
TRAFFIC IMPACT LETTER

THE GLEN AT WEST VALLEY

KNOX COUNTY, TENNESSEE

-Prepared For-



Volunteer Development LLC
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-Prepared By-



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September 2019



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September 5, 2019

**TO: Ms. Tarren Barrett, EIT
Transportation Engineer, Knoxville-Knox County Planning**

**RE: The Glen at West Valley – Traffic Impact Letter
Knox County, Tennessee**

This Traffic Impact Letter (TIL) provides new traffic count data for The Glen at West Valley residential subdivision and compares the new traffic count data with the previous study recommendations and traffic counts that was prepared in January 2017. This residential development is located off Millstone Lane and was referenced as “Millstone Subdivision” in the original traffic impact study. This letter provides the requirements and scope as outlined in your email addressed to me dated August 27th, 2019.

The presented information in this TIL includes new traffic count data at two intersections, a new proposed layout for the development, and a comparison and review of the original traffic impact study recommendations.

If you have any questions or comments about this submittal, please feel free to contact me at any time. I look forward to your review and approval.

Sincerely,

Ajax Engineering, LLC

Robert W. Jacks, P.E.

INTRODUCTION

The purpose of this traffic impact letter for The Glen at West Valley is to report the results of a new traffic count, offer comparisons to the original traffic counts and review the original traffic impact study recommendations that was provided for the residential subdivision. In the original traffic impact study (dated January 18th, 2017) with an initial name of “Millstone Subdivision”, the development was analyzed with a total of 136 single-family detached residential lots. Construction of the initial phase of the development is currently underway and after the original approval, the residential subdivision was officially named as “The Glen at West Valley”. Since the original approval by Knox County in 2017, some recent revisions have been proposed to change the layout for the remaining un-constructed portion of the development. The revisions include reducing the number of proposed lots by 17, for a total of 119 lots, accompanied with some changes to the internal subdivision road layout.

ORIGINAL AND CURRENT PROPOSED DEVELOPMENT TRIP GENERATION

■ ORIGINAL “MILLSTONE SUBDIVISION” PROPOSED DEVELOPMENT (2017)

As part of the development process in 2017 for “Millstone Subdivision”, a Level 1 Traffic Impact Study was completed. This traffic impact study analyzed the development with 136 single-family detached residential lots. The trip generation calculations from the report in 2017 was calculated using the Institute of Transportation Engineer’s (ITE) Trip Generation Manual, 9th Edition. The projected trip generation for the original 136-lot Millstone Subdivision is shown in Table 1.

TABLE 1
TRIP GENERATION FOR MILLSTONE SUBDIVISION (2017)
136 Single-Family Detached Homes

ITE LAND USE CODE	LAND USE DESCRIPTION	UNITS	GENERATED DAILY TRAFFIC	GENERATED TRAFFIC AM PEAK HOUR			GENERATED TRAFFIC PM PEAK HOUR		
				ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
				25%	75%		63%	37%	
#210	Single-Family Detached Housing	136 Lots	1,394	26	79	105	88	51	139
Total New Volume Site Trips			1,394	26	79	105	88	51	139

ITE Trip Generation Manual, 9th Edition

■ **CURRENT “THE GLEN AT WEST VALLEY” PROPOSED DEVELOPMENT (2019)**

The number of trips projected to be generated by 17 fewer single-family detached residential homes in The Glen at West Valley is shown in Table 2. The trip generation calculations for this table were calculated using the Institute of Transportation Engineer’s (ITE) Trip Generation Manual, 10th Edition. This is a newer version of the ITE manual than what was used in the original study in 2017.

TABLE 2
TRIP GENERATION FOR THE GLEN AT WEST VALLEY (2019)
119 Single-Family Detached Homes

ITE LAND USE CODE	LAND USE DESCRIPTION	UNITS	GENERATED DAILY TRAFFIC	GENERATED TRAFFIC AM PEAK HOUR			GENERATED TRAFFIC PM PEAK HOUR		
				ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
#210	Single-Family Detached Housing	119 Lots	1,221	25%	75%		63%	37%	
				22	68	90	76	45	121
Total New Volume Site Trips			1,221	22	68	90	76	45	121

ITE Trip Generation Manual, 10th Edition

■ **COMPARISON OF TRIP GENERATION**

A comparison of the calculated trip generation rates for the “Millstone Subdivision” traffic impact study in 2017 and the current “The Glen at West Valley” is presented in Table 3.

TABLE 3
TRIP GENERATION CALCULATION COMPARISONS

	GENERATED DAILY TRAFFIC	GENERATED TRAFFIC AM PEAK HOUR			GENERATED TRAFFIC PM PEAK HOUR		
		ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
Trip Generation for "Millstone Subdivision" with 136 Lots	1,394	26	79	105	88	51	139
Trip Generation for "The Glen at West Valley" with 119 Lots	1,221	22	68	90	76	45	121
Trip Generation Totals - Comparison between 136 and 119 Lots	-173	-4	-11	-15	-12	-6	-18
Trip Generation Percentage (%) - Comparison between 136 and 119 Lots	-12.4%	-15.4%	-13.9%	-14.3%	-13.6%	-11.8%	-12.9%

PAST AND CURRENT TRAFFIC VOLUMES

■ PAST TRAFFIC VOLUMES AND CURRENT TRAFFIC VOLUMES

The original traffic impact study in 2017 conducted traffic counts at two intersections adjacent to the proposed subdivision on November 9, 2016. The traffic counts were conducted at the intersections of Millstone Lane at George Williams Road and Millstone Lane at Freels Lane. More recent traffic counts were conducted on Thursday, August 29th, 2019 and are shown in the Appendix. Local schools were in session when the traffic counts were conducted. A comparison of the peak hour traffic volumes at the intersections between 11/9/16 and 8/29/19 are shown in Tables 4 and 5.

**TABLE 4
INTERSECTION TRAFFIC VOLUME COMPARISONS**

Millstone Lane at Freels Lane

	Millstone Lane Westbound		Freels Lane Northbound		Millstone Lane Eastbound	
	LT	THRU	LT	RT	THRU	RT
11/9/16 Traffic Count						
AM Peak	5	2	0	8	4	0
PM School Peak	7	5	0	3	7	0
PM Peak	6	2	0	4	2	1
8/29/19 Traffic Count						
AM Peak	1	11	0	4	10	1
PM School Peak	3	29	0	7	30	2
PM Peak	1	13	0	2	11	0
% Change in Actual Traffic Volumes between 11/9/16 & 8/29/19						
AM Peak	-80.0%	+450.0%	Not divisible	-50.0%	+150.0%	Not divisible
PM School Peak	-57.1%	+480.0%	Not divisible	+133.3%	+328.6%	Not divisible
PM Peak	-83.3%	+550.0%	Not divisible	-50.0%	+450.0%	-100.0%

TABLE 5
INTERSECTION TRAFFIC VOLUME COMPARISONS



Millstone Lane at George Williams Road	George Williams Road Southbound			George Williams Road Westbound			West Valley MS Driveway Northbound			Millstone Lane Eastbound		
	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT
	11/9/16 Traffic Count	116	214	3	353	6	60	0	190	384	14	6
AM Peak	85	61	5	125	13	84	0	71	180	5	15	0
PM School Peak	148	19	7	25	6	110	0	14	30	4	5	0
8/29/19 Traffic Count	113	242	7	331	9	61	0	151	360	9	6	2
AM Peak	97	73	17	129	28	82	1	90	187	14	36	4
PM School Peak	166	18	12	33	6	148	0	20	46	2	9	1
% Change in Actual Traffic Volumes between 11/9/16 & 8/29/19												
AM Peak	-2.6%	+13.1%	+133.3%	-6.2%	+50.0%	+1.7%	Not divisible	-20.5%	-6.3%	-35.7%	0.0%	+100.0%
PM School Peak	+14.1%	+19.7%	+240.0%	+3.2%	+115.4%	-2.4%	Not divisible	+26.8%	+3.9%	+180.0%	+140.0%	Not divisible
PM Peak	+12.2%	-5.3%	+71.4%	+32.0%	0.0%	+34.5%	Not divisible	+42.9%	+53.3%	-50.0%	+80.0%	Not divisible

Capacity analyses were undertaken to determine the updated projected Level of Service (LOS) for the intersections during the AM, School PM, and PM peak hours with respect to vehicular traffic when the subdivision is expected to be fully built-out and occupied. The capacity analyses were calculated by following the methods outlined in the Highway Capacity Manual and using Synchro Traffic Software (Version 8). The calculations were based on the same projected growth factor (3%), horizon year (2021), trip distribution, and traffic assignment as was utilized in the original report. Differences between this current analysis and the original analysis using the updated traffic counts from 8/29/19, updated trip generation totals, and using the calculated traffic movement peak hour factors from the recent traffic count. The traffic signal timing in the analysis for the intersection of George Williams Road at Millstone Drive was the same as previously used in the original study. According to John Sexton, PE with Knox County Engineering, the signal timing has not changed since the original report was completed in 2017.

From the capacity calculations, the results from the projected peak hour vehicular traffic can be seen in Table 6 for the intersections. The intersections in the table are shown with a LOS designation, delay (in seconds), and v/c ratio (volume/capacity) for the AM, School PM, and PM peak hours. The Appendix includes the worksheets from the capacity analyses for the peak hours.

The intersections are projected to operate at a good level with respect to Level of Service during all the projected peak hours for vehicular traffic in the year 2021. The calculated delays and Level of Service are very similar to the results from for the original traffic impact study.

**TABLE 6
2021 PEAK HOUR LEVEL OF SERVICE & DELAY - PROJECTED**

INTERSECTION	TRAFFIC CONTROL	APPROACH	LEVEL OF SERVICE			DELAY (seconds)		
			AM PEAK	SCHOOL PM PEAK	PM PEAK	AM PEAK	SCHOOL PM PEAK	PM PEAK
Millstone Lane at Freels Lane	 Unsignalized	Westbound Left/Thru	A	A	A	0.4	0.2	0.2
		Northbound Left/Right	A	A	A	8.9	8.7	9.0
Millstone Lane at George Williams Road	 Signalized	Eastbound	B	C	B	14.4	20.3	19.2
		Westbound	C	C	B	26.0	21.6	13.7
		Northbound	C	B	B	23.5	19.9	15.5
		Southbound	B	A	A	14.0	8.1	4.3
		Intersection Summary	C	B	B	20.7	18.8	11.8
		V/C Ratio	0.70	0.62	0.32			

Note: All analyses were calculated in Synchro 8 software and reported with HCM 2000 methodology

ORIGINAL RECOMMENDATIONS FOR “MILLSTONE SUBDIVISION” (2016)

The following lists the original traffic impact study recommendations and gives brief updates to the status and progress of the implementation of the recommendations. Updated comments are shown in bold. The original traffic impact study recommendations for Millstone Subdivision in 2016 by Ajax Engineering, LLC were the following:

▪ **Millstone Lane at Millstone Subdivision Road “A” (Valley Glen Boulevard):**

Completed ✓

- Only one single exiting lane is required at the Millstone Subdivision entrance. Also, a separate left turn lane on Millstone Lane into the development is not required.

Not Completed /
Subject to Knox
County Review

- Recommend that the 20-mph speed limit currently posted on Millstone Lane be changed to 25-mph once Millstone Lane upgrades are completed. **This change is not essential and is at the discretion of Knox County Engineering.**

Stop Sign Installed
but not Stop Bar

- Recommend that the main entrance approach at the intersection with Millstone Lane be designed and constructed with a 24” white stop bar and with a Stop Sign (R1-1). **A white stop bar should be applied prior to the end of the subdivision construction.**

Appears
Adequate ✓

- Intersection sight distance at the new proposed main entrance at Millstone Lane must not be impacted by new signage, future landscaping or existing vegetation.

▪ **Millstone Subdivision Internal Drives:**

Needs Future
Attention

- A Stop Sign (R1-1) should be installed at the Road “B”, Road “C”, Road “D”, Road “E”, and Road “F” approach intersections with Road “A”. **For the proposed layout revisions shown in the Concept Plan dated 8/26/19 by David Campbell, PE, this recommendation should be updated as the following: A Stop Sign (R1-1) should be installed at the Road “A”, Road “D”, and Road “E” approach intersections with Valley Glen Boulevard. A Stop Sign (R1-1) should also be installed at both ends of Road “B” at the intersections with Road “A” and Road “C”.**

The initial construction of the subdivision has included Valley Glen Boulevard and Kayak Road (previously Road “A” and Road “B”). A Stop Sign (R1-1) has been installed on Kayak Road at Valley Glen Boulevard, but a white stop bar has not been installed yet.

Completed ✓

- Recommend that the internal speed limit for Millstone Subdivision be 25 mph and this speed limit be posted on signage in the new residential subdivision as required.

Needs Future Attention

- Sight distance at all of the new internal “T” and four-way intersections must not be impacted by new signage, or future landscaping.

Needs Future Attention

- Sidewalks should be installed within the development and have appropriate ADA compliant curbed ramps at all of the internal intersection corners.

Subject to Knox County Review

- All road grade and intersection elements internally and externally should be designed to AASHTO, TDOT, and Knox County Engineering specifications and guidelines to ensure proper operation.

Possible Needs Future Attention

- Possible traffic calming measures might be needed for this development on Road “A” (Valley Glen Boulevard). **This original recommendation is not expected to be required.**

▪ **Millstone Lane at Freels Lane:**

Completed ✓

- A Stop Sign (R1-1) should be installed on the northbound approach on Freels Lane.

Completed ✓

- An additional northbound turn lane at Freels Lane is not required. Also, a separate left turn lane on Millstone Lane onto Freels Lane is not required.

▪ **Millstone Lane at George Williams Road:**

Possibly Needs Future Attention

- The signal timing of the intersection should be reviewed for possible greater efficiencies after the residential subdivision is constructed and occupied.

▪ **Millstone Lane:**

Completed ✓

- Millstone Lane should be widened from the existing curb, gutter, and sidewalk roadway section all the way to the proposed subdivision

Completed ✓

- entrance at Road “A” (Valley Glen Boulevard).
- The sidewalk that currently exists on the south side of Millstone Lane should be extended to the new residential subdivision entrance and tied to the internal subdivision sidewalk network.

CONCLUSION

Due to the proposed layout and lot revisions to The Glen at West Valley, traffic counts were re-conducted, and projected vehicle delays were re-calculated for the intersections of Millstone Lane at George Williams Road and Millstone Lane at Freels Lane. After reviewing the information, there are not any new identifiable specific issues or additional recommendations for The Glen at West Valley other than the bolded notes offered in the previous section. Overall, less trips are projected to occur for the subdivision due to the decrease in the number of lots. The recent traffic counts showed some intersection eastbound and westbound movement increases due to construction of the subdivision.

ADDITIONAL INFORMATION

The following is a discussion of additional information that could be beneficial for the road system adjacent to The Glen at West Valley during afternoon dismissals for West Valley Middle School.

West Valley Middle School is adjacent and to the east of The Glen at West Valley residential subdivision. Prior and during the afternoon school dismissal period at 3:30 pm, significant vehicle queues form at and in front of the school. This vehicle queue is formed by parents and guardians picking up schoolchildren and is observed backing up beyond the internal school road and spilling past the traffic signal onto both approaches of George Williams Road. During the traffic count, the queue was observed backing up past the signalized intersection and spilling onto the George Williams Road approaches at approximately 3:15 pm. The queues that extended past the signalized intersection were fully cleared and contained inside the school property around 3:50 pm, approximately 20 minutes after the 3:30 pm dismissal. This was a similar pattern that was observed at the prior traffic count on 11/9/16.

In addition to the queues forming on the approaches at the intersection, quite a few parents were observed parking on the eastbound side of Millstone Lane. Parent parking on Millstone Lane allowed for schoolchildren to walk from the school building at dismissal and assumedly for parents to save time and the hassle of being in the vehicle queue.

Parking in the right-most lane of Millstone Lane is accomplished by parents traveling past the signalized intersection via George Williams Road from the north or east and either turning around in the private driveways on the north side of Millstone Lane or turning around at the intersection of Millstone Lane at Freels Lane. The previous traffic count in 2016 did not observe this activity. It is not known if this is an on-going problem or if it might be reduced as the school year progresses or when colder weather arrives.

On a daily basis, a Knox County Sheriff Deputy assists students cross the intersection for those who walk home from school at dismissal. During the traffic count, the deputy confirmed the observation and reasoning for parents parking on Millstone Lane. The

deputy remarked that the drivers were not breaking any laws since they are parked in their vehicle and are not blocking emergency vehicle access. Drivers observed traveling east on Millstone Lane would drive in the center lane to go around the parked vehicles. During the recent observation, this did not seem to create much of an issue but could be an issue in the future. As more residents move into The Glen at West Valley, more motorists will be traveling on Millstone Lane; and if this parent parking behavior continues or increases, this could cause more access issues and complaints.

Other inefficiencies that were observed during the afternoon school dismissal was due to parents also parking in the front parking lot waiting for their children to be dismissed. Many of these parents arrived earlier to park and avoid the vehicle line and some of them parked there after bypassing the queue line. Allowing parents to park in the front parking lot increases delays to the loading and departure of the vehicle queue. This is due to the vehicle queue being held up for a significant amount of time for all the schoolchildren crossing in front of vehicle queue to reach their parents in the front parking lot. In addition to reducing the service rate of loading and departure, this also creates safety problems.

It is recommended that parking by parents along Millstone Lane and the front parking lots should be restricted, and other changes be made to the West Valley Middle School afternoon dismissal procedure to decrease schoolchildren/vehicle conflicts and reduce queues from forming on the roads outside of the school property. To improve the school dismissal, it is recommended that all afternoon traffic for student pickups enter from the school's eastern entrance on George Williams Road, queue along the eastern internal road, and either have schoolchildren picked up at the rear of the building or remain at the front. The existing queue length capacity from the signalized intersection at George Williams Road to the front-loading area is 1,100 feet. Making parents enter from the eastern entrance and queue along the eastern internal road would increase the queue length capacity to 1,850 feet for pickups at the rear of the building. If using the front-loading area is still desired, the queue length capacity would be increased to 2,970 feet which would create a 2.7 greater queue length capacity than what is currently being utilized.

Using the eastern entrance, allowing queues to snake around the back side of the school, and basically forcing departures only at the signalized intersection of George

Williams Road at Millstone Lane would also improve safety and reduce conflicts for schoolchildren walking home after school and crossing the signalized intersection.

While outside the scope of The Glen at West Valley, these recommendations are being made due to the observed inefficiencies and safety issues during the afternoon and its potential impact on the future residents of the new subdivision. Any changes to the school dismissal procedures would ultimately need to be coordinated with the school, Knox County Engineering, and the Knox County Sheriff Department. It is hoped that this discussion could lead to improvements to the school dismissal which would also positively impact the residents traveling to and from The Glen at West Valley.

APPENDIX

TRAFFIC COUNT DATA

Major Street: Millstone Lane (EB-WB)
 Minor Street: Freels Lane (NB)
 Traffic Control: Stop Controlled on Freels Lane

8/29/2019 (Thursday)
 Sunny
 Conducted by: Ajax Engineering

TIME BEGIN	Millstone Lane WESTBOUND		Freels Lane NORTHBOUND		Millstone Lane EASTBOUND		VEHICLE TOTAL	PEAK HOUR
	LT	THRU	LT	RT	THRU	RT		
7:00 AM	0	2	0	1	1	0	4	
7:15 AM	2	1	0	1	2	0	6	
7:30 AM	0	6	0	0	4	0	10	7:30 AM - 8:30 AM
7:45 AM	0	1	0	0	3	0	4	
8:00 AM	1	2	0	0	2	0	5	
8:15 AM	0	2	0	4	1	1	8	
8:30 AM	0	1	0	0	1	0	2	
8:45 AM	0	2	0	0	2	0	4	
TOTAL	3	17	0	6	16	1	43	
2:00 PM	0	3	2	1	5	0	11	
2:15 PM	1	3	0	2	2	0	8	
2:30 PM	0	1	0	1	1	0	3	
2:45 PM	2	4	0	0	3	0	9	
3:00 PM	1	7*	0	2	6*	1	17	3:00 PM - 4:00 PM
3:15 PM	1	9*	0	2	8*	0	20	
3:30 PM	0	8*	0	1	8*	0	17	
3:45 PM	1	5*	0	2	8*	1	17	
4:00 PM	2	0	0	1	3	0	6	
4:15 PM	0	2	1	0	4	0	7	
4:30 PM	0	2	0	0	3	0	5	
4:45 PM	1	1	0	0	0	0	2	
5:00 PM	0	5	0	0	4	0	9	5:00 PM - 6:00 PM
5:15 PM	0	2	0	0	2	0	4	
5:30 PM	1	4	0	1	2	0	8	
5:45 PM	0	2	0	1	3	0	6	
TOTAL	10	29	3	14	32	2	149	

* Includes school dismissal turn-around traffic at intersection

2019 AM Peak Hour **7:30 AM - 8:30 AM**

TIME BEGIN	Millstone Lane WESTBOUND		Freels Lane NORTHBOUND		Millstone Lane EASTBOUND	
	LT	THRU	LT	RT	THRU	RT
7:30 AM	0	6	0	0	4	0
7:45 AM	0	1	0	0	3	0
8:00 AM	1	2	0	0	2	0
8:15 AM	0	2	0	4	1	1
TOTAL	1	11	0	4	10	1
PHF	0.25	0.46	-	0.25	0.63	0.25

2019 PM School Peak Hour **3:00 PM - 4:00 PM**

TIME BEGIN	Millstone Lane WESTBOUND		Freels Lane NORTHBOUND		Millstone Lane EASTBOUND	
	LT	THRU	LT	RT	THRU	RT
3:00 PM	1	7	0	2	6	1
3:15 PM	1	9	0	2	8	0
3:30 PM	0	8	0	1	8	0
3:45 PM	1	5	0	2	8	1
TOTAL	3	29	0	7	30	2
PHF	0.75	0.81	-	0.88	0.94	0.50

2019 PM Peak Hour **5:00 PM - 6:00 PM**

TIME BEGIN	Millstone Lane WESTBOUND		Freels Lane NORTHBOUND		Millstone Lane EASTBOUND	
	LT	THRU	LT	RT	THRU	RT
5:00 PM	0	5	0	0	4	0
5:15 PM	0	2	0	0	2	0
5:30 PM	1	4	0	1	2	0
5:45 PM	0	2	0	1	3	0
TOTAL	1	13	0	2	11	0

TRAFFIC COUNT DATA

Major Street: George Williams Road (EB-WB)
 Minor Street: Millstone Lane and West Valley Middle School Driveway
 Traffic Control: Traffic Signal

8/29/2019 (Thursday)
 Sunny
 Conducted by: Ajax Engineering

TIME BEGIN	George Williams Road			George Williams Road			W. Valley MS Driveway			Millstone Lane			VEHICLE TOTAL	PEAK HOUR
	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND				
	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT		
7:00 AM	13	9	0	7	1	11	0	3	4	2	0	0	50	
7:15 AM	43	22	1	51	2	14	0	12	32	4	1	0	182	7:15 AM - 8:15 AM
7:30 AM	29	51	1	99	4	14	0	33	102	3	1	0	337	
7:45 AM	23	90	3	103	1	17	0	41	112	1	3	2	396	
8:00 AM	18	79	2	78	2	16	0	65	114	1	1	0	376	
8:15 AM	11	18	0	29	1	15	1	31	55	2	3	0	166	
8:30 AM	14	3	1	2	0	19	0	4	7	0	5	0	55	
8:45 AM	20	1	0	3	2	11	0	1	2	0	2	0	42	
TOTAL	171	273	8	372	13	117	1	190	428	13	16	2	1604	
2:00 PM	12	3	1	4	3	10	0	0	9	2	3	0	47	
2:15 PM	9	4	0	8	4	26	0	2	1	2	2	0	58	
2:30 PM	18	6	1	10	1	23	0	2	3	1	3	0	68	
2:45 PM	14	12	6	32	3	18	0	1	3	2	1	1	93	
3:00 PM	26	27	3	44	6	19	0	2	2	1	4	1	135	3:00 PM - 4:00 PM
3:15 PM	25	10	4	12	12	17	0	0	4	2	4	1	91	
3:30 PM	20	24	6	24	5	17	1	48	92	7	15	0	259	
3:45 PM	26	12	4	49	5	29	0	40	89	4	13	2	273	
4:00 PM	22	4	0	9	1	33	0	8	22	1	3	0	103	
4:15 PM	29	8	2	12	0	19	0	4	18	1	3	1	97	
4:30 PM	29	10	2	6	1	28	0	4	10	1	2	0	93	
4:45 PM	40	5	3	1	0	53	0	9	17	0	0	0	128	4:45 PM - 5:45 PM
5:00 PM	34	3	4	3	1	27	0	4	5	0	2	1	84	
5:15 PM	48	6	0	18	2	35	0	0	3	1	3	0	116	
5:30 PM	44	4	5	11	3	33	0	7	21	1	4	0	133	
5:45 PM	39	0	1	1	2	27	0	0	1	2	3	0	76	
TOTAL	435	138	42	244	49	414	1	131	300	28	65	7	1854	

2019 AM Peak Hour 7:15 AM - 8:15 AM

TIME BEGIN	George Williams Road			George Williams Road			W. Valley MS Driveway			Millstone Lane			PHF
	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND			
	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	
7:15 AM	43	22	1	51	2	14	0	12	32	4	1	0	
7:30 AM	29	51	1	99	4	14	0	33	102	3	1	0	
7:45 AM	23	90	3	103	1	17	0	41	112	1	3	2	
8:00 AM	18	79	2	78	2	16	0	65	114	1	1	0	
TOTAL	113	242	7	331	9	61	0	151	360	9	6	2	
PHF	0.66	0.67	0.58	0.80	0.56	0.90	-	0.58	0.79	0.56	0.50	0.25	

2019 PM School Peak Hour 3:00 PM - 4:00 PM

TIME BEGIN	George Williams Road			George Williams Road			W. Valley MS Driveway			Millstone Lane			PHF
	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND			
	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	
3:00 PM	26	27	3	44	6	19	0	2	2	1	4	1	
3:15 PM	25	10	4	12	12	17	0	0	4	2	4	1	
3:30 PM	20	24	6	24	5	17	1	48	92	7	15	0	
3:45 PM	26	12	4	49	5	29	0	40	89	4	13	2	
TOTAL	97	73	17	129	28	82	1	90	187	14	36	4	
PHF	0.93	0.68	0.71	0.66	0.58	0.71	0.25	0.47	0.51	0.50	0.60	0.50	

2019 PM Peak Hour 4:45 PM - 5:45 PM

TIME BEGIN	George Williams Road			George Williams Road			W. Valley MS Driveway			Millstone Lane			PHF
	SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND			
	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	LT	THRU	RT	
4:45 PM	40	5	3	1	0	53	0	9	17	0	0	0	
5:00 PM	34	3	4	3	1	27	0	4	5	0	2	1	
5:15 PM	48	6	0	18	2	35	0	0	3	1	3	0	
5:30 PM	44	4	5	11	3	33	0	7	21	1	4	0	
TOTAL	166	18	12	33	6	148	0	20	46	2	9	1	
PHF	0.86	0.75	0.60	0.46	0.50	0.70	-	0.56	0.55	0.50	0.56	0.25	

HCM Signalized Intersection Capacity Analysis

3: W. Valley MS Driveway & Millstone Lane & George Williams Road

9/3/2019



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	27	54	5	331	25	65	1	151	360	120	242	13
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			3%				3%
Total Lost time (s)	5.5	5.5		5.5	5.5	5.5		6.0	6.0	5.5	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Frt	1.00	0.98		1.00	1.00	0.85		1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805	1855		1805	1900	1615		1871	1591	1778	1855	
Flt Permitted	0.73	1.00		0.67	1.00	1.00		1.00	1.00	0.38	1.00	
Satd. Flow (perm)	1383	1855		1282	1900	1615		1869	1591	707	1855	
Peak-hour factor, PHF	0.56	0.50	0.25	0.80	0.56	0.90	0.90	0.58	0.79	0.66	0.67	0.58
Adj. Flow (vph)	48	108	20	414	45	72	1	260	456	182	361	22
RTOR Reduction (vph)	0	7	0	0	0	35	0	0	341	0	3	0
Lane Group Flow (vph)	48	121	0	414	45	37	0	261	115	182	380	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		Perm	NA	pm+ov	Perm	NA	Perm	pm+pt	NA	
Protected Phases		8			4	1		2		1	6	
Permitted Phases	8			4		4	2		2	6		
Actuated Green, G (s)	28.7	28.7		28.7	28.7	37.8		18.4	18.4	33.0	33.0	
Effective Green, g (s)	28.7	28.7		28.7	28.7	37.8		18.4	18.4	33.0	33.0	
Actuated g/C Ratio	0.39	0.39		0.39	0.39	0.52		0.25	0.25	0.45	0.45	
Clearance Time (s)	5.5	5.5		5.5	5.5	5.5		6.0	6.0	5.5	6.0	
Vehicle Extension (s)	2.5	2.5		2.5	2.5	2.5		3.0	3.0	2.5	3.0	
Lane Grp Cap (vph)	542	727		502	744	955		469	399	451	836	
v/s Ratio Prot		0.07			0.02	0.00				0.05	c0.20	
v/s Ratio Perm	0.03			c0.32		0.02		c0.14	0.07	0.13		
v/c Ratio	0.09	0.17		0.82	0.06	0.04		0.56	0.29	0.40	0.45	
Uniform Delay, d1	14.0	14.5		20.0	13.9	8.7		23.8	22.1	12.9	13.9	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.1	0.1		10.4	0.0	0.0		1.4	0.4	0.4	0.4	
Delay (s)	14.1	14.6		30.4	13.9	8.7		25.3	22.5	13.4	14.3	
Level of Service	B	B		C	B	A		C	C	B	B	
Approach Delay (s)		14.4			26.0			23.5			14.0	
Approach LOS		B			C			C			B	

Intersection Summary

HCM 2000 Control Delay	20.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	73.2	Sum of lost time (s)	17.0
Intersection Capacity Utilization	65.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

3: W. Valley MS Driveway & Millstone Lane & George Williams Road

9/3/2019



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	15	112	41	129	114	87	38	90	187	103	73	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			3%				3%
Total Lost time (s)	5.5	5.5		5.5	5.5	5.5		6.0	6.0	5.5	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Frt	1.00	0.95		1.00	1.00	0.85		1.00	0.85	1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.98	1.00	0.95	1.00	
Satd. Flow (prot)	1805	1813		1805	1900	1615		1831	1591	1778	1818	
Flt Permitted	0.62	1.00		0.50	1.00	1.00		0.79	1.00	0.36	1.00	
Satd. Flow (perm)	1176	1813		953	1900	1615		1488	1591	666	1818	
Peak-hour factor, PHF	0.50	0.60	0.50	0.66	0.58	0.71	0.25	0.47	0.51	0.93	0.68	0.71
Adj. Flow (vph)	30	187	82	195	197	123	152	191	367	111	107	25
RTOR Reduction (vph)	0	19	0	0	0	72	0	0	244	0	8	0
Lane Group Flow (vph)	30	250	0	195	197	51	0	343	123	111	124	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		Perm	NA	pm+ov	Perm	NA	Perm	pm+pt	NA	
Protected Phases		8			4	1		2		1	6	
Permitted Phases	8			4		4	2		2	6		
Actuated Green, G (s)	19.5	19.5		19.5	19.5	28.2		22.8	22.8	37.0	37.0	
Effective Green, g (s)	19.5	19.5		19.5	19.5	28.2		22.8	22.8	37.0	37.0	
Actuated g/C Ratio	0.29	0.29		0.29	0.29	0.41		0.34	0.34	0.54	0.54	
Clearance Time (s)	5.5	5.5		5.5	5.5	5.5		6.0	6.0	5.5	6.0	
Vehicle Extension (s)	2.5	2.5		2.5	2.5	2.5		3.0	3.0	2.5	3.0	
Lane Grp Cap (vph)	337	519		273	544	800		498	533	504	989	
v/s Ratio Prot		0.14			0.10	0.01				c0.03	0.07	
v/s Ratio Perm	0.03			c0.20		0.02		c0.23	0.08	0.09		
v/c Ratio	0.09	0.48		0.71	0.36	0.06		0.69	0.23	0.22	0.13	
Uniform Delay, d1	17.7	20.1		21.8	19.3	12.0		19.5	16.3	8.4	7.6	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.1	0.5		8.0	0.3	0.0		4.0	0.2	0.2	0.1	
Delay (s)	17.8	20.6		29.8	19.6	12.0		23.5	16.5	8.5	7.6	
Level of Service	B	C		C	B	B		C	B	A	A	
Approach Delay (s)		20.3			21.6			19.9			8.1	
Approach LOS		C			C			B			A	

Intersection Summary

HCM 2000 Control Delay	18.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	48.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

3: W. Valley MS Driveway & Millstone Lane & George Williams Road

9/3/2019



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	13	42	3	33	59	157	4	20	46	176	18	32
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		0%			0%			3%				3%
Total Lost time (s)	5.5	5.5		5.5	5.5	5.5		6.0	6.0	5.5	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Frt	1.00	0.98		1.00	1.00	0.85		1.00	0.85	1.00	0.90	
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1805	1861		1805	1900	1615		1862	1591	1778	1678	
Flt Permitted	0.68	1.00		0.70	1.00	1.00		0.97	1.00	0.49	1.00	
Satd. Flow (perm)	1294	1861		1331	1900	1615		1813	1591	920	1678	
Peak-hour factor, PHF	0.50	0.56	0.25	0.46	0.50	0.70	0.90	0.56	0.55	0.86	0.75	0.60
Adj. Flow (vph)	26	75	12	72	118	224	4	36	84	205	24	53
RTOR Reduction (vph)	0	8	0	0	0	126	0	0	65	0	20	0
Lane Group Flow (vph)	26	79	0	72	118	98	0	40	19	205	57	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		Perm	NA	pm+ov	Perm	NA	Perm	pm+pt	NA	
Protected Phases		8			4	1		2		1	6	
Permitted Phases	8			4		4	2		2	6		
Actuated Green, G (s)	7.6	7.6		7.6	7.6	22.1		11.3	11.3	31.3	31.3	
Effective Green, g (s)	7.6	7.6		7.6	7.6	22.1		11.3	11.3	31.3	31.3	
Actuated g/C Ratio	0.15	0.15		0.15	0.15	0.44		0.22	0.22	0.62	0.62	
Clearance Time (s)	5.5	5.5		5.5	5.5	5.5		6.0	6.0	5.5	6.0	
Vehicle Extension (s)	2.5	2.5		2.5	2.5	2.5		3.0	3.0	2.5	3.0	
Lane Grp Cap (vph)	195	280		200	286	884		406	356	818	1042	
v/s Ratio Prot		0.04			c0.06	0.03				c0.07	0.03	
v/s Ratio Perm	0.02			0.05		0.03		0.02	0.01	c0.08		
v/c Ratio	0.13	0.28		0.36	0.41	0.11		0.10	0.05	0.25	0.05	
Uniform Delay, d1	18.5	19.0		19.2	19.4	8.4		15.5	15.3	4.4	3.7	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.2	0.4		0.8	0.7	0.0		0.1	0.1	0.1	0.0	
Delay (s)	18.8	19.4		20.0	20.1	8.4		15.6	15.4	4.6	3.8	
Level of Service	B	B		C	C	A		B	B	A	A	
Approach Delay (s)		19.2			13.7			15.5			4.3	
Approach LOS		B			B			B			A	

Intersection Summary

HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.32		
Actuated Cycle Length (s)	50.4	Sum of lost time (s)	17.0
Intersection Capacity Utilization	47.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis

2: Freels Lane & Millstone Lane

9/3/2019



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	79	1	1	34	0	4
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.63	0.25	0.25	0.46	0.92	0.25
Hourly flow rate (vph)	125	4	4	74	0	16
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)				679		
pX, platoon unblocked						
vC, conflicting volume			129		209	127
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			129		209	127
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	98
cM capacity (veh/h)			1469		781	928

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	129	78	16
Volume Left	0	4	0
Volume Right	4	0	16
cSH	1700	1469	928
Volume to Capacity	0.08	0.00	0.02
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.4	8.9
Lane LOS		A	A
Approach Delay (s)	0.0	0.4	8.9
Approach LOS			A

Intersection Summary			
Average Delay		0.8	
Intersection Capacity Utilization		14.2%	ICU Level of Service
Analysis Period (min)		15	A

HCM Unsignalized Intersection Capacity Analysis

2: Freels Lane & Millstone Lane

9/3/2019



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	142	2	3	142	0	7
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.50	0.75	0.81	0.90	0.88
Hourly flow rate (vph)	151	4	4	175	0	8
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)	679					
pX, platoon unblocked						
vC, conflicting volume			155			336 153
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			155			336 153
tC, single (s)			4.1			6.4 6.2
tC, 2 stage (s)						
tF (s)			2.2			3.5 3.3
p0 queue free %			100			100 99
cM capacity (veh/h)			1437			661 898

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	155	179	8
Volume Left	0	4	0
Volume Right	4	0	8
cSH	1700	1437	898
Volume to Capacity	0.09	0.00	0.01
Queue Length 95th (ft)	0	0	1
Control Delay (s)	0.0	0.2	9.0
Lane LOS		A	A
Approach Delay (s)	0.0	0.2	9.0
Approach LOS			A

Intersection Summary			
Average Delay			0.3
Intersection Capacity Utilization	19.9%	ICU Level of Service	A
Analysis Period (min)			15

HCM Unsignalized Intersection Capacity Analysis

2: Freels Lane & Millstone Lane

9/3/2019



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	57	0	1	90	0	2
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.69	0.90	0.25	0.65	0.90	0.50
Hourly flow rate (vph)	83	0	4	138	0	4
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)	679					
pX, platoon unblocked						
vC, conflicting volume			83			83
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			83			83
tC, single (s)			4.1			6.2
tC, 2 stage (s)						
tF (s)			2.2			3.3
p0 queue free %			100			100
cM capacity (veh/h)			1527			983

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	83	142	4
Volume Left	0	4	0
Volume Right	0	0	4
cSH	1700	1527	983
Volume to Capacity	0.05	0.00	0.00
Queue Length 95th (ft)	0	0	0
Control Delay (s)	0.0	0.2	8.7
Lane LOS	A		A
Approach Delay (s)	0.0	0.2	8.7
Approach LOS	A		

Intersection Summary			
Average Delay			0.3
Intersection Capacity Utilization	15.5%	ICU Level of Service	A
Analysis Period (min)			15