Kimley»Horn

Memorandum

To: Marc Stout, P.E., City Engineer
City of Roseville

From: Matt Weir, P.E., T.E., PTOE

Re: **John Adams Academy**
Traffic Access and Circulation Evaluation

Date: January 13, 2016

The purpose of this memorandum is to document our evaluation of access and circulation within, and in the vicinity of, the John Adams Academy (JAA) campus in Roseville. Kimley-Horn understands that JAA proposes to construct an 11,600-square foot multi-purpose building on their campus located at 1 Sierragate Plaza. In addition, JAA recently acquired 7 Sierragate Plaza (the former Heald College building), which is anticipated to contribute to increasing the school's ultimate enrollment by 371 students. Based on data provided by JAA at initiation of this evaluation, the current enrollment was 1,239 K-12 students. At full occupancy (projected to be the 2022-23 academic year) and with the addition of 7 Sierragate Plaza, the campus is now anticipated to have a population of up to 1,610 students.

The purpose of this study was to evaluate JAA's existing operations including: on- and off-site traffic control; on-site signing and striping; on-site circulation patterns and related inefficiencies; student staggered arrival and departure schedules; and opportunities for operational improvements. This evaluation also considered the effect of the anticipated increase in students and makes recommendations for operational improvements that can be applied to current conditions, as well as those anticipated to be realized with enrollment at capacity.

The following is a summary of the recommendations that are supported by the technical analyses and discussion contained herein:

Offsite Recommendations

The offsite recommendations are those that address controlling traffic and maintaining/improvement safety within the public right-of-way. After considering numerous combinations of offsite operations improvements, it was determined that the following set of options results in improved operations at the Harding/JAA Driveway intersection, as well as reasonable queuing along the westbound Lead Hill approach to Harding (see attached **Exhibit 10**):

1. Harding/Lead Hill intersection:
    - Removal of the existing westbound right-turn overlap and right-turns-on-red at Harding/Lead Hill.
    - Conversion of the westbound Lead Hill approach from dual lefts/single right, to single left/dual rights.

Because of their ability to improve safety and overall operations within the public right-of-way, these offsite recommendations should be implemented as quickly as practicable.

Onsite Recommendations

The following onsite strategies are recommended for JAA and the neighboring businesses' consideration:

1. Use of a permanent, one-way onsite circulation pattern that remains in place 24-hours a day, 7 days a week. (As noted, JAA will be required to coordinate with, and seek concurrence from the neighboring businesses on any such circulation change to the comment, shared ring-road.)
2. Use of both exit lanes as right-turns during school peak periods at the Harding/JAA driveway intersection.
3. Use of improved staggered start/end times accounting for class building locations
4. Use of incentives for non-motorized or carpool commuting

JAA will be required to coordinate with, and seek concurrence from the neighboring businesses on circulation changes to the common, shared ring-road. If applied correctly, a permanent circulation pattern can actually allow for a simplified signing and striping program, improved safety associated with minimized wrong-way movements, and ultimately require fewer "staffed" traffic control locations.

The following sections describe the data used, and the technical analyses and key findings of this evaluation:

I. Baseline Data

The following are the primary data on which this evaluation was based:

- JAA Student Enrollment: 1,239 current, 1,610 projected (30% growth)
  - over 90% (362) of the growth is anticipated in Grades 7-12
- Monday-Thursday Start/End times are currently staggered as follows:
  - Drop-Off: 30% - 7:40 AM, Grades 7-12 (381 students)
    64% - 8:00 AM, Grades TK-6 (789 students)
    6% - 11:45 AM, Grades TK-K (69 students)
  - Pick-Up: 7% - 11:30 AM, Grades TK-K (80 students)
    38% - 2:50 PM, Grades 1-4 (477 students)
    55% - 3:15 PM, Grades TK, K, 5-6, and 7-12 (682 students)
  - Pick-Up (Friday): 12% - 11:30 AM, Grades TK-K (149 students)
    57% - 12:00 PM, Grades 1-6 (709 students)
    31% - 12:30 PM, Grades 7-12 (381 students)

II. Off-Site Study Facilities

Through consultation with the City, the following off-site intersections (see **Exhibit 1**) were identified for inclusion in this evaluation:

1. Harding Boulevard at JAA Driveway
2. Harding Boulevard at Wills Road
3. Harding Boulevard at Lead Hill Boulevard
4. Lead Hill Boulevard at Business Park Driveway
5. Lead Hill Boulevard at Sunrise Avenue

III. Data Collection

Traffic Counts

Off-site traffic counts were conducted for the AM (6:30-8:30) and school-PM (2:00-4:00) peak-periods during the week of October 26, 2015 (Tuesday, Wednesday, and Thursday). It is important to note that JAA modified their on-site circulation from one-way to a two-way pattern on Thursday, October 29th. Accordingly, because the two-way circulation pattern was observed to result in significant off-site queuing and longer drop-off and pick-up periods than observed for the one-way configuration, it was determined that data from that day

(Thursday) would not be appropriate for use in this study as it limited the ability to thoroughly capture all vehicles entering and exiting the site during the study period. Therefore, the traffic data from Tuesday and Wednesday were averaged and represent Baseline Conditions for use in this study. Existing peak-hour (AM, 7:15-8:15 and school-PM, 3:00-4:00) traffic volumes are depicted in **Exhibit 2**.

Trip Generation Rate

Because this evaluation includes consideration of a growth scenario in which an additional 371 students are anticipated to attend JAA, it was necessary to collect data appropriate for determining the site's unique trip generation rate. For the purposes of this evaluation, all JAA traffic was assumed to use the single Harding Boulevard site access driveway (study Intersection #1), and not access the site via other Sierragate business parking lots. As such, using the site driveway count data and knowledge of the enrollment at the time of the data collection, it was possible to calculate the following unique JAA trip generation rates:

AM Peak-Hour: *0.90 trips/student*
School-PM Peak-Hour: *0.58 trips/student*

Using these rates we were then able to approximate that the 371 additional students are anticipated to equate to 334 additional AM, and 216 additional school-PM peak-hour trips. These additional trips were added to the existing count data using the existing student trip distribution patterns to establish conditions anticipated to be realized at JAA full enrollment.

IV. Traffic Analysis Methodology

Level of Service (LOS) Analyses

Analysis of transportation facility operations is based on the concept of Level of Service (LOS). The LOS of a facility is a qualitative measure used to describe operational conditions. LOS ranges from A (best), which represents minimal delay, to F (worst), which represents heavy delay and a facility that is operating at or near its functional capacity. Levels of Service for this study were determined using methods defined in the *Highway Capacity Manual, 2010 (HCM)*.

The HCM includes procedures for analyzing side-street stop controlled (SSSC), all-way stop controlled (AWSC), and signalized intersections. These procedures define LOS as a function of average control delay. **Table 1** presents intersection LOS definitions as defined in the HCM.

Table 1 – Intersection Level of Service Criteria

Level of Service (LOS)	Un-Signalized	Signalized
	Average Control Delay (sec/veh)	Control Delay per Vehicle (sec/veh)
A	≤ 10	≤ 10
B	> 10 – 15	> 10 – 20
C	> 15 – 25	> 20 – 35
D	> 25 – 35	> 35 – 55
E	> 35 – 50	> 55 – 80
F	> 50	> 80

Source: Highway Capacity Manual, 2010

Consistent with methodology approved by the City, Levels of Service were determined using the SimTraffic® traffic analysis software. SimTraffic® is a microsimulation tool that is useful for analyzing complex situations such as closely spaced intersections and the effects of signals on nearby unsignalized intersections and driveways. The SimTraffic® models were validated based on field observations of traffic volumes, driver behavior, lane utilization, and maximum vehicle queue lengths. As a result of these observations, adjustments were incorporated that improve the accuracy of the simulated vehicles' behavior. For this simulation effort, a seed time of 10 minutes was used and 10 runs were averaged to obtain the results. The SimTraffic® Measures of Effectiveness (MOEs) were compared against the HCM intersection delay thresholds (**Table 1**) to equate the SimTraffic® results to HCM LOS.

Queuing Evaluations

Vehicle queuing for critical movements at the study intersections was also evaluated. Queuing for these movements was approximated using the aforementioned SimTraffic® models. 95th percentile vehicle queues were compared against baseline conditions and available vehicle storage lengths, and were used as a primary measure of the various improvement options' effectiveness.

Analysis Scenarios

This traffic evaluation considered the following analysis scenarios:

A. Baseline Conditions
   Documents existing on-the-ground counts and conditions at the time of initiation of this evaluation. As previously discussed, these conditions reflect the JAA one-way on-site circulation pattern. Off-site improvement options were considered with these volumes to identify opportunities for improved operations and safety.
B. Baseline plus JAA Growth Conditions
   Reflects conditions anticipated to be realized when JAA reaches full occupancy at 1,610 students. The approximate 30 percent increase in students is currently anticipated to be achieved for the 2022-23 academic year. Although it is acknowledged that the background traffic will certainly fluctuate over this period, for the purposes of this evaluation, the additional traffic associated with JAA's growth was added to Baseline Conditions and analyzed as such.

V. Baseline Conditions

As previously discussed, Baseline Conditions were established for use in this study by incorporating the following information:

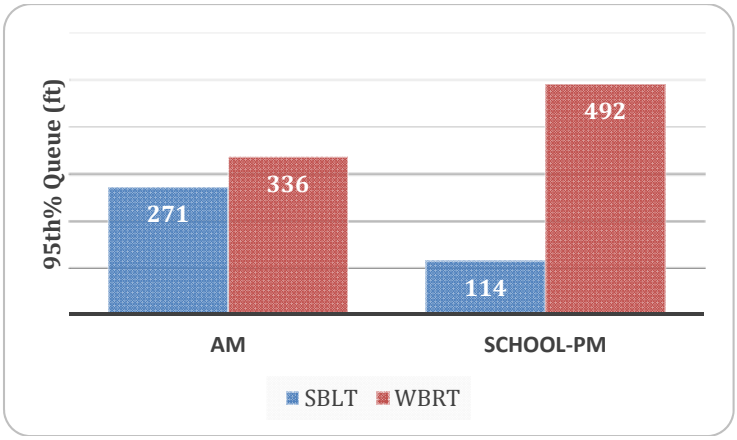
- Off-site traffic count data from October 27th and 28th, 2015.
- Field observations from October 7th and November 6th, 2015.
- Review of Harding Boulevard and Lead Hill Boulevard videos to establish existing queuing patterns and vehicle interactions at, and in the vicinity of the Harding Boulevard driveway and the Lead Hill Boulevard access driveway.
- Feedback from the City and JAA regarding typical peak-period operations including off-site conflicts, on-site challenges related to Sierragate businesses' access and concerns, and firsthand knowledge of the area's traffic patterns and tendencies.

Moreover, the Baseline Conditions (one-way on-site traffic circulation) were observed to result in the following:

- Frequent conflicts and observed frustration for drivers turning into and out of the site driveway along Harding Boulevard. These conflicts appear to be created by a limited number and size of gaps in the Harding Boulevard traffic stream which primarily affects the southbound left-turn into the site, and the outbound right-turn leaving the site.
- Extended peak period southbound left-turn queuing from Harding Boulevard into the site driveway that routinely extends north, past the existing apartment and dentist driveways, to the Dry Creek bridge.
- Excessive onsite queuing for traffic waiting to exit onto Harding Boulevard (a movement that is restricted to right-turn only during peak periods).
- Pick-up procedures that result in on-site queuing that frequently spills back to the main driveway intersection, however rarely adversely affecting off-site traffic flow along Harding Boulevard.

While the following section provides a more thorough discussion of the quantitative aspects of this evaluation, it is helpful to expound on the above Baseline Conditions by further discussing the current vehicle queuing that routinely occurs during peak periods. As reflected in **Exhibit 3**, the inbound (southbound) left-turn queue is worse during the AM peak-hour while the outbound (westbound) right-turn leaving the campus is worse during the school-PM peak-hour. These conditions are the primary contributors to the broad impression and frustrations associated with the Baseline Conditions.

Exhibit 3 – Baseline Conditions Queuing, Harding/JAA Driveway



VI. Offsite Recommendations

Off-site traffic operations were evaluated to quantify levels of service and queuing associated with several improvement options. The following options were included in this evaluation:

- **NRT**: Removal of the westbound Lead Hill right-turn-on-red (RTOR) to assist in creating gaps in the Harding traffic stream in the vicinity of the JAA driveway intersection
- **NOV**: Removal of the westbound Lead Hill right-turn overlap signal phase to assist in creating gaps in the Harding traffic stream in the vicinity of the JAA driveway intersection
- **TMGS**: Changes to the Harding/Lead Hill signal timings to assist in creating gaps in the Harding traffic stream in the vicinity of the JAA driveway intersection

- **Dual Right**: Modifications to the westbound Lead Hill approach lane designations to change from dual lefts/single right, to single left/dual rights to reduce the amount of queuing along the Lead Hill approach to Harding
- **(Onsite) Dual Right at JAA**: Conversion to dual right-turns departing JAA at Harding
- **G:** Incorporation of the JAA student growth and associated traffic
- **Traditional**: Consideration for the traditional PM peak-hour

Exhibits 4-6 present queuing results for three improvement conditions. As depicted in these exhibits, changes to the Harding/Lead Hill signal timings to improve conditions along Harding in the vicinity of the JAA driveway intersection result in excessive queuing along the westbound Lead Hill approach to Harding. As a result, the exhibits reflect the need for and effectiveness of the conversion to dual rights along the westbound Lead Hill approach. With this combined improvement option (NRT+NOV+Dual Right), additional gaps are provided along Harding in the vicinity of the JAA driveway intersection as a result of the restriction of right-turns on red and elimination of the right-turn overlap, and the westbound Lead Hill approach has adequate capacity to accommodate the additional westbound right-turn queuing that results from these operations changes. When compared to baseline conditions, these combined improvements are shown to equate to an approximately 25 percent reduction in the Harding/JAA Driveway southbound left-turn queue, a 19-33 percent reduction in the Harding/JAA Driveway westbound right-turn queue, and a 7-14 percent reduction in the Harding/Lead Hill westbound right-turn queue.

Exhibit 4 – Improvement Conditions Queuing, **Harding/JAA Driveway - SBLT**

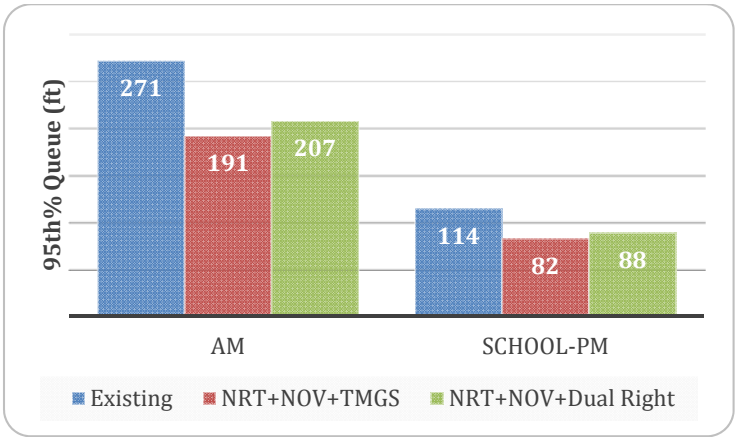


Exhibit 5 – Improvement Conditions Queuing, **Harding/JAA Driveway - WBRT**

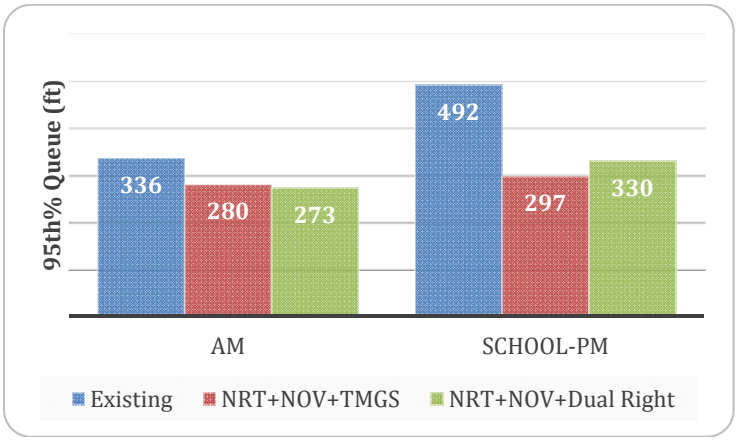
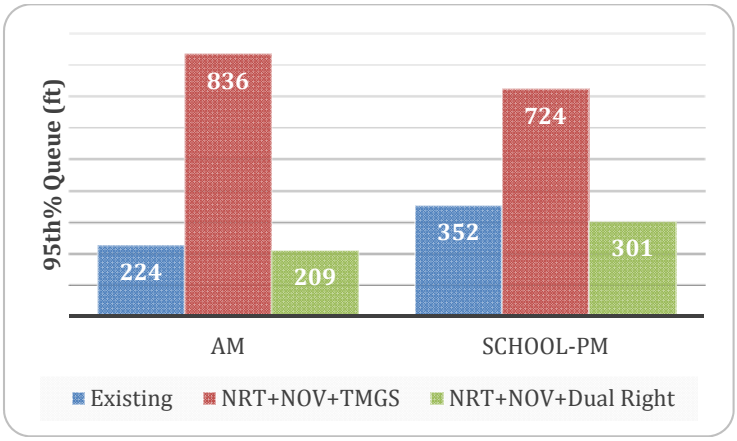


Exhibit 6 – Improvement Conditions Queuing, **Harding/Lead Hill - WBRT**



Summary tables of the intersection LOS analyses and approach queuing are provided in **Appendix A**. As shown in Appendix A, the improvement conditions accommodate the traditional PM peak-hour volumes with LOS and queuing values comparable to or better than existing conditions. An overview of the improvement condition is provided in **Exhibit 10**. Technical analysis worksheets are available upon request.

VII. Onsite Recommendations

Additional consideration for the combined improvement conditions included assessment of its ability to accommodate projected JAA growth and an additional operational improvement at the JAA driveway in which dual right turns are provided (presumably limited to the school peak periods) (see **Exhibits 7-9**). Doubling the outbound right-turn capacity at the JAA Driveway reduces the amount of onsite queuing, while the addition of the projected JAA growth demonstrates that additional evaluation may be required at the time that growth is realized to perform a refined assessment of the signal timings to better accommodate the anticipated demand and queuing.

Exhibit 7 – Improvement Conditions (plus Growth) Queuing, **Harding/JAA Driveway – SBLT**

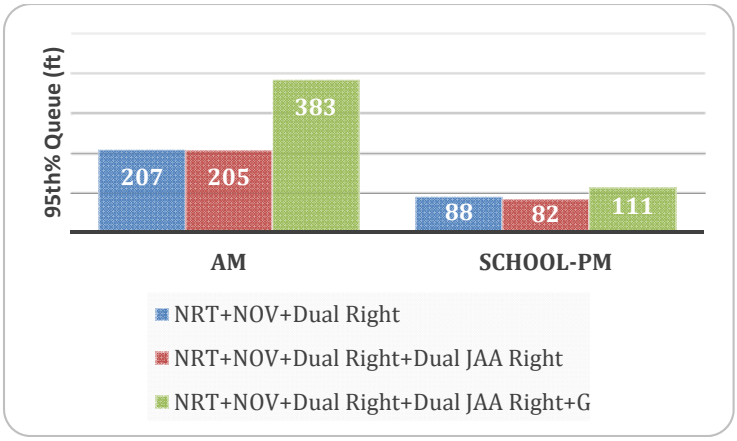


Exhibit 8 – Improvement Conditions (plus Growth) Queuing, **Harding/JAA Driveway - WBRT**

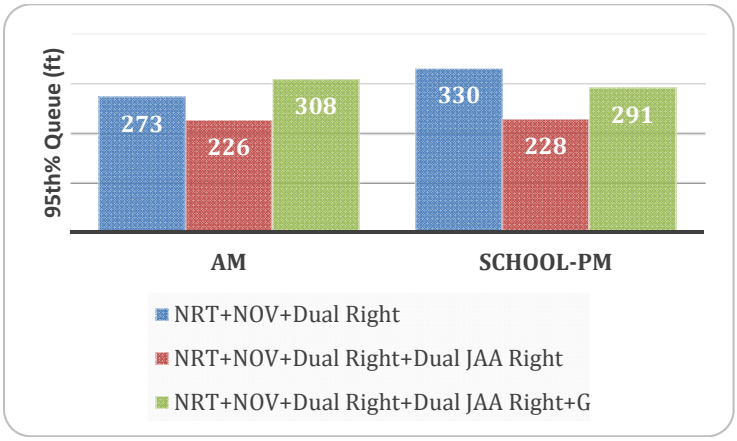
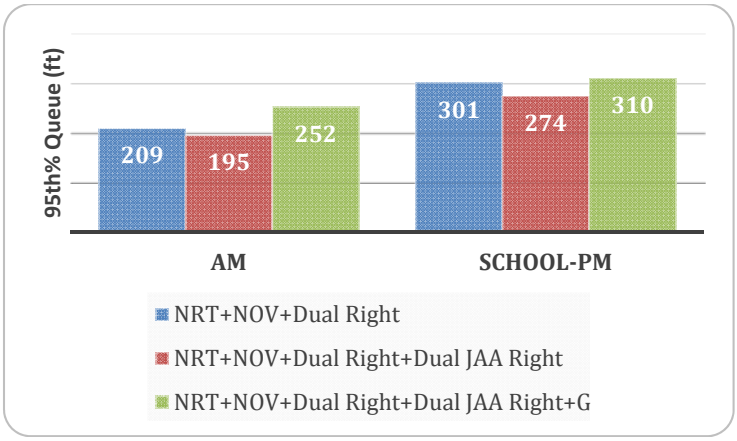


Exhibit 9 – Improvement Conditions (plus Growth) Queuing, **Harding/Lead Hill - WBRT**



Summary tables of the intersection LOS analyses and approach queuing are provided in **Appendix A**. Technical analysis worksheets are available upon request.

While we understand that there are existing reciprocal property rights that could cause challenges to implementing operational changes onsite, this discussion is intended to provide suggestions or tools for JAA's independent consideration. JAA is encouraged to review and implement these suggested actions in a manner that is acceptable to JAA and the other Sierragate businesses.

1. As previously stated, JAA is anticipating 30 percent growth to reach capacity. Upon review of the current and projected number of students, by grade, and by building, it was revealed that over 90 percent of the anticipated growth will occur in the former Heald College Building. As a result, the current traffic patterns at the other three buildings are long-term and represent the "worst case" scenario as these grades are essentially at capacity today.

   When combined with the current bell schedules, there appear to be opportunities to improve the grouping of grades and buildings to create a stagger in the campus' schedule that serves to lessen the peak periods and improve the operations for both drop-off and pick-up activities. As an example, the current bell schedule has Grades 1-4 released "early" at 2:50, however these grades are located in three different buildings. As a result, it is difficult to envision the grouping of these students for a concentrated pick-up because their class locations are dispersed.

It is recommended that JAA re-examine the staggered start/end times with an eye toward combining the various groups at certain areas of the designated parking lots. If this dynamic can be achieved, it may be possible to make better use of the multiple drive aisles to dramatically increase the capacity and improve the (predominantly pick-up) operations. Well vetted and thoughtful staggered start/end times have the potential to minimize conflicts, alleviate current "peak" traffic periods, and improve the overall site operations. Consideration will have to be given to those families (149 currently) with students in multiple grades, in multiple buildings, etc. Perhaps those cases are specifically addressed with direction to abide by the student's schedule who ends the latest.

2. While we don't anticipate that even the most elaborate of incentives could get enough students out of their cars to alleviate the traffic congestion currently being experienced, we do recognize that there are inevitably benefits to be gained from reducing the number of vehicles, even if in small quantities. Similar to other driver behavior, most families will only adjust their commute habits with incentives that are significant enough to justify the desired action. To this point, the following incentive concepts have been identified: carpooling, walk/bike, and remote shuttling.

   It is recommended that JAA consider incentives that are likely to be effective in altering students' commute behavior. Some primary examples include carpool (3 or 4+) use of the parking lot located closest to Harding Boulevard to bypass the majority of the loop, and offering "JAA gear" to those who arrive by foot/bike. In addition, there should be incentives for the JAA families to patronize the Sierragate businesses.

3. Recognizing that JAA has used both one-way and two-way circulation plans this school year, they have the unique benefit of being able to compare and contrast the two. As such it is recommended that, in addition to implementation of a permanent one-way onsite circulation pattern that remains in place 24-hours a day, 7 days a week, JAA consider on-site operational changes that are aimed at improving the efficiency of the drop-off and pick-up activities. Some initial strategies include grouping of grades to allow for more efficient use of the multiple parking lot drive aisles, clear and consistent student or "area" designations (by color and/or letter), and improved signing and striping.

4. We understand that this school year has seen the use of both one-way and two-way on-site circulation patterns. At the time of our field observations, JAA was using a time-of-day program in which one-way operation was used only during peak JAA periods, reverting back to two-way during the off-peak periods. Time-of-Day traffic control strategies are largely considered to be confusing to JAA and the other businesses' traffic, and seems to add an unnecessary additional layer of inefficiency.

   It is recommended that JAA consider the use of a permanent on-site circulation pattern that remains in place 24 hours a day, 7 days a week. It is acknowledged that JAA will need to coordinate with, and seek concurrence from the neighboring businesses on any such circulation change to the common, shared ring-road. If applied correctly, a permanent circulation pattern can actually allow for a simplified signing and striping program, improved safety associated with minimized wrong-way movements, and ultimately require fewer "staffed" traffic control locations.

VIII. Summary of Recommendations

Based on the information and analyses presented herein, the following recommendations are offered:

A. Offsite

The offsite recommendations are those that address controlling traffic and maintaining/improvement safety within the public right-of-way. After considering numerous combinations of offsite operations improvements, it was determined that the following set of options results in improved operations at the Harding/JAA Driveway intersection, as well as reasonable queuing along the westbound Lead Hill approach to Harding (see **Exhibit 10**):

1. Harding/Lead Hill intersection:
    - Removal of the existing westbound right-turn overlap and right-turns-on-red at Harding/Lead Hill.
    - Conversion of the westbound Lead Hill approach from dual lefts/single right, to single left/dual rights.

Because of their ability to improve safety and overall operations within the public right-of-way, these offsite recommendations should be implemented as quickly as practicable.

B. Onsite

The following onsite strategies are recommended for JAA and the neighboring businesses' consideration:

1. Use of a permanent, one-way onsite circulation pattern that remains in place 24-hours a day, 7 days a week. (As noted, JAA will be required to coordinate with, and seek concurrence from the neighboring businesses on any such circulation change to the comment, shared ring-road.)
2. Use of both exit lanes as right-turns during school peak periods at the Harding/JAA driveway intersection.
3. Use of improved staggered start/end times accounting for class building locations
4. Use of incentives for non-motorized or carpool commuting

As previously noted, JAA will be required to coordinate with, and seek concurrence from the neighboring businesses on circulation changes to the common, shared ring-road. If applied correctly, a permanent circulation pattern can actually allow for a simplified signing and striping program, improved safety associated with minimized wrong-way movements, and ultimately require fewer "staffed" traffic control locations.

Attachments:

Exhibit 1 – Study Intersections, Traffic Control, and Lane Geometries
Exhibit 2 – Baseline Peak-Hour Traffic Volumes
Exhibit 10 – Offsite Recommendations

Appendix A – Intersection LOS and Queuing Analysis Results Tables

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Exhibit 1
Study Intersections, Traffic Control, and Lane Geometries

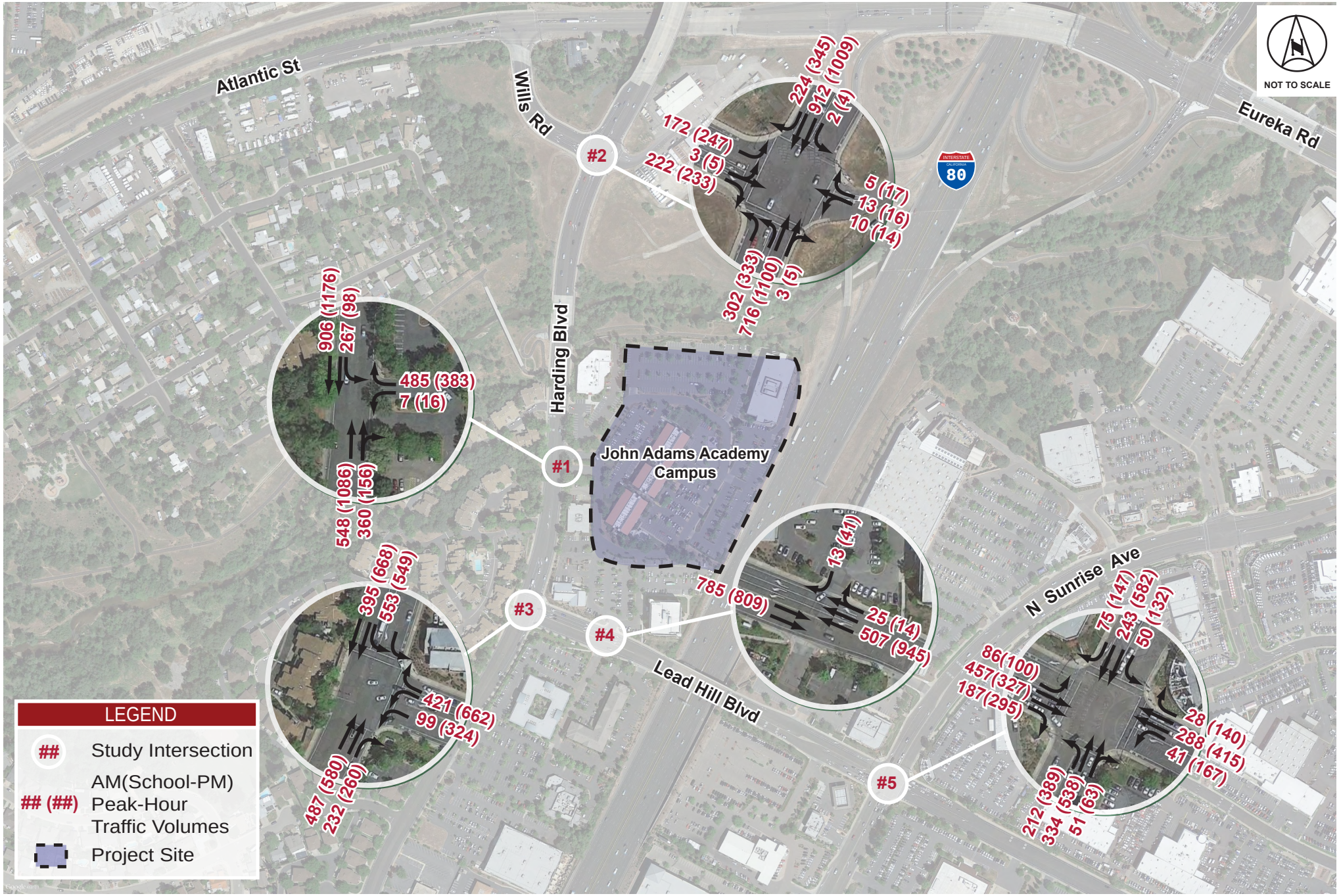

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Exhibit 2
Baseline Peak-Hour Traffic Volumes

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Exhibit 10
Offsite Recommendations

Appendix A

Intersection LOS and Queuing Analysis Results Tables

Intersection / Analysis Scenario	Control	AM Peak-Hour		PM Peak-Hour	
		Delay (sec)	LOS	Delay (sec)	LOS
#1, Harding Blvd at Project Driveway	**SSSC***				
Existing		11.6 (20.5 WBR)	C	13.7 (54.6 WBR)	F
Existing + NRT		12.3 (20.7 WBR)	C	13.8 (59.9 WBR)	F
Existing + NOV		11.2 (20.4 WBR)	C	12.6 (49.4WBR)	E
Existing + NRT + NOV		10.3 (21.1 WBR)	C	7.7 (20.4 WBR)	C
Existing + NRT + NOV + TMGS		9.2 (16.3 WBR)	C	8.4 (24.2 WBR)	C
Existing + NRT + NOV + Dual Right		9.2 (16.1 WBR)	C	8.9 (29.6 WBR)	D
Existing + NRT + NOV + Dual Right + Dual Right at JAA		9.4 (16.8 WBR)	C	8.5 (27.7 WBR)	D
Existing + NRT + NOV + TMGS + Dual Right		9.5 (17.1 WBR)	C	8.9 (30.8 WBR)	D
Existing + NRT + NOV + Dual Right + TMGS		10.5 (24.1 WBR)	C	9.5 (33.4 WBR)	D
Ex + G + NRT + NOV + Dual Right		26.6 (63.1 WBR)	F	21.4 (96.5 WBR)	F
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA		14.7 (22.0 WBR)	C	10.9 (34.8 WBR)	D
Traditional		*PM Only*		3.8 (10.5 WBR)	B
Traditional + Dual Right				3.6 (9.6 WBR)	A
Traditional + Dual Right + NRT + NOV				3.6 (8.1 WBR)	A
#2, Harding Blvd at Wills Rd	**Signal**				
Existing		22.8	C	26.3	C
Existing + NRT		23.5	C	25.5	C
Existing + NOV		23.7	C	24.7	C
Existing + NRT + NOV		23.7	C	24.2	C
Existing + NRT + NOV + TMGS		23.3	C	24.0	C
Existing + NRT + NOV + Dual Right		24.5	C	24.2	C
Existing + NRT + NOV + Dual Right + Dual Right at JAA		24.8	C	26.4	C
Existing + NRT + NOV + TMGS + Dual Right		23.3	C	24.9	C
Existing + NRT + NOV + Dual Right + TMGS		23.4	C	24.9	C
Ex + G + NRT + NOV + Dual Right		31.5	C	26.6	C
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA		28.9	C	26.8	C
Traditional		*PM Only*		17.9	B
Traditional + Dual Right				17.7	B
Traditional + Dual Right + NRT + NOV				17.9	B
#3, Harding Blvd at Lead Hill Blvd	**Signal**				
Existing		15.4	B	17.1	B
Existing + NRT		16.3	B	19.7	B
Existing + NOV		18.6	B	22.0	C
Existing + NRT + NOV		29.7	C	28.5	C
Existing + NRT + NOV + TMGS		29.3	C	28.3	C
Existing + NRT + NOV + Dual Right		20.6	C	23.7	C
Existing + NRT + NOV + Dual Right + Dual Right at JAA		20.6	C	23.6	C
Existing + NRT + NOV + TMGS + Dual Right		21.5	C	23.5	C
Existing + NRT + NOV + Dual Right + TMGS		23.1	C	25.7	C
Ex + G + NRT + NOV + Dual Right		22.4	C	23.2	C
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA		22.2	C	24.0	C
Traditional		*PM Only*		16.7	B
Traditional + Dual Right				16.2	B
Traditional + Dual Right + NRT + NOV				22.5	C

Source: *Highway Capacity Manual (HCM) 2010* methodology per Synchro© v9.
*Side Street Stop Controlled (SSSC) intersections are reported as the overall intersection delay followed by the critical minor street approach movement's delay. The reported LOS corresponds to the critical minor street approach movement.

Intersection / Analysis Scenario	Control	AM Peak-Hour		PM Peak-Hour	
		Delay (sec)	LOS	Delay (sec)	LOS
#4, Lead Hill Blvd at Project Driveway	**SSSC***				
Existing		1.0 (6.2 SBR)	A	1.7 (13.7 SBR)	B
Existing + NRT		1.2 (9.8 SBR)	A	6.4 (54.8 SBR)	F
Existing + NOV		1.2 (7.0 SBR)	A	4.3 (36.1 SBR)	E
Existing + NRT + NOV		34.5 (523.7 SBR)	F	63.2 (958.5 SBR)	F
Existing + NRT + NOV + TMGS		24.7 (237.5 SBR)	F	65.9 (1169.9 SBR)	F
Existing + NRT + NOV + Dual Right		0.8 (4.5 SBR)	A	1.3 (9.6 SBR)	A
Existing + NRT + NOV + Dual Right + Dual Right at JAA		0.8 (4.2 SBR)	A	1.2 (8.3 SBR)	A
Existing + NRT + NOV + TMGS + Dual Right		0.8 (3.9 SBR)	A	1.3 (10.1 SBR)	B
Existing + NRT + NOV + Dual Right + TMGS		0.8 (5.9 SBR)	A	2.1 (11.3 SBR)	B
Ex + G + NRT + NOV + Dual Right		0.8 (4.3 SBR)	A	1.2 (9.1 SBR)	A
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA		0.9 (5.3 SBR)	A	1.4 (11.0 SBR)	B
Traditional		*PM Only*		4.5 (51.8 SBR)	F
Traditional + Dual Right				1.3 (10.4 SBR)	B
Traditional + Dual Right + NRT + NOV				2.3 (12.7 SBR)	B
#5, Lead Hill Blvd at N. Sunrise Ave	**Signal**				
Existing		21.4	C	40.6	D
Existing + NRT		21.2	C	41.0	D
Existing + NOV		21.6	C	39.9	D
Existing + NRT + NOV		24.5	C	72.3	E
Existing + NRT + NOV + TMGS		22.3	C	76.1	E
Existing + NRT + NOV + Dual Right		22.0	C	40.3	D
Existing + NRT + NOV + Dual Right + Dual Right at JAA		22.7	C	39.9	D
Existing + NRT + NOV + TMGS + Dual Right		21.6	C	39.2	D
Existing + NRT + NOV + Dual Right + TMGS		21.3	C	39.6	D
Ex + G + NRT + NOV + Dual Right		22.6	C	41.0	D
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA		22.3	C	40.6	D
Traditional		*PM Only*		49.6	D
Traditional + Dual Right				47.0	D
Traditional + Dual Right + NRT + NOV				47.2	D

Source: *Highway Capacity Manual (HCM) 2010* methodology per Synchro© v9.
*Side Street Stop Controlled (SSSC) intersections are reported as the overall intersection delay followed by the critical minor street approach movement's delay. The reported LOS corresponds to the critical minor street approach movement.

Intersection / Analysis Scenario	Movement	AM Peak-Hour		PM Peak-Hour	
		Available Storage (ft)	95th % Queue (ft)	Available Storage (ft)	95th % Queue (ft)
#1, Harding Blvd at Project Driveway	**SBL**				
Existing		175 (Driveway) 425 (Bridge)	271	175 (Driveway) 425 (Bridge)	114
Existing + NRT			289		101
Existing + NOV			244		98
Existing + NRT + NOV			220		82
Existing + NRT + NOV + TMGS			191		82
Existing + NRT + NOV + Dual Right			207		88
Existing + NRT + NOV + Dual Right + Dual Right at JAA			205		82
Existing + NRT + NOV + TMGS + Dual Right			205		78
Existing + NRT + NOV + Dual Right + TMGS			187		85
Ex + G + NRT + NOV + Dual Right			398		109
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA			383		111
Traditional		*PM Only*			29
Traditional + Dual Right					28
Traditional + Dual Right + NRT + NOV					23
	NBR				
Existing		440* (Lead Hill)	41	440* (Lead Hill)	20
Existing + NRT			46		20
Existing + NOV			39		21
Existing + NRT + NOV			39		19
Existing + NRT + NOV + TMGS			43		15
Existing + NRT + NOV + Dual Right			35		15
Existing + NRT + NOV + Dual Right + Dual Right at JAA			46		31
Existing + NRT + NOV + TMGS + Dual Right			32		15
Existing + NRT + NOV + Dual Right + TMGS			32		17
Ex + G + NRT + NOV + Dual Right			40		20
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA			58		35
Traditional		*PM Only*			0
Traditional + Dual Right					0
Traditional + Dual Right + NRT + NOV					0
	WBR				
Existing			336		492
Existing + NRT			323		521
Existing + NOV			338		447
Existing + NRT + NOV			346		259
Existing + NRT + NOV + TMGS			280		297
Existing + NRT + NOV + Dual Right			273		330
Existing + NRT + NOV + Dual Right + Dual Right at JAA			226		228
Existing + NRT + NOV + TMGS + Dual Right			279		349
Existing + NRT + NOV + Dual Right + TMGS			402		374
Ex + G + NRT + NOV + Dual Right			707		717
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA			308		291
Traditional		*PM Only*			44
Traditional + Dual Right					45
Traditional + Dual Right + NRT + NOV					44

Source: *Highway Capacity Manual (HCM) 2010* methodology per Synchro© v9.

Intersection / Analysis Scenario	Movement	AM Peak-Hour		PM Peak-Hour	
		Available Storage (ft)	95th % Queue (ft)	Available Storage (ft)	95th % Queue (ft)
#3, Harding Blvd at Lead Hill Blvd	**WBR**				
Existing		230 (JAA) 300 (Pocket)	224	230 (JAA) 300 (Pocket)	352
Existing + NRT			294		601
Existing + NOV			301		516
Existing + NRT + NOV			869		745
Existing + NRT + NOV + TMGS			836		724
Existing + NRT + NOV + Dual Right			209		301
Existing + NRT + NOV + Dual Right + Dual Right at JAA			195		274
Existing + NRT + NOV + TMGS + Dual Right			201		285
Existing + NRT + NOV + Dual Right + TMGS			228		355
Ex + G + NRT + NOV + Dual Right			231		284
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA			252		310
Traditional		*PM Only*			558
Traditional + Dual Right					173
Traditional + Dual Right + NRT + NOV					355
	WBL				
Existing		230 (JAA) 300 (Pocket)	62	230 (JAA) 300 (Pocket)	129
Existing + NRT			55		134
Existing + NOV			58		126
Existing + NRT + NOV			60		110
Existing + NRT + NOV + TMGS			62		112
Existing + NRT + NOV + Dual Right			96		226
Existing + NRT + NOV + Dual Right + Dual Right at JAA			104		228
Existing + NRT + NOV + TMGS + Dual Right			104		224
Existing + NRT + NOV + Dual Right + TMGS			115		231
Ex + G + NRT + NOV + Dual Right			98		229
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA			104		225
Traditional		*PM Only*			159
Traditional + Dual Right					253
Traditional + Dual Right + NRT + NOV					258
	SBL				
Existing		235 (Driveway) 465 (JAA)	223	235 (Driveway) 465 (JAA)	236
Existing + NRT			215		224
Existing + NOV			230		262
Existing + NRT + NOV			253		257
Existing + NRT + NOV + TMGS			256		244
Existing + NRT + NOV + Dual Right			234		250
Existing + NRT + NOV + Dual Right + Dual Right at JAA			230		255
Existing + NRT + NOV + TMGS + Dual Right			209		253
Existing + NRT + NOV + Dual Right + TMGS			224		233
Ex + G + NRT + NOV + Dual Right			235		231
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA			229		245
Traditional		*PM Only*			203
Traditional + Dual Right					219
Traditional + Dual Right + NRT + NOV					209

Source: *Highway Capacity Manual (HCM) 2010* methodology per Synchro© v9.

Intersection / Analysis Scenario	Movement	AM Peak-Hour		PM Peak-Hour	
		Available Storage (ft)	95th % Queue (ft)	Available Storage (ft)	95th % Queue (ft)
#3, Harding Blvd at Lead Hill Blvd	**SBT**				
Existing			91		139
Existing + NRT			93		139
Existing + NOV			109		171
Existing + NRT + NOV			115		174
Existing + NRT + NOV + TMGS			106		166
Existing + NRT + NOV + Dual Right			111		162
Existing + NRT + NOV + Dual Right + Dual Right at JAA			111		171
Existing + NRT + NOV + TMGS + Dual Right			109		173
Existing + NRT + NOV + Dual Right + TMGS			111		174
Ex + G + NRT + NOV + Dual Right			112		161
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA			112		161
Traditional		*PM Only*			143
Traditional + Dual Right					156
Traditional + Dual Right + NRT + NOV					164
	NBT				
Existing			153		212
Existing + NRT			159		215
Existing + NOV			177		220
Existing + NRT + NOV			171		228
Existing + NRT + NOV + TMGS			177		221
Existing + NRT + NOV + Dual Right			163		210
Existing + NRT + NOV + Dual Right + Dual Right at JAA			171		225
Existing + NRT + NOV + TMGS + Dual Right			176		221
Existing + NRT + NOV + Dual Right + TMGS			195		234
Ex + G + NRT + NOV + Dual Right			198		224
Ex + G + NRT + NOV + Dual Right + Dual Right at JAA			199		225
Traditional		*PM Only*			218
Traditional + Dual Right					221
Traditional + Dual Right + NRT + NOV					219

Source: *Highway Capacity Manual (HCM) 2010* methodology per Synchro© v9.