2	29.8
Change Period (Y+Rc), s	4.5	6.0	4.5	5.5	4.5	6.0	4.5	5.5
Max Green Setting (Gmax), s	14.5	19.4	8.6	27.0	5.1	28.8	7.2	28.4
Max Q Clear Time (g_c+I1), s	14.0	21.4	8.7	11.4	4.7	13.9	4.6	19.9
Green Ext Time (p_c), s	0.1	0.0	0.0	6.3	0.0	4.5	0.0	4.4

Intersection Summary	
HCM 6th Ctrl Delay	32.8
HCM 6th LOS	C

DELAY (CONTROL)

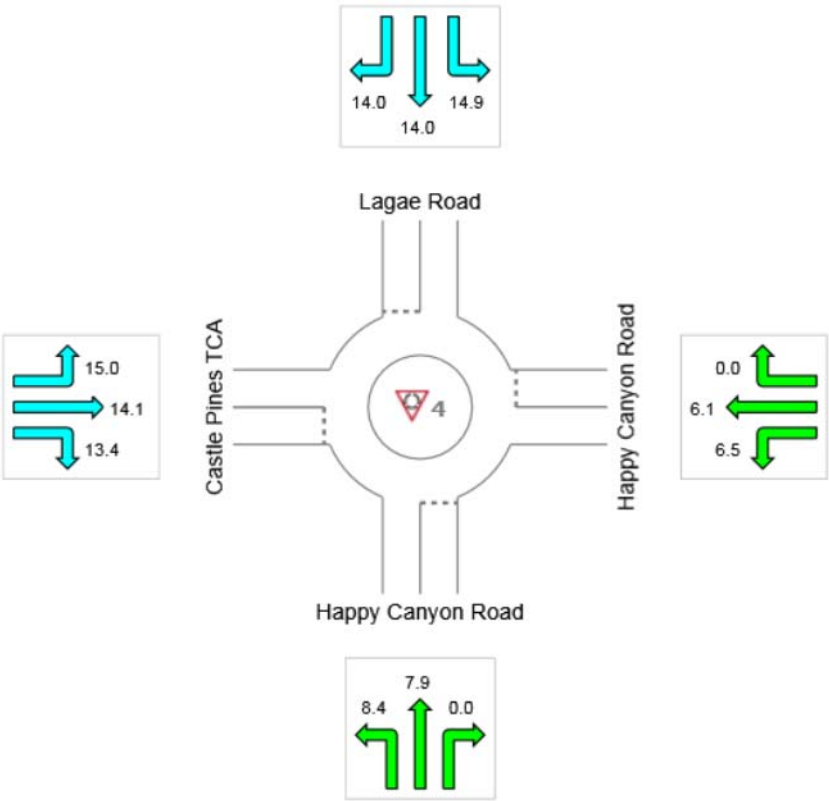
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: 4 [2040 AM]

New Site
Site Category: (None)
Roundabout

All Movement Classes

	Approaches				Intersection
	South	East	North	West	
Delay (Control)	2.5	2.7	14.5	14.1	6.9
LOS	A	A	B	B	A



Colour code based on Level of Service

LOS A	LOS B	LOS C	LOS D	LOS E	LOS F

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

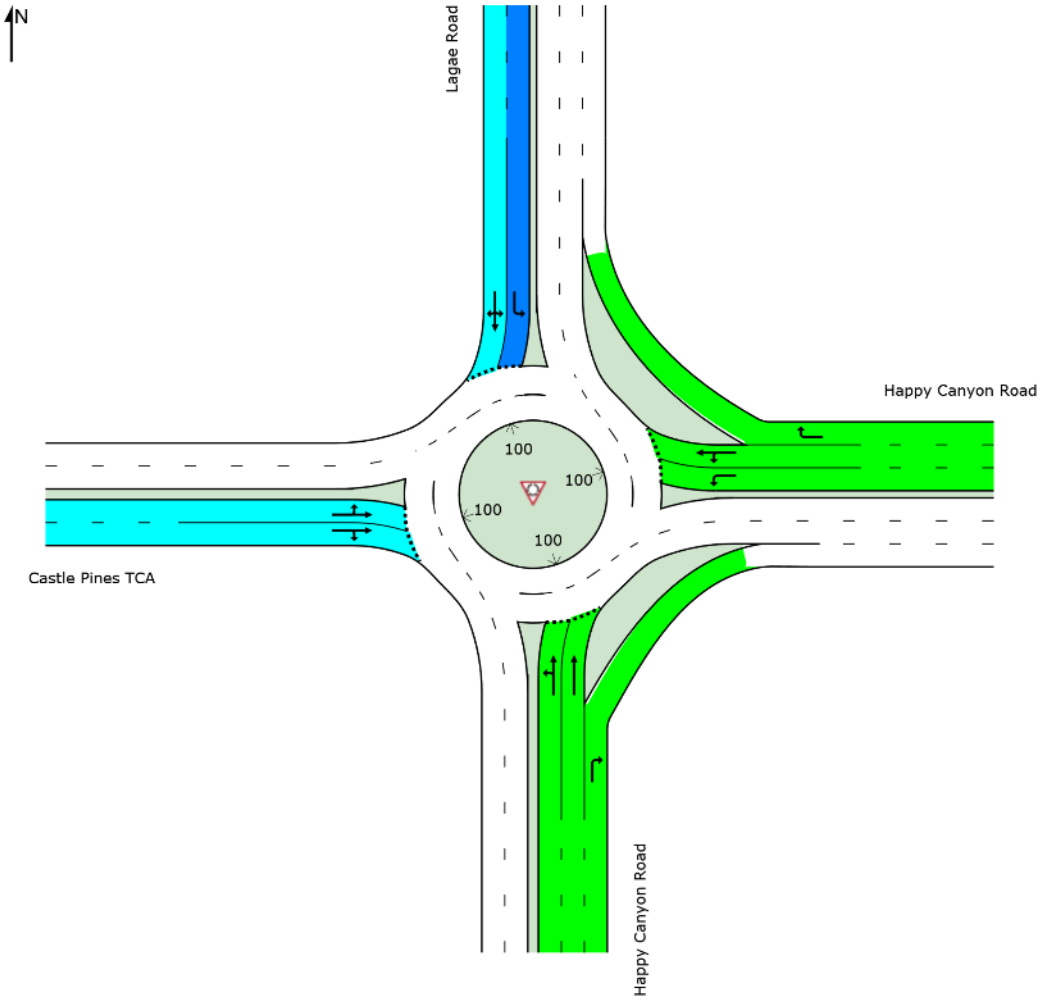
LANE LEVEL OF SERVICE

Lane Level of Service

Site: 4 [2040 AM]

New Site
Site Category: (None)
Roundabout

	Approaches				Intersection
	South	East	North	West	
LOS	A	A	B	B	A



Colour code based on Level of Service

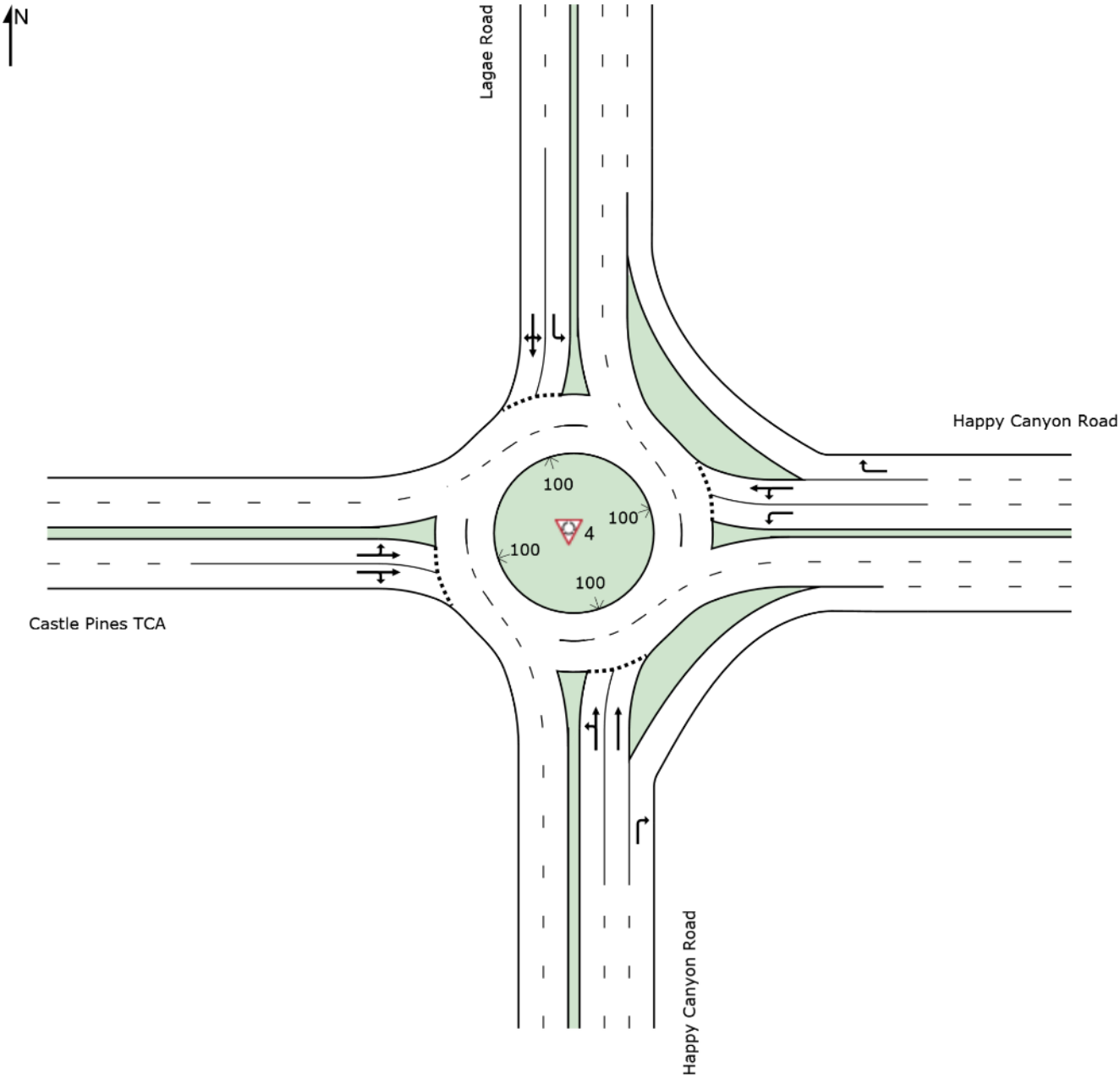
LOS A	LOS B	LOS C	LOS D	LOS E	LOS F

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

SITE LAYOUT

Site: 4 [2040 AM]

New Site
Site Category: (None)
Roundabout



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	43	973	455	845	1084	53	742	30	786	48	37	48
Future Volume (veh/h)	43	973	455	845	1084	53	742	30	786	48	37	48
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	45	1024	0	889	1141	56	781	32	0	51	39	51
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	352	1146		907	1377	614	755	82		381	81	69
Arrive On Green	0.20	0.32	0.00	0.26	0.39	0.39	0.22	0.04	0.00	0.21	0.04	0.04
Sat Flow, veh/h	1781	3554	1585	3456	3554	1585	3456	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	45	1024	0	889	1141	56	781	32	0	51	39	51
Grp Sat Flow(s),veh/h/ln	1781	1777	1585	1728	1777	1585	1728	1870	1585	1781	1870	1585
Q Serve(g_s), s	2.4	31.4	0.0	29.2	33.1	2.6	25.0	1.9	0.0	2.6	2.3	2.6
Cycle Q Clear(g_c), s	2.4	31.4	0.0	29.2	33.1	2.6	25.0	1.9	0.0	2.6	2.3	2.6
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	352	1146		907	1377	614	755	82		381	81	69
V/C Ratio(X)	0.13	0.89		0.98	0.83	0.09	1.03	0.39		0.13	0.48	0.74
Avail Cap(c_a), veh/h	352	1243		907	1927	859	755	875		381	613	520
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	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	37.8	36.9	0.0	41.9	31.6	22.2	44.7	53.2	0.0	36.4	53.4	27.7
Incr Delay (d2), s/veh	0.2	8.2	0.0	25.1	2.2	0.1	41.7	3.0	0.0	0.2	4.3	14.2
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	14.4	0.0	15.2	14.0	1.0	15.0	1.0	0.0	1.2	1.2	1.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	37.9	45.0	0.0	67.0	33.8	22.3	86.4	56.2	0.0	36.5	57.7	41.9
LnGrp LOS	D	D		E	C	C	F	E		D	E	D
Approach Vol, veh/h		1069	A		2086			813	A		141	
Approach Delay, s/veh		44.7			47.6			85.2			44.3	
Approach LOS		D			D			F			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	34.0	41.9	29.0	9.5	26.6	49.3	29.0	9.5
Change Period (Y+Rc), s	4.0	5.0	4.0	4.5	4.0	5.0	4.5	* 4.5
Max Green Setting (Gmax), s	30.0	40.0	25.0	37.5	8.0	62.0	9.0	* 54
Max Q Clear Time (g_c+I1), s	31.2	33.4	27.0	4.6	4.4	35.1	4.6	3.9
Green Ext Time (p_c), s	0.0	3.5	0.0	0.3	0.0	9.2	0.0	0.1

Intersection Summary	
HCM 6th Ctrl Delay	54.2
HCM 6th LOS	D

Notes

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

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	0.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	8	12	1394	13	20	1168
Future Vol, veh/h	8	12	1394	13	20	1168
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	-	-	50	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	8	13	1467	14	21	1229

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2131	741	0	0	1481	0
Stage 1	1474	-	-	-	-	-
Stage 2	657	-	-	-	-	-
Critical Hdwy	6.84	6.94	-	-	4.14	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	-	-	2.22	-
Pot Cap-1 Maneuver	42	359	-	-	450	-
Stage 1	177	-	-	-	-	-
Stage 2	477	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	40	359	-	-	450	-
Mov Cap-2 Maneuver	131	-	-	-	-	-
Stage 1	177	-	-	-	-	-
Stage 2	455	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	23	0	0.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	131	359	450	-
HCM Lane V/C Ratio	-	-	0.064	0.035	0.047	-
HCM Control Delay (s)	-	-	34.4	15.4	13.4	-
HCM Lane LOS	-	-	D	C	B	-
HCM 95th %tile Q(veh)	-	-	0.2	0.1	0.1	-

Intersection	
Int Delay, s/veh	0.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	8	12	1389	13	20	1171
Future Vol, veh/h	8	12	1389	13	20	1171
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	0	-	-	50	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	8	13	1462	14	21	1233

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	2128	738	0	0	1476	0
Stage 1	1469	-	-	-	-	-
Stage 2	659	-	-	-	-	-
Critical Hdwy	6.84	6.94	-	-	4.14	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	-	-	2.22	-
Pot Cap-1 Maneuver	43	360	-	-	452	-
Stage 1	178	-	-	-	-	-
Stage 2	476	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	41	360	-	-	452	-
Mov Cap-2 Maneuver	131	-	-	-	-	-
Stage 1	178	-	-	-	-	-
Stage 2	454	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	23	0	0.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	131	360	452	-
HCM Lane V/C Ratio	-	-	0.064	0.035	0.047	-
HCM Control Delay (s)	-	-	34.4	15.4	13.4	-
HCM Lane LOS	-	-	D	C	B	-
HCM 95th %tile Q(veh)	-	-	0.2	0.1	0.1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	84	333	92	588	352	806	99	376	388	736	55	86
Future Volume (veh/h)	84	333	92	588	352	806	99	376	388	736	55	86
Number	7	4	14	3	8	18	5	2	12	1	6	16
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
Adj Sat Flow, veh/h/ln	1676	1676	1676	1676	1676	1676	1676	1676	1676	1676	1676	1710
Adj Flow Rate, veh/h	88	351	97	619	371	848	104	396	408	775	58	91
Adj No. of Lanes	1	1	1	2	1	2	1	2	1	2	1	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	108	374	318	616	594	1509	439	508	511	766	70	110
Arrive On Green	0.07	0.22	0.22	0.20	0.35	0.35	0.28	0.16	0.16	0.25	0.12	0.12
Sat Flow, veh/h	1597	1676	1425	3097	1676	2508	1597	3185	1425	3097	589	924
Grp Volume(v), veh/h	88	351	97	619	371	848	104	396	408	775	0	149
Grp Sat Flow(s),veh/h/ln	1597	1676	1425	1549	1676	1254	1597	1593	1425	1549	0	1513
Q Serve(g_s), s	6.5	24.6	3.5	23.8	22.0	24.4	6.0	14.3	19.1	29.6	0.0	11.5
Cycle Q Clear(g_c), s	6.5	24.6	3.5	23.8	22.0	24.4	6.0	14.3	19.1	29.6	0.0	11.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		0.61
Lane Grp Cap(c), veh/h	108	374	318	616	594	1509	439	508	511	766	0	180
V/C Ratio(X)	0.82	0.94	0.31	1.01	0.62	0.56	0.24	0.78	0.80	1.01	0.00	0.83
Avail Cap(c_a), veh/h	133	378	321	616	594	1509	439	508	511	766	0	426
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	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	55.1	45.7	10.6	48.0	32.0	14.3	33.6	48.3	34.5	45.1	0.0	51.5
Incr Delay (d2), s/veh	26.4	30.8	0.5	37.5	2.0	0.5	0.3	7.6	8.7	35.5	0.0	9.2
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	3.7	14.6	2.5	13.3	10.4	8.4	2.7	6.8	13.3	16.3	0.0	5.3
LnGrp Delay(d),s/veh	81.4	76.5	11.1	85.5	34.1	14.8	33.9	55.9	43.3	80.5	0.0	60.7
LnGrp LOS	F	E	B	F	C	B	C	E	D	F		E
Approach Vol, veh/h		536			1838			908			924	
Approach Delay, s/veh		65.5			42.5			47.7			77.4	
Approach LOS		E			D			D			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	34.1	25.1	28.3	32.2	38.9	20.3	12.6	47.9
Change Period (Y+Rc), s	4.5	6.0	4.5	5.5	6.0	* 6	4.5	5.5
Max Green Setting (Gmax), s	29.6	19.1	23.8	27.0	15.0	* 34	10.0	40.8
Max Q Clear Time (g_c+I1), s	31.6	21.1	25.8	26.6	8.0	13.5	8.5	26.4
Green Ext Time (p_c), s	0.0	0.0	0.0	0.1	2.6	0.7	0.0	7.4

Intersection Summary	
HCM 6th Ctrl Delay	54.2
HCM 6th LOS	D

DELAY (CONTROL)

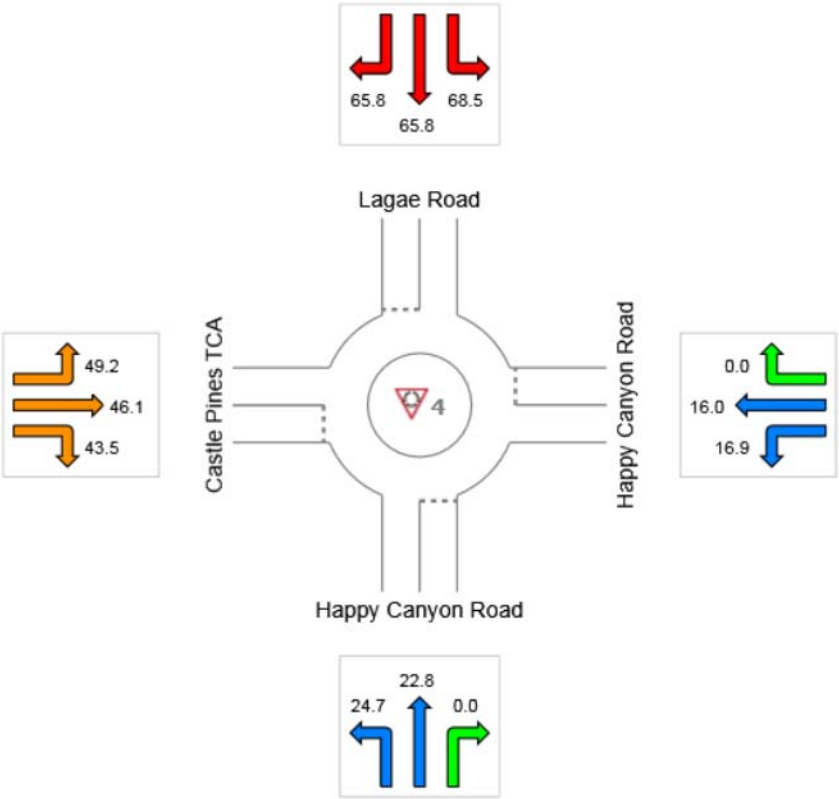
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: 4 [2040 PM]

New Site
Site Category: (None)
Roundabout

All Movement Classes

	Approaches				Intersection
	South	East	North	West	
Delay (Control)	12.8	9.0	68.0	46.1	27.5
LOS	B	A	F	E	D



Colour code based on Level of Service

LOS A	LOS B	LOS C	LOS D	LOS E	LOS F

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

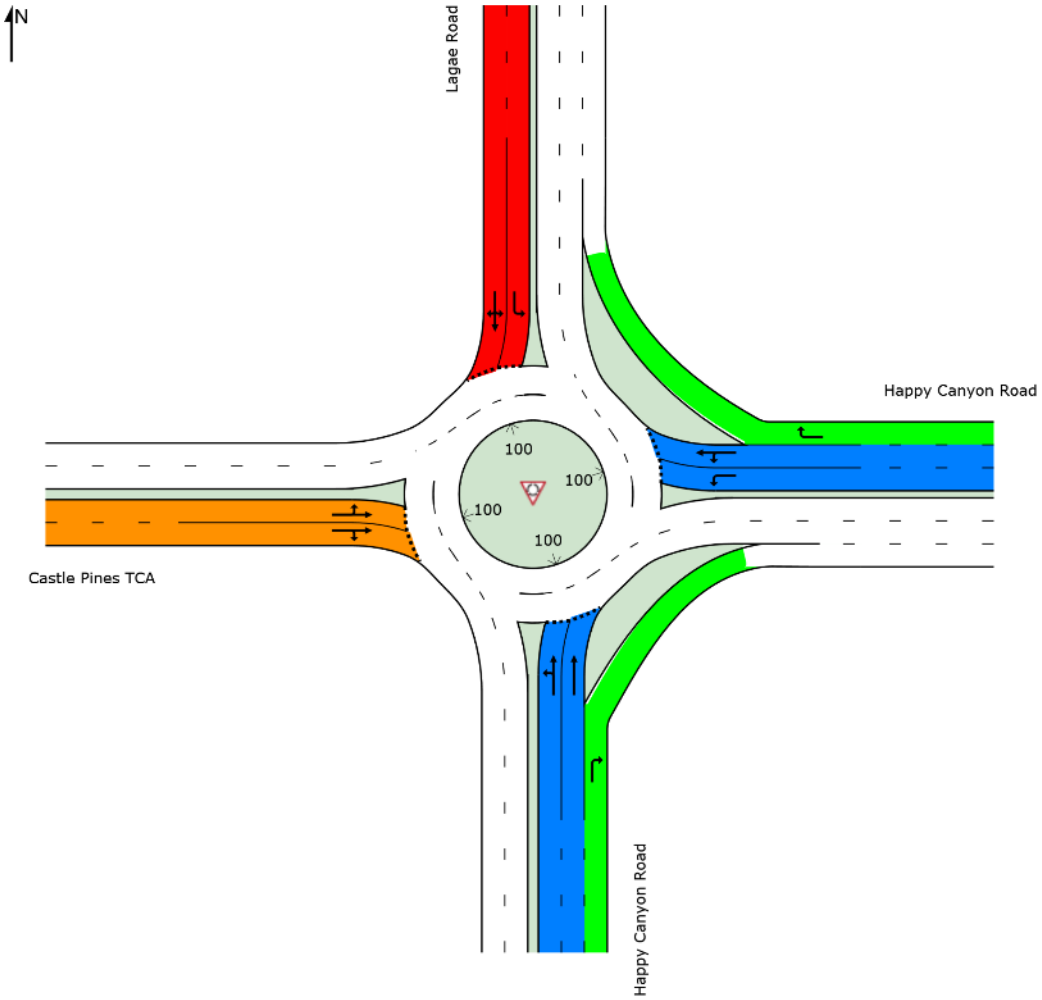
LANE LEVEL OF SERVICE

Lane Level of Service

Site: 4 [2040 PM]

New Site
Site Category: (None)
Roundabout

	Approaches				Intersection
	South	East	North	West	
LOS	B	A	F	E	D



Colour code based on Level of Service

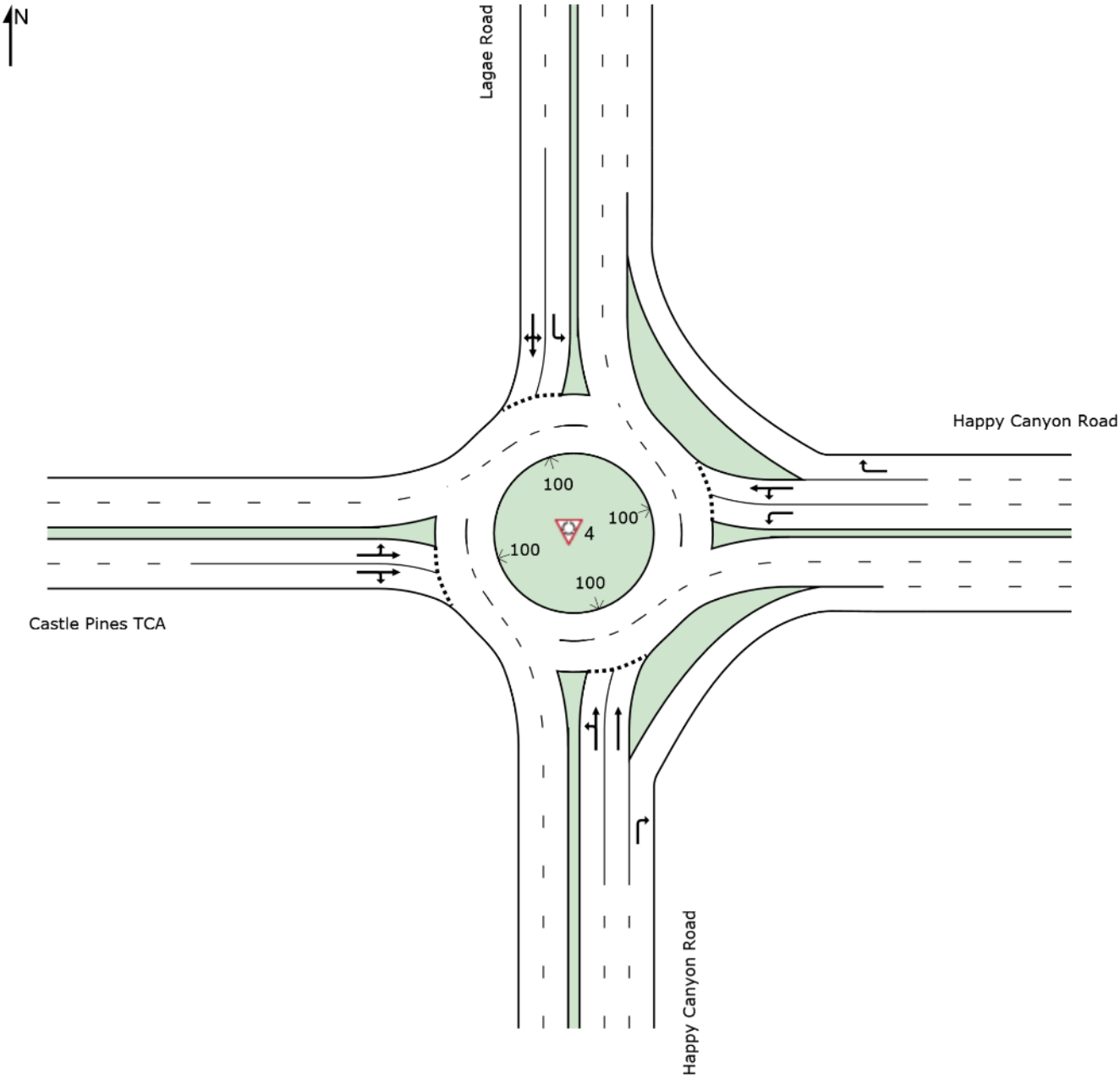
LOS A	LOS B	LOS C	LOS D	LOS E	LOS F

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Roundabout Level of Service Method: Same as Sign Control
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

SITE LAYOUT

Site: 4 [2040 PM]

New Site
Site Category: (None)
Roundabout



APPENDIX C

QUEUING ANALYSIS WORKSHEETS

Intersection: 2: Lagae Road & PA-7 North Access

Movement	WB	WB	SB
Directions Served	L	R	L
Maximum Queue (ft)	31	31	30
Average Queue (ft)	17	12	3
95th Queue (ft)	40	36	18
Link Distance (ft)	368	368	
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			50
Storage Blk Time (%)			0
Queuing Penalty (veh)			0

Intersection: 3: Lagae Road & PA-7 South Access

Movement	WB	WB	SB
Directions Served	L	R	L
Maximum Queue (ft)	31	55	31
Average Queue (ft)	9	15	6
95th Queue (ft)	31	42	25
Link Distance (ft)	360	360	
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			50
Storage Blk Time (%)			0
Queuing Penalty (veh)			0

Network Summary

Network wide Queuing Penalty: 0

Intersection: 2: Lagae Road & PA-7 North Access

Movement	WB	WB	SB
Directions Served	L	R	L
Maximum Queue (ft)	72	31	32
Average Queue (ft)	19	12	16
95th Queue (ft)	62	36	40
Link Distance (ft)	368	368	
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			50
Storage Blk Time (%)			0
Queuing Penalty (veh)			0

Intersection: 3: Lagae Road & PA-7 South Access

Movement	WB	WB	SB
Directions Served	L	R	L
Maximum Queue (ft)	74	31	48
Average Queue (ft)	15	8	14
95th Queue (ft)	48	29	39
Link Distance (ft)	361	361	
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			50
Storage Blk Time (%)			0
Queuing Penalty (veh)			2

Network Summary

Network wide Queuing Penalty: 2