I Can Child Care

Commander Shepard Boulevard
@
Old Armistead Avenue

Traffic Signal Warrant Analysis
&
Operational Analysis

August 18, 2017

Hampton, VA

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

Contact: W. Scott Dunn, AICP, PTP

1001 Boulders Parkway, Suite 300 • Richmond, VA 23225
(804) 200-6987 phone • (804) 560-1438 fax
www.timmons.com

INTRODUCTION

This report presents the findings of the traffic signal warrant analysis and operational analysis performed for the Commander Shepard Boulevard/Old Armistead Avenue intersection in Hampton, VA.

The analyses were completed in association with the proposed 130-student I Can Child Care Center on Old Armistead Avenue, immediately north of the aforementioned intersection.

The following steps were taken to complete the signal warrant and operational analyses at the Commander Shepard Boulevard/Old Armistead Avenue intersection:

1. Traffic Data – 12-hour (6 AM to 6 PM) directional turning movement (DTM) counts were collected the Commander Shepard Boulevard/Old Armistead Avenue intersection on Thursday August 10, 2017.

2. Trip Generation – The estimated hourly traffic volumes generated by the proposed 130-student day care center were estimated using the ITE's *Trip Generation Manual*, 9th Edition.

3. Traffic Distribution - The trip distribution percentages for site-generated traffic were calculated using the 12-hour DTM count data.

4. Future Traffic Projections with Full Development – The estimated site traffic was added to the 2017 background volumes to obtain the 2017 total traffic volumes (with development) used in the analysis.

5. Signal Warrant Analyses – Traffic signal warrant analyses at the Commander Shepard Boulevard/Old Armistead Avenue intersection were performed using the 2017 total volumes. The warrant analysis was completed using Warrants 1, 2 and 3 from the 2009 *Manual on Uniform Traffic Control Devices* (MUTCD) using the 100% volume thresholds.

6. Operational Analyses – AM and PM peak operational analysis were completed at the Commander Shepard Boulevard/Old Armistead Avenue intersection to determine existing levels of service (LOS), delays, and queues and the impact that the proposed day care traffic will have on the intersection.

STUDY LOCATIONd

The I Can Child Care Center is proposed in the northwest quadrant of the Commander Shepard Boulevard/Old Armistead Avenue intersection in Hampton, VA. The site is currently occupied by Langley Auctions.

2017 TRAFFIC VOLUMES

Twelve-hour (6 AM to 6 PM) directional turning movement counts were collected at the Commander Shepard Boulevard/Old Armistead Avenue intersection on Thursday August 10, 2017. The hourly volumes by movement are summarized in Table 1. The complete count data is provided in Appendix A.

Table 1 – 2017 Existing Volumes
Commander Shepard Boulevard/Old Armistead Avenue

Time	MAJOR STREET				MINOR STREET	
	Commander Shepard - EB		Commander Shepard - WB		Old Armistead - SB	
	Left	Through	Through	Right	Left	Right
06:00 - 07:00	46	638	444	11	7	49
07:00 - 08:00	43	932	601	26	11	49
08:00 - 9:00	31	744	495	34	11	40
9:00 - 10:00	27	484	368	24	13	30
10:00 - 11:00	25	371	392	31	9	28
11:00 - 12:00	35	456	571	57	18	29
12:00 - 13:00	34	636	505	47	18	33
13:00 - 14:00	34	506	473	30	10	31
14:00 - 15:00	37	482	505	33	14	35
15:00 - 16:00	36	579	693	62	4	34
16:00 - 17:00	31	713	829	153	5	37
17:00 - 18:00	47	769	775	122	7	44

2017 SITE TRIPS

Site traffic for the proposed development was estimated based on the anticipated maximum number of students supplied by the developer and subsequently distributed onto the surrounding roadway network.

The site-generated traffic volumes for weekday traffic, shown in Table 2, are based on trip generation information provided in the 9th edition of the Institute of Transportation Engineer's (ITE's) *Trip Generation Manual.*

Table 2 – Trip Generation Summary

LAND USE	ITE CODE	AMOUNT	UNITS	WEEKDAY						
					AM PEAK HOUR			PM PEAK HOUR		
				ADT	IN	OUT	TOTAL	IN	OUT	TOTAL
Day Care Center	565	130	Students	569	53	47	100	45	50	95

The estimated hourly volumes for the proposed residential development were calculated using the site traffic distribution statistics provided for Land Use Code 565 (Daycare Center). The entering/exiting hourly volumes for all residential development are summarized in Table 3.

Table 3 – Hourly Site Trips Summary, Daycare Uses

Time Period	Average Weekday				
	% of 24-Hour Traffic[1]		Estimated Hourly Volume		
	Entering	Exiting	Entering	Exiting	Total
6:00 - 7:00	1.4%	0.8%	4	2	6
7:00 - 8:00	15.6%	11.8%	44	34	78
8:00 - 9:00	19.4%	15.8%	55	45	100
9:00 - 10:00	6.9%	7.9%	20	22	42
10:00 - 11:00	3.0%	3.0%	9	9	17
11:00 - 12:00	5.2%	4.7%	15	13	28
12:00 - 13:00	4.0%	3.3%	11	9	21
13:00 - 14:00	2.4%	2.6%	7	7	14
14:00 - 15:00	2.4%	2.7%	7	8	15
15:00 - 16:00	5.9%	5.5%	17	16	32
16:00 - 17:00	8.4%	9.1%	24	26	50
17:00 - 18:00	15.0%	17.0%	43	48	91
18:00 - 19:00	7.8%	12.6%	22	36	58
19:00 - 20:00	1.0%	1.5%	3	4	7
20:00 - 21:00	0.4%	0.5%	1	1	3
21:00 - 22:00	0.6%	0.8%	2	2	4
22:00 - 23:00	0.6%	0.5%	2	1	3
Total:	100.0%	100.0%	285	285	569

[1]SOURCE: Institute of Transportation Engineers' *Trip Generation Manual* 9th Edition

TRAFFIC DISTRIBUTION

The new site trips were distributed onto the roadway network based on the 2017 hourly counts.

The estimated hourly 2017 weekday site trip distributions, are summarized in Table 4.

Table 4 – Hourly Site-Generated Traffic Distribution

Time	MAJOR STREET				MINOR STREET	
	Commander Shepard - EB		Commander Shepard - WB		Old Armistead - SB	
	Left	Through	Through	Right	Left	Right
06:00 - 07:00	70%			30%	25%	75%
07:00 - 08:00	70%			30%	25%	75%
08:00 - 9:00	50%			50%	25%	75%
9:00 - 10:00	50%			50%	25%	75%
10:00 - 11:00	50%			50%	25%	75%
11:00 - 12:00	50%			50%	25%	75%
12:00 - 13:00	50%			50%	25%	75%
13:00 - 14:00	50%			50%	25%	75%
14:00 - 15:00	50%			50%	25%	75%
15:00 - 16:00	20%			80%	25%	75%
16:00 - 17:00	20%			80%	25%	75%
17:00 - 18:00	20%			80%	25%	75%

The hourly site-generated traffic distributions from Table 4 were applied to the entering and exiting traffic volumes from Table 3 to calculate the hourly site-generated traffic volumes summarized in Table 5.

Table 5 -2017 Hourly Site-Generated Traffic Volumes

Time	MAJOR STREET				MINOR STREET	
	Commander Shepard - EB		Commander Shepard - WB		Old Armistead - SB	
	Left	Through	Through	Right	Left	Right
06:00 - 07:00	3			1	1	2
07:00 - 08:00	31			13	8	25
08:00 - 9:00	28			28	11	34
9:00 - 10:00	10			10	6	17
10:00 - 11:00	4			4	2	6
11:00 - 12:00	7			7	3	10
12:00 - 13:00	6			6	2	7
13:00 - 14:00	3			3	2	6
14:00 - 15:00	3			3	2	6
15:00 - 16:00	3			13	4	12
16:00 - 17:00	5			19	6	19
17:00 - 18:00	9			34	12	36

2017 TOTAL TRAFFIC VOLUMES

The 2017 background volumes from Table 1 were added to the 2017 site traffic volumes from Table 5 to generate the 2017 total traffic volumes shown in Table 6.

Table 6 – 2017 Total Volumes
Commander Shepard Boulevard/Old Armistead Avenue d
d

Time	MAJOR STREET				MINOR STREET	
	Commander Shepard - EB		Commander Shepard - WB		Old Armistead - SB	
	Left	Through	Through	Right	Left	Right
06:00 - 07:00	49	638	444	12	8	51
07:00 - 08:00	74	932	601	39	19	74
08:00 - 9:00	59	744	495	62	22	74
9:00 - 10:00	37	484	368	34	19	47
10:00 - 11:00	29	371	392	35	11	34
11:00 - 12:00	42	456	571	64	21	39
12:00 - 13:00	40	636	505	53	20	40
13:00 - 14:00	37	506	473	33	12	37
14:00 - 15:00	40	482	505	36	16	41
15:00 - 16:00	39	579	693	75	8	46
16:00 - 17:00	36	713	829	172	11	56
17:00 - 18:00	56	769	775	156	19	80

TRAFFIC SIGNAL WARRANT ANALYSES

Signal warrant analyses were completed using the 2017 background and 2017 total volumes from Tables 1 and 6, respectively. The warrant analyses were conducted following procedures from the 2009 edition of the *Manual on Uniform Traffic Control Devices* (MUTCD) using Highway Capacity Software (HCS) Version 7.1 and the hourly volumes from 6:00 AM to 6:00 PM. Warrants 1 (Eight-Hour), 2 (Four-Hour), and 3 (Peak Hour) of the nine (9) signal warrants outlined in the 2009 MUTCD were considered for the analyses and are described in detail below.

The 100% volume thresholds were used to complete the analyses since there are no characteristics supporting the use of the 70% volume thresholds.

The lane geometry for the major street is two (2) lanes and the lane geometry for the minor street is one (1) lane.

The following six (6) warrants were not in included in this analysis due to the fact that they are not applicable to the nature/context of the development and/or adjacent roadway infrastructure.

- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossing
- Warrant 6 – Coordinated Signal System
- Warrant 7 – Crash Experience
- Warrant 8 – Intersection Near a Grade Crossing
- Warrant 9 – Roadway Network

Warrant 1 (Eight-Hour Vehicular Volume)

Condition A:

This warrant is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The need for a traffic control signal is considered when for each of any eight (8) hours of an average day, a minimum of **500** vehicles per hour exist on the major street approaches and **150** vehicles per hour are present on the higher-volume minor street approach. These are the 100% volume thresholds for a two-lane major street approach and a one-lane minor street approach from the 2009 MUTCD Table 4C-1.

Condition B:

This warrant is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

The need for a traffic control signal is considered when for each of any eight (8) hours of an average day, a minimum of **750** vehicles per hour exist on the major street approaches and **75** vehicles are present on the higher-volume minor street approach. These are the 100% volume thresholds for a two-lane major street approach and a one-lane minor street approach from the 2009 MUTCD Table 4C-1.

Combination of Conditions A and B

This warrant reduces the volume thresholds found in Conditions A and B by 20% and considers both conditions simultaneously. The need for a traffic control signal is considered when for each of any eight (8) hours of an average day, a minimum of **400** vehicles are present on the major street approaches and **120** vehicles are present on the higher volumes minor street approach (Condition A) and a minimum of **600** vehicles are present on the major street approaches and **60** vehicles are present on the higher volumes minor street approach (Condition B). These are the 100% volume thresholds for a two-lane major street approach and a one-lane minor street approach from the 2009 MUTCD Table 4C-1.

Warrant 2 (Four-Hour Vehicular Volume)

This warrant is intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic signal.

The need for a traffic control signal can be considered when, for each of any four (4) hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor street approach all fall above the applicable curve (on MUTCD Figures 4C-1 and 4C-2) for the existing combination of approach lanes.

Warrant 3 (Peak Hour Vehicular Volume)

This warrant is intended for use at a location where traffic conditions are such that for a minimum of one (1) hour of an average day, the minor street traffic suffers undue delay when entering or crossing the major street.

The need for a traffic control signal can be considered if the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor street approach for one (1) hour of an average day falls above the applicable curve (on MUTCD Figure 4C-2) for the existing combination of approach lanes.

Warrant Analysis Summary

The 2017 total volumes used in the traffic signal warrant analyses, along with the results, are summarized in Tables 7 and 8.

Table 7
Summary of 2017 Existing Traffic Signal Warrant Analysis
Commander Shepard Boulevard/Old Armistead Avenue

Time Period	Major Street Volume	Minor Street Volume (Highest Approach)	100% WARRANTS					
			#1 (8-hour)				#2 (4-hour)	#3 (Peak Hour)
			Condition A	Condition B	Combination			
					Condition A	Condition B		
06:00 - 07:00	1,139	56						
07:00 - 08:00	1,602	60			✓			
08:00 - 9:00	1,304	51						
9:00 - 10:00	903	43						
10:00 - 11:00	819	37						
11:00 - 12:00	1,119	47						
12:00 - 13:00	1,222	51						
13:00 - 14:00	1,043	41						
14:00 - 15:00	1,057	49						
15:00 - 16:00	1,370	38						
16:00 - 17:00	1,726	42						
17:00 - 18:00	1,713	51						
# of Hours Warrant is Met			0	0	1	0	0	0
# of Hours Warrant is Required to be Met			8	8	8	8	4	1
Is Warrant Satisfied?			No	No	No		No	No

Table 8
Summary of 2017 Total Traffic Signal Warrant Analysis
Commander Shepard Boulevard/Old Armistead Avenue

Time Period	Major Street Volume	Minor Street Volume (Highest Approach)	100% WARRANTS					
			#1 (8-hour)				#2 (4-hour)	#3 (Peak Hour)
			Condition A	Condition B	Combination			
					Condition A	Condition B		
06:00 - 07:00	1,143	58						
07:00 - 08:00	1,646	94		✓		✓	✓	
08:00 - 9:00	1,359	96		✓		✓	✓	
9:00 - 10:00	923	65				✓		
10:00 - 11:00	828	46						
11:00 - 12:00	1,134	60				✓		
12:00 - 13:00	1,233	60				✓		
13:00 - 14:00	1,050	48						
14:00 - 15:00	1,064	57						
15:00 - 16:00	1,387	54						
16:00 - 17:00	1,750	68				✓		
17:00 - 18:00	1,756	99		✓		✓	✓	
# of Hours Warrant is Met			0	3	0	7	3	0
# of Hours Warrant is Required to be Met			8	8	8	8	4	1
Is Warrant Satisfied?			No	No	No		No	No

Based on the information presented in Tables 7 and 8, neither the existing nor the projected total volumes at the Commander Shepard/Old Armistead Avenue satisfy the vehicular volume warrants for the installation of a traffic signal.

The HCS analysis results are included in Appendix B.

OPERATIONAL ANALYSES

Operational analyses for the Commander Shepard Boulevard/Old Armistead Avenue intersection were completed for existing and total conditions using SYNCHRO Version 9.1 to quantify the impacts of projected AM and PM peak hour site-generated traffic on overall intersection operations.

Tables 9 and 10 summarize the results of the operational analyses.

Table 9
Summary of 2017 Existing Operational Analysis
Commander Shepard Boulevard/Old Armistead Avenue

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay [1] (sec/veh)	LOS [1]	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay [1] (sec/veh)	LOS [1]	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
1. Commander Shepard Blvd (E-W) at	EB Left	150	9.2	A	4	41	10.5	B	6	58
Old Armistead Ave (N)	EB Thru		†	†	†	†	†	†	†	†
Unsignalized	*EB Approach*		*†*	*†*	--	--	*†*	*†*	--	--
	WB Thru-Right		†	†	†	†	†	†	†	†
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	SB Left-Right		15.5	C	14	69	17.2	C	14	65
	SB Approach		*15.5*	*C*	--	--	*17.2*	*C*	--	--

[1] *Overall intersection LOS and delay reported for signalized intersections only.*

† SYNCHRO does not provide level of service or delay for unsignalized movements with no conflicting volumes.

Table 10
Summary of 2017 Total Operational Analysis
Commander Shepard Boulevard/Old Armistead Avenue

Intersection and Type of Control	Movement and Approach	Turn Lane Storage (ft)	AM PEAK HOUR				PM PEAK HOUR			
			Delay [1] (sec/veh)	LOS [1]	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)	Delay [1] (sec/veh)	LOS [1]	HCS 95th Percentile Queue Length (ft)	Simulated Maximum Queue Length (ft)
1. Commander Shepard Blvd (E-W) at	EB Left	150	9.4	A	7	57	10.8	B	7	64
Old Armistead Ave (N)	EB Thru		†	†	†	†	†	†	†	†
Unsignalized	*EB Approach*		*†*	*†*	--	--	*†*	*†*	--	--
	WB Thru-Right		†	†	†	†	†	†	†	†
	WB Approach		*†*	*†*	--	--	*†*	*†*	--	--
	SB Left-Right		19.0	C	29	94	24.0	C	40	124
	SB Approach		*19.0*	*C*	--	--	*24.0*	*C*	--	--

[1] *Overall intersection LOS and delay reported for signalized intersections only.*

† SYNCHRO does not provide level of service or delay for unsignalized movements with no conflicting volumes.

Based on the information presented above, the intersection currently operates at a LOS C during both the AM and PM peak hours and is expected to continue doing so once the day care center is operational. The highest increase of approach delay is noted on SB Old Armistead Avenue at 3.5 and 6.8 seconds during the AM and PM peaks, respectively.

The supporting SYNCHRO outputs are included in Appendix C.

CONCLUSIONS

Signal warrant analyses were completed using existing 2017 traffic volumes and total traffic volumes that include traffic generated by the proposed 130-student child care center for the Commander Shepard Boulevard/Old Armistead Avenue intersection.

The signal warrant analysis includes the three (3) applicable, volume-based signal warrants – Warrant 1 (Eight-Hour Vehicular Volume), Warrant 2 (Four-Hour Vehicular Volume), and Warrant 3 (Peak Hour) from the 2009 MUTCD. The 100% volume thresholds were used to complete the analyses since there are no characteristics supporting the use of the 70% volume thresholds.

Based on the analyses shown above, none of the 100% volume thresholds were met for Warrants 1, 2, or 3 at the study intersection. It is concluded that a traffic signal is not warranted at the Commander Shepard Boulevard/Old Armistead Avenue intersection.

With respect to the operational analysis, the Shepard Boulevard/Old Armistead Avenue intersection currently operates at a LOS C and is anticipated to continue doing so once the day care center is operational. Minimal increases in both delay and queues were noted. No geometric improvements are recommended.