

# 875 CORNERSTONE DRIVE APARTMENTS

## KNOX COUNTY, TENNESSEE

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TRAFFIC IMPACT STUDY

CORNERSTONE DRIVE AT MURDOCK DRIVE  
KNOX COUNTY, TENNESSEE

CCI PROJECT NO. 01554-0000

REV 1

PREPARED FOR:

Berkley Hall Companies  
500-D State Street  
Greensboro, NC 27405

SUBMITTED BY:

Cannon & Cannon, Inc.  
8550 Kingston Pike  
Knoxville, TN 37919  
865.670.8555



REVISED  
February 23  
**2021**

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**REVISION 1 (02/23/21)**

This report replaces the previous version of the traffic impact study dated 01/18/2020 prepared for this project in its entirety. The associated changes are related to comments received from the Knoxville-Knox County Planning, which are located in Appendix F.

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## EXECUTIVE SUMMARY

This report provides a summary of a traffic impact study that was performed for a proposed multi-family residential development to be located on Cornerstone Drive in Knox County, Tennessee. The project site is located in the northeast quadrant of the intersection of Cornerstone Drive and Murdock Drive. The development plan for this project proposes a multi-family residential development with 216 units. The proposed development will have two access driveways, one access onto Cornerstone Drive and one access onto Murdock Drive.

The purpose of this study was the evaluation of the traffic operational and safety impacts of the proposed development upon roadways in the vicinity of the project site. Discussion with Knox County officials resulted in the existing intersection of Cornerstone Drive at Murdock Drive being identified for detailed study. Additionally, the proposed site access locations along Cornerstone Drive and Murdock Drive were included in the study. Appropriate intersection evaluations such as capacity analyses and signal warrant analyses were conducted at the study intersections for existing and future conditions, both with and without site generated traffic, in order to determine the anticipated impacts and to establish recommended measures to mitigate these impacts.

The primary conclusion of this study is that the traffic generated from the proposed development will not have significant impacts at the studied intersections. The capacity analysis indicates a minimal increase in delay is expected at each intersection once the proposed development is built-out. The intersection of Cornerstone Drive at Murdock Drive does not warrant a signal installation under build-out conditions and the existing intersection configuration / control is expected to adequately accommodate traffic generated by the proposed development.

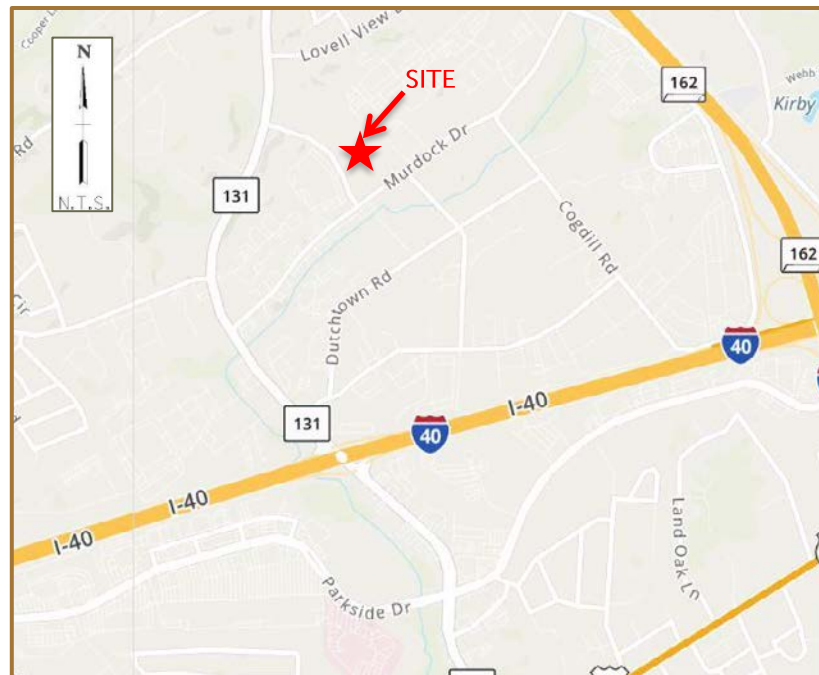
Additionally, anticipated traffic volumes at the site access intersection along Murdock Drive indicate a westbound right-turn lane is not recommended to be installed. Currently, the site access on Murdock Drive is proposed to be installed in the existing right-turn lane taper for the intersection of Cornerstone Drive and Murdock Drive. It is recommended to shorten the existing right-turn lane / taper to accommodate the installation of the proposed site access so the site access is not installed within a turn lane taper.

The following listing is a summary of the improvements that are recommended to be implemented with the construction of this project:

1. Install STOP signs at the site access locations on the site access approaches to Cornerstone Drive and Murdock Drive.
2. At the intersection of Cornerstone Drive at Murdock Drive, shorten the existing westbound right-turn lane storage from 250' to 150' and shorten the existing right-turn lane taper from 200' to 150' to allow for the proposed site access along Murdock Drive to be installed outside of the existing right-turn lane taper.
3. Maintain intersection corner sight distances on the site driveways by ensuring that new site signage and landscaping is appropriately located.

## INTRODUCTION & PURPOSE OF STUDY

This report provides a summary of a traffic impact study that was performed for a proposed multi-family residential development to be located on Cornerstone Drive in Knox County, Tennessee. The project site is located in the northeast quadrant of the intersection of Cornerstone Drive and Murdock Drive. FIGURE 1 is a location map showing the major roadways in the project site vicinity.



**FIGURE 1  
LOCATION MAP**

The development plan for this project proposes a multi-family residential development with 216 units. The proposed development will have two access driveways, one access onto Cornerstone Drive and one access onto Murdock Drive. FIGURE 2 is a Conceptual Site Plan detailing the proposed site.

The purpose of this study was the evaluation of the traffic operational and safety impacts of the proposed development upon roadways in the vicinity of the project site. Discussion with Knox County officials resulted in the existing intersection of Cornerstone Drive at Murdock Drive being identified for detailed study. Additionally, the proposed site access locations along Cornerstone Drive and Murdock Drive were included in the study. Appropriate intersection evaluations such as capacity analyses and signal warrant analyses were conducted at the study intersections for existing and future conditions, both with and without site generated traffic, in order to determine the anticipated impacts and to establish recommended measures to mitigate these impacts.



## EXISTING CONDITIONS

### EXISTING ROADWAY CONDITIONS

Roadway conditions for the study roadways are summarized as follows:

- Cornerstone Drive is a three-lane local road with one lane in each direction and a center two-way left-turn lane. Lane widths are 12 feet and curb, gutter, and sidewalk are on both sides. There is no posted speed limit along Cornerstone Drive.
- Murdock Drive is a three-lane road with one lane in each direction and a center two-way left-turn lane. It is classified as a Minor Arterial per Knoxville-Knox County Planning Major Road Plan. Lane widths are 12 feet and the posted speed limit is 40 mph within the vicinity of the proposed site.

Traffic control for the study intersections is as follows:

- Cornerstone Drive at Murdock Drive is currently side-street STOP controlled.

### EXISTING SITE CONDITIONS

The project site is located in the northeast quadrant of the intersection of Cornerstone Drive at Murdock Drive. It is bordered by the US Cellular Soccer Complex to the north and the US Cellular Business Office to the west. The site is relatively flat and does slope upward from Murdock Drive to the soccer fields north of the proposed site. The site access point on Cornerstone Drive is proposed to tie into the road across from the existing US Cellular Business Office access, creating a four-way intersection along Cornerstone Drive. FIGURE 3 provides an aerial view of the project site and the surrounding area.

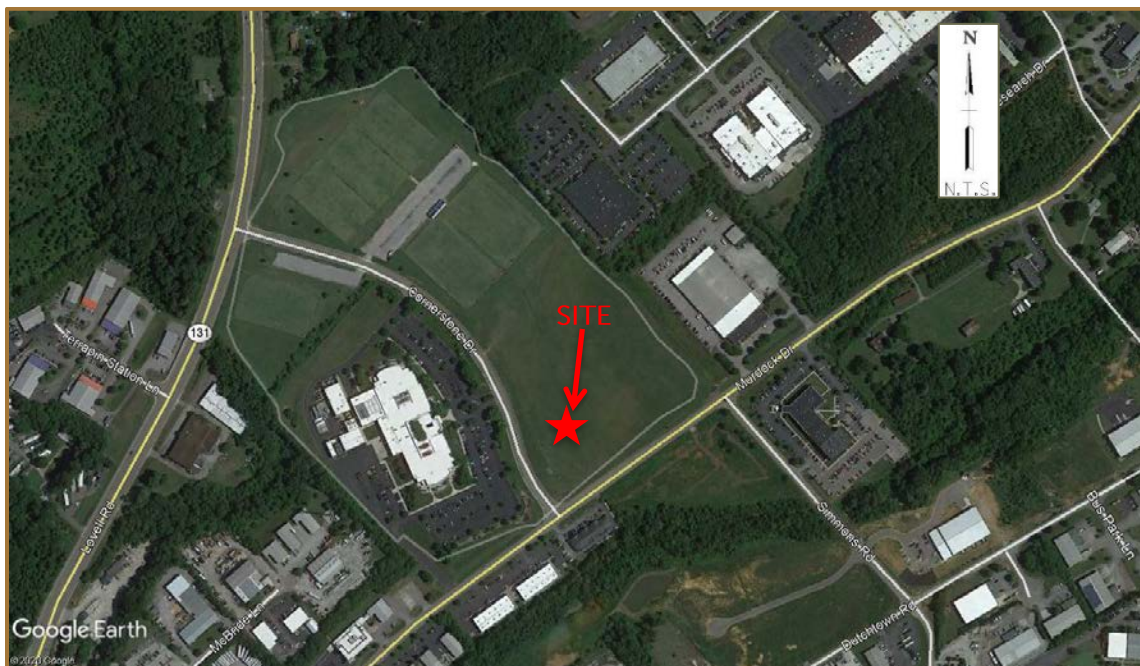


FIGURE 3  
EXISTING SITE CONDITIONS



### EXISTING TRAFFIC DATA

Two types of existing traffic data were gathered for this study. The Tennessee Department of Transportation (TDOT) collects annual average daily traffic (AADT) data on roadways in the study area. A count station was found near the project site that was felt to have particular relevance for this study. The most currently available data from this station is contained in Table 1.

**TABLE 1: ANNUAL AVERAGE DAILY TRAFFIC COUNT SUMMARY**

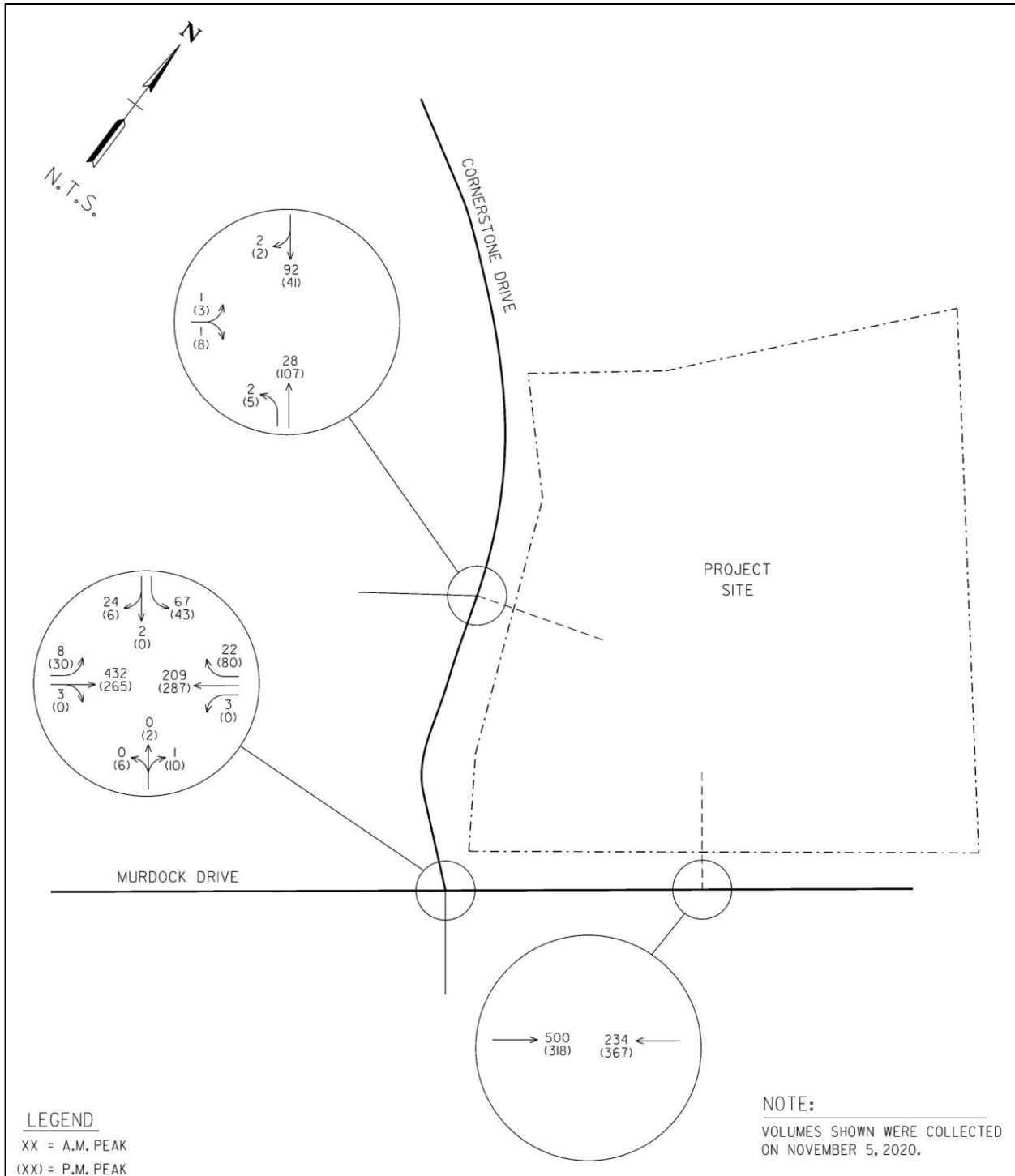
COUNT YEAR	TDOT COUNT STATION 47000464 MURDOCK DRIVE EAST OF CORNERSTONE DRIVE
2014	6,119
2015	6,775
2016	7,147
2017	6,821
2018	6,476
2019	6,555

In addition to the available AADT data, intersection turning movement traffic counts were conducted at the existing study intersections to determine the current peak hour operating volumes. The traffic counts were conducted during the first week of November 2020. During this time, regional traffic volumes and patterns were recovering from COVID-19 pandemic restrictions, including business and school closures and widespread telecommuting or working from home practices. At the time of the counts, schools were conducting in-school instruction at a reduced student capacity. In consultation with the Knoxville-Knox County Planning, the November 2020 count data was increased by 20% to address reductions in typical travel volumes due to the ongoing pandemic.

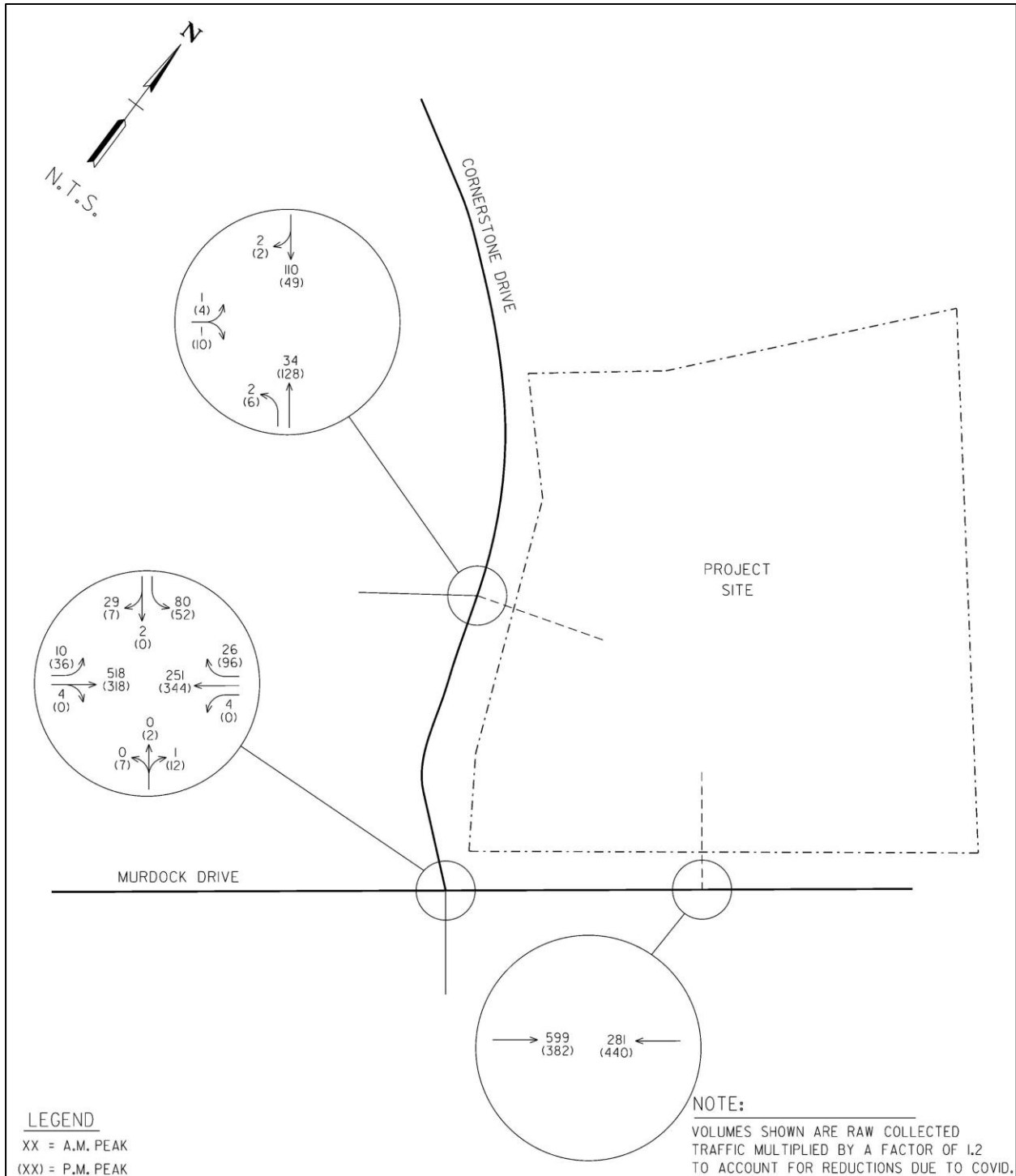
The 2020 raw traffic data is summarized in FIGURE 4 and the factored traffic data is summarized in FIGURE 5. The raw data traffic count summary sheets are contained in APPENDIX A.

### EXISTING CAPACITY ANALYSES / LEVELS-OF-SERVICE

Capacity analyses employing the methods of the *Highway Capacity Manual* were conducted for the existing conditions at the study intersections. These analyses were performed with the 2020 existing factored traffic volumes, shown in FIGURE 5, and existing intersection traffic control and lane configurations. The EVALUATIONS section of this report may be referenced for tabular summaries of these analyses, while more detailed summaries are presented on the computer printouts contained in APPENDIX C. Also contained in APPENDIX C is a section entitled "Capacity and Level of Service Concepts", which provides a description of the utilized procedures.



**FIGURE 4**  
**2020 EXISTING RAW TRAFFIC VOLUMES**



**FIGURE 5**  
**2020 EXISTING FACTORED TRAFFIC VOLUMES**

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**BACKGROUND CONDITIONS****BACKGROUND TRAFFIC GROWTH**

The proposed development is anticipated to be constructed in one general phase with completion anticipated by 2022. Therefore, year 2022 was established as the appropriate design / analysis year for the study. In order to determine traffic volumes resulting solely from background traffic growth to year 2022, it was necessary to establish an annual growth rate for existing traffic. The TDOT ADT values previously discussed, as well as knowledge of the area, were used to determine an approximate annual growth rate. Based on the available data, a background annual growth rate of two percent was assumed. FIGURE 6 contains the background traffic volumes that would result from this annual growth rate from year 2020, when the counts were conducted, to year 2022.

**BACKGROUND CAPACITY ANALYSES / LEVELS-OF-SERVICE**

Capacity analyses as described in the Existing Conditions section of this report were conducted utilizing the Year 2022 background volumes shown in FIGURE 6 and existing intersection traffic control and lane configurations. The EVALUATIONS section of this report may be referenced for tabular summaries of these analyses, while more detailed summaries are presented on the computer printouts contained in APPENDIX C.

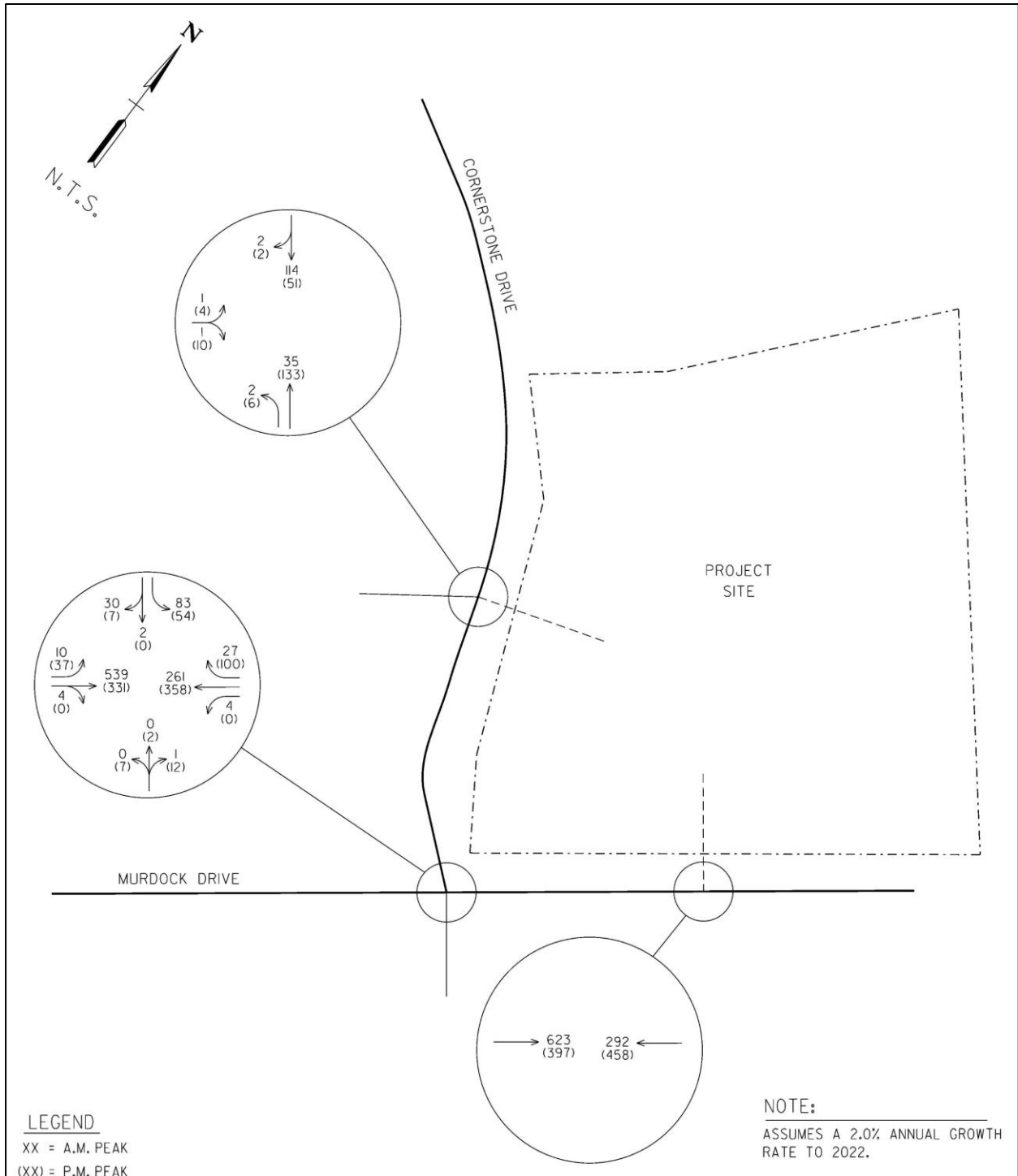


FIGURE 6  
2022 BACKGROUND TRAFFIC VOLUMES

**FUTURE CONDITIONS**

**TRIP GENERATION**

In order to estimate the expected traffic volumes to be generated by the proposed development, the procedures recommended by the Institute of Transportation Engineers were utilized. The proposed development will include 216 multi-family residential apartment units. Local trip generation rates developed by the Knoxville-Knox County Metropolitan Planning Commission for multi-family apartment type developments within the region were utilized to generate the estimated trips. The generated traffic volumes were determined based on the data for the peak hours of adjacent street traffic. See TABLE 2 for a summary of the traffic generated for this project. More detailed information is contained in APPENDIX B.

**TABLE 2: TRIP GENERATION SUMMARY**

LAND USE	ITE CODE	SIZE	WEEKDAY (TRIPS/DAY)	AM PEAK HOUR (TRIPS/HOUR)	PM PEAK HOUR (TRIPS/HOUR)
Multi-Family Residential	n/a	216 Dwelling Units	1,906	109	155
Entering Trips			953 (50%)	24 (22%)	85 (55%)
Exiting Trips			953 (50%)	85 (78%)	70 (45%)

A.M. Peak Hour trip generation is based on Peak Hour of Adjacent Street Traffic, One Hour Between 7 and 9 a.m.  
P.M. Peak Hour trip generation is based on Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6 p.m.

**TRIP DISTRIBUTION AND ASSIGNMENT**

The proposed trip distribution for this development was determined through a review of existing travel patterns, local knowledge of the study area, proposed site location in relation to surrounding roadway network, and engineering judgement. FIGURE 7 provides a summary of how the above site generated trips would be assigned to the study intersection. FIGURE 8 provides the proposed trip assignment volumes to the studied intersections.

**FUTURE TRAFFIC VOLUMES**

Future projected traffic volumes for the study intersection were developed by adding the generated and assigned trips shown in FIGURE 8 to the 2022 background traffic volumes developed in the previous section and shown in FIGURE 6. These combined 2022 volumes reflect the existing traffic, the background traffic growth, and the generated traffic from the proposed development. These future volumes are shown on FIGURE 9 and are the combined volumes used in the analyses of future conditions with the proposed development.

**FUTURE CAPACITY ANALYSES / LEVELS-OF-SERVICE**

Capacity analyses, as described in the Existing Conditions section of this report, were conducted for future conditions utilizing the traffic volumes shown in the build-out scenario. These analyses employed appropriate modifications to the existing lane configurations and traffic control in order to serve the development, as discussed in the EVALUATIONS section of this report. Tabular summaries of the analysis results and associated discussion are also contained in the EVALUATIONS section. In addition, detailed computer printout summaries of the analyses are contained in APPENDIX C.

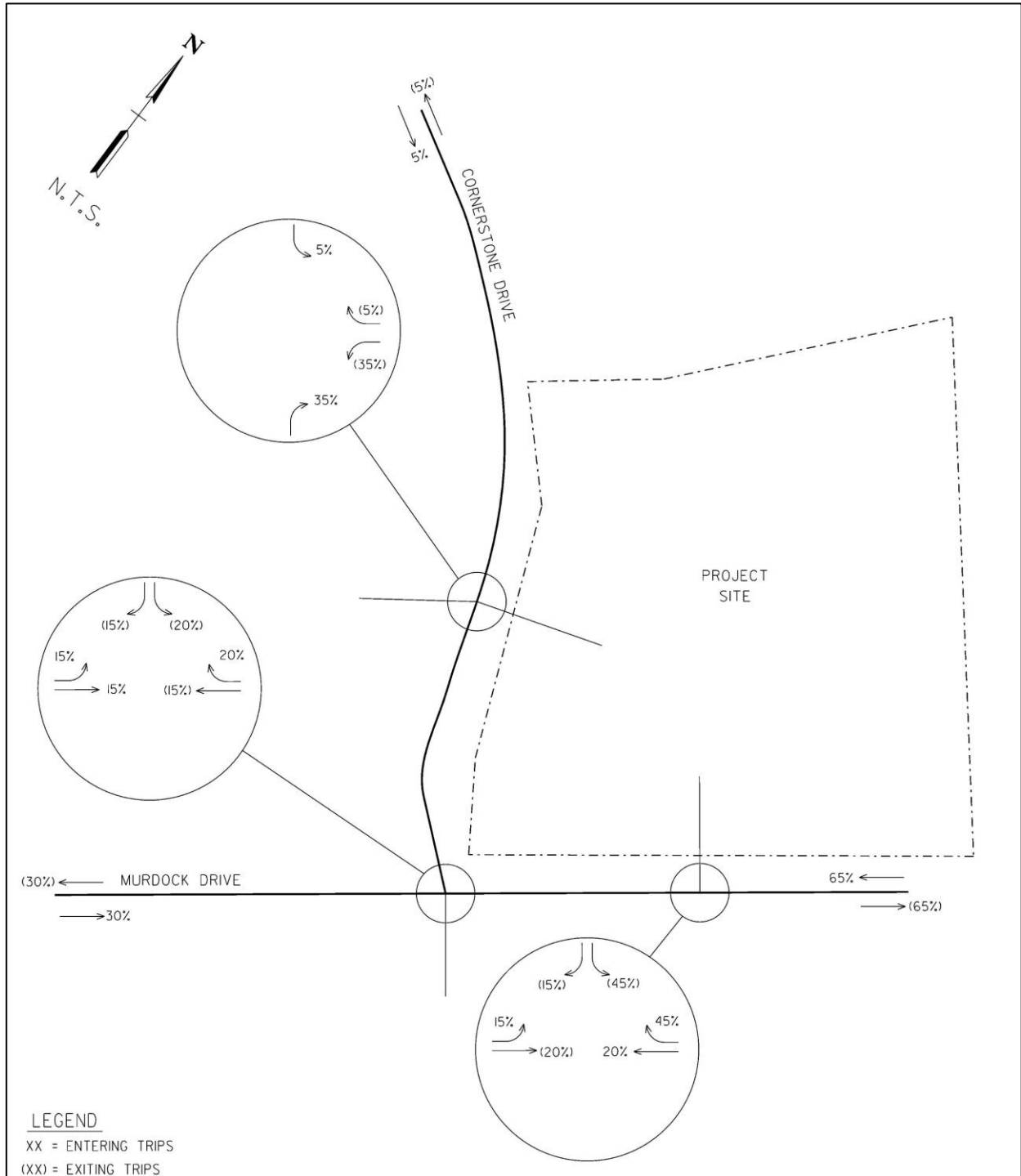


FIGURE 7  
TRIP DISTRIBUTION



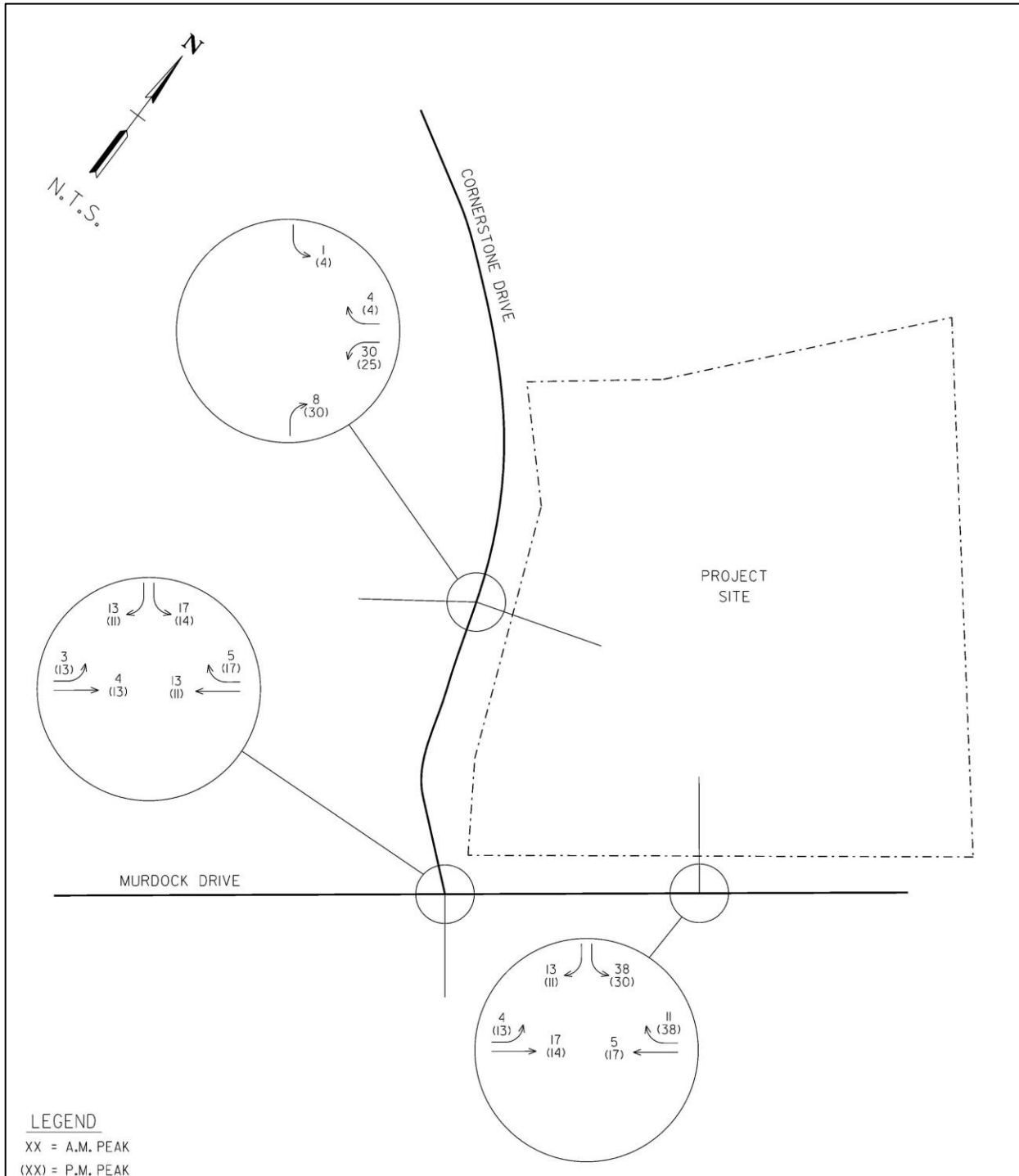


FIGURE 8  
TRIP ASSIGNMENT

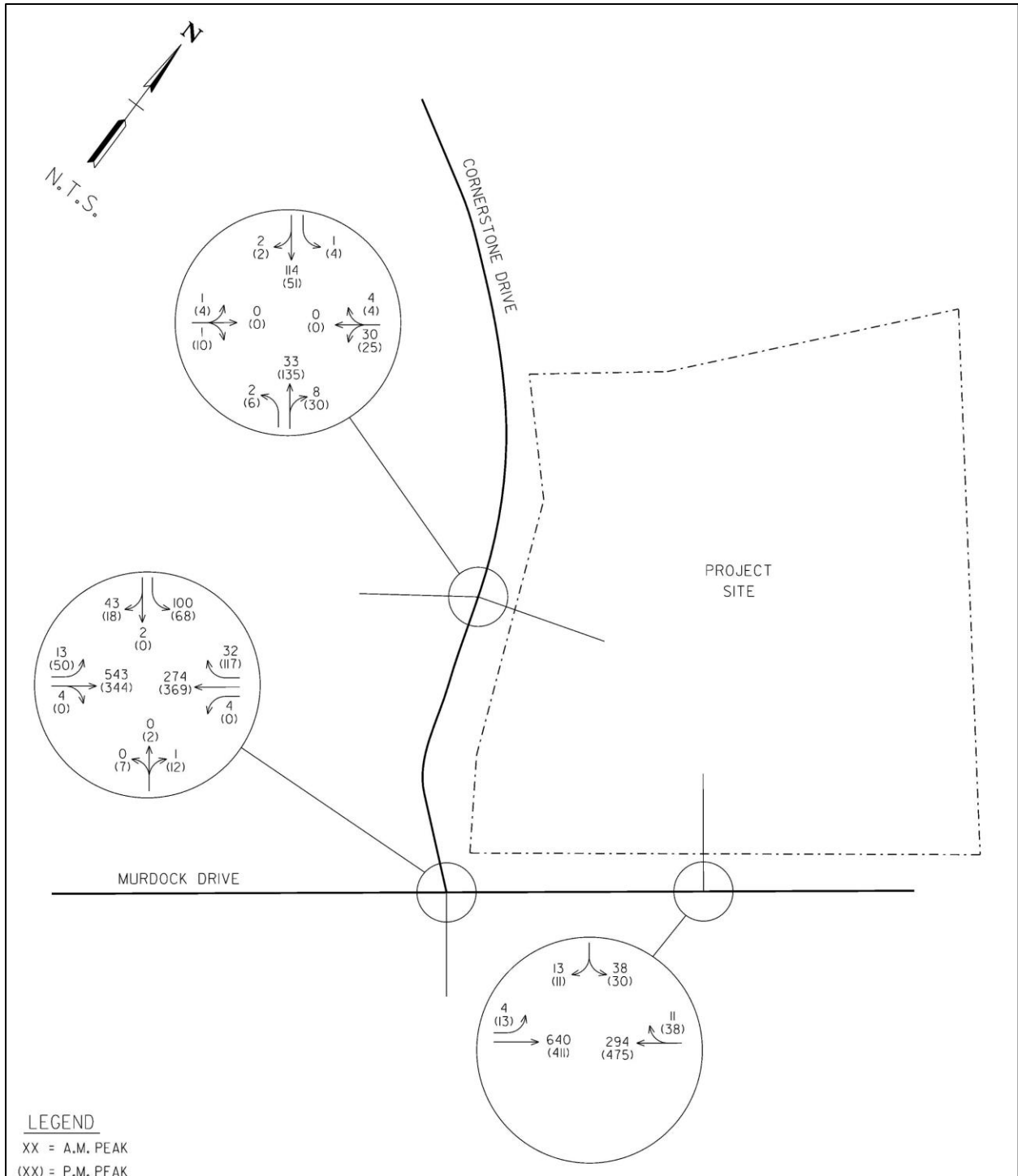


FIGURE 9  
2022 COMBINED TRAFFIC VOLUMES

## EVALUATIONS

### INTERSECTION CAPACITY ANALYSES

As discussed in the preceding sections of this report, capacity analyses employing the methods of the Highway Capacity Manual (HCM 6<sup>th</sup> Edition) were conducted for the study intersections. These analyses were performed for the previously discussed development scenarios. A summary of the capacity analyses results is shown in TABLE 3, while the resulting conclusions and recommendations are covered in the CONCLUSIONS and RECOMMENDATIONS section of this report.

**TABLE 3: CAPACITY ANALYSES SUMMARY**

INTERSECTION	TIME PERIOD	YEAR 2020 EXISTING (LOS/DELAY)	YEAR 2022 BACKGROUND (LOS/DELAY)	YEAR 2022 COMBINED (LOS/DELAY)
Cornerstone Dr. at Murdock Dr. <sup>1</sup> SIDE STREET STOP CONTROL	A.M.	C 17.1	C 17.8	C 19.0
	P.M.	C 16.7	C 17.4	C 18.6
Site Access at Cornerstone Dr. <sup>1</sup> SIDE STREET STOP CONTROL	EB A.M.	A 9.3	A 9.4	A 9.5
	EB P.M.	A 9.1	A 9.1	A 9.3
Site Access at Murdock Dr. <sup>1</sup> SIDE STREET STOP CONTROL	WB A.M.	-	-	B 10.0
	WB P.M.	-	-	B 10.7
Site Access at Murdock Dr. <sup>1</sup> SIDE STREET STOP CONTROL	A.M.	-	-	C 15.8
	P.M.	-	-	C 15.9

<sup>1</sup>SIDE STREET STOP CONTROL – Data shown are Level-of-Service and Average Vehicular Delay (seconds) for the critical side street approach utilizing HCM methodology.

### TRAFFIC SIGNAL WARRANT ASSESSMENT

The traffic signal volume warrants from the Manual on Uniform Traffic Control Devices were evaluated for the study intersection of Cornerstone Drive at Murdock Drive. Traffic signal warrant analyses were performed for three different scenarios; existing, background, and combined. These are summarized below, along with the associated results. Spreadsheets summarizing these analyses are contained in APPENDIX D.

- Scenario 1 – 2020 Existing Factored Traffic Volumes – No signal warrants satisfied
  - Raw traffic data factored by 1.2 to account for reductions due to COVID-19 impacts
- Scenario 2 – Year 2022 Background Traffic Volumes – No signal warrants satisfied
  - Existing factored data with 2.0% annual growth applied from Year 2020 to Year 2022
- Scenario 3 – Year 2022 Combined Traffic Volumes – No signal warrants satisfied
  - AM Peak hour generated trips were added to volumes beginning at hours 7am, 8am, 11am, and 12pm
  - PM Peak hour generated trips were added to volumes beginning at hours 2pm, 3pm, 4pm, and 5pm

## **TURN LANE ASSESSMENTS**

A turn lane evaluation was conducted for a potential right-turn lane to enter the project site at the proposed site access intersections along Cornerstone Drive and Murdock Drive. This evaluation, which utilized Knox County turn lane warrants, found that a right-turn lane is not warranted for the Murdock Drive site access intersection and is not warranted for the Cornerstone Drive site access intersection. The spreadsheets summarizing this evaluation are contained in APPENDIX E.

The existing two-way-left-turn lane along Murdock Drive was evaluated for potential queuing conflicts for eastbound left turns entering the site along Murdock Drive and existing westbound left turns entering the existing commercial development at the intersection of Cornerstone Drive and Murdock Drive. Proposed development plans indicate the site access along Murdock Drive will be constructed roughly 400 feet to the east of the intersection of Cornerstone Drive at Murdock Drive.

The interaction of left turns at these two intersections is typically not desirable and can often result in conflicting left-turn movements from the main road to the side streets. However, the capacity analysis for these two study intersections indicate minimal left turn queues of less than 25 feet at each intersection is expected during the studied peak hours. Since minimal offset left-turn traffic is expected at each of these intersections, the offset left-turn configuration is not anticipated to negatively impact intersection operation at either intersection of Cornerstone Drive at Murdock Drive and the proposed site access at Murdock Drive.

## **SIGHT DISTANCE ASSESSMENT**

Intersection sight distance was assessed looking both directions from the proposed site driveway intersections. Excellent sight distance is available at all locations to satisfy requirements, as all roadway approaches are relatively flat, straight and without sight limiting vegetation or fixed objects. Care should be taken during the site development process to ensure that site features such as landscaping and signage do not restrict these existing sight distances.

## **PEDESTRIAN CONNECTION ASSESSMENT**

The proposed development will provide sidewalk along the property frontage to Murdock Drive and tie into existing sidewalk along Cornerstone Drive. The existing property contains a walking trail that traverses the US Cellular soccer fields and office building properties. The proposed development will remove the portion of the walking trail on this site property.

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## CONCLUSIONS & RECOMMENDATIONS

The primary conclusion of this study is that the traffic generated from the proposed development will not have significant impacts at the studied intersections. The capacity analysis indicates a minimal increase in delay is expected at each intersection once the proposed development is built-out. The intersection of Cornerstone Drive at Murdock Drive does not warrant a signal installation under build-out conditions and the existing intersection configuration / control is expected to adequately accommodate traffic generated by the proposed development.

Additionally, anticipated traffic volumes at the site access intersection along Murdock Drive indicate a westbound right-turn lane is not recommended to be installed. Currently, the site access on Murdock Drive is proposed to be installed in the existing right-turn lane taper for the intersection of Cornerstone Drive and Murdock Drive. It is recommended to shorten the existing right-turn lane / taper to accommodate the installation of the proposed site access so the site access is not installed within a turn lane taper.

The following listing is a summary of the improvements that are recommended to be implemented with the construction of this project:

1. Install STOP signs at the site access locations on the site access approaches to Cornerstone Drive and Murdock Drive.
2. At the intersection of Cornerstone Drive at Murdock Drive, shorten the existing westbound right-turn lane storage from 250' to 150' and shorten the existing right-turn lane taper from 200' to 150' to allow for the proposed site access along Murdock Drive to be installed outside of the existing right-turn lane taper.
3. Maintain intersection corner sight distances on the site driveways by ensuring that new site signage and landscaping is appropriately located.

**APPENDIX**

**APPENDIX ORDER:**

**A. TRAFFIC DATA**

**B. TRIP GENERATION INFORMATION**

**C. CAPACITY ANALYSES**

**D. SIGNAL WARRANT SPREADSHEETS**

**E. TURN LANE WARRANT SHEETS**

**F. MPC COMMENTS**

**APPENDIX A – TRAFFIC DATA**





Project ID: 20-190017-001  
 Location: Cornerstone Dr/Sentinel Builders Dwy & Murdock Dr  
 City: Knoxville

Day, Thursday  
 Date: 11/05/2020

Start Time	Cornerstone Dr/Sentinel Builders Dwy					Cornerstone Dr/Sentinel Builders Dwy					Groups Printed - Cars, PU, Vans - Heavy Trucks					Murdock Dr					Murdock Dr									
	Left	Thru	Uturn	Peds	App. Total	Left	Thru	Uturn	Peds	App. Total	Left	Thru	Uturn	Peds	App. Total	Left	Thru	Uturn	Peds	App. Total	Left	Thru	Uturn	Peds	App. Total	Left	Thru	Uturn	Peds	App. Total
7:00 AM	0	0	0	0	0	5	0	0	1	7	0	32	0	0	32	0	30	5	0	35	0	30	5	0	35	0	30	5	0	35
7:15 AM	0	0	0	0	0	0	1	2	0	5	0	1	7	0	8	0	29	3	0	32	0	29	3	0	32	0	29	3	0	32
7:30 AM	0	0	0	0	0	19	1	6	0	26	1	70	1	0	72	0	44	4	0	48	0	44	4	0	48	0	44	4	0	48
7:45 AM	0	0	0	0	0	21	1	8	0	30	3	129	0	0	132	1	62	8	0	71	1	62	8	0	71	1	62	8	0	71
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>55</b>	<b>3</b>	<b>18</b>	<b>0</b>	<b>76</b>	<b>5</b>	<b>337</b>	<b>2</b>	<b>0</b>	<b>344</b>	<b>1</b>	<b>165</b>	<b>20</b>	<b>0</b>	<b>186</b>	<b>1</b>	<b>165</b>	<b>20</b>	<b>0</b>	<b>186</b>	<b>1</b>	<b>165</b>	<b>20</b>	<b>0</b>	<b>186</b>
8:00 AM	0	0	1	0	0	1	12	0	6	2	18	2	124	1	0	127	0	65	2	0	67	213	0	0	0	0	67			
8:15 AM	0	0	1	0	0	0	15	0	4	0	3	19	2	73	1	0	76	2	38	9	0	49	144	0	0	0	0	144		
8:30 AM	1	0	1	0	0	2	8	0	9	0	7	17	2	58	3	0	63	3	38	5	0	46	128	0	0	0	0	128		
8:45 AM	0	0	0	0	0	0	15	0	4	0	6	19	6	44	0	5	36	8	0	49	118	0	0	0	0	118				
<b>Total</b>	<b>1</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>3</b>	<b>50</b>	<b>0</b>	<b>23</b>	<b>0</b>	<b>18</b>	<b>73</b>	<b>12</b>	<b>299</b>	<b>5</b>	<b>0</b>	<b>316</b>	<b>10</b>	<b>177</b>	<b>24</b>	<b>0</b>	<b>211</b>	<b>603</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>603</b>			
***BREAK***																														
11:00 AM	0	0	3	0	0	11	2	5	0	1	18	4	38	1	0	43	0	47	12	0	59	123	0	0	0	0	123			
11:15 AM	0	0	2	0	0	9	0	2	0	5	11	4	28	0	2	32	0	48	5	0	53	98	0	0	0	0	98			
11:30 AM	1	0	3	0	4	16	0	3	0	4	19	1	33	0	0	34	0	49	23	0	72	129	0	0	0	0	129			
11:45 AM	2	0	1	0	0	10	0	1	0	5	11	2	58	2	0	62	0	58	9	0	67	143	0	0	0	0	143			
<b>Total</b>	<b>3</b>	<b>0</b>	<b>9</b>	<b>0</b>	<b>12</b>	<b>46</b>	<b>2</b>	<b>11</b>	<b>0</b>	<b>15</b>	<b>59</b>	<b>11</b>	<b>157</b>	<b>3</b>	<b>2</b>	<b>171</b>	<b>0</b>	<b>202</b>	<b>49</b>	<b>0</b>	<b>251</b>	<b>493</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>493</b>			
12:00 PM	0	0	0	0	0	0	13	0	1	0	5	14	1	47	0	40	2	50	19	0	71	133	0	0	0	0	133			
12:15 PM	2	0	0	0	0	2	14	0	2	0	16	2	38	0	0	40	1	46	5	0	52	110	0	0	0	0	110			
12:30 PM	0	0	0	0	0	0	11	0	1	0	3	12	4	52	1	0	57	2	53	8	0	63	132	0	0	0	0	132		
12:45 PM	0	0	1	0	0	0	20	0	1	0	23	2	64	2	0	68	0	44	12	0	56	148	0	0	0	0	148			
<b>Total</b>	<b>2</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>58</b>	<b>0</b>	<b>7</b>	<b>0</b>	<b>10</b>	<b>65</b>	<b>9</b>	<b>201</b>	<b>3</b>	<b>0</b>	<b>213</b>	<b>5</b>	<b>193</b>	<b>44</b>	<b>0</b>	<b>242</b>	<b>523</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>523</b>			
***BREAK***																														
2:00 PM	0	0	1	0	0	14	0	2	0	1	16	1	35	1	0	37	0	53	11	0	64	118	0	0	0	0	118			
2:15 PM	0	0	0	0	0	12	0	1	0	2	13	1	46	1	0	48	0	39	8	0	47	108	0	0	0	0	108			
2:30 PM	1	1	0	0	2	7	0	1	0	3	8	0	53	1	0	54	1	52	15	0	68	132	0	0	0	0	132			
2:45 PM	3	0	1	0	0	4	10	0	1	0	5	11	4	57	0	61	1	52	8	0	61	137	0	0	0	0	137			
<b>Total</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>0</b>	<b>7</b>	<b>43</b>	<b>0</b>	<b>5</b>	<b>0</b>	<b>11</b>	<b>48</b>	<b>6</b>	<b>191</b>	<b>3</b>	<b>0</b>	<b>200</b>	<b>2</b>	<b>196</b>	<b>42</b>	<b>0</b>	<b>240</b>	<b>495</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>495</b>			
3:00 PM	0	1	1	0	0	2	10	0	0	3	10	2	53	0	0	55	1	64	17	0	82	149	0	0	0	0	149			
3:15 PM	0	1	0	0	0	1	7	0	5	0	4	12	0	54	0	54	1	78	11	0	90	157	0	0	0	0	157			
3:30 PM	0	1	2	0	0	3	9	1	2	0	4	12	3	63	1	0	67	1	89	15	0	105	187	0	0	0	0	187		
3:45 PM	1	0	1	0	0	2	13	1	2	0	3	16	3	59	1	0	63	2	95	13	0	110	191	0	0	0	0	191		
<b>Total</b>	<b>1</b>	<b>3</b>	<b>4</b>	<b>0</b>	<b>8</b>	<b>39</b>	<b>2</b>	<b>9</b>	<b>0</b>	<b>14</b>	<b>50</b>	<b>8</b>	<b>229</b>	<b>2</b>	<b>0</b>	<b>239</b>	<b>5</b>	<b>326</b>	<b>56</b>	<b>0</b>	<b>387</b>	<b>684</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>684</b>			
4:00 PM	2	0	1	0	0	3	8	0	3	0	6	11	10	54	2	0	66	0	69	18	0	87	167	0	0	0	0	167		
4:15 PM	2	1	0	0	0	4	8	0	2	1	6	11	5	51	1	0	57	0	46	15	0	61	133	0	0	0	0	133		
4:30 PM	1	0	1	0	0	2	11	0	0	7	11	5	61	0	0	66	0	65	17	0	82	161	0	0	0	0	161			
4:45 PM	3	0	5	0	0	5	0	0	0	5	5	6	64	0	0	70	0	60	19	0	79	162	0	0	0	0	162			
<b>Total</b>	<b>8</b>	<b>1</b>	<b>8</b>	<b>0</b>	<b>17</b>	<b>32</b>	<b>0</b>	<b>5</b>	<b>1</b>	<b>24</b>	<b>38</b>	<b>26</b>	<b>230</b>	<b>3</b>	<b>0</b>	<b>259</b>	<b>0</b>	<b>240</b>	<b>69</b>	<b>0</b>	<b>309</b>	<b>623</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>623</b>			
5:00 PM	2	0	1	0	0	3	14	0	3	0	4	17	86	0	0	103	0	86	23	0	109	232	0	0	0	0	232			
5:15 PM	0	2	3	0	0	5	13	0	3	0	2	16	2	54	0	0	56	0	76	21	0	97	174	0	0	0	0	174		
5:30 PM	0	0	0	0	0	0	7	0	0	0	10	7	3	52	0	0	55	0	68	17	0	85	147	0	0	0	0	147		
5:45 PM	0	0	0	0	0	2	0	2	0	6	4	3	39	0	0	42	0	57	15	0	72	118	0	0	0	0	118			
<b>Total</b>	<b>2</b>	<b>2</b>	<b>4</b>	<b>0</b>	<b>8</b>	<b>36</b>	<b>0</b>	<b>8</b>	<b>0</b>	<b>22</b>	<b>44</b>	<b>25</b>	<b>231</b>	<b>0</b>	<b>0</b>	<b>256</b>	<b>0</b>	<b>287</b>	<b>76</b>	<b>0</b>	<b>363</b>	<b>671</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>671</b>			
<b>Grand Total</b>	<b>21</b>	<b>7</b>	<b>30</b>	<b>0</b>	<b>58</b>	<b>359</b>	<b>7</b>	<b>86</b>	<b>1</b>	<b>124</b>	<b>453</b>	<b>102</b>	<b>1875</b>	<b>21</b>	<b>0</b>	<b>3</b>	<b>1998</b>	<b>23</b>	<b>1786</b>	<b>380</b>	<b>0</b>	<b>0</b>	<b>2189</b>	<b>4688</b>						
<b>Approach %</b>	<b>36.2</b>	<b>12.1</b>	<b>51.7</b>	<b>0.0</b>	<b>0.0</b>	<b>79.2</b>	<b>1.5</b>	<b>19.0</b>	<b>0.2</b>	<b>27.4</b>	<b>5.1</b>	<b>93.8</b>	<b>1.1</b>	<b>0.0</b>	<b>0.2</b>	<b>1.1</b>	<b>81.6</b>	<b>17.4</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>46.6</b>	<b>4688</b>						
<b>Total %</b>	<b>0.4</b>	<b>0.1</b>	<b>0.6</b>	<b>0.0</b>	<b>0.0</b>	<b>1.2</b>	<b>7.6</b>	<b>0.1</b>	<b>1.8</b>	<b>0.0</b>	<b>9.6</b>	<b>2.2</b>	<b>39.9</b>	<b>0.4</b>	<b>0.0</b>	<b>0.1</b>	<b>42.5</b>	<b>0.5</b>	<b>38.0</b>	<b>8.1</b>	<b>0.0</b>	<b>0.0</b>	<b>46.6</b>	<b>4688</b>						
<b>Cars, PU, Vans</b>	<b>21</b>	<b>7</b>	<b>30</b>	<b>0</b>	<b>58</b>	<b>354</b>	<b>7</b>	<b>85</b>	<b>1</b>	<b>124</b>	<b>447</b>	<b>101</b>	<b>1808</b>	<b>21</b>	<b>0</b>	<b>1930</b>	<b>23</b>	<b>1737</b>	<b>373</b>	<b>0</b>	<b>0</b>	<b>2133</b>	<b>4568</b>							
<b>% Cars, PU, Vans</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>0.0</b>	<b>100.0</b>	<b>98.6</b>	<b>100.0</b>	<b>98.8</b>	<b>100.0</b>	<b>98.7</b>	<b>98.7</b>	<b>99.0</b>	<b>96.4</b>	<b>100.0</b>	<b>0.0</b>	<b>96.6</b>	<b>100.0</b>	<b>97.3</b>	<b>98.2</b>	<b>0.0</b>	<b>0.0</b>	<b>97.4</b>	<b>97.2</b>							
<b>Heavy Trucks</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>5</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>6</b>	<b>1</b>	<b>67</b>	<b>0</b>	<b>0</b>	<b>68</b>	<b>0</b>	<b>49</b>	<b>7</b>	<b>0</b>	<b>0</b>	<b>56</b>	<b>130</b>							
<b>% Heavy Trucks</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>1.4</b>	<b>0.0</b>	<b>1.2</b>	<b>0.0</b>	<b>1.3</b>	<b>1.0</b>	<b>3.6</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>3.4</b>	<b>0.0</b>	<b>2.7</b>	<b>1.8</b>	<b>0.0</b>	<b>0.0</b>	<b>2.6</b>	<b>2.8</b>							

**PEAK HOURS**

**AM**

Start Time	Cornerstone Dr/Sentinel Builders Dwy Northbound				Cornerstone Dr/Sentinel Builders Dwy Southbound				Murdock Dr Eastbound				Murdock Dr Westbound						
	Left	Thru	Rgt	Uturn	Left	Thru	Rgt	Uturn	Left	Thru	Rgt	Uturn	Left	Thru	Rgt	Uturn	App. Total	Int. Total	
Peak Hour Analysis from 07:00 AM to 09:00 AM																			
Peak Hour for Entire Intersection Begins at 07:30 AM																			
7:30 AM	0	0	0	0	19	1	6	0	26	1	106	1	0	108	0	44	4	0	48
7:45 AM	0	0	0	0	21	1	8	0	30	3	129	0	0	132	1	62	8	0	71
8:00 AM	0	0	1	0	12	0	6	0	18	2	124	1	0	127	0	65	2	0	67
8:15 AM	0	0	0	0	15	0	4	0	19	2	73	1	0	76	2	38	9	0	49
Total Volume	0	0	1	0	67	2	24	0	93	8	432	3	0	443	3	209	23	0	235
% App. Total	0.0	0.0	100.0	0.0	72.0	2.2	25.8	0.0	100.0	1.8	97.5	0.7	0.0	100.0	1.3	88.9	9.8	0.0	100.0
PHF	0.775																		
Cars, P.U. Vans	0	0	1	0	66	2	24	0	92	7	422	3	0	432	3	203	23	0	229
% Cars, P.U. Vans	0.0	0.0	100.0	0.0	98.5	100.0	100.0	0.0	98.9	87.5	97.7	100.0	0.0	97.5	100.0	97.1	100.0	0.0	97.4
Heavy Trucks	0	0	0	0	1	0	0	0	1	1	10	0	0	11	0	6	0	0	6
% Heavy Trucks	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	1.1	12.5	2.3	0.0	0.0	2.5	0.0	2.9	0.0	0.0	2.6

**NOON**

Start Time	Cornerstone Dr/Sentinel Builders Dwy Northbound				Cornerstone Dr/Sentinel Builders Dwy Southbound				Murdock Dr Eastbound				Murdock Dr Westbound						
	Left	Thru	Rgt	Uturn	Left	Thru	Rgt	Uturn	Left	Thru	Rgt	Uturn	Left	Thru	Rgt	Uturn	App. Total	Int. Total	
Peak Hour Analysis from 11:00 AM to 01:00 PM																			
Peak Hour for Entire Intersection Begins at 12:00 PM																			
12:00 PM	0	0	0	0	13	0	1	0	14	1	47	0	0	48	2	50	19	0	71
12:15 PM	2	0	0	0	14	0	2	0	16	2	38	0	0	40	1	46	5	0	52
12:30 PM	0	0	0	0	11	0	1	0	12	4	52	1	0	57	2	53	8	0	63
12:45 PM	0	0	1	0	20	0	3	0	23	2	64	2	0	68	0	44	12	0	56
Total Volume	2	0	1	0	58	0	7	0	65	9	201	3	0	213	5	193	44	0	242
% App. Total	66.7	0.0	33.3	0.0	89.2	0.0	10.8	0.0	100.0	4.2	94.4	1.4	0.0	100.0	2.1	79.8	18.2	0.0	100.0
PHF	0.375																		
Cars, P.U. Vans	2	0	1	0	57	0	6	0	63	9	192	3	0	204	5	186	43	0	234
% Cars, P.U. Vans	100.0	0.0	100.0	0.0	98.3	0.0	85.7	0.0	96.9	100.0	95.5	100.0	0.0	95.8	100.0	96.4	97.7	0.0	96.7
Heavy Trucks	0	0	0	0	1	0	1	0	2	0	9	0	0	9	0	7	1	0	8
% Heavy Trucks	0.0	0.0	0.0	0.0	1.7	0.0	14.3	0.0	3.1	0.0	4.5	0.0	0.0	4.2	0.0	3.6	2.3	0.0	3.3

**PM**

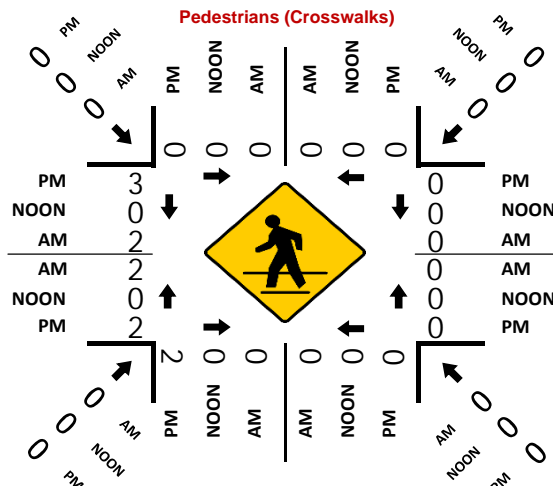
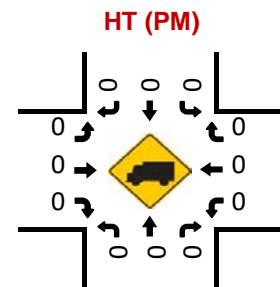
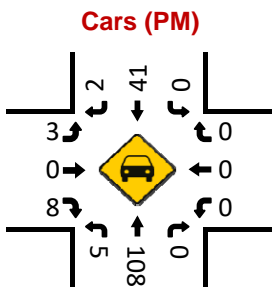
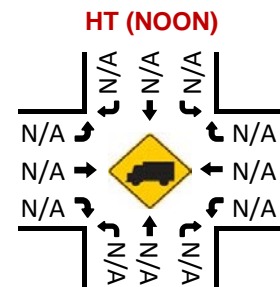
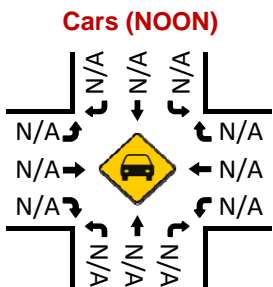
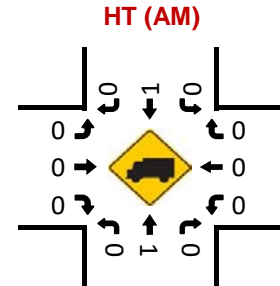
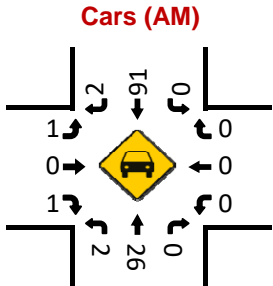
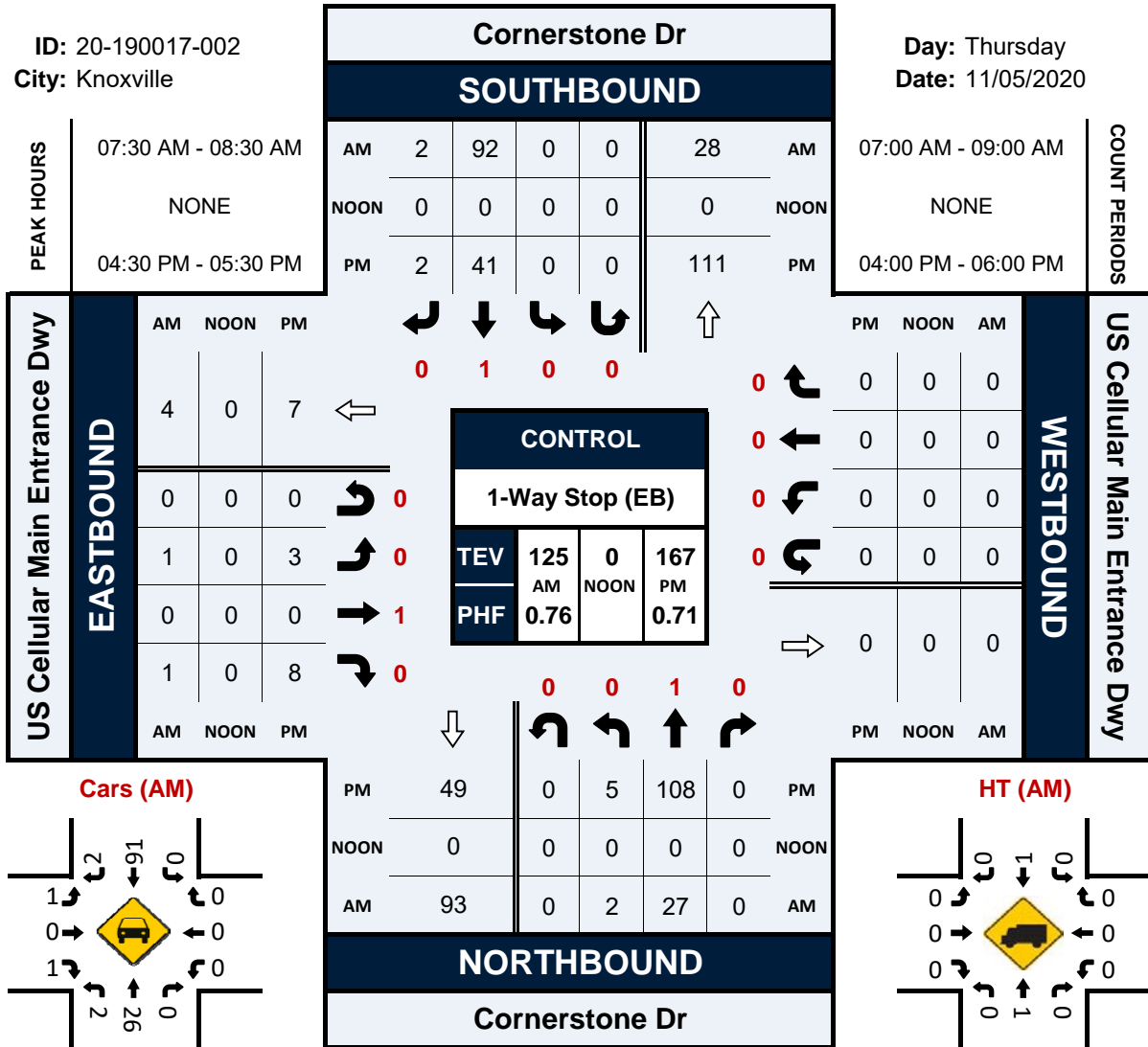
Start Time	Cornerstone Dr/Sentinel Builders Dwy Northbound				Cornerstone Dr/Sentinel Builders Dwy Southbound				Murdock Dr Eastbound				Murdock Dr Westbound						
	Left	Thru	Rgt	Uturn	Left	Thru	Rgt	Uturn	Left	Thru	Rgt	Uturn	Left	Thru	Rgt	Uturn	App. Total	Int. Total	
Peak Hour Analysis from 02:00 PM to 06:00 PM																			
Peak Hour for Entire Intersection Begins at 04:30 PM																			
4:30 PM	1	0	1	0	2	11	0	0	11	5	61	0	0	66	0	65	17	0	82
4:45 PM	3	0	5	0	8	5	0	0	5	6	64	0	0	70	0	60	19	0	79
5:00 PM	2	0	1	0	3	14	0	3	17	17	86	0	0	103	0	86	23	0	109
5:15 PM	0	2	3	0	5	13	0	3	16	2	54	0	0	56	0	76	21	0	97
Total Volume	6	2	10	0	18	43	0	6	49	30	265	0	0	295	0	287	80	0	367
% App. Total	33.3	11.1	55.6	0.0	100.0	87.8	0.0	12.2	100.0	10.2	89.8	0.0	0.0	100.0	0.0	78.2	21.8	0.0	100.0
PHF	0.563																		
Cars, P.U. Vans	6	2	10	0	18	43	0	6	49	30	257	0	0	287	0	284	80	0	364
% Cars, P.U. Vans	100.0	100.0	100.0	0.0	100.0	100.0	0.0	100.0	100.0	100.0	97.0	0.0	0.0	97.3	0.0	99.0	100.0	0.0	99.2
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	8	0	0	8	0	3	0	0	3
% Heavy Trucks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	2.7	0.0	1.0	0.0	0.0	0.8

# Cornerstone Dr & US Cellular Main Entrance Dwy

## Peak Hour Turning Movement Count

ID: 20-190017-002  
City: Knoxville

Day: Thursday  
Date: 11/05/2020



Project ID: 20-190017-002  
 Location: Cornerstone Dr & US Cellular Main Entrance Dwy  
 City: Knoxville  
 Day: Thursday  
 Date: 11/05/2020

Start Time	Cornerstone Dr										Groups Printed - Cars, PU, Vans - Heavy Trucks										US Cellular Main Entrance Dwy									
	Northbound					Southbound					Eastbound					Westbound					US Cellular Main Entrance Dwy									
	Left	Thru	Rgt	Uturn	Peds	App. Total	Left	Thru	Rgt	Uturn	Peds	App. Total	Left	Thru	Rgt	Uturn	Peds	App. Total	Left	Thru	Rgt	Uturn	Peds	App. Total	Int. Total					
7:00 AM	0	5	0	0	0	5	0	6	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	12				
7:15 AM	0	4	0	0	0	4	0	12	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	17				
7:30 AM	0	5	0	0	0	5	0	25	1	0	0	26	0	0	1	0	0	0	0	0	0	0	0	0	0	32				
7:45 AM	1	10	0	0	0	11	0	30	0	0	0	30	0	0	0	0	2	0	0	0	0	0	0	0	0	41				
Total	1	24	0	0	0	25	0	73	1	0	0	74	0	0	3	0	2	0	0	0	0	0	0	0	0	102				
8:00 AM	1	2	0	0	0	3	0	18	0	0	0	18	1	0	0	0	2	1	0	0	0	0	0	0	0	22				
8:15 AM	0	10	0	0	0	10	0	19	1	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	30				
8:30 AM	2	7	0	0	0	9	0	18	4	0	0	22	0	0	1	0	1	1	0	0	0	0	0	0	0	32				
8:45 AM	1	13	0	0	0	14	0	16	4	0	0	20	0	0	1	0	0	0	0	0	0	0	0	0	0	35				
Total	4	32	0	0	0	36	0	71	9	0	0	80	1	0	2	0	3	3	0	0	0	0	0	0	0	119				
***BREAK***																														
4:00 PM	0	28	0	0	0	28	0	10	0	0	0	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	39			
4:15 PM	0	21	0	0	0	21	0	11	0	0	0	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	33			
4:30 PM	0	23	0	0	0	23	0	9	1	0	0	10	2	0	1	0	3	3	0	0	0	0	0	0	0	0	36			
4:45 PM	3	22	0	0	0	25	0	5	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30			
Total	3	94	0	0	0	97	0	35	1	0	0	36	3	0	2	0	4	5	0	0	0	0	0	0	0	0	138			
5:00 PM	2	38	0	0	0	40	0	14	0	0	0	14	0	0	5	0	1	5	0	0	0	0	0	0	0	0	59			
5:15 PM	0	25	0	0	0	25	0	13	1	0	0	14	1	0	2	0	1	3	0	0	0	0	0	0	0	0	42			
5:30 PM	1	19	0	0	0	20	0	6	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26			
5:45 PM	1	16	0	0	0	17	0	2	1	0	0	3	2	0	2	0	3	4	0	0	0	0	0	0	0	0	24			
Total	4	98	0	0	0	102	0	35	2	0	0	37	3	0	9	0	5	12	0	0	0	0	0	0	0	0	151			
Grand Total	12	248	0	0	0	260	0	214	13	0	0	227	7	0	16	0	14	23	0	0	0	0	0	0	0	0	510			
Approach %	4.6	95.4	0.0	0.0	0.8	51.0	0.0	94.3	5.7	0.0	0.0	60.9	30.4	0.0	69.6	0.0	60.9	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Total %	2.4	48.6	0.0	0.0	0.4	51.0	0.0	42.0	2.5	0.0	0.0	44.5	1.4	0.0	3.1	0.0	2.7	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Cars, PU, Vans	12	245	0	0	0	257	0	213	13	0	0	226	6	0	16	0	16	22	0	0	0	0	0	0	0	0	505			
% Cars, PU, Vans	100.0	98.8	0.0	0.0	0.0	99.6	0.0	99.5	100.0	0.0	0.0	99.6	85.7	0.0	100.0	0.0	95.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.0				
Heavy Trucks	0	3	0	0	0	3	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	5				
% Heavy Trucks	0.0	1.2	0.0	0.0	0.0	1.2	0.0	0.5	0.0	0.0	0.0	0.4	14.3	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0				

Project ID: 20-190017-002  
 Location: Cornerstone Dr & US Cellular Main Entrance Dwy  
 City: Knoxville

Day: Thursday  
 Date: 11/05/2020

### PEAK HOURS

AM

Start Time	Cornerstone Dr Northbound			Cornerstone Dr Southbound			US Cellular Main Entrance Dwy Eastbound			US Cellular Main Entrance Dwy Westbound			Int. Total		
	Left	Thru	Rgt.	Left	Thru	Rgt.	Left	Thru	Rgt.	Left	Thru	Rgt.			
Peak Hour Analysis from 07:00 AM to 09:00 AM															
Peak Hour for Entire Intersection Begins at 07:30 AM															
7:30 AM	0	5	0	0	25	1	0	26	0	0	1	0	0	0	32
7:45 AM	1	10	0	0	30	0	0	30	0	0	0	0	0	0	41
8:00 AM	1	2	0	0	18	0	0	18	1	0	0	0	0	0	22
8:15 AM	0	10	0	0	19	1	0	20	0	0	0	0	0	0	30
Total Volume	2	27	0	29	92	2	94	100	1	0	1	0	2	0	125
% App. Total	6.9	93.1	0.0	100.0	97.9	2.1	100.0	100.0	50.0	0.0	100.0	0.0	0.0	0.0	0.0
PHF	0.783													0.762	
Cars, P.U. Vans	2	26	0	28	91	2	93	1	0	1	0	0	0	0	124
% Cars, P.U. Vans	100.0	96.3	0.0	96.6	98.9	100.0	98.9	100.0	0.0	100.0	0.0	100.0	0.0	0.0	98.4
Heavy Trucks	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2
% Heavy Trucks	0.0	3.7	0.0	3.4	0.0	1.1	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.6

PM

Start Time	Cornerstone Dr Northbound			Cornerstone Dr Southbound			US Cellular Main Entrance Dwy Eastbound			US Cellular Main Entrance Dwy Westbound			Int. Total		
	Left	Thru	Rgt.	Left	Thru	Rgt.	Left	Thru	Rgt.	Left	Thru	Rgt.			
Peak Hour Analysis from 04:00 PM to 06:00 PM															
Peak Hour for Entire Intersection Begins at 04:30 PM															
4:30 PM	0	23	0	0	9	1	0	10	2	0	1	0	0	0	36
4:45 PM	3	22	0	0	5	0	0	5	0	0	0	0	0	0	30
5:00 PM	2	38	0	0	14	0	0	14	0	0	5	0	0	0	59
5:15 PM	0	25	0	0	13	1	0	14	1	0	2	0	0	0	42
Total Volume	5	108	0	113	41	2	43	43	3	0	8	0	11	0	167
% App. Total	4.4	95.6	0.0	100.0	95.3	4.7	100.0	100.0	27.3	0.0	72.7	0.0	100.0	0.0	0.0
PHF	0.706													0.550	
Cars, P.U. Vans	5	108	0	113	41	2	43	3	0	8	0	11	0	0	167
% Cars, P.U. Vans	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Heavy Trucks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

**APPENDIX B – TRIP GENERATION INFORMATION**

**KNOX COUNTY**  
**LOCAL APARTMENT TRIP GENERATION STUDY**

**PURPOSE**

A Traffic Impact Study (TIS) is currently required in Knox County when a proposed development is projected to generate in excess of 750 trips per day. The determinations of when the threshold is met as well as all subsequent analyses in the TIS are performed using the rates and equations given in the Institute of Transportation Engineers (ITE) Trip Generation Manual. Local governmental agencies rely heavily on the accuracy of these trip generation rates in order to correctly predict the impacts of a proposed development on the transportation system. Therefore, in certain instances, it is logical to verify whether the "national" rates and equations given in the ITE Trip Generation Manual are appropriate for use in a specific local area or region.

The decision was made to study the local trip-making characteristics of apartments because of the discrepancy between the trip generation rates for apartments and single family residential land uses as given in the ITE Trip Generation Manual. While these two land uses are similar in nature, the Trip Generation Manual predicts about three less trips per dwelling unit generated by apartments for the average weekday. Additionally the Trip Generation Manual points out that due to the age of their database, which dates back to the 1960's, "the rates for apartments probably had changed over time". It is also assumed that some of the ITE data had come from larger metropolitan areas with denser development and greater transit use than Knox County, which would contribute to lower trip generation rates. Therefore, this study will be used to either verify the rates given in the Trip Generation Manual or generate new ones that can be applied to locally proposed apartment developments.

**PROCEDURE**

The procedures recommended by ITE in conducting local trip generation studies were generally followed for this study, along with some important assumptions that have made. ITE has published a proposed recommended practice entitled "Trip Generation Handbook" which specifically outlines procedures for conducting local trip generation studies and establishing new rates and equations.

The first step in the study was to define the number and location of the sites to be studied, as well as the counting methodology. Initially 14 sites were selected, although one apartment complex – the College Park Apartments – was later omitted due to uncharacteristically high traffic generation numbers. The number of sites used in this study far exceeds the recommended minimum amount suggested by ITE, which is five sites. Traffic counts were taken for week-long periods at 15-minute intervals between July 22, 1996 and August 9, 1996 at the access points to the apartment complexes. A Technical Appendix to this report contains the traffic count data collected at each apartment complex.

## RESULTS

The traffic count data was analyzed using spreadsheets in order to determine the weighted average rates and regression equations. In order to be considered valid, the local rates and equations for each time period of analysis that were generated must meet certain statistical criteria. First, the standard deviation of the independent variable (dwelling units) should be no more than 110 percent of the weighted average rate; and secondly, the regression equations require a computed coefficient of determination ( $R^2$ ) value of at least 0.75 before good data fit is indicated. This statistical criteria is met by the local data results, and in fact it often exceeds the level of data fit given by their counterparts in the ITE Trip Generation Manual. Finally, in order to simplify the use of the local data, plots were generated that appear identical to the actual ones in the ITE Trip Generation Manual.

The resulting rates and equations calculated from the local data indicate that the average weekday trip generation of apartments in this area is well above the national rates reported in the ITE manual. For example, the locally computed average rate for number of trips generated during a weekday is 35% higher than the rate given by ITE (increase from 6.63 trips per dwelling unit to 9.03 trips per dwelling unit). The trip generation rates do not increase as much for the AM and PM peak hours however. The local rate is roughly 8% higher for the AM peak, and 16% higher for the PM peak. The plots from the ITE Trip Generation Manual are included in the Technical Appendix for comparison purposes.

## ASSUMPTIONS MADE

Some important assumptions have been made which may affect the results of the local data that was collected:

- It is important to note that the local trip generation rates were computed for the *total* number of dwelling units in the apartment complex, and not necessarily for the number of *occupied* dwelling units. There are several reasons why this was done, chiefly because of the need for comparability with the rates given in ITE Trip Generation Manual, as it does not specify whether the dwelling units are occupied. According to ITE procedures the selected sites must only be of "reasonably full occupancy (i.e. at least 85%)". The Apartment Association of Greater Knoxville (AAGK) publishes quarterly reports on occupancy levels of apartment complexes, and the report covering the period of the data collection was reviewed to determine occupancy levels. According to the AAGK report from July 1, 1996 – September 30, 1996 all of the apartment complexes surveyed in this study met the minimum 85% occupancy level, with an average occupancy rate for all sites studied of 94%.
- The count data that was collected at each apartment complex was used "raw" meaning that it was not factored for possible daily or seasonal variations. Once again, according to an ITE representative it is not known whether the data used in the Trip Generation Manual was factored or not, so therefore in order to be able to compare



local rates to those in the manual you must assume that count data should not be factored. Additionally, it was felt that apartment complexes would generally not be as susceptible to major seasonal fluctuations as other land uses might be. The local rates were also developed using count data that was collected and averaged over an entire week, which should limit some of the daily variations. Finally, reliable local daily and seasonal variation factors do not truly exist.

## CONCLUSION

The local apartment study methodology and results were distributed for comment to a group of local transportation professionals who are directly responsible for either preparing or reviewing traffic impact studies. A meeting was held between this group on February 16, 2000 in order to gather comments and discuss the study in greater detail. The following conclusions are based on the discussion and consensus reached at this meeting:

1. The trip generation rates and equations meet statistical requirements and resulted from a study that followed accepted procedures; therefore they should be adopted for future use. Furthermore, the rates and equations are recommended for use in reviewing the traffic impact of any development termed as "multi-family", such as townhouse and condominium developments due to their similarity to apartment complexes.
2. The Traffic Access and Impact Study Guidelines and Procedures adopted by MPC should be amended with the language that local data should be used when available, which will allow the implementation of these new multi-family trip generation rates.
3. The following suggestions were made for future consideration:
  - This study should be updated with data collected from local townhouse and condominium developments in order to further justify the use of the new trip generation rates.
  - A statistical comparison should be made between any newly developed rates and the ITE single family trip generation rates to determine if there is a significant difference. If there is no difference then perhaps ITE single-family rates could be used for any residential development proposed in Knox County.

# Local Apartment Trip Generation Study

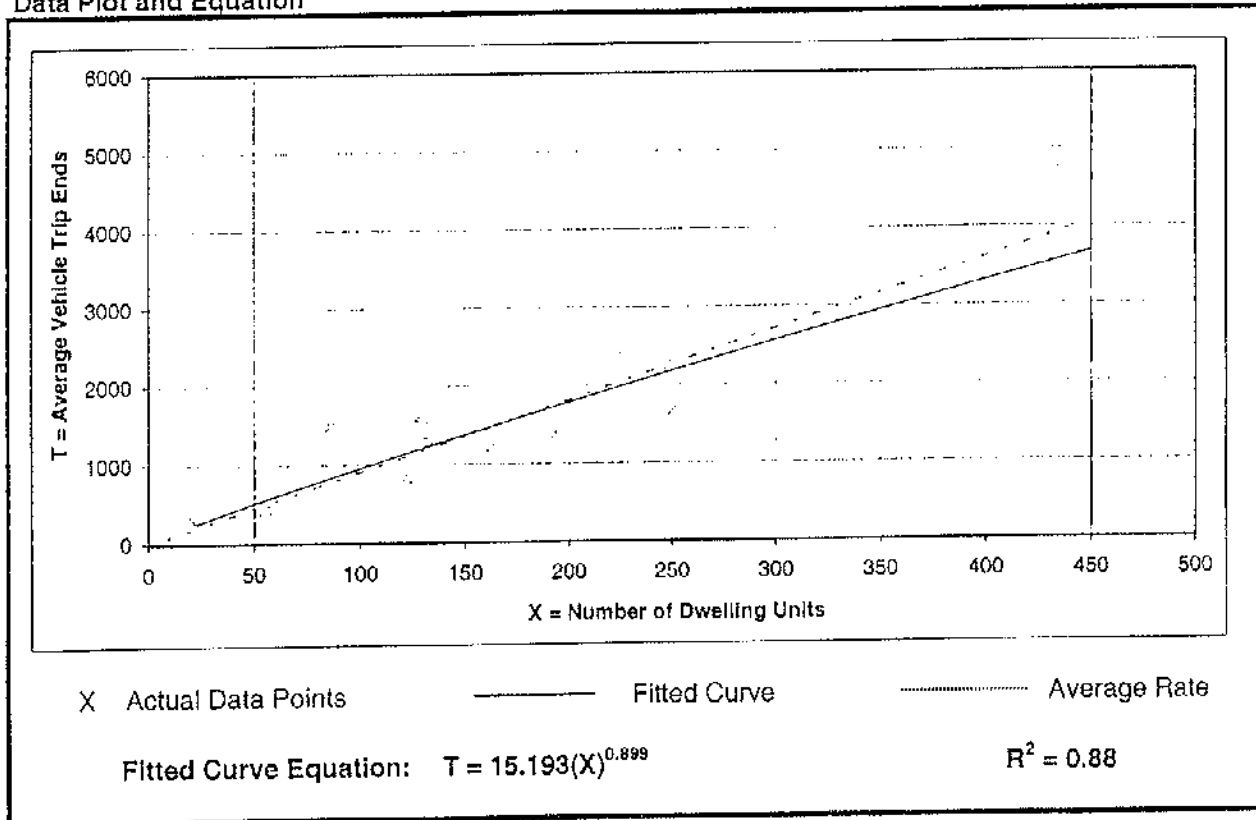
Average Vehicle Trip Ends vs: Dwelling Units  
On a: Weekday

Number of Studies: 13  
Average Number of Dwelling Units: 193  
Directional Distribution: 50% entering, 50% exiting

## Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
9.03	6.59 - 17.41	2.47

## Data Plot and Equation



# Local Apartment Trip Generation Study

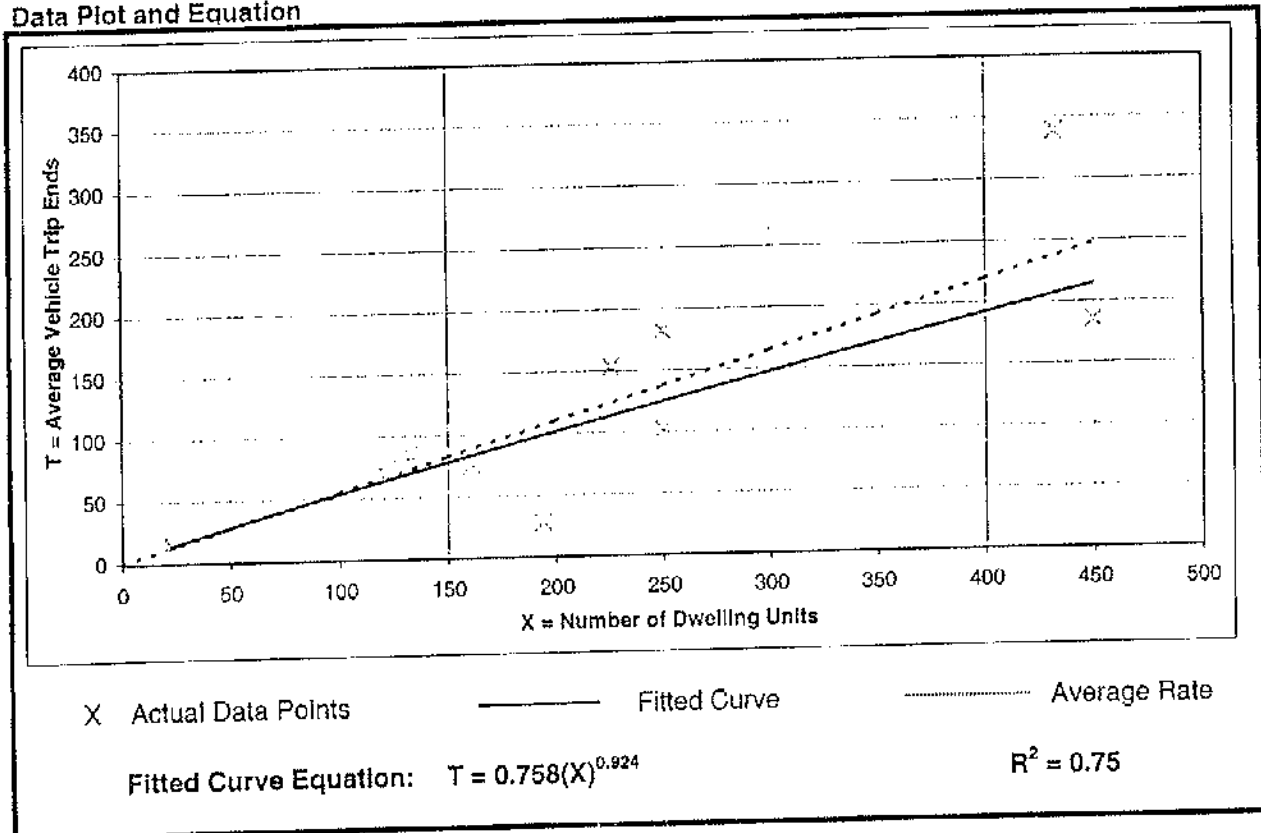
Average Vehicle Trip Ends vs: Dwelling Units  
 On a: Weekday,  
 Peak Hour of Adjacent Street Traffic,  
 One Hour Between 7 and 9 a.m.

Number of Studies: 13  
 Average Number of Dwelling Units: 193  
 Directional Distribution: 22% entering, 78% exiting

## Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
0.55	0.14 - 0.78	0.18

## Data Plot and Equation



# Local Apartment Trip Generation Study

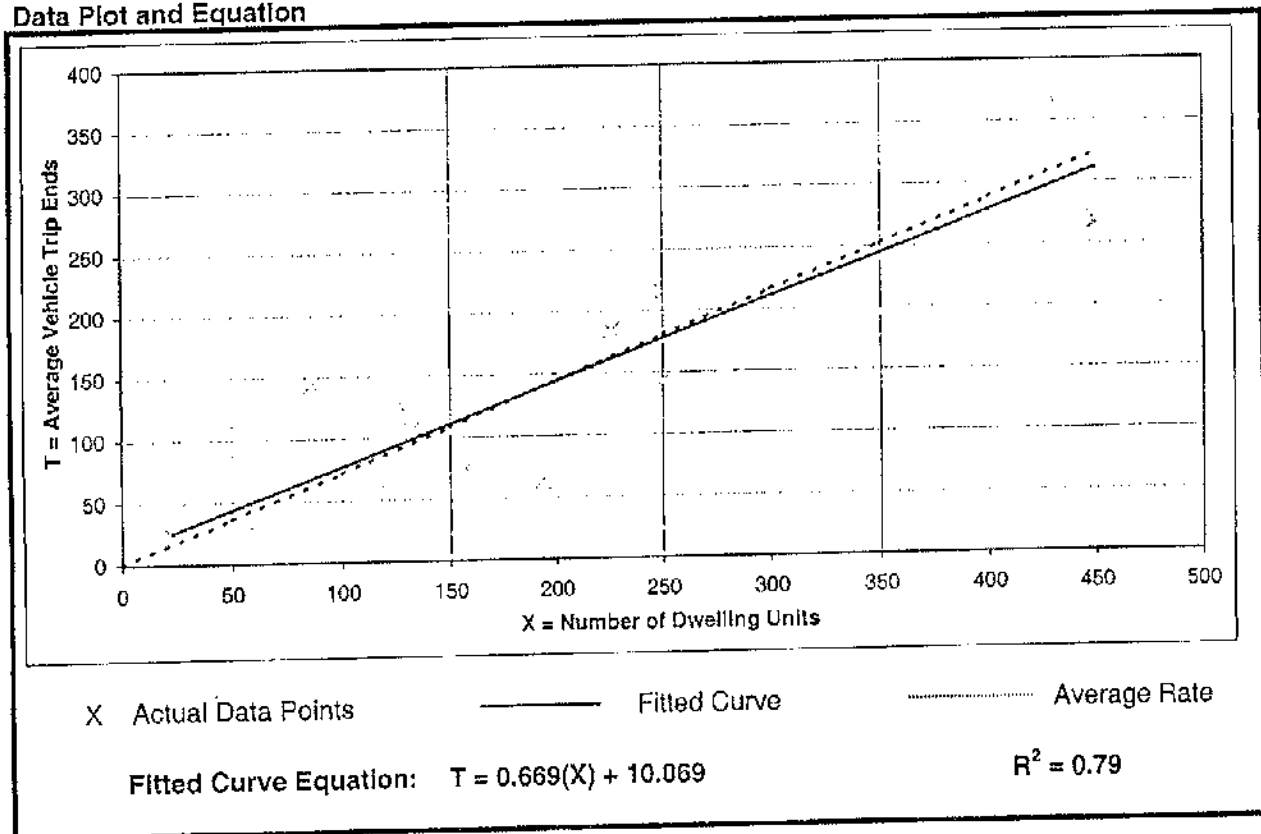
Average Vehicle Trip Ends vs: Dwelling Units  
 On a: Weekday,  
 Peak Hour of Adjacent Street Traffic,  
 One Hour Between 4 and 6 p.m.

Number of Studies: 13  
 Average Number of Dwelling Units: 193  
 Directional Distribution: 55% entering, 45% exiting

## Trip Generation Per Dwelling Unit

Average Rate	Ranges of Rates	Standard Deviation
0.72	0.32 - 1.66	0.25

## Data Plot and Equation



**APPENDIX C – CAPACITY ANALYSES**

## CAPACITY AND LEVEL-OF-SERVICE CONCEPTS

In a general sense, a roadway is similar to a pipeline or other material carrying conduit in that it has a certain capacity for the amount of material (vehicles) that it can efficiently carry. As the number of vehicles in a given time period gradually increases, the quality of traffic flow gradually decreases. On roadway sections this results in increasing turbulence in the traffic stream, and at intersections it results in increasing stops and delay. As the volumes begin to approach the capacity of the facility, these problems rapidly magnify, with resulting serious levels of congestion, stops, delay, excess fuel consumption, pollutant emissions, etc.

The Transportation Research Board has published the Year 2010 Highway Capacity Manual (HCM2010), which establishes theoretical techniques to quantify the capacity conditions on all types of roadways, intersections, ramps, pedestrian facilities, etc. A basic concept that is applicable to most of these techniques is the idea of level of service (LOS). This concept establishes a rating system that quantifies the quality of traffic flow, as perceived by motorists and/or passengers. The general system is similar to a school grade scale, and is outlined as follows:

Level of Service (LOS)	General Quality of Traffic Flow	Description of Corresponding Conditions
A	Excellent	Roadways – Free flow, high maneuverability Intersections – Very few stops, very low delay
B	Very Good	Roadways – Free flow, slightly lower maneuverability Intersections – Minor stops, low delay
C	Good	Roadways – Stable flow, restricted maneuverability Intersections – Significant stops, significant delay
D	Fair	Roadways – Marginally stable flow, congestion seriously restricts maneuverability Intersections – High stops, long but tolerable delay
E	Poor	Roadways – Unstable flow*, lower operating speeds, congestion severely restricts maneuverability Intersections – All vehicles stop, very long queues and very long intolerable delay
F	Very Poor	Roadways – Forced flow, stoppages may be lengthy, congestion severely restricts maneuverability Intersections – All vehicles stop, extensive queues and extremely long intolerable delay

\*Unstable flow is such that minor fluctuations or disruptions can result in rapid degradation to LOS F.

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**LOS CRITERIA: SIGNALIZED & UNSIGNALIZED INTERSECTIONS**

LOS	CONTROL DELAY (S/VEH)		
	SIGNALIZED	UNSIGNALIZED	ROUNDAABOUT
A	≤10	≤10	≤10
B	>10-20	>10-15	>10-15
C	>20-35	>15-25	>15-25
D	>35-55	>25-35	>25-35
E	>55-80	>35-50	>35-50
F	>80	>50	>50

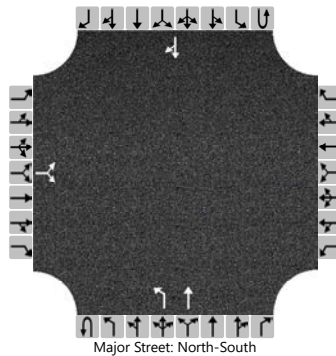
Another measure of intersection capacity that is often used in the evaluation of intersection operations is the volume to capacity (V/C) ratio. This ratio is defined as “the ratio of flow rate to capacity”, and is a good measure of how much of an intersection’s available capacity has been used up by the analysis volumes. Conversely, it also provides an indication of the reserve capacity available for future growth in traffic volumes.

The Intersection Capacity Utilization (ICU) is another measure that expresses a value similar to the V/C ratio. Specifically, the ICU method “sums the amount of the time required to serve all movements at saturation for a given cycle length and divides by that reference cycle length.” The ICU is considered a more accurate measure of volume to capacity conditions for a signalized intersection, primarily because it accounts for the effects of the signal timing on intersection capacity.

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Cornerstone at Access		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Site Access		
Analysis Year	2020			North/South Street	Cornerstone Drive		
Time Analyzed	AM Peak			Peak Hour Factor	0.76		
Intersection Orientation	North-South			Analysis Time Period (hrs)	0.25		
Project Description	2020 Existing						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	0
Configuration			LR							L	T					TR
Volume (veh/h)		1		1						2	34				110	2
Percent Heavy Vehicles (%)		3		3						3						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized																
Median Type   Storage		Left Only											1			

## Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.43		6.23						4.13						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.53		3.33						2.23						

## Delay, Queue Length, and Level of Service

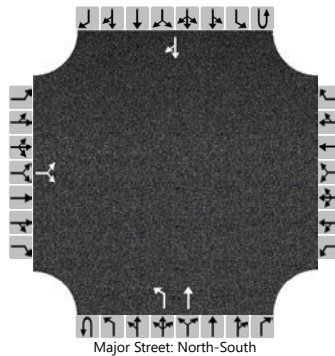
Flow Rate, v (veh/h)			3							3						
Capacity, c (veh/h)			832							1428						
v/c Ratio			0.00							0.00						
95% Queue Length, Q <sub>95</sub> (veh)			0.0							0.0						
Control Delay (s/veh)			9.3							7.5						
Level of Service (LOS)			A							A						
Approach Delay (s/veh)		9.3								0.4						
Approach LOS		A														



# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Cornerstone at Access		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Site Access		
Analysis Year	2020			North/South Street	Cornerstone Drive		
Time Analyzed	PM Peak			Peak Hour Factor	0.71		
Intersection Orientation	North-South			Analysis Time Period (hrs)	0.25		
Project Description	2020 Existing						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	0
Configuration			LR							L	T					TR
Volume (veh/h)		4		10						6	128				49	2
Percent Heavy Vehicles (%)		3		3						3						
Proportion Time Blocked																
Percent Grade (%)	0															
Right Turn Channelized																
Median Type   Storage	Left Only								1							

## Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.43		6.23						4.13						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.53		3.33						2.23						

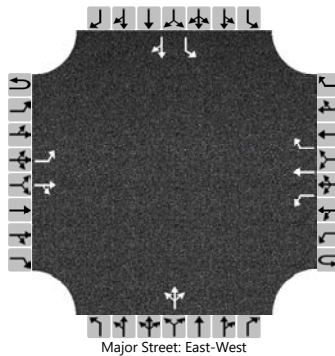
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			20							8						
Capacity, c (veh/h)			895							1522						
v/c Ratio			0.02							0.01						
95% Queue Length, Q <sub>95</sub> (veh)			0.1							0.0						
Control Delay (s/veh)			9.1							7.4						
Level of Service (LOS)			A							A						
Approach Delay (s/veh)	9.1								0.3							
Approach LOS	A															

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Murdock at Cornerstone		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Murdock Drive		
Analysis Year	2020			North/South Street	Cornerstone Drive		
Time Analyzed	AM Peak			Peak Hour Factor	0.83		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2020 Existing						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6	7	8	9		10	11	12	
Priority																
Number of Lanes	0	1	1	0	0	1	1	1	0	1	0		1	1	0	
Configuration		L		TR		L	T	R		LTR				L		TR
Volume (veh/h)		10	518	4		4	251	26		0	0	1		80	2	29
Percent Heavy Vehicles (%)		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized					No											
Median Type   Storage					Left Only								1			

## Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.13				4.13				7.13	6.53	6.23		7.13	6.53	6.23
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.23				2.23				3.53	4.03	3.33		3.53	4.03	3.33

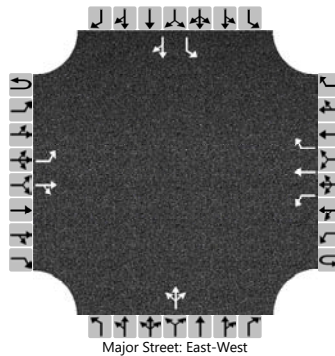
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		12				5				1				96		37
Capacity, c (veh/h)		1220				948				482				344		653
v/c Ratio		0.01				0.01				0.00				0.28		0.06
95% Queue Length, Q <sub>95</sub> (veh)		0.0				0.0				0.0				1.1		0.2
Control Delay (s/veh)		8.0				8.8				12.5				19.5		10.8
Level of Service (LOS)		A				A				B				C		B
Approach Delay (s/veh)	0.2				0.1				12.5				17.1			
Approach LOS									B				C			

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Murdock at Cornerstone		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Murdock Drive		
Analysis Year	2020			North/South Street	Cornerstone Drive		
Time Analyzed	PM Peak			Peak Hour Factor	0.79		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2020 Existing						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	1	0	0	1	1	1		0	1	0		1	1	0
Configuration		L		TR		L	T	R			LTR			L		TR
Volume (veh/h)		36	318	0		0	344	96		7	2	12		52	0	7
Percent Heavy Vehicles (%)		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized					No											
Median Type   Storage	Left Only								1							

## Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.13				4.13				7.13	6.53	6.23		7.13	6.53	6.23
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.23				2.23				3.53	4.03	3.33		3.53	4.03	3.33

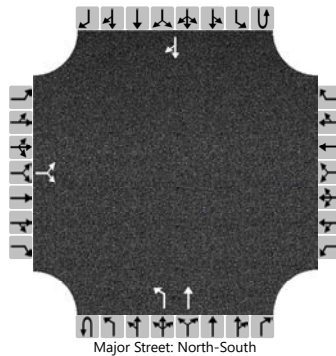
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		46				0				27				66		9
Capacity, c (veh/h)		1009				1151				428				353		619
v/c Ratio		0.05				0.00				0.06				0.19		0.01
95% Queue Length, Q <sub>95</sub> (veh)		0.1				0.0				0.2				0.7		0.0
Control Delay (s/veh)		8.7				8.1				14.0				17.5		10.9
Level of Service (LOS)		A				A				B				C		B
Approach Delay (s/veh)	0.9				0.0				14.0				16.7			
Approach LOS									B				C			

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Cornerstone at Access		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Site Access		
Analysis Year	2022			North/South Street	Cornerstone Drive		
Time Analyzed	AM Peak			Peak Hour Factor	0.76		
Intersection Orientation	North-South			Analysis Time Period (hrs)	0.25		
Project Description	2022 Background						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	0
Configuration			LR							L	T					TR
Volume (veh/h)		1		1						2	35				114	2
Percent Heavy Vehicles (%)		3		3						3						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized																
Median Type   Storage		Left Only								1						

## Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.43		6.23						4.13						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.53		3.33						2.23						

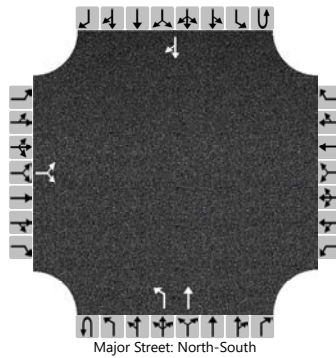
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			3							3						
Capacity, c (veh/h)			827							1422						
v/c Ratio			0.00							0.00						
95% Queue Length, Q <sub>95</sub> (veh)			0.0							0.0						
Control Delay (s/veh)			9.4							7.5						
Level of Service (LOS)			A							A						
Approach Delay (s/veh)		9.4								0.4						
Approach LOS		A														

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Cornerstone at Access		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Site Access		
Analysis Year	2022			North/South Street	Cornerstone Drive		
Time Analyzed	PM Peak			Peak Hour Factor	0.71		
Intersection Orientation	North-South			Analysis Time Period (hrs)	0.25		
Project Description	2022 Background						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	0	1	0
Configuration			LR							L	T					TR
Volume (veh/h)		4		10						6	133				51	2
Percent Heavy Vehicles (%)		3		3						3						
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized																
Median Type   Storage					Left Only								1			

## Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.43		6.23						4.13						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.53		3.33						2.23						

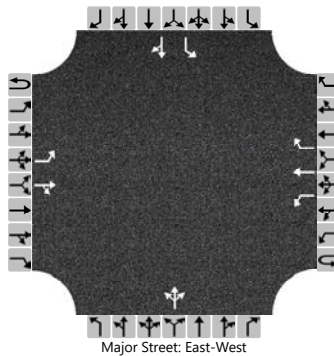
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			20							8						
Capacity, c (veh/h)			890							1518						
v/c Ratio			0.02							0.01						
95% Queue Length, Q <sub>95</sub> (veh)			0.1							0.0						
Control Delay (s/veh)			9.1							7.4						
Level of Service (LOS)			A							A						
Approach Delay (s/veh)		9.1								0.3						
Approach LOS		A														

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Murdock at Cornerstone		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Murdock Drive		
Analysis Year	2022			North/South Street	Cornerstone Drive		
Time Analyzed	AM Peak			Peak Hour Factor	0.83		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2022 Background						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	1	0	0	1	1	1		0	1	0		1	1	0
Configuration		L		TR		L	T	R			LTR			L		TR
Volume (veh/h)		10	539	4		4	261	27		0	0	1		83	2	30
Percent Heavy Vehicles (%)		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized					No											
Median Type   Storage	Left Only								1							

## Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.13				4.13				7.13	6.53	6.23		7.13	6.53	6.23
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.23				2.23				3.53	4.03	3.33		3.53	4.03	3.33

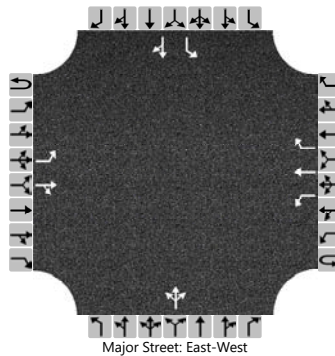
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		12				5					1			100		39
Capacity, c (veh/h)		1206				928					466			332		642
v/c Ratio		0.01				0.01					0.00			0.30		0.06
95% Queue Length, Q <sub>95</sub> (veh)		0.0				0.0					0.0			1.2		0.2
Control Delay (s/veh)		8.0				8.9					12.7			20.4		11.0
Level of Service (LOS)		A				A					B			C		B
Approach Delay (s/veh)	0.1				0.1				12.7				17.8			
Approach LOS									B				C			

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Murdock at Cornerstone		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Murdock Drive		
Analysis Year	2022			North/South Street	Cornerstone Drive		
Time Analyzed	PM Peak			Peak Hour Factor	0.79		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2022 Background						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	1	0	0	1	1	1		0	1	0		1	1	0
Configuration		L		TR		L	T	R			LTR			L		TR
Volume (veh/h)		37	331	0		0	358	100		7	2	12		54	0	7
Percent Heavy Vehicles (%)		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized					No											
Median Type   Storage	Left Only								1							

## Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.13				4.13				7.13	6.53	6.23		7.13	6.53	6.23
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.23				2.23				3.53	4.03	3.33		3.53	4.03	3.33

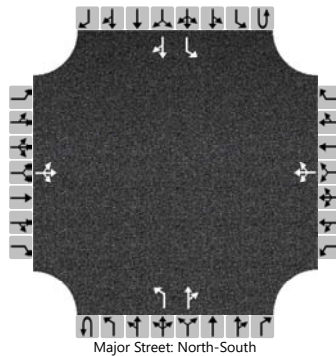
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		47				0					27				68		9	
Capacity, c (veh/h)		989				1135					413				341		605	
v/c Ratio		0.05				0.00					0.06				0.20		0.01	
95% Queue Length, Q <sub>95</sub> (veh)		0.1				0.0					0.2				0.7		0.0	
Control Delay (s/veh)		8.8				8.2					14.3				18.2		11.0	
Level of Service (LOS)		A				A					B				C		B	
Approach Delay (s/veh)		0.9				0.0					14.3				17.4			
Approach LOS											B				C			

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Cornerstone at Access		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Site Access		
Analysis Year	2022			North/South Street	Cornerstone Drive		
Time Analyzed	AM Peak			Peak Hour Factor	0.76		
Intersection Orientation	North-South			Analysis Time Period (hrs)	0.25		
Project Description	2022 Combined						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement																
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	1	0	0	1	1	0
Configuration			LTR				LTR			L		TR		L		TR
Volume (veh/h)		1	0	1		30	0	4		2	33	8		1	114	2
Percent Heavy Vehicles (%)		3	3	3		3	3	3		3				3		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized																
Median Type   Storage	Left Only								1							

## Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.13	6.53	6.23		7.13	6.53	6.23		4.13				4.13		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.53	4.03	3.33		3.53	4.03	3.33		2.23				2.23		

## Delay, Queue Length, and Level of Service

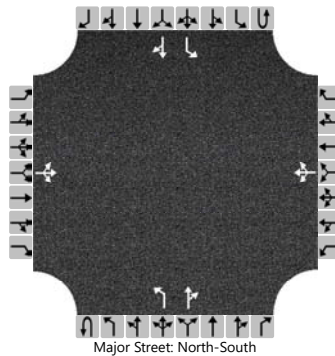
Flow Rate, v (veh/h)			3				45				3				1	
Capacity, c (veh/h)			808				764				1422				1545	
v/c Ratio			0.00				0.06				0.00				0.00	
95% Queue Length, Q <sub>95</sub> (veh)			0.0				0.2				0.0				0.0	
Control Delay (s/veh)			9.5				10.0				7.5				7.3	
Level of Service (LOS)			A				B				A				A	
Approach Delay (s/veh)	9.5				10.0				0.4				0.1			
Approach LOS	A				B											



# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Cornerstone at Access		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Site Access		
Analysis Year	2022			North/South Street	Cornerstone Drive		
Time Analyzed	PM Peak			Peak Hour Factor	0.71		
Intersection Orientation	North-South			Analysis Time Period (hrs)	0.25		
Project Description	2022 Combined						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	1	0	0	1	1	0
Configuration			LTR				LTR			L		TR		L		TR
Volume (veh/h)		4	0	10		25	0	4		6	135	30		4	51	2
Percent Heavy Vehicles (%)		3	3	3		3	3	3		3				3		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized																
Median Type   Storage	Left Only								1							

## Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.13	6.53	6.23		7.13	6.53	6.23		4.13				4.13		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.53	4.03	3.33		3.53	4.03	3.33		2.23				2.23		

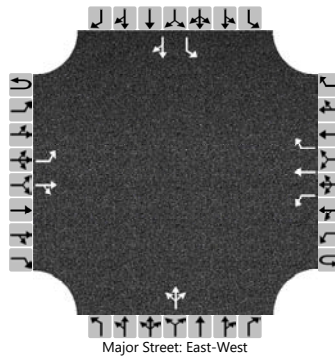
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			20				41							6		
Capacity, c (veh/h)			860				671							1329		
v/c Ratio			0.02				0.06							0.00		
95% Queue Length, Q <sub>95</sub> (veh)			0.1				0.2							0.0		
Control Delay (s/veh)			9.3				10.7							7.7		
Level of Service (LOS)			A				B							A		
Approach Delay (s/veh)	9.3				10.7				0.3				0.5			
Approach LOS	A				B											

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Murdock at Cornerstone		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Murdock Drive		
Analysis Year	2022			North/South Street	Cornerstone Drive		
Time Analyzed	AM Peak			Peak Hour Factor	0.83		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2022 Combined						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	1	0	0	1	1	1		0	1	0		1	1	0
Configuration		L		TR		L	T	R			LTR			L		TR
Volume (veh/h)		13	543	4		4	274	32		0	0	1		100	2	43
Percent Heavy Vehicles (%)		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized					No											
Median Type   Storage	Left Only								1							

## Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.13				4.13				7.13	6.53	6.23		7.13	6.53	6.23
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.23				2.23				3.53	4.03	3.33		3.53	4.03	3.33

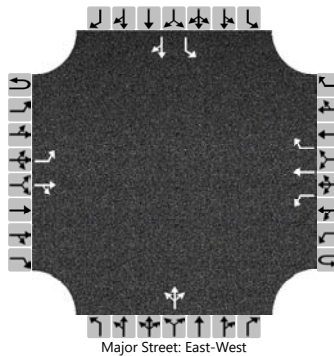
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		16				5					1			120		54		
Capacity, c (veh/h)		1184				924					463			324		648		
v/c Ratio		0.01				0.01					0.00			0.37		0.08		
95% Queue Length, Q <sub>95</sub> (veh)		0.0				0.0					0.0			1.7		0.3		
Control Delay (s/veh)		8.1				8.9					12.8			22.6		11.1		
Level of Service (LOS)		A				A					B			C		B		
Approach Delay (s/veh)		0.2				0.1					12.8				19.0			
Approach LOS											B				C			

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Murdock at Cornerstone		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Murdock Drive		
Analysis Year	2022			North/South Street	Cornerstone Drive		
Time Analyzed	PM Peak			Peak Hour Factor	0.79		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2022 Combined						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	1	0	0	1	1	1		0	1	0		1	1	0
Configuration		L		TR		L	T	R			LTR			L		TR
Volume (veh/h)		50	344	0		0	369	117		7	2	12		68	0	18
Percent Heavy Vehicles (%)		3				3				3	3	3		3	3	3
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized					No											
Median Type   Storage					Left Only								1			

## Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.1	6.5	6.2		7.1	6.5	6.2
Critical Headway (sec)		4.13				4.13				7.13	6.53	6.23		7.13	6.53	6.23
Base Follow-Up Headway (sec)		2.2				2.2				3.5	4.0	3.3		3.5	4.0	3.3
Follow-Up Headway (sec)		2.23				2.23				3.53	4.03	3.33		3.53	4.03	3.33

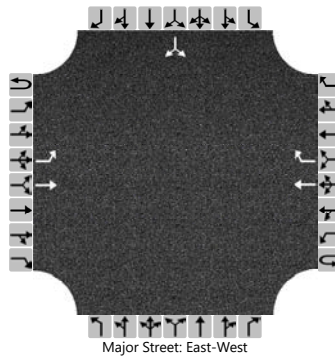
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		63				0					27				86		23	
Capacity, c (veh/h)		960				1119					379				316		594	
v/c Ratio		0.07				0.00					0.07				0.27		0.04	
95% Queue Length, Q <sub>95</sub> (veh)		0.2				0.0					0.2				1.1		0.1	
Control Delay (s/veh)		9.0				8.2					15.2				20.6		11.3	
Level of Service (LOS)		A				A					C				C		B	
Approach Delay (s/veh)		1.1				0.0					15.2				18.6			
Approach LOS											C				C			

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Murdock at Site Access		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Murdock Drive		
Analysis Year	2022			North/South Street	Site Access		
Time Analyzed	AM Peak			Peak Hour Factor	0.83		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	Combined 2022						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	1	0	0	0	1	1		0	0	0		0	1	0
Configuration		L	T				T	R							LR	
Volume (veh/h)		4	640				294	11						38		13
Percent Heavy Vehicles (%)		3												3		3
Proportion Time Blocked																
Percent Grade (%)														0		
Right Turn Channelized							No									
Median Type   Storage							Left Only							1		

## Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.13												6.43		6.23
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.23												3.53		3.33

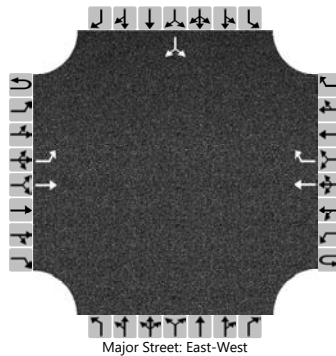
## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		5														61
Capacity, c (veh/h)		1186														394
v/c Ratio		0.00														0.16
95% Queue Length, Q <sub>95</sub> (veh)		0.0														0.5
Control Delay (s/veh)		8.0														15.8
Level of Service (LOS)		A														C
Approach Delay (s/veh)		0.0												15.8		
Approach LOS														C		

# HCS7 Two-Way Stop-Control Report

General Information				Site Information			
Analyst	BJH			Intersection	Murdock at Site Access		
Agency/Co.	Cannon & Cannon, Inc.			Jurisdiction	Knox County		
Date Performed	11/24/2020			East/West Street	Murdock Drive		
Analysis Year	2022			North/South Street	Site Access		
Time Analyzed	PM Peak			Peak Hour Factor	0.79		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	Combined 2022						

## Lanes



## Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	1	0	0	0	1	1		0	0	0		0	1	0
Configuration		L	T				T	R							LR	
Volume (veh/h)		13	411				475	38						30		11
Percent Heavy Vehicles (%)		3												3		3
Proportion Time Blocked																
Percent Grade (%)														0		
Right Turn Channelized							No									
Median Type   Storage							Left Only							1		

## Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.13												6.43		6.23
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.23												3.53		3.33

## Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		16														52	
Capacity, c (veh/h)		932														381	
v/c Ratio		0.02														0.14	
95% Queue Length, Q <sub>95</sub> (veh)		0.1														0.5	
Control Delay (s/veh)		8.9														15.9	
Level of Service (LOS)		A														C	
Approach Delay (s/veh)		0.3												15.9			
Approach LOS														C			

**APPENDIX D – SIGNAL WARRANT SPREADSHEETS**

## TRAFFIC SIGNAL WARRANT ANALYSIS - VOLUME WARRANTS

Intersection : **Murdock Drive at Cornerstone Drive**  
 City or County : **Knox County** Date of Count: **5-Nov-20**  
 State : **Tennessee** Day of Week of Count: **Thursday**

Are warranting volumes to be adjusted for speeds or built up area? . . . . . **No**  
 Adjustment factor for day of week and month of year of count . . . . . **1.00**  
 Number of Lanes: Major Street . . . **1** Minor Street . . . **1**

Time	Major Street			Minor Street	
	Actual Volume	Adjusted Total Volume	Actual Volume	Adjusted Total Volume	
Beginning	App #1	App #2	Total	Actual Volume	Adjusted Total Volume
6:00 am	0	0	0	0	0
7:00	413	223	636	91	91
8:00	379	253	632	88	88
9:00 am	0	0	0	0	0
10:00	0	0	0	0	0
11:00	205	301	506	71	71
12:00 noon	256	290	546	78	78
1:00	0	0	0	0	0
2:00	240	288	528	58	58
3:00 pm	287	464	751	60	60
4:00	311	371	682	46	46
5:00	307	436	743	53	53
6:00 pm	0	0	0	0	0
7:00	0	0	0	0	0
8:00	0	0	0	0	0

Warrant #1A (8 Hr. - Min. Vol.)	
Percent of Warrant	
Major	Minor
0	0
127	61
126	59
0	0
0	0
101	47
109	52
0	0
106	39
150	40
136	31
149	35
0	0
0	0
0	0
Warranting Volumes	500 150
Total Hours Meeting Warrant =	0 .
Warrant Met	No

Warrant #1B (8 Hr. - Interruption)	
Percent of Warrant	
Major	Minor
0	0
85	121
84	117
0	0
0	0
67	95
73	104
0	0
70	77
100	80
91	61
99	71
0	0
0	0
0	0
Warranting Volumes	750 75
Total Hours Meeting Warrant =	0 .
Warrant Met	No

Combination (Warrants 1A & 1B)	
Percent of Warrant	
Major	Minor
0	0
106	76
105	73
0	0
0	0
84	59
91	65
0	0
88	48
125	50
114	38
124	44
0	0
0	0
0	0
Warranting Volumes	600 120
Total Hours Meeting Warrant =	0 .
Warrant Met	No

Warrant #2 (Four Hour Vols.)	
Warrant Volume	Percent of Warrant
0	****
200	46
200	44
0	****
0	****
250	28
230	34
0	****
240	24
160	38
180	26
160	33
0	****
0	****
0	****
Warranting Volumes From MUTCD Fig. 4-7	0 .
Warrant Met	No

Warrant #3 (Peak Hour Vols.)	
Warrant Volume	Percent of Warrant
0	****
340	27
340	26
0	****
0	****
410	17
390	20
0	****
400	15
290	21
320	14
290	18
0	****
0	****
0	****
Warranting Volumes From MUTCD Fig. 4-5	0 .
Warrant Met	No

Note: , No adjustment made  
 - Where more than one minor approach exists use the higher approach volume  
 . Number of hours shown is the minimum meeting the MUTCD requirements. Additional hours outside of the count period may meet the MUTCD specified volume levels.

\*\*\*\* Major Street volume is so low that no Minor Street warrant exists

Comments: (include any information which may be useful to the reviewer)

Major Street = Murdock Drive  
 Minor Street = Cornerstone Drive  
 All volumes included.

All approaches considered single lane.  
 Raw traffic data factored by 1.2 to account for reductions due to Covid.

Analysis Prepared by: **CANNON AND CANNON, INC.**  
 Brian J. Haas, P.E., PTOE

Date: 12/09/20  
 Time: 13:41

Developed by: T. Darcy Sullivan, P.E.  
 Distributed by: Tennessee Transportation Assistance Program (TTAP) VC/R1

## TRAFFIC SIGNAL WARRANT ANALYSIS - VOLUME WARRANTS

Intersection : **Murdock Drive at Cornerstone Drive**  
 City or County : **Knox County**      Date of Count: **2022 Background**  
 State : **Tennessee**      Day of Week of Count: **Thursday**

Are warranting volumes to be adjusted for speeds or built up area? . . . . . **No**  
 Adjustment factor for day of week and month of year of count . . . . . **1.00**  
 Number of Lanes:      Major Street . . . **1**      Minor Street . . . **1**

Time	Major Street			Minor Street	
	Actual Volume		Adjusted Total Volume	Actual Volume	Adjusted Total Volume
	App #1	App #2			
Beginning					
6:00 am	0	0	0	0	0
7:00	430	232	662	95	95
8:00	394	263	657	92	92
9:00 am	0	0	0	0	0
10:00	0	0	0	0	0
11:00	213	313	526	74	74
12:00 noon	266	302	568	81	81
1:00	0	0	0	0	0
2:00	250	300	550	60	60
3:00 pm	298	483	781	62	62
4:00	323	386	709	48	48
5:00	319	453	772	55	55
6:00 pm	0	0	0	0	0
7:00	0	0	0	0	0
8:00	0	0	0	0	0

Warrant #1A (8 Hr. - Min. Vol.)	
Percent of Warrant	
Major	Minor
0	0
132	63
131	61
0	0
0	0
105	49
114	54
0	0
110	40
156	41
142	32
154	37
0	0
0	0
0	0
Warranting Volumes 500    150	
Total Hours Meeting Warrant = 0 .	
Warrant Met <b>No</b>	

Warrant #1B (8 Hr. - Interruption)	
Percent of Warrant	
Major	Minor
0	0
88	127
88	123
0	0
0	0
70	99
76	108
0	0
73	80
104	83
95	64
103	73
0	0
0	0
0	0
Warranting Volumes 750    75	
Total Hours Meeting Warrant = 0 .	
Warrant Met <b>No</b>	

Combination (Warrants 1A & 1B)	
Percent of Warrant	
Major	Minor
0	0
110	79
110	77
0	0
0	0
88	62
95	68
0	0
92	50
130	52
118	40
129	46
0	0
0	0
0	0
Warranting Volumes 600    120	
Total Hours Meeting Warrant = 0 .	
Warrant Met <b>No</b>	

Warrant #2 (Four Hour Vols.)	
Warrant Volume	Percent of Warrant
0	****
190	50
190	48
0	****
0	****
240	31
220	37
0	****
230	26
150	41
170	28
150	37
0	****
0	****
0	****
Warranting Volumes From MUTCD Fig. 4-7	
Total Hours Meeting Warrant = 0 .	
Warrant Me <b>No</b>	

Warrant #3 (Peak Hour Vols.)	
Warrant Volume	Percent of Warrant
0	****
330	29
330	28
0	****
0	****
400	19
380	21
0	****
390	15
280	22
310	15
280	20
0	****
0	****
0	****
Warranting Volumes From MUTCD Fig. 4-5	
Total Hours Meeting Warrant = 0 .	
Warrant Me <b>No</b>	

Note: . No adjustment made  
 - Where more than one minor approach exists use the higher approach volume  
 . Number of hours shown is the minimum meeting the MUTCD requirements. Additional hours outside of the count period may meet the MUTCD specified volume levels.

\*\*\*\* Major Street volume is so low that no Minor Street warrant exists

Comments: (include any information which may be useful to the reviewer)

Major Street = Murdock Drive  
 Minor Street = Cornerstone Drive  
 All volumes included.

All approaches considered single lane.  
 Volumes shown are existing with 2.0% annual growth from Year 2020 to Year 2022.

Analysis Prepared by: <b>CANNON AND CANNON, INC.</b> Brian J. Haas, P.E., PTOE	Date: 12/09/20 Time: 13:42	Developed by: T. Darcy Sullivan, P.E.      VC/R1 Distributed by: Tennessee Transportation Assistance Program (TTAP)
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## TRAFFIC SIGNAL WARRANT ANALYSIS - VOLUME WARRANTS

Intersection : **Murdock Drive at Cornerstone Drive**  
 City or County : **Knox County**      Date of Count: **2022 Combined**  
 State : **Tennessee**      Day of Week of Count: **Thursday**

Are warranting volumes to be adjusted for speeds or built up area? . . . . . **No**  
 Adjustment factor for day of week and month of year of count . . . . . **1.00**  
 Number of Lanes:      Major Street . . . **1**      Minor Street . . . **1**

Time	Major Street			Minor Street		
	App #1	App #2	Total	Actual Volume	Adjusted Total Volume	Adjusted Total Volume
Beginning						
6:00 am	0	0	0	0	0	0
7:00	437	250	687	687	125	125
8:00	401	281	682	682	122	122
9:00 am	0	0	0	0	0	0
10:00	0	0	0	0	0	0
11:00	220	331	551	551	104	104
12:00 noon	273	320	593	593	111	111
1:00	0	0	0	0	0	0
2:00	276	328	604	604	85	85
3:00 pm	324	511	835	835	87	87
4:00	349	414	763	763	73	73
5:00	345	481	826	826	80	80
6:00 pm	0	0	0	0	0	0
7:00	0	0	0	0	0	0
8:00	0	0	0	0	0	0

Warrant #1A (8 Hr. - Min. Vol.)	
Percent of Warrant	
Major	Minor
0	0
137	83
136	81
0	0
0	0
110	69
119	74
0	0
121	57
167	58
153	49
165	53
0	0
0	0
0	0
Warranting Volumes 500    150	
Total Hours Meeting Warrant = 0 .	
Warrant Met <b>No</b>	

Warrant #1B (8 Hr. - Interruption)	
Percent of Warrant	
Major	Minor
0	0
92	167
91	163
0	0
0	0
73	139
79	148
0	0
81	113
111	116
102	97
110	107
0	0
0	0
0	0
Warranting Volumes 750    75	
Total Hours Meeting Warrant = 2 .	
Warrant Met <b>No</b>	

Combination (Warrants 1A & 1B)	
Percent of Warrant	
Major	Minor
0	0
115	104
114	102
0	0
0	0
92	87
99	93
0	0
101	71
139	73
127	61
138	67
0	0
0	0
0	0
Warranting Volumes 600    120	
Total Hours Meeting Warrant = 2 .	
Warrant Met <b>No</b>	

Warrant #2 (Four Hour Vols.)	
Warrant Volume	Percent of Warrant
0	****
180	69
180	68
0	****
0	****
230	45
210	53
0	****
210	40
140	62
160	46
140	57
0	****
0	****
0	****
Warranting Volumes From MUTCD Fig. 4-7	
Total Hours Meeting Warrant = 0 .	
Warrant Me <b>No</b>	

Warrant #3 (Peak Hour Vols.)	
Warrant Volume	Percent of Warrant
0	****
320	39
320	38
0	****
0	****
390	27
360	31
0	****
360	24
260	33
290	25
260	31
0	****
0	****
0	****
Warranting Volumes From MUTCD Fig. 4-5	
Total Hours Meeting Warrant = 0 .	
Warrant Me <b>No</b>	

Note: . No adjustment made  
 - Where more than one minor approach exists use the higher approach volume  
 . Number of hours shown is the minimum meeting the MUTCD requirements. Additional hours outside of the count period may meet the MUTCD specified volume levels.

\*\*\*\* Major Street volume is so low that no Minor Street warrant exists

Comments: (include any information which may be useful to the reviewer)

Major Street = Murdock Drive  
 Minor Street = Cornerstone Drive  
 All volumes included.

All approaches considered single lane.  
 Volumes shown are 2022 combined with site traffic.  
 AM Peak hour generated trips were added to volumes beginning at hours 7am, 8am, 11am, and 12pm.  
 PM Peak hour generated trips were added to volumes beginning at hours 2pm, 3pm, 4pm, and 5pm.

Analysis Prepared by: **CANNON AND CANNON, INC.**  
**Brian J. Haas, P.E., PTOE**

Date: 12/09/20  
 Time: 13:42

Developed by: T. Darcy Sullivan, P.E.      VC/R1  
 Distributed by: Tennessee Transportation Assistance Program (TTAP)

**APPENDIX E – TURN LANE WARRANT SHEETS**

TABLE 4B  
 RIGHT-TURN LANE VOLUME THRESHOLDS  
 FOR TWO-LANE ROADWAYS WITH A PREVAILING SPEED OF 35 MPH OR LESS

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 - 249 250 - 299						Yes
300 - 349 350 - 399				Yes	Yes	Yes
400 - 449 450 - 499			Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599		Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes



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 50 - 99					Yes	Yes Yes
100 - 149 150 - 199			Yes	Yes Yes	Yes Yes	Yes Yes
200 - 249 250 - 299	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
300 - 349 350 - 399	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

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

AM Peak:

- Right Turn Volume = 8
- Through Volume = 33

Right turn lane IS NOT warranted.

PM Peak:

- Right Turn Volume = 130
- Through Volume = 135

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 - 249 250 - 299					Yes	Yes
300 - 349 350 - 399			Yes	Yes	Yes	Yes
400 - 449 450 - 499		Yes	Yes	Yes	Yes	Yes
500 - 549 550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

AM Peak

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 50 - 99				Yes	Yes	Yes
100 - 149 150 - 199		Yes	Yes	Yes	Yes	Yes
200 - 249 250 - 299	Yes	Yes	Yes	Yes	Yes	Yes
300 - 349 350 - 399	Yes	Yes	Yes	Yes	Yes	Yes
400 - 449 450 - 499	Yes	Yes	Yes	Yes	Yes	Yes
500 - 549 550 - 599	Yes	Yes	Yes	Yes	Yes	Yes
600 or More	Yes	Yes	Yes	Yes	Yes	Yes

PM Peak

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

AM Peak:

- Right Turn Volume = 11
- Through Volume = 294

Right turn lane IS NOT warranted.

PM Peak:

- Right Turn Volume = 38
- Through Volume = 475

**APPENDIX F – MPC COMMENTS**

Date: February 23, 2021

Project Name: 875 Cornerstone Drive Apartments

To: Knoxville-Knox County Planning

Subject: TIS Comment Response Document for 875 Cornerstone Drive Apartments

Review Comments Dated: February 18, 2021 (Knoxville-Knox County Planning)

Dear Knoxville-Knox County Planning staff,

The following comment response document is submitted to address comments dated February 18, 2021:

**Knoxville-Knox County Planning (February 18, 2021)**

1. **Reviewer Comment:** On page 4, please correct the discussion of Murdock Drive to “it is classified as a Minor Arterial per Knoxville-Knox County Planning Major Road Plan.”

Response: Requested correction made and reflected on page 4 of the Revised TIS.

2. **Reviewer Comment:** On page 5, please correct “Knoxville-Knox County Metropolitan Planning Commission” to “Knoxville-Knox County Planning”.

Response: Requested correction made and reflected on page 5 of the Revised TIS.

3. **Reviewer Comment:** On page 6, with both traffic counts being completed at the same time, there is some discrepancy with the volumes balancing. The volumes between the two count locations are for the same peak hours and they do not have any other intersections between them. Therefore, for example, we would expect the northbound movement from Murdock Drive at Cornerstone Drive to be the same in the AM and PM as the northbound movement at the project driveway on Cornerstone Drive (i.e. the volume coming out of one intersection equals the volume coming into another intersection). This is true for the AM peak, northbound PM peak, and southbound PM peak volumes. The traffic heading north on Cornerstone Drive from Murdock Drive is 312 vehicles, but only 113 northbound vehicles arrive at the US Cellular driveway. Please revise or explain why the difference since there is no place for traffic to go.

Response: This discrepancy is due to a typo for the westbound right turn volume at the intersection of Murdock Drive at Cornerstone Drive when transposing the data collected and shown in Appendix A to FIGURE 4. The westbound right turn volume was depicted as 280 vehicles for the PM peak hour and should have been depicted as 80 vehicles. The peak hour volumes between the intersections of Murdock Drive at Cornerstone Drive and US Cellular Office Access at Cornerstone Drive now balance as expected. Revised FIGURE 4 can be found on page 6.

This discrepancy in the reported westbound right turn volume resulted in a “domino effect” of revising the subsequent analyzed scenarios depicted in FIGURE 5, FIGURE 6, and FIGURE 9. Most notably, the corrected volumes resulted in the originally proposed westbound right turn lane into

the site access along Murdock Drive no longer being warranted / recommended based on the revised volumes. The revised turn lane warrant spreadsheet has been provided in Appendix E-3.

4. **Reviewer Comment:** On page 17, please reset the numbering of the recommended improvements to begin at 1 instead of 5.

Response: Requested correction made and reflected on page 17 of the Revised TIS.

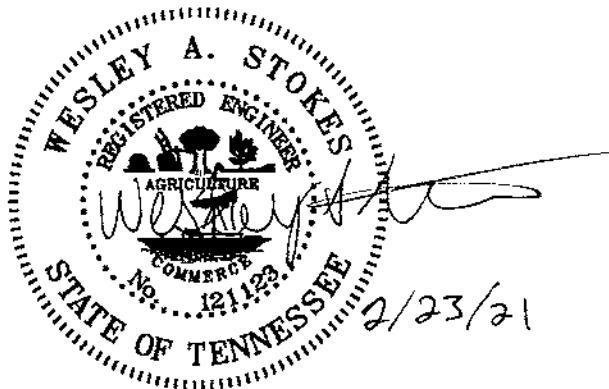
- a. The right-turn lane taper and storage lengths of the proposed access off Murdock Drive need to be increased. Per TDOT Design Guidelines, the taper length should be  $WS/3$  where  $W$  is the lateral offset in feet and  $S$  is the speed in MPH. In this case, the recommended taper length is  $12 \times 40/3 = 160$  feet. The guidelines go on to say that the total length of taper plus storage should provide adequate deceleration length for a complete stop. At 40 MPH, that length is 275 feet. We would propose that the right-turn lane at the new driveway be extended, perhaps to 150 feet each for storage and taper lengths, to provide the 275 feet of deceleration length.

Response: Right-turn lane no longer warranted / recommended as discussed in previous Comment 3 response.

5. **Reviewer Comment:** This current site of the proposed apartment complex has a heavily used greenway on the parcel. Please mention what mitigation will be done to complete the connection to other portions of the greenway. Please add a section discussing Pedestrian connections, which is a requirement for the study per the Transportation Impact Analysis Guidelines.

Response: Comment address in revised TIS in new *PEDESTRIAN CONNECTION ASSESSMENT* section on page 16.

Sincerely,



Wesley Stokes, P.E.