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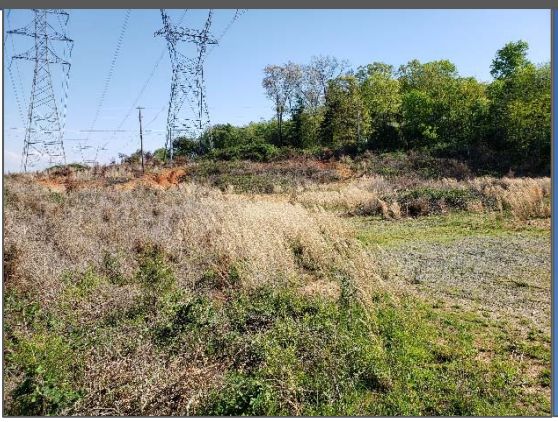
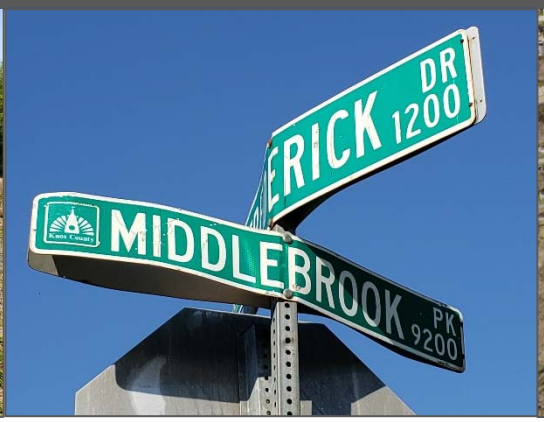
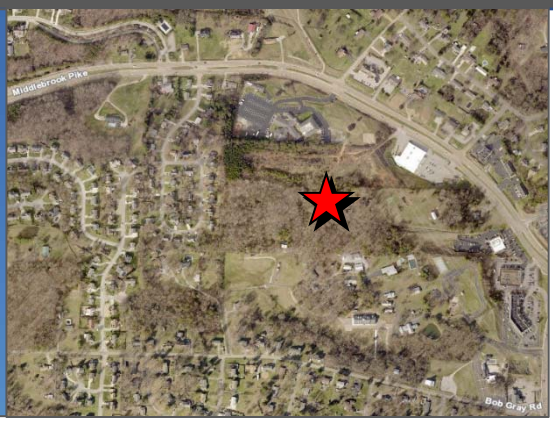
Transportation Impact Study - ADDENDUM

Middlebrook Commons

Knox County, Tennessee







September 2021

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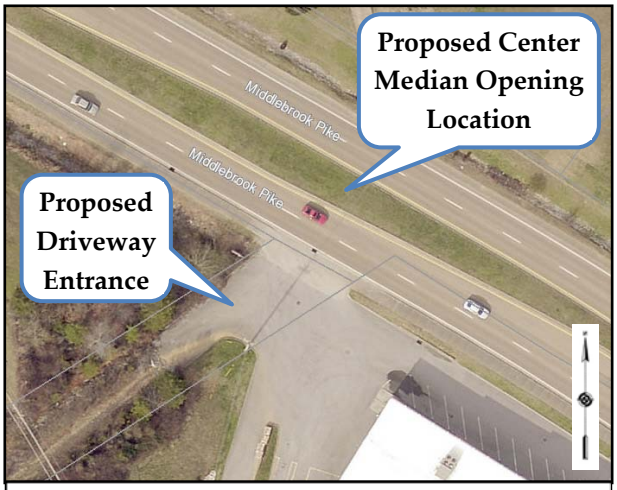
ADDENDUM

Preface:



View of Existing Access to Site Development Property off Middlebrook Pike

The Middlebrook Commons apartment site plans and Transportation Impact Study (TIS) were approved by Knoxville/Knox County Planning and the Tennessee Department of Transportation (TDOT) in August 2021. The TIS analyzed the proposed driveway entrance for the apartment development with a right-in/right-out configuration due to the unavailability of a median opening on Middlebrook Pike. However, the TIS included a request and documentation for a center median opening that would allow, at a minimum, westbound left-turns into the development. Ultimately, the TIS approval included a denial by TDOT for a median opening on Middlebrook Pike. This denial would force all future apartment residents at the proposed driveway entrance to enter only via an eastbound right-turn and exit only via a northbound right-turn at Middlebrook Pike.

Since the original approval, a further investigation was undertaken to request a full center median opening on Middlebrook Pike for the proposed development entrance. This additional investigation was spurred by Congressman Tim Burchett's office stating that a median opening on Middlebrook Pike could be approved if the design met TDOT guidelines and allowed the adjacent church to the west to have access to the proposed median opening.

It is believed that the TDOT design guidelines can be met, and this addendum updates the original TIS and includes analyzing the proposed development with a full center median opening on Middlebrook Pike. This median opening would allow both entering and exiting left-turns at the proposed apartment entrance in addition to right-turns.

This addendum only addresses the proposed driveway entrance and does not re-analyze the upstream and downstream existing intersections included in the original study. This addendum analyzes the development with 120 multi-family apartments and assumes that the development is still anticipated to be fully built-out and occupied by 2023. The existing traffic volumes

obtained in the original study were re-used and included a requested increase of 20% to the raw tabulated volumes to account for Covid-19.

Some of the original figures and traffic volumes are included in this addendum. The following figures are included in this addendum:

- Figure 1 - 2021 Existing Peak Hour Traffic Volumes (+20% to account for Covid)
- Figure 2 - 2023 Projected Peak Hour Traffic Volumes (Without the Project)
- Figure 3 - Directional Distribution of Generated Traffic during AM and PM Peak Hour
- Figure 4 - Traffic Assignment of Generated Traffic during AM and PM Peak Hour
- Figure 5 - 2023 Peak Hour Traffic Volumes (With the Project)

Of the above, Figures 3 – 5 have been updated in this addendum that takes into account a full center median opening on Middlebrook Pike.

The existing traffic volumes (Figure 1) were increased to the horizon year 2023 with a growth rate of 2% (Figure 2), as originally done in the TIS. The generated trips for the 120 units in the Middlebrook Commons were distributed and assigned with the same 65%/35% split as completed in the original TIS (Figures 3 and 4).

An intersection capacity analysis was conducted in Synchro 8 software at the proposed driveway entrance to determine the projected Level of Service (LOS) with the development traffic in 2023 (Figure 5) with a full center median opening on Middlebrook Pike. The updated analysis included an exclusive westbound left-turn lane in the center median. Table 1 shows the AM and PM peak hours results, and the Appendix includes the worksheets for these capacity analyses. The results show that the proposed driveway entrance with a full center median opening on Middlebrook Pike will operate with average vehicle delays.

TABLE 1
2023 INTERSECTION CAPACITY ANALYSIS RESULTS -
OPENING YEAR (WITH THE PROJECT - 120 Apartments)

INTERSECTION	TRAFFIC CONTROL	APPROACH/ MOVEMENT	AM PEAK			PM PEAK		
			LOS	DELAY (seconds)	v/c	LOS	DELAY (seconds)	v/c
Middlebrook Pike at Proposed Apartment Driveway	STOP Unsignalized	Westbound Left	B	11.6	0.020	B	12.4	0.070
		Northbound Left/Right	C	20.0	0.190	C	22.4	0.180

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

A re-evaluation of the need for separate entering turn lanes on Middlebrook Pike for the development in 2023 was conducted. The design policy used for these turn lane evaluations is based on "Knox County's Access Control and Driveway Design Policy".

The evaluation was based on the entering projected 2023 AM and PM peak hour traffic volumes (Figure 5) at the proposed driveway entrance and the posted speed limit of 40-mph on Middlebrook Pike.

As included in the capacity analysis, the results indicate that a separate westbound left-turn lane would be warranted, and a separate eastbound right-turn lane would not be warranted. The Knox County turn lane policy worksheets are in the Appendix.

The projected vehicle queue lengths in the 2023 AM and PM hours were calculated utilizing SimTraffic software. The calculated vehicle queue results were based on averaging the outcome obtained during ten traffic simulations. The vehicle queue worksheets from the SimTraffic software are in the Appendix. The 95th percentile queue lengths at the intersection are shown in Table 2.

TABLE 2
TURN LANE STORAGE & VEHICLE QUEUE SUMMARY -
2023 PROJECTED PEAK HOUR TRAFFIC VOLUMES - 120 APARTMENTS

INTERSECTION	APPROACH/ MOVEMENT	SIMTRAFFIC 95th PERCENTILE QUEUE LENGTH (ft)	
		AM PEAK HOUR	PM PEAK HOUR
Middlebrook Pike at Proposed Apartment Driveway	Westbound Left	29	46
	Northbound Left/Right	62	60

Note: 95th percentile queues were calculated in SimTraffic 8 software

Thus, based on the projected 2023 volumes, a separate westbound left-turn lane is recommended to be constructed with 75 feet of vehicle storage, providing storage length for one additional passenger vehicle than calculated.

Addendum Results:

The findings of this addendum include the following:

- A full center median opening on Middlebrook Pike that will allow full entering and exiting turning movements is calculated to operate adequately in 2023 with respect to projected LOS and vehicle delays.
- A westbound exclusive left-turn lane will be warranted based on the projected 2023 AM and PM peak hour traffic volumes with 120 apartments. An eastbound exclusive right-turn lane will not be warranted.
- The westbound exclusive left-turn lane is recommended to have 75 feet of vehicle storage. A lane taper of 160 feet would be appropriate at this location. A lane taper of 160 feet would be nearly 15:1 (based on a 11-foot lane). This taper would allow the exclusive left-turn lane to be constructed without requiring modifications to the existing catch basin located in the gutter of the inside westbound travel lane on Middlebrook Pike.

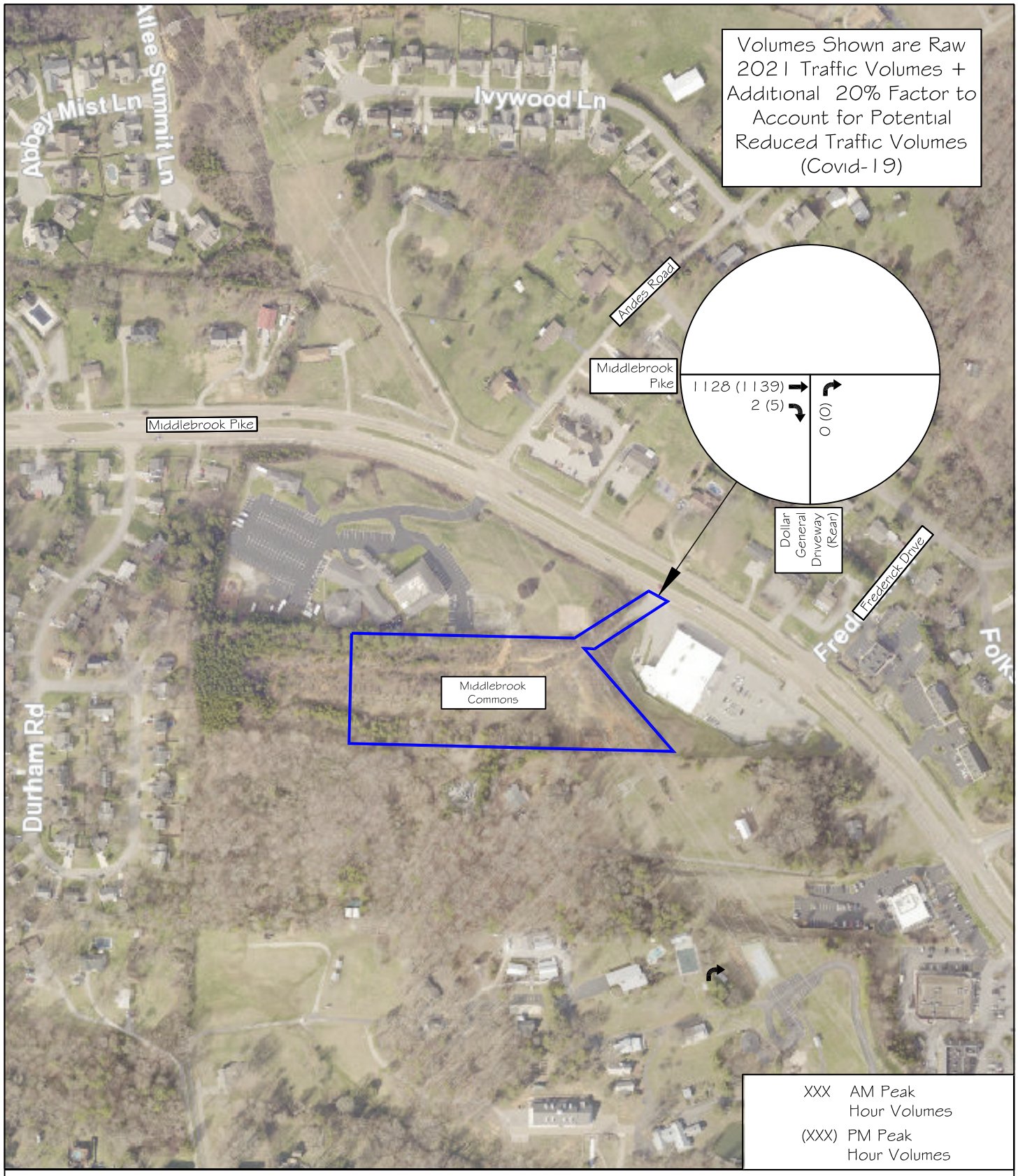


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FIGURE 1 - Addendum

Middlebrook Commons

2021 Peak Hour Traffic Volumes (+ 20% to account for Covid)

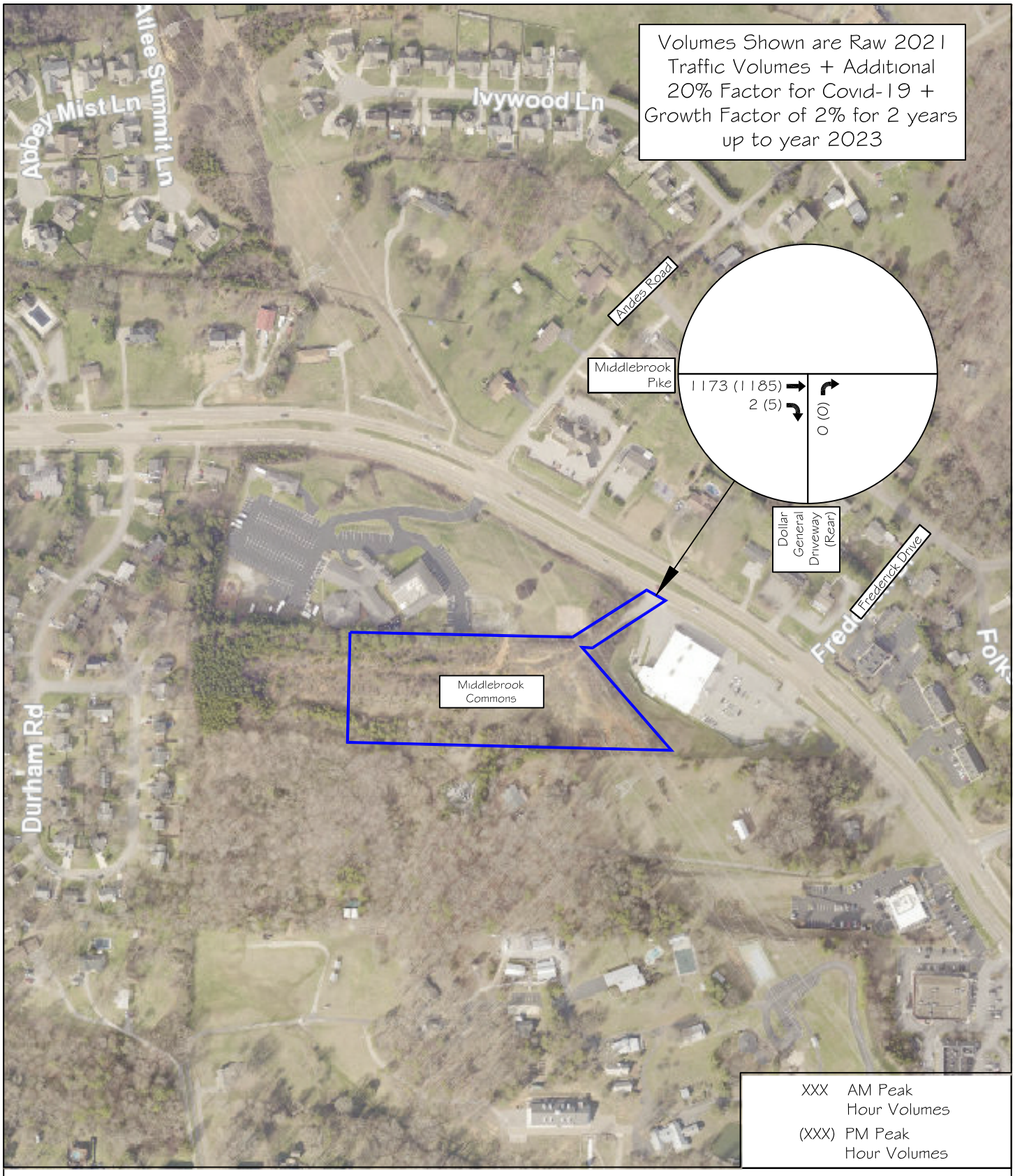

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FIGURE 2 - Addendum

Middlebrook Commons

2023 Projected Peak Hour Traffic Volumes (WITHOUT THE PROJECT)

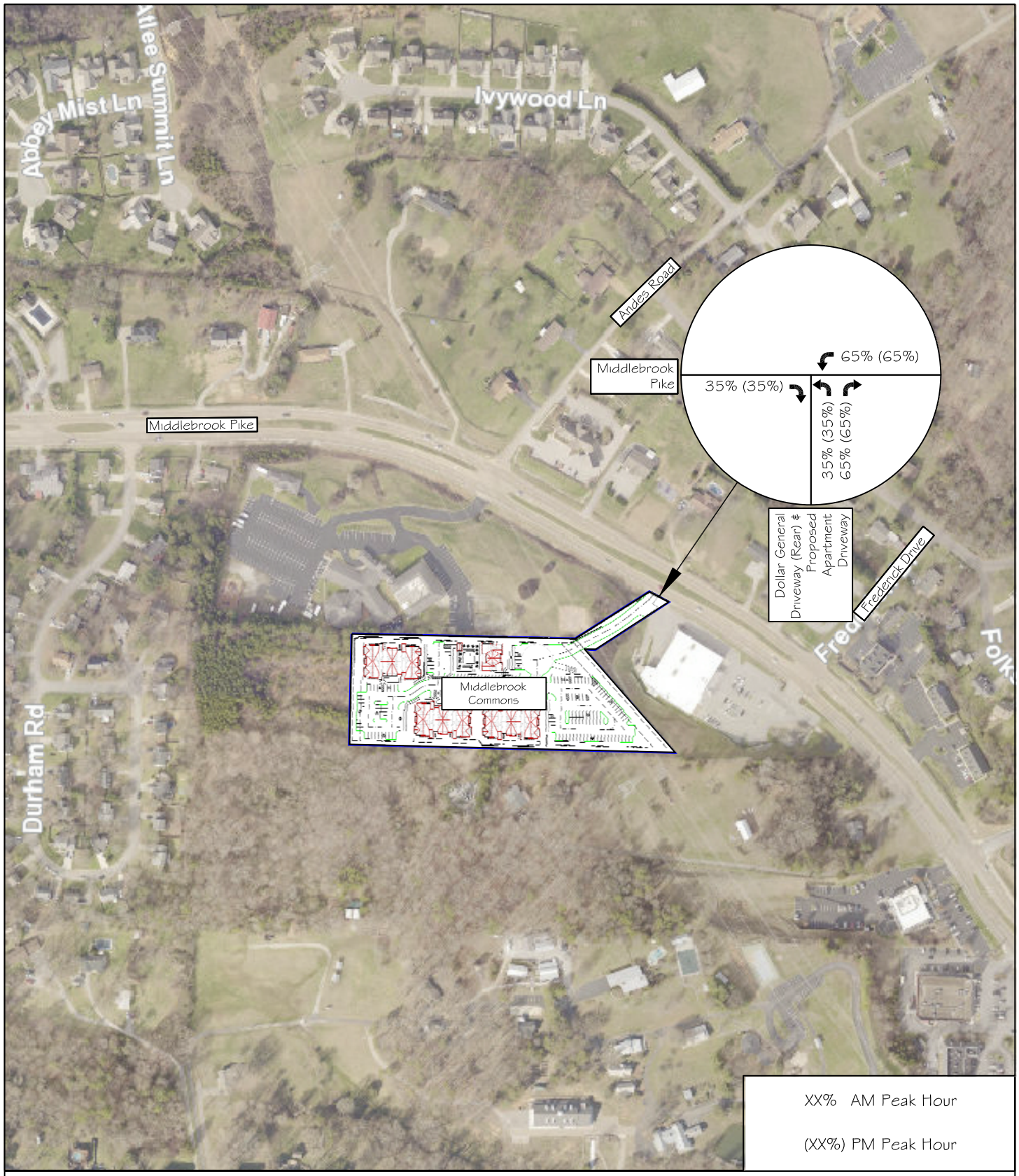

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FIGURE 3 - Addendum

Middlebrook Commons

Directional Distribution of Generated Traffic during AM and PM Peak Hour

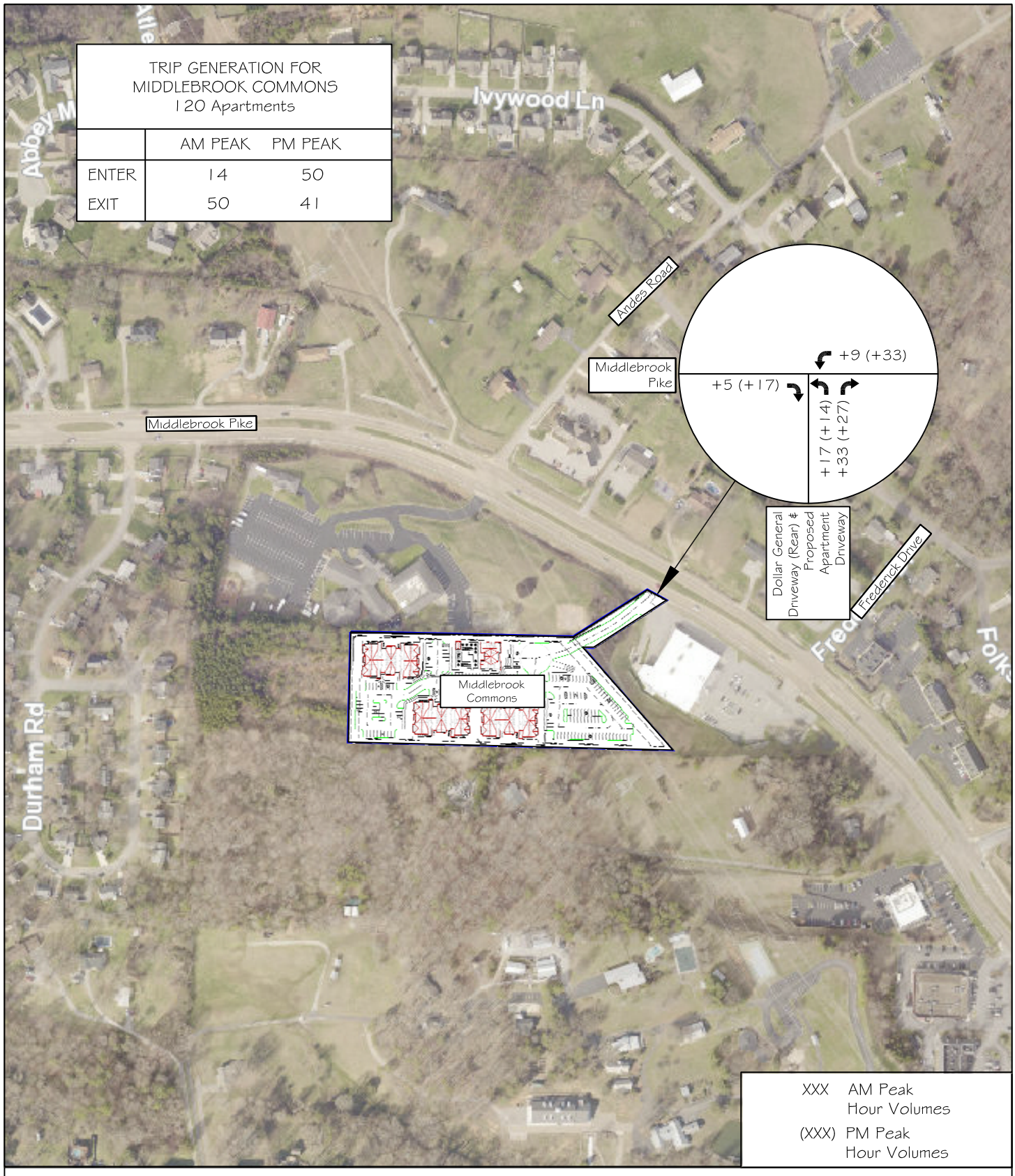

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FIGURE 4 - Addendum

Middlebrook Commons

Traffic Assignment of Generated Traffic during AM and PM Peak Hour

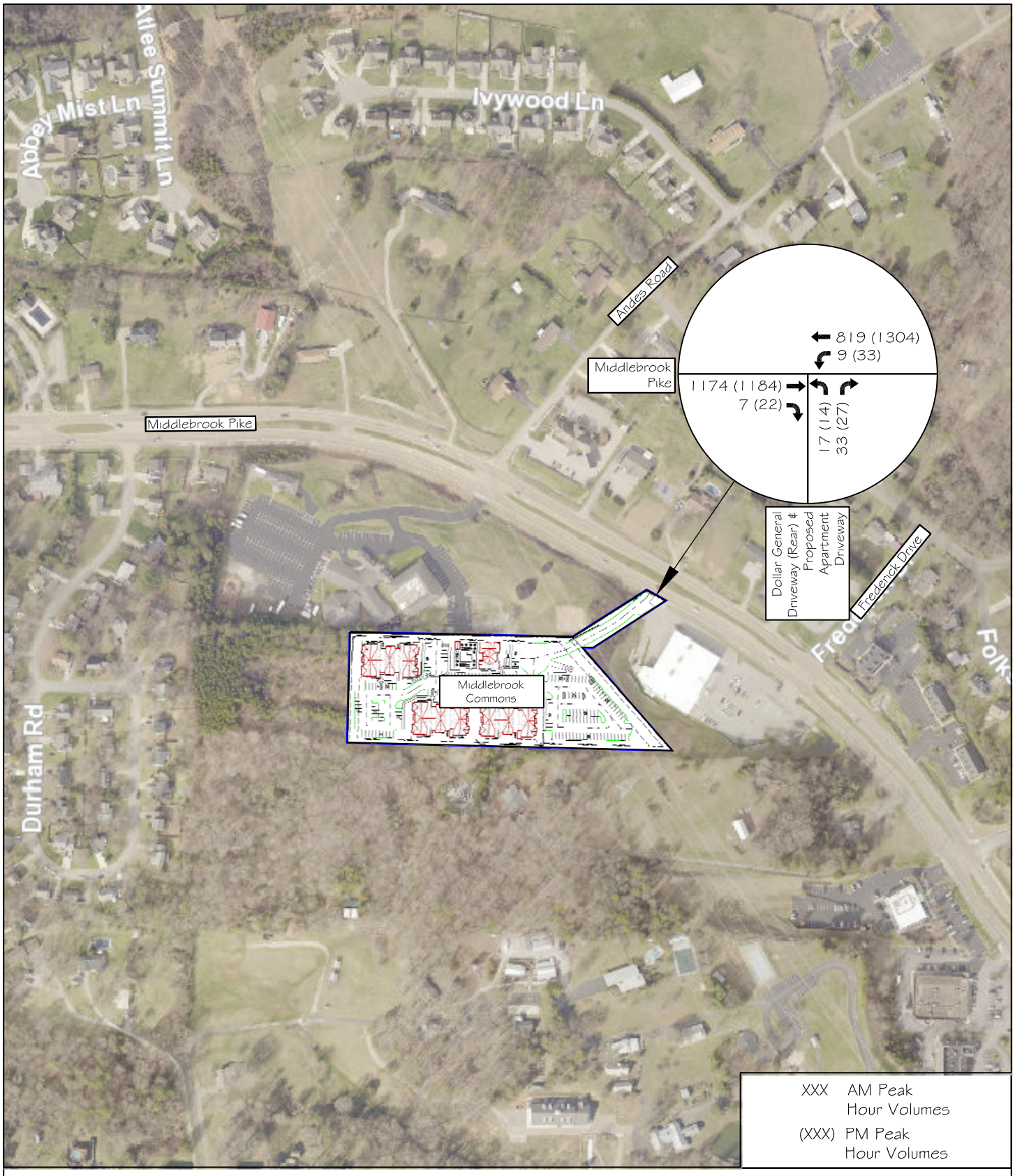

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FIGURE 5 - Addendum

Middlebrook Commons

2023 Peak Hour Traffic Volumes - (WITH THE PROJECT)

APPENDIX

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	1174	7	9	819	17	33
Sign Control	Free			Free	Stop	
Grade	-3%			3%	-3%	
Peak Hour Factor	0.94	0.50	0.90	0.98	0.90	0.90
Hourly flow rate (vph)	1249	14	10	836	19	37
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	Raised			Raised		
Median storage veh)	1			1		
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1263		1694	631
vC1, stage 1 conf vol					1256	
vC2, stage 2 conf vol					438	
vCu, unblocked vol			1263		1694	631
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)					5.8	
tF (s)			2.2		3.5	3.3
p0 queue free %			98		90	91
cM capacity (veh/h)			557		185	429

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	833	430	10	418	418	56
Volume Left	0	0	10	0	0	19
Volume Right	0	14	0	0	0	37
cSH	1700	1700	557	1700	1700	296
Volume to Capacity	0.49	0.25	0.02	0.25	0.25	0.19
Queue Length 95th (ft)	0	0	1	0	0	17
Control Delay (s)	0.0	0.0	11.6	0.0	0.0	20.0
Lane LOS			B			C
Approach Delay (s)	0.0		0.1			20.0
Approach LOS						C

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	1184	22	33	1304	14	27
Sign Control	Free			Free	Stop	
Grade	-3%			3%	-3%	
Peak Hour Factor	0.93	0.33	0.90	0.91	0.90	0.90
Hourly flow rate (vph)	1273	67	37	1433	16	30
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	Raised			Raised		
Median storage veh)	1			1		
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1340		2096	670
vC1, stage 1 conf vol					1306	
vC2, stage 2 conf vol					790	
vCu, unblocked vol			1340		2096	670
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)					5.8	
tF (s)			2.2		3.5	3.3
p0 queue free %			93		89	93
cM capacity (veh/h)			521		146	405

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1
Volume Total	849	491	37	716	716	46
Volume Left	0	0	37	0	0	16
Volume Right	0	67	0	0	0	30
cSH	1700	1700	521	1700	1700	252
Volume to Capacity	0.50	0.29	0.07	0.42	0.42	0.18
Queue Length 95th (ft)	0	0	6	0	0	16
Control Delay (s)	0.0	0.0	12.4	0.0	0.0	22.4
Lane LOS			B			C
Approach Delay (s)	0.0		0.3			22.4
Approach LOS						C

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	46.0%	ICU Level of Service	A
Analysis Period (min)	15		

TABLE 5A

LEFT-TURN LANE VOLUME THRESHOLDS FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
100 - 149 150 - 199	250 200	180 140	140 105	110 90	80 70	70 60
200 - 249 250 - 299	160 130	115 100	85 75	75 65	65 60	55 50
300 - 349 350 - 399	110 100	90 80	70 65	60 55	55 50	45 40
400 - 449 450 - 499	90 80	70 65	60 55	50 45	45 40	35 30
500 - 549 550 - 599	70 65	60 55	45 40	35 35	35 30	25 25
600 - 649 650 - 699	60 55	45 35	35 35	30 30	25 25	25 20
700 - 749 750 or More	50 45	35 35	30 25	25 25	20 20	20 20

1174/2 = 587 * 1.05 = 617 + 7 = 624

819/2 = 410 * 1.05 = 431

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	=/ > 600
100 - 149 150 - 199	70 60	60 55	50 45	45 40	40 35	35 30
200 - 249 250 - 299	55 50	50 45			30 30	30 30
300 - 349 350 - 399	45 40	40 35			25 25	25 20
400 - 449 450 - 499	35 30	30 25			20 20	20 20
500 - 549 550 - 599	25 25	25 20			20 20	15 15
600 - 649 650 - 699	25 20	20 20	20	20	20 20	15 15
700 - 749 750 or More	20 20	20 20	20 20	15 15	15 15	15 15

Middlebrook Pike at Proposed Apartment Entrance - 120 Apartments

2023 Projected AM WB Left Turns = 9

Left Turn Lane NOT Warranted

* Or through volume only if a right-turn lane exists

TABLE 5B

RIGHT-TURN LANE VOLUME THRESHOLDS FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25						
25 - 49						
50 - 99						
100 - 149						
150 - 199						
200 - 249						Yes
250 - 299					Yes	Yes
300 - 349				Yes	Yes	Yes
350 - 399			Yes	Yes	Yes	Yes
400 - 449			Yes	Yes	Yes	Yes
450 - 499		Yes	Yes	Yes	Yes	Yes
500 - 549		Yes	Yes	Yes	Yes	Yes
550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

1174/2 = 587 * 1.05 = 617

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25						
25 - 49					Yes	Yes
50 - 99				Yes	Yes	Yes
100 - 149				Yes	Yes	Yes
150 - 199				Yes	Yes	Yes
200 - 249	Yes			Yes	Yes	Yes
250 - 299	Yes			Yes	Yes	Yes
300 - 349	Yes			Yes	Yes	Yes
350 - 399	Yes			Yes	Yes	Yes
400 - 449	Yes			Yes	Yes	Yes
450 - 499	Yes			Yes	Yes	Yes
500 - 549	Yes	Yes	Yes	Yes	Yes	Yes
550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Middlebrook Pike at Proposed Apartment Entrance - 120 Apartments

2023 Projected AM EB Right Turns = 7

Right Turn Lane NOT Warranted

* Or through volume only if a left-turn lane exists.

TABLE 5A

LEFT-TURN LANE VOLUME THRESHOLDS FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

(If the left-turn volume exceeds the table value a left -turn lane is needed)

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	100 - 149	150 - 199	200 - 249	250 - 299	300 - 349	350 - 399
100 - 149 150 - 199	250 200	180 140	140 105	110 90	80 70	70 60
200 - 249 250 - 299	160 130	115 100	85 75	75 65	65 60	55 50
300 - 349 350 - 399	110 100	90 80	70 65	60 55	55 50	45 40
400 - 449 450 - 499	90 80	70 65	60 55	50 45	45 40	35 30
500 - 549 550 - 599	70 65	60 55	45 40	35 35	35 30	25 25
600 - 649 650 - 699	60 55	45 35	35 35	30 30	25 25	25 20
700 - 749 750 or More	50 45	35 35	30 25	25 25	20 20	20 20

1184/2 = 592 * 1.05 = 622 + 22 = 644

1304/2 = 652 * 1.05 = 685

OPPOSING VOLUME	THROUGH VOLUME PLUS RIGHT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 599	=/ > 600
100 - 149 150 - 199	70 60		50 45	45 40	40 35	35 30
200 - 249 250 - 299	55 50		40 35	35 30	30 30	30 30
300 - 349 350 - 399	45 40		35 30	30 25	25 25	25 20
400 - 449 450 - 499	35 30		30 25	25 20	20 20	20 20
500 - 549 550 - 599	25 25	20 20	20 20	20 20	20 20	15 15
600 - 649 650 - 699	25 20	20 20	20 20	20 20	20 20	15 15
700 - 749 750 or More	20 20	20 20	20 20	15 15	15 15	15 15

Middlebrook Pike at Proposed Apartment Entrance - 120 Apartments

2023 Projected PM WB Left Turns = 33

Left Turn Lane Warranted

* Or through volume only if a right-turn lane exists

TABLE 5B

RIGHT-TURN LANE VOLUME THRESHOLDS FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 36 TO 45 MPH

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	<100	100 - 199	200 - 249	250 - 299	300 - 349	350 - 399
Fewer Than 25						
25 - 49						
50 - 99						
100 - 149						
150 - 199						
200 - 249						Yes
250 - 299					Yes	Yes
300 - 349				Yes	Yes	Yes
350 - 399			Yes	Yes	Yes	Yes
400 - 449			Yes	Yes	Yes	Yes
450 - 499		Yes	Yes	Yes	Yes	Yes
500 - 549		Yes	Yes	Yes	Yes	Yes
550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

1184/2 = 592 * 1.05 = 622

RIGHT-TURN VOLUME	THROUGH VOLUME PLUS LEFT-TURN VOLUME *					
	350 - 399	400 - 449	450 - 499	500 - 549	550 - 600	+ / > 600
Fewer Than 25						
25 - 49					Yes	Yes
50 - 99				Yes	Yes	Yes
100 - 149				Yes	Yes	Yes
150 - 199				Yes	Yes	Yes
200 - 249	Yes			Yes	Yes	Yes
250 - 299	Yes			Yes	Yes	Yes
300 - 349	Yes			Yes	Yes	Yes
350 - 399	Yes			Yes	Yes	Yes
400 - 449	Yes			Yes	Yes	Yes
450 - 499	Yes			Yes	Yes	Yes
500 - 549	Yes	Yes	Yes	Yes	Yes	Yes
550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

Middlebrook Pike at Proposed Apartment Entrance - 120 Apartments

2023 Projected PM EB Right Turns = 22

Right Turn Lane NOT Warranted

* Or through volume only if a left-turn lane exists.

Intersection: 9: Dollar General Driveway (Rear) & Middlebrook Pike

Movement	WB	NB
Directions Served	L	LR
Maximum Queue (ft)	40	77
Average Queue (ft)	7	30
95th Queue (ft)	29	62
Link Distance (ft)		188
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)	75	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0

Intersection: 9: Dollar General Driveway (Rear) & Middlebrook Pike

Movement	EB	WB	NB
Directions Served	TR	L	LR
Maximum Queue (ft)	2	54	72
Average Queue (ft)	0	17	28
95th Queue (ft)	2	46	60
Link Distance (ft)	231		188
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)		75	
Storage Blk Time (%)		0	
Queuing Penalty (veh)		0	

Network Summary

Network wide Queuing Penalty: 0