LEGENDS AT WASHINGTON PIKE – PHASE 2

Traffic Impact Study

Washington Pike

Knoxville, TN

A Traffic Impact Study for the Proposed Legends at Washington Pike – Phase 2

Submitted to

Knoxville – Knox County Metropolitan Planning Commission

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Executive Summary

Maddox Companies is proposing a residential development with single family homes and duplex townhomes within the Knoxville city limits. The project is located at the existing intersection of Washington Pike at Rising Oak Way. The development will consist of 179 single family homes and 82 duplex townhomes in addition to the existing Legends at Oak Grove apartment complex located on Rising Oak Way.

The development will connect to the existing Legends at Oak Grove at the end of Rising Oak Way. Construction is proposed to take place this year and this study assumes full buildout for the development will occur in 2021.

In order to maintain or provide an acceptable level-of-service for each of the intersections studied, some recommendations are presented.

Washington Pike at Rising Oak Way
FMA recommends adding a separate right and left turn lane at the intersection with Washington Pike to be built during the Legends at Washington Pike – Phase 2 construction in order for the intersection to operate at an acceptable LOS.

After the completion of the Legends at Washington Pike – Phase 2 including the proposed improvements to the intersection the eastbound approach exiting the development will operate at a LOS D during the AM peak hour and a LOS C during the PM peak hour and the northbound approach will operate at a LOS B during the AM peak hour and a LOS A during the PM peak hour.

A right turn lane warrant is met during the AM peak hour at the intersection of Washington Pike at Rising Oak Way. FMA recommends a 75 foot storage length and a 100 foot taper. The design of the right turn lane should be coordinated with the City of Knoxville engineering department.

Washington Pike at Mill Road
After the completion of the Legends at Washington Pike – Phase 2 the signalized intersection of Washington Pike at Mill Road will operate at a LOS C during AM peak hour and a LOS F during the PM peak hour using the existing signal timing provided by the City of Knoxville.

FMA does not recommend any improvements to the intersection of Washington Pike at Mill Road as a part of the Legends at Washington Pike – Phase 2 development. The highest delay from this intersection is a result of the southbound left turn lane on Washington Pike which is not affected by this development.

1 Introduction

1.1 Project Description

This report provides a summary of a traffic impact study that was performed for the proposed Legends at Washington Pike – Phase 2. The project is located near the existing intersection of Washington Pike at Rising Oak Way in the Knoxville City Limits. The location of the site is shown in Figure 1.

The Legends at Washington Pike – Phase 2 will consist of 179 single family homes and 82 duplex townhomes in addition to the existing Legends at Oak Grove apartment complex located on Rising Oak Way. Construction is proposed to take place this year and this study assumes full build out for the development will occur in 2021.

The development will connect to the existing Legends at Oak Grove at the end of Rising Oak Way. The traffic from the proposed Legends at Washington Pike will enter and exit the site using the existing intersection of Washington Pike at Rising Oak Way. The proposed site layout is shown in Figure 2.

The purpose of this study is to evaluate the impacts to the traffic conditions caused by the proposed development.

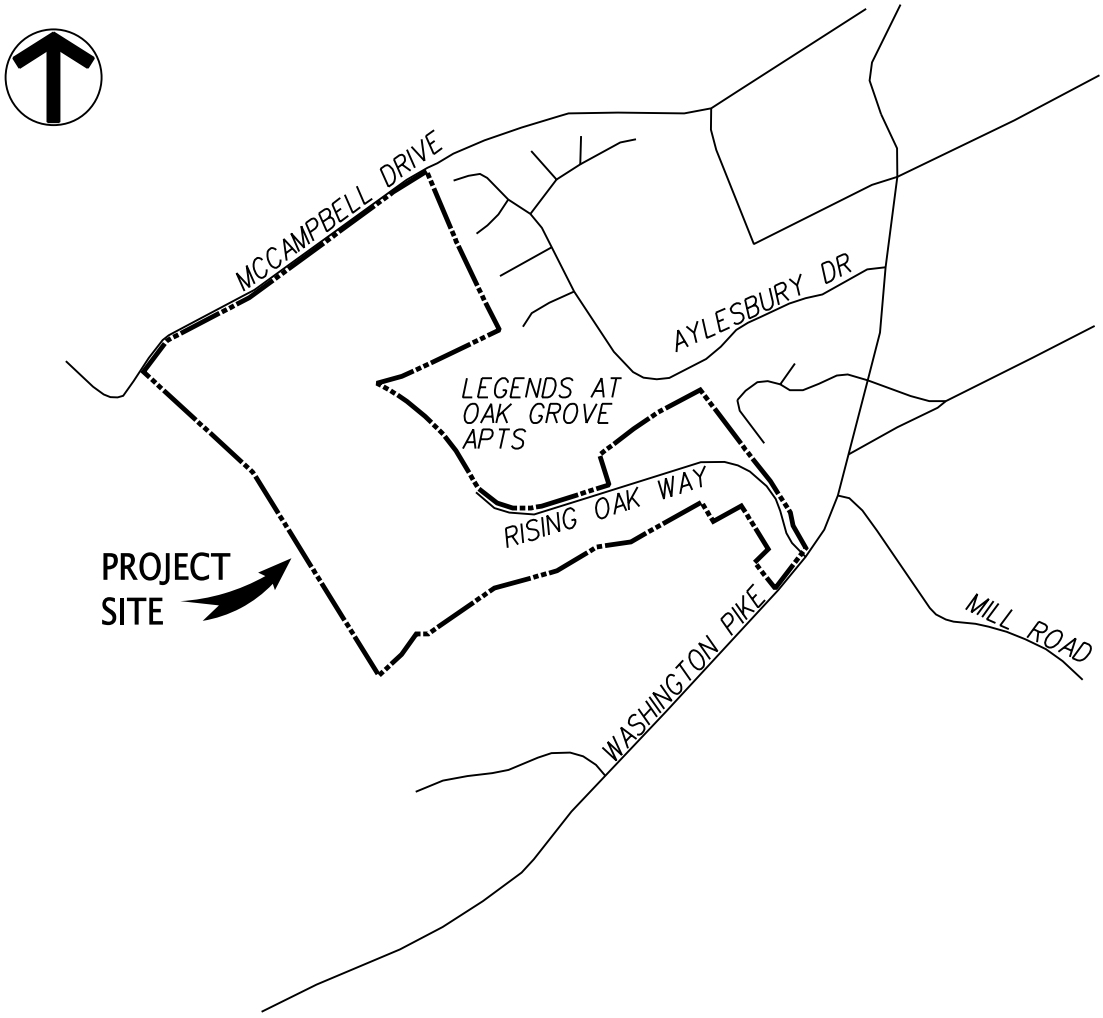


Figure 1: Location Map

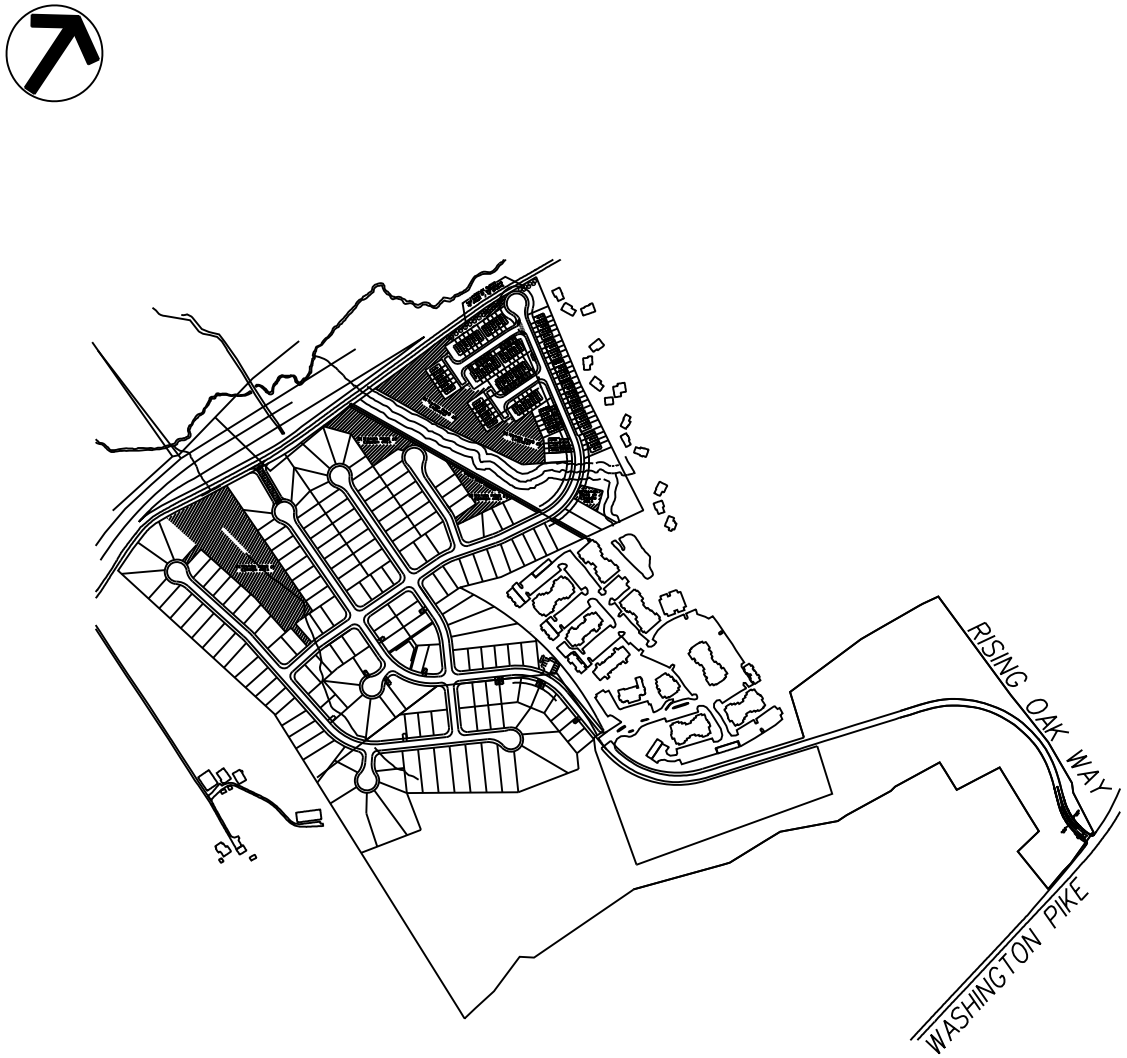


Figure 2: Site Plan

1.2 Existing Site Conditions

The proposed site access will connect to the existing Rising Oak Way. All traffic from the proposed development will enter and exit the site at the existing intersection of Washington Pike at Rising Oak Way.

Rising Oak Way is a two-lane private road with a driveway width of 28 feet at the intersection at Washington Pike. Located at the intersection of Washington Pike at Rising Oak Way is a left turn lane on Washington Pike with a storage length of 80 feet. The intersection of Rising Oak Way at Washington Pike is located 440 feet south of the intersection of Washington Pike at Mill Road. The Knoxville-Knox County Metropolitan Planning Commission does not classify Rising Oak Way; therefore it is considered a local street. The posted speed limit on Rising Oak Way is 20 mph.

The minimum required sight distance for a road with a posted speed limit of 40 mph is 400 feet in each direction in accordance with the "Subdivision Regulations" for Knoxville and Knox County. FMA measured the sight distance at the existing intersection of Washington Pike at Rising Oak Way. At 15 feet from the edge of pavement the sight distance at the existing intersection is 400 feet northbound and 410 feet southbound; however the northbound sight distance is partially blocked due by the tree line.

Washington Pike is a two-lane road south of the intersection of Mill Road. The Knoxville-Knox County Metropolitan Planning Commission classifies Washington Pike between Millertown Pike and Murphy Road as a minor arterial per the Major Road Plan. The posted speed limit on Washington Pike is 40 mph.

Mill Road is a two-lane road between Millertown Pike and Washington Pike. The Knoxville-Knox County Metropolitan Planning Commission classifies Mill Road from Millertown Pike to Washington Pike as a major collector per the Major Road Plan. The posted speed limit on Mill Road is 30 mph.

Aerial photos of the existing intersections are included in Attachment 9.

2 Existing Traffic Volumes

FMA conducted a turning movement count at the intersection of Washington Pike at Mill Road on Tuesday May 15, 2018. FMA also conducted a turning movement count at the intersection of Washington Pike at Rising Oak Way on Wednesday May 16, 2018.

The current AM peak hour and PM peak hour were determined using the turning movement count that FMA conducted. At the intersection of Washington Pike at Mill Road the AM peak hour occurred between 7:15 am and 8:15 am, and the PM peak hour occurred between 5:00 pm and 6:00 pm. At the intersection of Washington Pike at Rising Oak Way the AM peak hour occurred between 7:00 am and 8:00 am, and the PM peak hour occurred between 4:15 pm and 5:15 pm.

The existing volumes including the AM and PM peak hour traffic volumes at the count locations are shown in Figure 3, and the count data collected is included in Attachment 1.

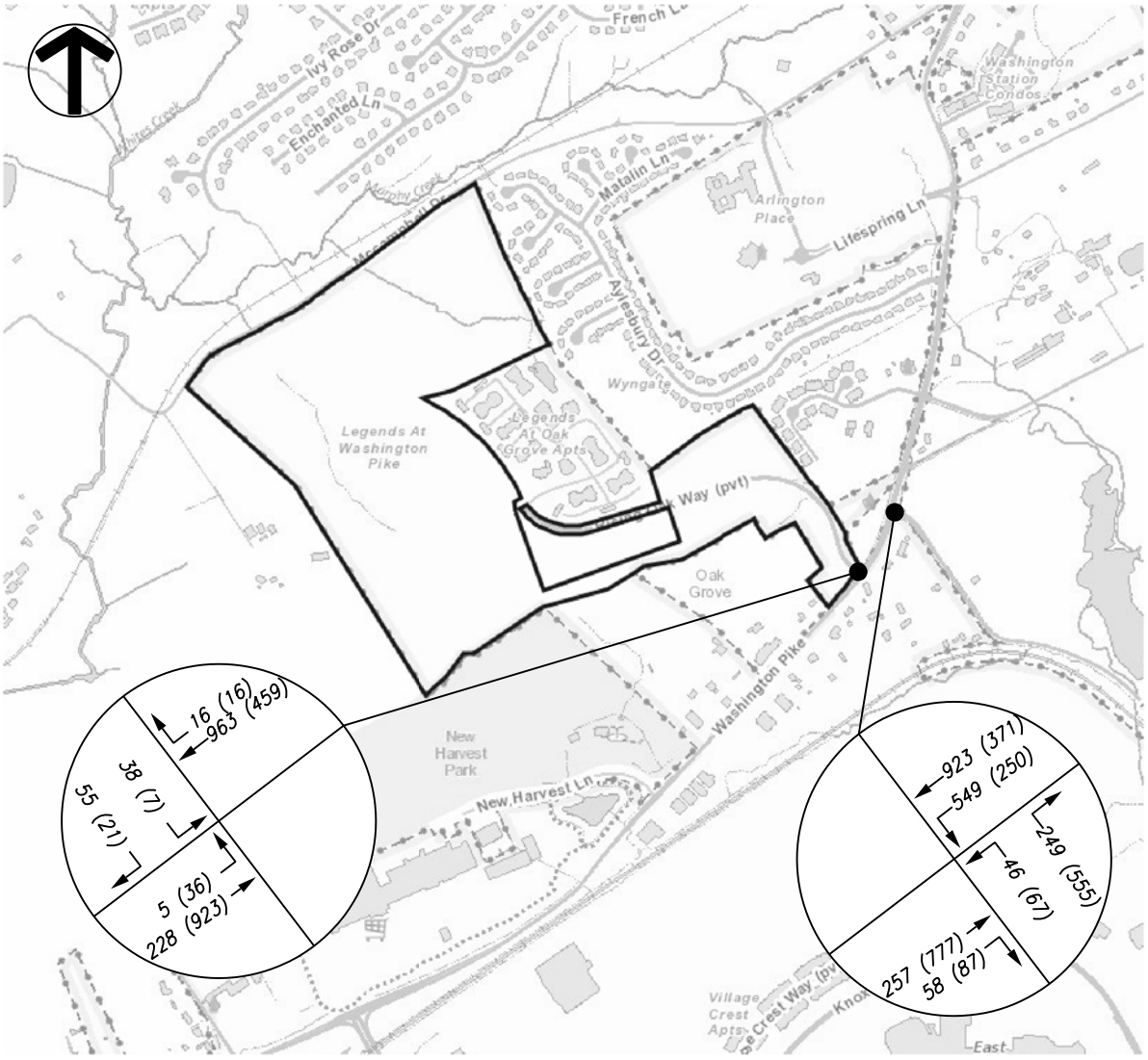


Figure 3: 2018 Existing Peak Hour Traffic

3 Background Growth

The Tennessee Department of Transportation (TDOT) and the Knoxville Regional Transportation Planning Organization (TPO) maintain count stations in the vicinity of the proposed development.

TDOT count station #000041 is located on Mill Road south of the intersection of Washington Pike. The annual traffic growth rate for this station over the last five years is approximately 1.45%.

Knoxville TPO count station ID 093M035 is located on Washington Pike 200 feet west of the intersection with Mill Road. The annual growth rate for this station over the last five years is approximately 1.98%.

For the purpose of this study, an annual growth rate of 2.0% was assumed for traffic at the intersections of Washington Pike at Mill Road and Washington Pike at Rising Oak Way until full occupancy is reached in 2021. Attachment 2 shows the trend line growth charts for the TDOT and TPO count stations.

Figure 4 demonstrates the projected background peak hour volumes at the intersection after applying the background growth rate to the existing conditions.

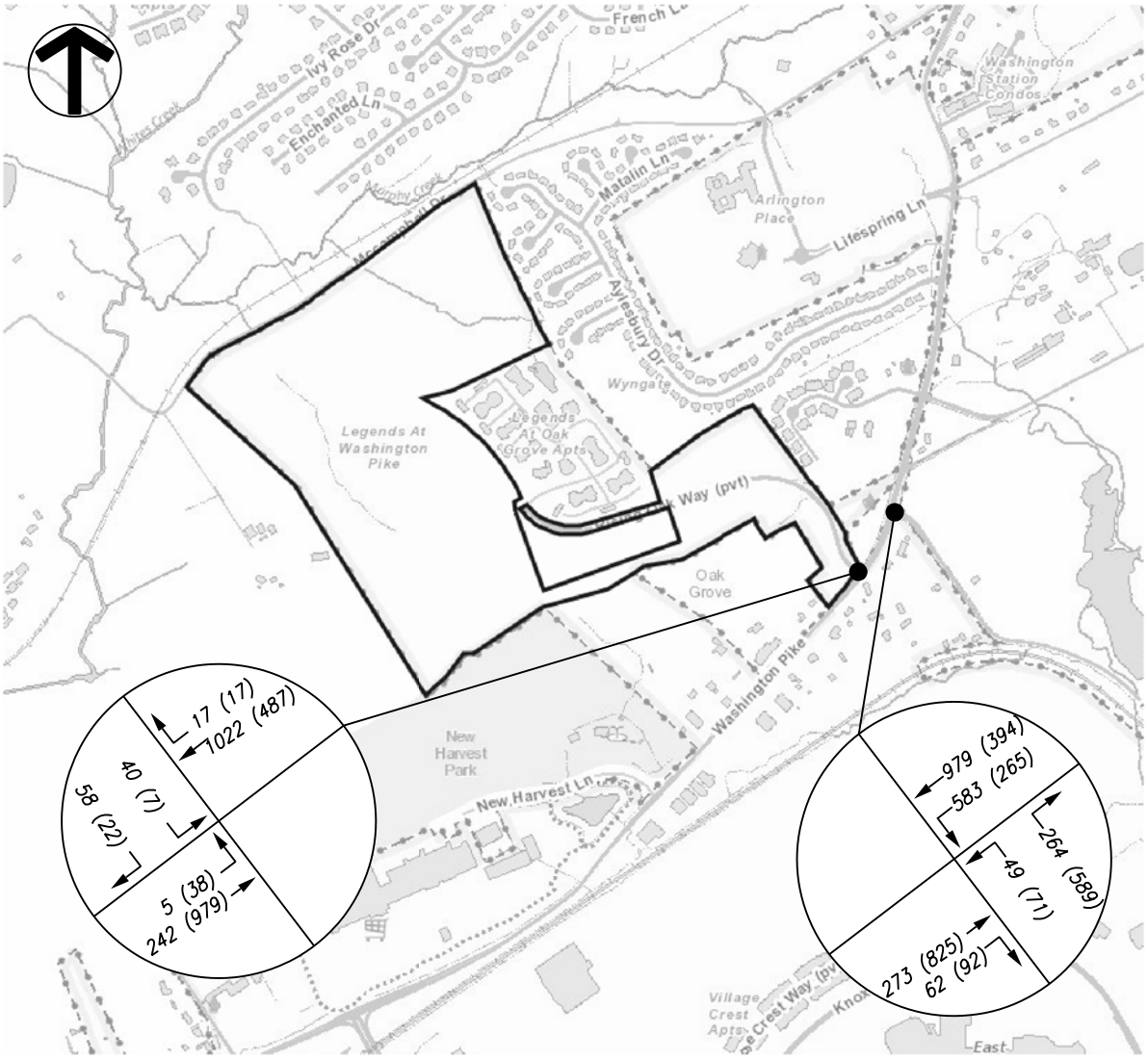


Figure 4: 2021 Background Peak Hour Traffic

4 Trip Generation and Trip Distribution

The Knoxville-Knox County Metropolitan Planning Commission published a memorandum ("Local Trip Generation Rates for Multi-Family Residential Uses", August 14, 2000) for the purpose of providing locally collected data for all multi-family residential developments. The fitted curve equations from the local study were used to calculate site trips for the duplex townhomes.

Single-Family Detached Housing or Land Use 210 was used to calculate site trips for the proposed Single Family Housing using the fitted curve equations from *Trip Generation, 9th Edition,* published by the Institute of Transportation Engineers. The land use worksheets are included in Attachment 3.

The total combined trips generated by the Legends at Washington Pike – Phase 2 for 179 single family homes and 82 duplex townhomes was estimated to be 2,592 daily trips. The estimated trips are 180 trips during the AM peak hour and 242 trips during the PM peak hour. A trip generation summary is shown in Table 4-1.

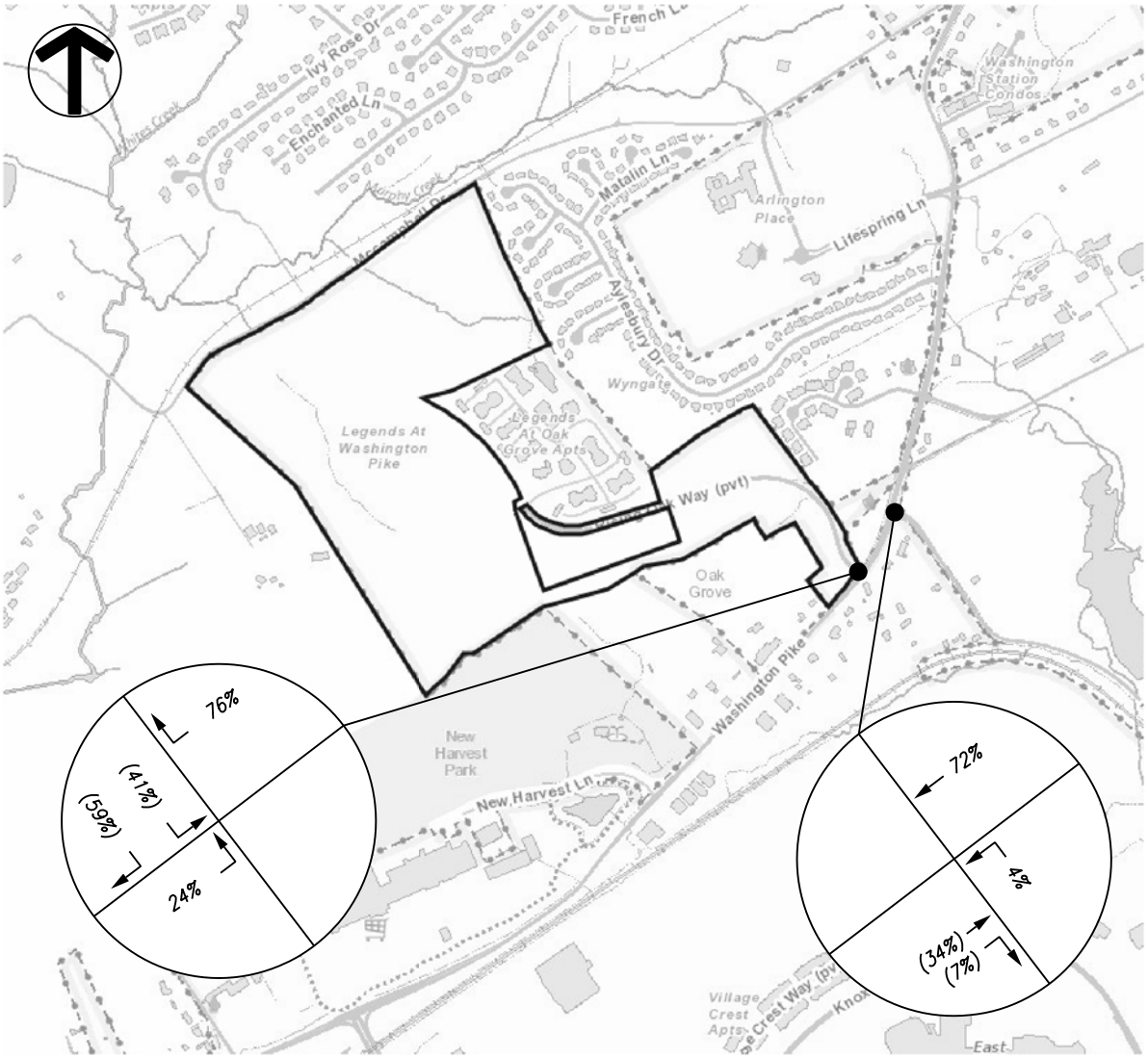
Table 4-1
Legends at Washington Pike – Phase 2
Trip Generation Summary

	Total New Trips	% Entering	%Exiting	Number Entering	Number Exiting
Single-Family Detached Housing (Land Use 210)					
Weekday	1794	50	50	897	897
A.M. Peak	135	25	75	34	101
P.M. Peak	177	63	37	112	65
Local Apartment Trip Generation Study					
Weekday	798	50	50	399	399
A.M. Peak	45	22	78	10	35
P.M. Peak	65	55	45	36	29
Total Combined Trips					
Weekday	2,592			1,296	1,296
A.M. Peak	180			44	136
P.M. Peak	242			148	94

Thru traffic on Washington Pike at Rising Oak Way has a trip distribution of 20% northbound and 80% southbound during the AM peak hour and 67% northbound and 33% southbound during the PM peak hour.

The directional distribution of the traffic generated by the Legends at Washington Pike – Phase 2 was determined using the existing traffic volumes. Figure 5 shows the AM peak hour trip distribution and Figure 6 shows the PM peak hour trip distribution.

Figure 7 shows the peak hour site traffic and Figure 8 shows the full buildout peak hour traffic.



LEGEND:

← 50% (50%) TRIP DISTRIBUTION ENTERING (EXITING)

Figure 5: AM Peak Hour Trip Distribution

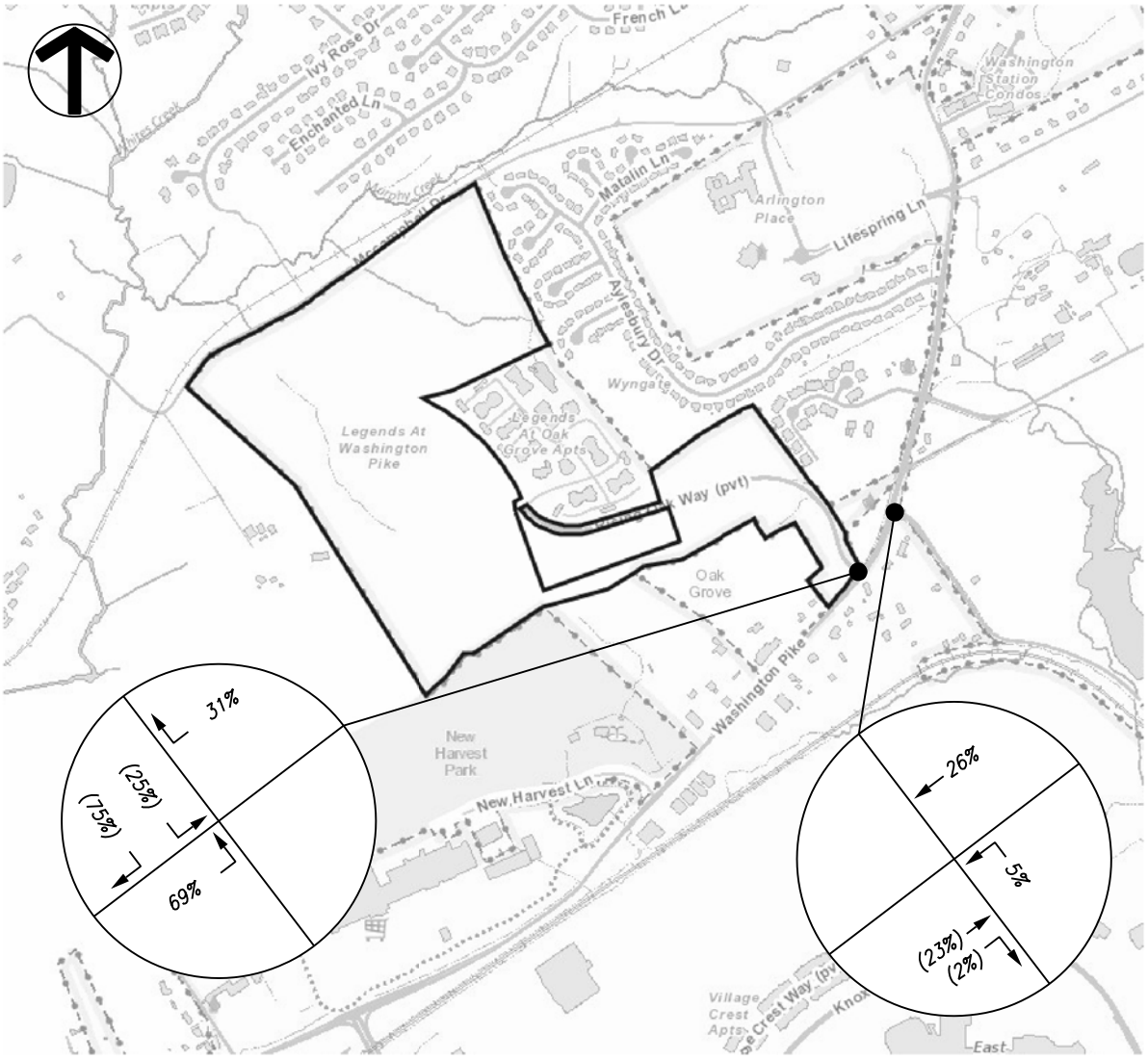
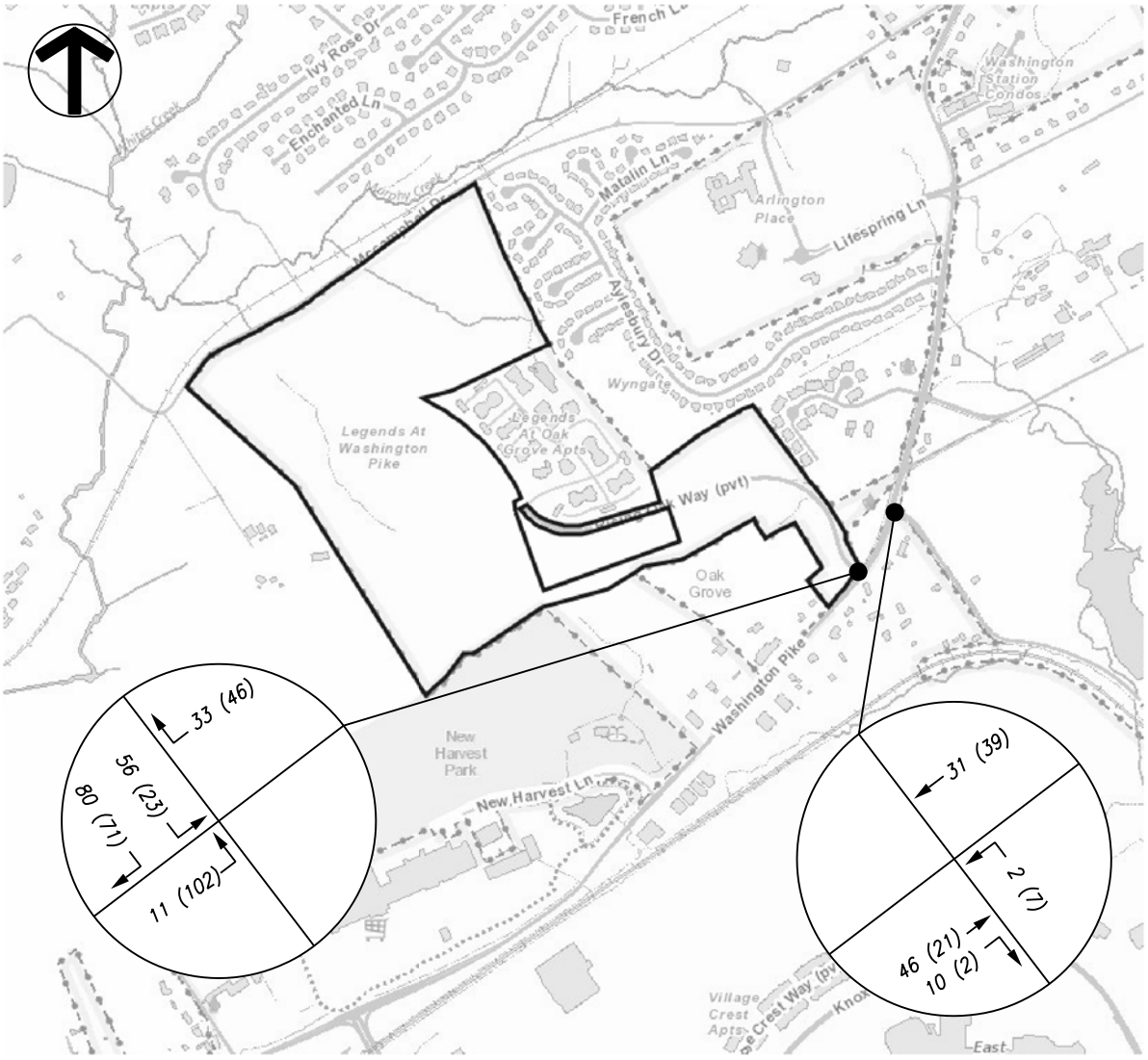


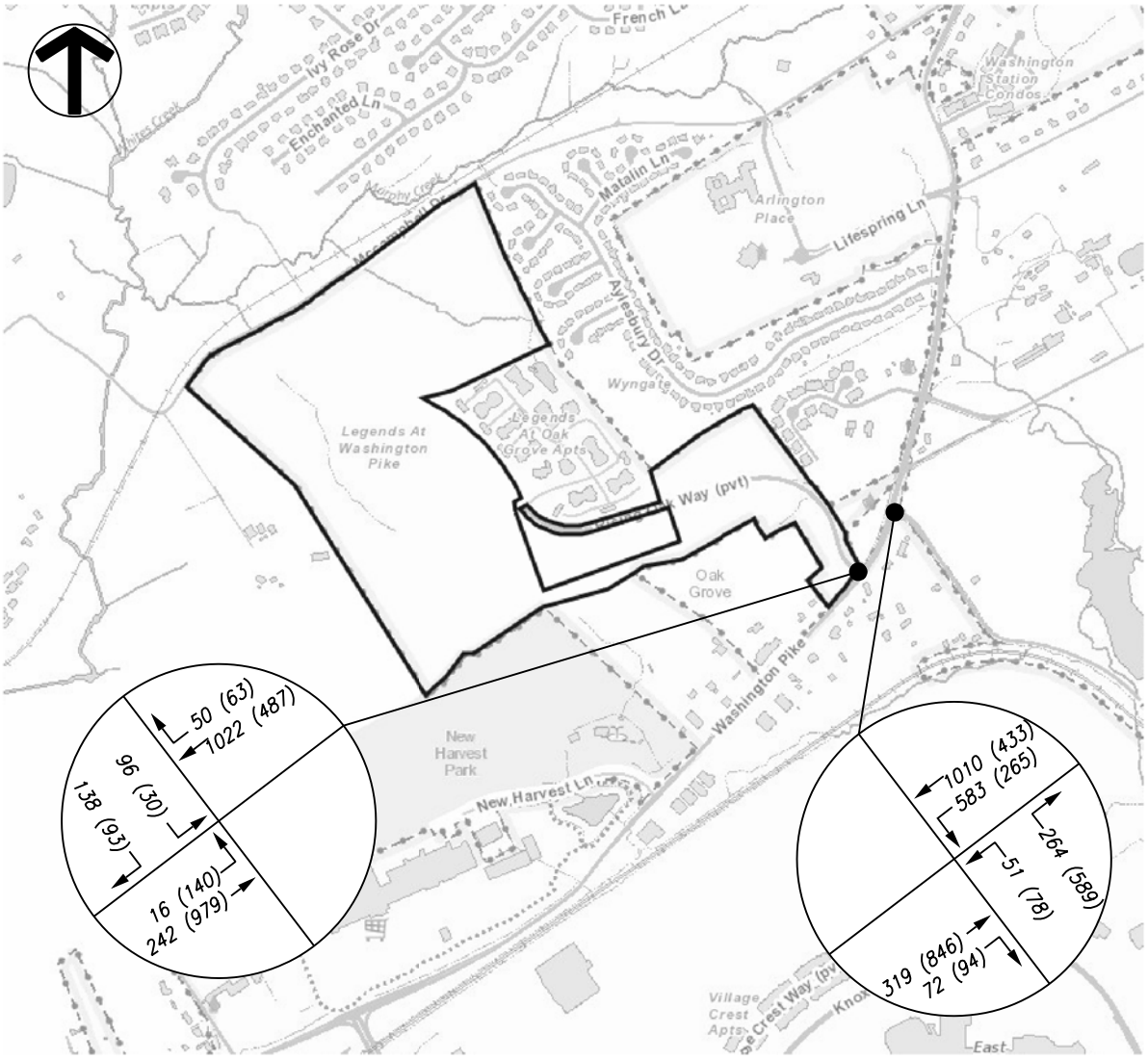
Figure 6: PM Peak Hour Trip Distribution



LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

Figure 7: Peak Hour Site Traffic



LEGEND:

← 5 (16) TURNING MOVEMENT VOLUME AM (PM)

Figure 8: Peak Hour Full Buildout Traffic

5 Projected Capacity and Level of Service

Signalized intersection capacity analyses were performed using Highway Capacity Software (HCS7) with the existing signal timing for the AM and PM peak hours to evaluate the traffic conditions at the intersection of Washington Pike at Mill Road. The existing signal timing was provided by the City of Knoxville and is included in Attachment 4.

Unsignalized intersection capacity analysis was performed using the Highway Capacity Software (HCS7) for the AM and PM peak hours to evaluate the traffic conditions at the intersection of Washington Pike at Rising Oak Way.

The results from the analyses are expressed with a term "level of service" (LOS), which is based on the amount of delay experienced at the intersection. The LOS index ranges from LOS A, indicating excellent traffic conditions with minimal delay, to LOS F indicating very congested conditions with excessive delay. LOS D generally is considered the minimum acceptable condition in urban areas. The HCS7 worksheets are included in Attachments 5, 6, and 7. Table 5-1 shows the results of the capacity analyses.

Table 5-1
Intersection Analysis
Level of Service (LOS) Summary

		Delay (sec)/LOS
Washington Pike @ Mill Road (Existing 2018)		
AM Peak	Intersection	18.3 / B
PM Peak	Intersection	64.9 / E
Washington Pike @ Rising Oak Way (Existing 2018)		
AM Peak	EB Approach NB Approach	22.2 / C 10.4 / B
PM Peak	EB Approach NB Approach	14.0 / B 8.7 / A
Washington Pike @ Mill Road (Background 2021)		
AM Peak	Intersection	21.0 / C
PM Peak	Intersection	78.6 / E
Washington Pike @ Rising Oak Way (Background 2021)		
AM Peak	EB Approach NB Approach	24.8 / C 10.7 / B
PM Peak	EB Approach NB Approach	14.6 / B 8.9 / A
Washington Pike @ Mill Road (Full Buildout 2021)		
AM Peak	Intersection	22.8 / C
PM Peak	Intersection	81.7 / F
Washington Pike @ Rising Oak Way (Full Buildout 2021)		
AM Peak	EB Approach NB Approach	28.5 / D 11.0 / B
PM Peak	EB Approach NB Approach	18.6 / C 9.7 / A

6 Turn Lane Warrant Analysis

The intersection of Washington Pike at Rising Oak Way was evaluated to determine if a southbound right turn lane is warranted. The Knox County Department of Engineering and Public Works handbook, "Access Control and Driveway Design Policy," was used to analyze the information. A right turn lane is warranted on Washington Pike at the intersection of Rising Oak Way during the AM peak hour.

The right-of-way for Washington Pike at the intersection with Rising Oak Way is 88 feet per the Major Road Plan. There is approximately 10 feet between the edge of pavement and the property line for the Oak Grove Zion Church therefore; the owner may need to acquire property from the Oak Grove Zion Church in order to install a right turn lane. Per AASHTO "A Policy on Geometric Design of Highways and Streets" the recommended storage length for the right turn lane is three car lengths (approximately 75 feet) and the recommended taper length is 100 feet. The turn lane warrant worksheets and diagram are included in Attachment 8.

7 Conclusions and Recommendations

7.1 Washington Pike @ Rising Oak Way

Currently at the intersection of Washington Pike at Rising Oak Way the eastbound approach exiting the development operates at a LOS C during the AM peak hour and a LOS B during the PM peak hour and the northbound approach operates at a LOS B during the AM peak hour and a LOS A during the PM peak hour.

It is estimated based on field observations that the existing driveway connection is blocked approximately 10% during the PM peak hour by northbound traffic from the signalized intersection of Washington Pike at Mill Road. The signalized intersection capacity analysis for the intersection of Washington Pike at Mill Road shows an existing 95% queue length for the northbound approach of 159.9 feet during the AM peak hour and 1320.5 feet during the PM peak hour.

The existing northbound left turn lane on Washington Pike measures 125 feet with enough storage space for approximately 5 vehicles. The unsignalized intersection capacity analyses show a 95% queue length of less than one vehicle during both the AM and PM peak hour after the completion of the Legends at Washington Pike – Phase 2, therefore; the existing storage capacity will be adequate.

A turn lane warrant is met for a southbound right turn lane on Washington Pike during the AM peak hour at the intersection of Washington Pike at Rising Oak Way.

Per AASHTO "A Policy on Geometric Design of Highways and Streets" the recommended storage length is three car lengths (approximately 75 feet) and the recommended taper length is 100 feet. The design of the right turn lane should be coordinated with the City of Knoxville engineering department.

FMA recommends adding a separate right and left turn lane at the intersection with Washington Pike to be built during the Legends at Washington Pike – Phase 2 construction in order for the intersection to operate at an acceptable LOS.

After the completion of the Legends at Washington Pike – Phase 2 including the proposed improvements to the intersection the eastbound approach exiting the development will operate at a LOS D during the AM peak hour and a LOS C during the PM peak hour and the northbound approach will operate at a LOS B during the AM peak hour and a LOS A during the PM peak hour.

The 95% queue length on Rising Oak Way for the exiting traffic after the completion of The Legends at Washington Pike – Phase 2 is calculated at 1.3 vehicles in the left turn lane and 3.0 vehicles in the right turn lane during the AM peak hour and less than one vehicle for both the right and left turn lanes during the PM peak hour. Rising Oak Way does have adequate storage capacity for 3 vehicles.

The existing northbound left turn lane on Washington Pike measures 125 feet with enough storage space for approximately 5 vehicles. The unsignalized intersection capacity analyses show a 95% queue length of less than one vehicle during both the AM and PM peak hour after the completion of the Legends at Washington Pike – Phase 2, therefore; the existing storage capacity will be adequate.

The minimum required sight distance for a road with a posted speed limit of 40 mph is 400 feet in each direction in accordance with the "Subdivision Regulations" for Knoxville and Knox County. FMA measured the sight distance at the existing intersection of Washington Pike at Rising Oak Way. At 15 feet from the edge of pavement the sight distance at the existing intersection is 400 feet northbound and 410 feet southbound; however the northbound sight distance is partially blocked due by the tree line.

FMA recommends that the sight distance be re-evaluated in the field after the completion of the proposed intersection improvements to ensure that the sight distance complies with the City of Knoxville Department of Engineering requirements. FMA also recommends any landscaping be installed so as to maintain the sight distance and continue to comply with the City of Knoxville Department of Engineering.

7.2 Washington Pike @ Mill Road

The existing traffic conditions at the signalized intersection of Washington Pike at Mill Road operate at a LOS B during the AM peak hour and a LOS E during the PM peak hour using the existing signal timing provided by the City of Knoxville.

The background traffic conditions at the signalized intersection of Washington Pike at Mill Road operate at a LOS C during the AM peak hour and a LOS E during the PM peak hour using the existing signal timing provided by the City of Knoxville.

After the completion of the Legends at Washington Pike – Phase 2 the signalized intersection of Washington Pike at Mill Road will operate at a LOS C during AM peak hour and a LOS F during the PM peak hour using the existing signal timing provided by the City of Knoxville.

FMA does not recommend any improvements to the intersection of Washington Pike at Mill Road as a part of the Legends at Washington Pike – Phase 2 development. The highest delay from this intersection is a result of the southbound left turn lane on Washington Pike which is not affected by this development.

Attachment 1
Traffic Counts

Project: Legends at Washington Pike
Intersection: Washington Pike at Mill Road
Date Conducted: 05/15/2018

	Mill Road Westbound			Washington Pike Northbound			Washington Pike Southbound			
Start	Left	Right	Total	Thru	Right	Total	Left	Thru	Total	Int. Total
7:00 AM	10	49	59	37	11	48	107	233	340	447
7:15 AM	9	55	64	61	10	71	131	240	371	506
7:30 AM	10	73	83	61	12	73	125	252	377	533
7:45 AM	14	56	70	70	20	90	137	239	376	536
Total	43	233	276	229	53	282	500	964	1464	2022
8:00 AM	13	65	78	65	16	81	156	192	348	507
8:15 AM	14	79	93	55	11	66	104	185	289	448
8:30 AM	13	49	62	53	9	62	96	174	270	394
8:45 AM	8	49	57	53	7	60	106	111	217	334
Total	48	242	290	226	43	269	462	662	1124	1683
11:00 AM	8	58	66	58	13	71	48	84	132	269
11:15 AM	11	75	86	59	8	67	61	89	150	303
11:30 AM	9	64	73	63	10	73	54	95	149	295
11:45 AM	17	64	81	67	12	79	69	84	153	313
Total	45	261	306	247	43	290	232	352	584	1180
12:00 PM	8	53	61	89	7	96	56	91	147	304
12:15 PM	12	89	101	77	16	93	62	95	157	351
12:30 PM	11	71	82	73	7	80	68	80	148	310
12:45 PM	10	75	85	77	10	87	67	86	153	325
Total	41	288	329	316	40	356	253	352	605	1290
2:00 PM	9	88	97	92	22	114	66	88	154	365
2:15 PM	7	84	91	102	13	115	66	130	196	402
2:30 PM	8	94	102	79	20	99	85	98	183	384
2:45 PM	20	90	110	91	16	107	78	89	167	384
Total	44	356	400	364	71	435	295	405	700	1535
3:00 PM	13	70	83	103	20	123	100	114	214	420
3:15 PM	12	130	142	108	23	131	80	101	181	454
3:30 PM	13	106	119	114	21	135	67	85	152	406
3:45 PM	9	150	159	136	24	160	78	104	182	501
Total	47	456	503	461	88	549	325	404	729	1781
4:00 PM	10	125	135	145	29	174	82	124	206	515
4:15 PM	18	128	146	152	28	180	71	104	175	501
4:30 PM	8	115	123	163	28	191	87	89	176	490
4:45 PM	14	125	139	176	22	198	62	110	172	509
Total	50	493	543	636	107	743	302	427	729	2015
5:00 PM	5	131	136	207	17	224	65	86	151	511
5:15 PM	15	139	154	194	20	214	54	89	143	511
5:30 PM	25	130	155	191	23	214	65	91	156	525
5:45 PM	22	155	177	185	27	212	66	105	171	560
Total	67	555	622	777	87	864	250	371	621	2107
Grand Total	385	2884	3269	3256	532	3788	2619	3937	6556	13613
Approach %	11.8	88.2		86.0	14.0		39.9	60.1		
Total %	2.8	21.2	24.0	23.9	3.9	27.8	19.2	28.9	48.2	

Project: Legends at Washington Pike
Date Conducted: 5/15/2018

AM Peak Hour	7:15 AM - 8:15 AM	2082
PM Peak Hour	5:00 PM - 6:00 PM	2107

	Mill Road Westbound			Washington Pike Northbound			Washington Pike Southbound			
Start	Left	Right	App. Total	Thru	Right	App. Total	Left	Thru	App. Total	Int. Total
Peak Hour Analysis from 7:00 AM to 9:00 AM										
AM Peak Hour begins at 7:15 AM										
7:15 AM	9	55	64	61	10	71	131	240	371	506
7:30 AM	10	**73**	83	61	12	73	125	**252**	377	533
7:45 AM	**14**	56	70	**70**	**20**	90	137	239	376	**536**
8:00 AM	13	65	78	65	16	81	**156**	192	348	507
Total Volume	46	249	295	257	58	315	549	923	1472	2082
Future (2% over 3 yrs)	49	264	313	273	62	334	583	979	1562	2209
PHF	0.82	0.85		0.92	0.73		0.88	0.92		0.97
Peak Hour Analysis from 3:00 PM to 6:00 PM										
PM Peak Hour begins at 5:00 PM										
5:00 PM	5	131	136	**207**	17	224	65	86	151	511
5:15 PM	15	139	154	194	20	214	54	89	143	511
5:30 PM	**25**	130	155	191	23	214	65	91	156	525
5:45 PM	22	**155**	177	185	**27**	212	**66**	**105**	171	**560**
Total Volume	67	555	622	777	87	864	250	371	621	2107
Future (2% over 3 yrs)	71	589	660	825	92	917	265	394	659	2236
PHF	0.67	0.90		0.94	0.81		0.95	0.88		0.94

Project: Legends at Washington Pike
Intersection: Washington Pike at Rising Oak Way
Date Conducted: 05/16/2018

	Rising Oak Way Eastbound			Washington Pike Northbound			Washington Pike Southbound			
Start	Left	Right	Total	Left	Thru	Total	Thru	Right	Total	Int. Total
7:00 AM	12	10	22	1	41	42	222	5	227	291
7:15 AM	12	14	26	2	45	47	260	1	261	334
7:30 AM	8	17	25	1	61	62	254	3	257	344
7:45 AM	6	14	20	1	81	82	227	7	234	336
Total	38	55	93	5	228	233	963	16	979	1305
8:00 AM	4	7	11	3	60	63	173	0	173	247
8:15 AM	3	6	9	3	76	79	184	1	185	273
8:30 AM	2	8	10	3	55	58	184	0	184	252
8:45 AM	4	5	9	1	59	60	128	2	130	199
Total	13	26	39	10	250	260	669	3	672	971
11:00 AM	0	1	1	1	69	70	105	3	108	179
11:15 AM	3	4	7	5	82	87	105	1	106	200
11:30 AM	1	3	4	1	79	80	99	5	104	188
11:45 AM	3	2	5	1	107	108	92	0	92	205
Total	7	10	17	8	337	345	401	9	410	772
12:00 PM	1	5	6	1	84	85	104	1	105	196
12:15 PM	2	2	4	6	114	120	101	5	106	230
12:30 PM	2	2	4	2	94	96	98	7	105	205
12:45 PM	4	4	8	6	104	110	81	6	87	205
Total	9	13	22	15	396	411	384	19	403	836
2:00 PM	1	4	5	3	92	95	92	1	93	193
2:15 PM	2	10	12	3	128	131	111	2	113	256
2:30 PM	2	2	4	5	112	117	102	2	104	225
2:45 PM	0	6	6	2	105	107	91	1	92	205
Total	5	22	27	13	437	450	396	6	402	879
3:00 PM	2	4	6	2	137	139	112	11	123	268
3:15 PM	9	2	11	5	137	142	100	2	102	255
3:30 PM	3	4	7	6	127	133	90	7	97	237
3:45 PM	2	3	5	10	166	176	107	7	114	295
Total	16	13	29	23	567	590	409	27	436	1055
4:00 PM	6	3	9	10	164	174	129	7	136	319
4:15 PM	1	8	9	5	205	210	127	2	129	348
4:30 PM	1	5	6	7	296	303	126	2	128	437
4:45 PM	2	1	3	10	210	220	98	4	102	325
Total	10	17	27	32	875	907	480	15	495	1429
5:00 PM	3	7	10	14	212	226	108	8	116	352
5:15 PM	2	8	10	11	210	221	107	1	108	339
5:30 PM	7	2	9	15	202	217	125	7	132	358
5:45 PM	1	2	3	12	208	220	112	5	117	340
Total	13	19	32	52	832	884	452	21	473	1389
Grand Total	111	175	286	158	3922	4080	4154	116	4270	8636
Approach %	38.8	61.2		3.9	96.1		97.3	2.7		
Total %	1.3	2.0	3.3	1.8	45.4	47.2	48.1	1.3	49.4	

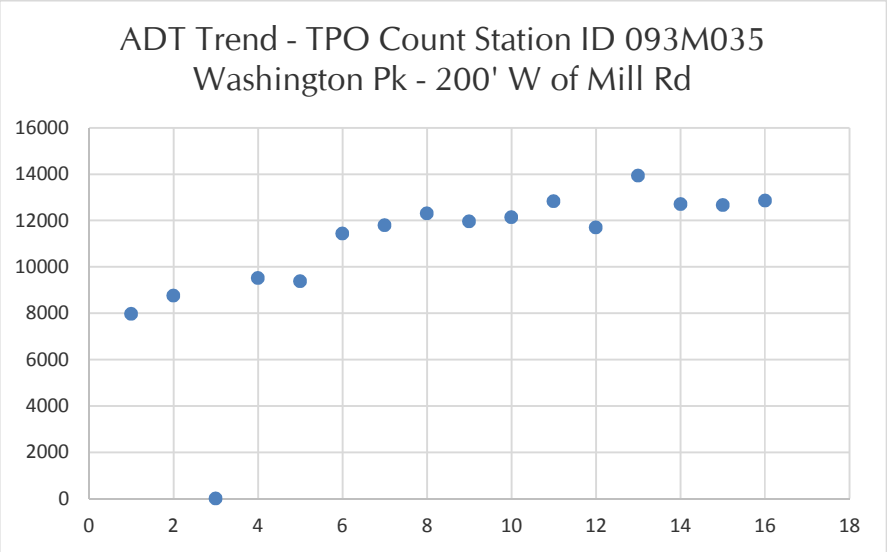
Project: Legends at Washington Pike
Date Conducted: 5/16/2018

AM Peak Hour	7:00 AM - 8:00 AM	1305
PM Peak Hour	4:15 PM - 5:15 PM	1462

	Rising Oak Way Eastbound			Washington Pike Northbound			Washington Pike Southbound			
Start	Left	Right	App. Total	Left	Thru	App. Total	Thru	Right	App. Total	Int. Total
Peak Hour Analysis from 7:00 AM to 9:00 AM										
AM Peak Hour begins at 7:15 AM										
7:00 AM	12	10	22	1	41	42	222	5	227	291
7:15 AM	**12**	14	26	**2**	45	47	**260**	1	261	334
7:30 AM	8	**17**	25	1	61	62	254	3	257	**344**
7:45 AM	6	14	20	1	**81**	82	227	**7**	234	336
Total Volume	38	55	93	5	228	233	963	16	979	1305
Future (2% over 3 yrs)	40	58		5	242		1022	17		1385
PHF	0.79	0.81		0.63	0.70		0.93	0.57		0.95
Peak Hour Analysis from 3:00 PM to 6:00 PM										
PM Peak Hour begins at 5:00 PM										
4:15 PM	1	**8**	9	5	205	210	**127**	2	129	348
4:30 PM	1	5	6	7	**296**	303	126	2	128	**437**
4:45 PM	2	1	3	10	210	220	98	4	102	325
5:00 PM	**3**	7	10	**14**	212	226	108	**8**	116	352
Total Volume	7	21	28	36	923	959	459	16	475	1462
Future (2% over 3 yrs)	7	22		38	979		487	17		1551
PHF	0.58	0.66		0.64	0.78		0.90	0.50		0.84

Attachment 2
ADT Trends

	Year	Adjusted Average Daily Traffic
1	2001	7970
2	2002	8760
3	2003	0
4	2004	9520
5	2005	9379
6	2006	11440
7	2007	11790
8	2008	12310
9	2009	11960
10	2010	12140
11	2011	12830
12	2012	11700
13	2013	13940
14	2014	12710
15	2015	12660
16	2016	12860

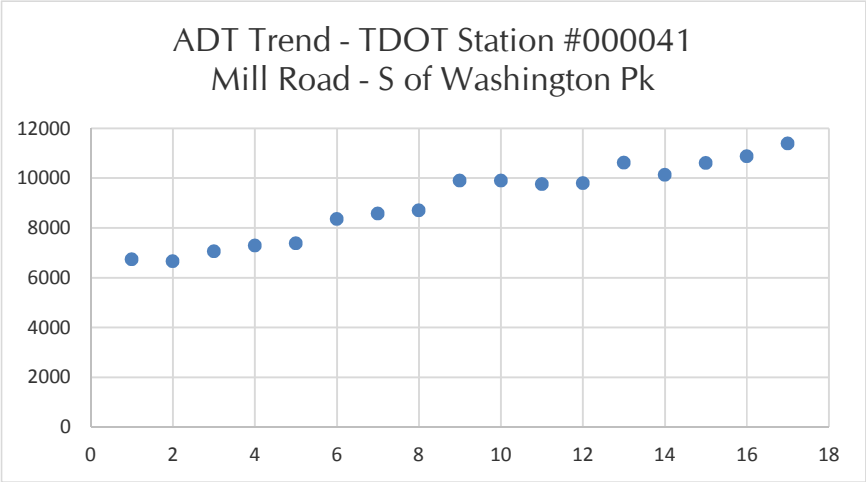


Most Recent Trend Line Growth

Year	ADT
2012	11700
2016	12860

Annual Percent Growth **1.98%**

	Year	Adjusted Average Daily Traffic
1	2000	6734
2	2001	6663
3	2002	7062
4	2003	7287
5	2004	7378
6	2005	8359
7	2006	8578
8	2007	8701
9	2008	9894
10	2009	9901
11	2010	9756
12	2011	9793
13	2012	10623
14	2013	10133
15	2014	10611
16	2015	10870
17	2016	11392



Most Recent Trend Line Growth

Year	ADT
2012	10623
2016	11392

Annual Percent Growth **1.45%**

Attachment 3
Trip Generation

Project: Legends at Washington Pike
Date Conducted: 8/2/2018

Local Apartment Trip Generation Study
82 Duplex Townhomes

Average Daily Traffic
T = 15.193 (X)^0.899
T = 15.193 (82) ^0.899
T = 798

Peak Hour of Adjacent Street Traffic
One Hour Between 7 and 9 a.m.
T = 0.758 (X) ^0.924
T = 0.758 (82) ^0.924
T = 45

Peak Hour of Adjacent Street Traffic
One Hour Between 4 and 6 p.m.
T = 0.669 (X) + 10.069
T = 0.669 (82) + 10.069
T = 65

		Percent		Number	
Time Period	Total Trips	Enter	Exit	Enter	Exit
Weekday (24 hours)	798	50%	50%	399	399
AM Peak Hour	45	22%	78%	10	35
PM Peak Hour	65	55%	45%	36	29

Project: Legends at Washington Pike
Date Conducted: 8/2/2018

Single-Family Detached Housing (LUC 210)
179 Single Family

Average Daily Traffic
$Ln(T) = 0.92Ln(X) + 2.72$
$Ln(T) = 0.92Ln(179) + 2.72$
$T = 1794$

Peak Hour of Adjacent Street Traffic
One Hour Between 7 and 9 a.m.
$T = 0.70(X) + 9.74$
$T = 0.70(179) + 9.74$
$T = 135$

Peak Hour of Adjacent Street Traffic
One Hour Between 4 and 6 p.m.
$Ln(T) = 0.90Ln(X) + 0.51$
$Ln(T) = 0.90Ln(179) + 0.51$
$T = 177$

Time Period	Total Trips	Percent		Number	
		Enter	Exit	Enter	Exit
Weekday (24 hours)	1794	50%	50%	897	897
AM Peak Hour	135	25%	75%	34	101
PM Peak Hour	177	63%	37%	112	65

KNOXVILLE·KNOX COUNTY
MPC
METROPOLITAN
PLANNING
COMMISSION
TENNESSEE

MEMORANDUM

To: Traffic Impact Study Reviewers and Preparers (see attached list)

From: Mike Conger MDC

Date: August 14, 2000

Subject: Local Trip Generation Rates for Multi-Family Residential Uses

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Attached please find a summary of the final report with data plots for the Knox County Local Apartment Trip Generation Study. As you will recall, this report was discussed when the traffic impact study group last convened this past February. A consensus was reached at that meeting that the trip generation rates developed in the local study should be used for new apartment complexes and any other "multi-family" residential uses that are being proposed.

The MPC voted at its July 2000 meeting to officially amend the Traffic Impact Study Guidelines with language which reads that "trip generation rates for proposed uses shall be calculated using the latest edition of the ITE Trip Generation Manual, or using local data when it is available". This amendment allows the full implementation of the new rates, and they should be used for future proposed multi-family developments unless it can be demonstrated otherwise.

Thanks for your assistance and cooperation in this matter, if there are any questions or comments, please let me know.

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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

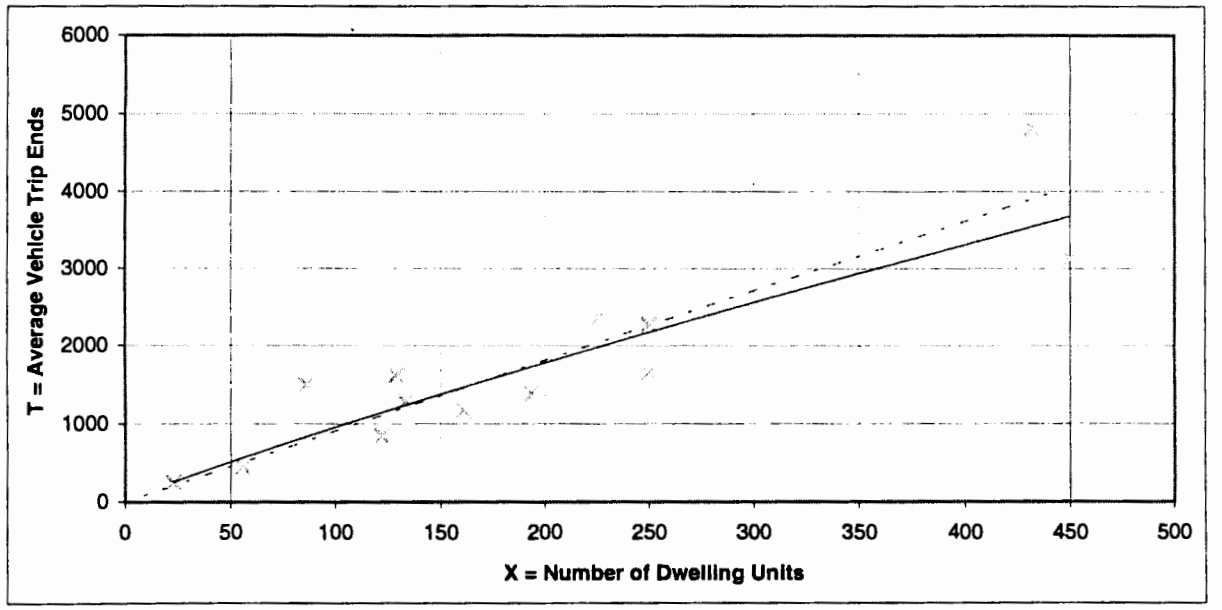
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday**

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



X Actual Data Points ——— Fitted Curve ····· Average Rate

Fitted Curve Equation: $T = 15.193(X)^{0.899}$ $R^2 = 0.88$

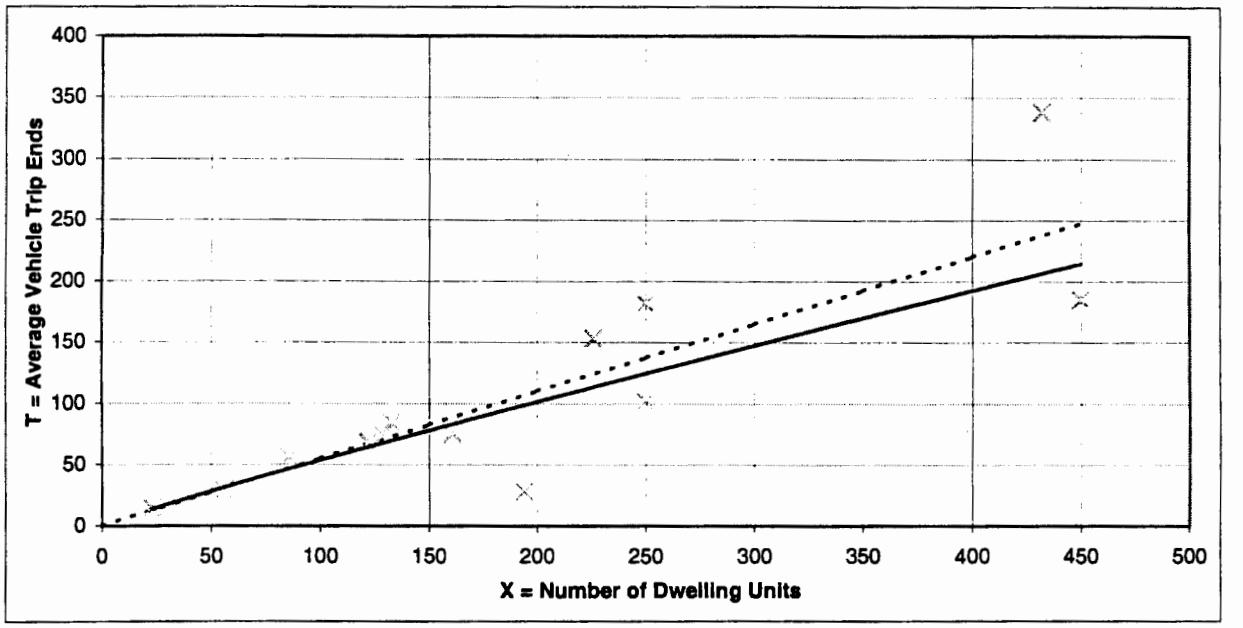
Local Apartment
Trip Generation Study

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



X Actual Data Points ——— Fitted Curve ····· Average Rate

Fitted Curve Equation: $T = 0.758(X)^{0.924}$ $R^2 = 0.75$

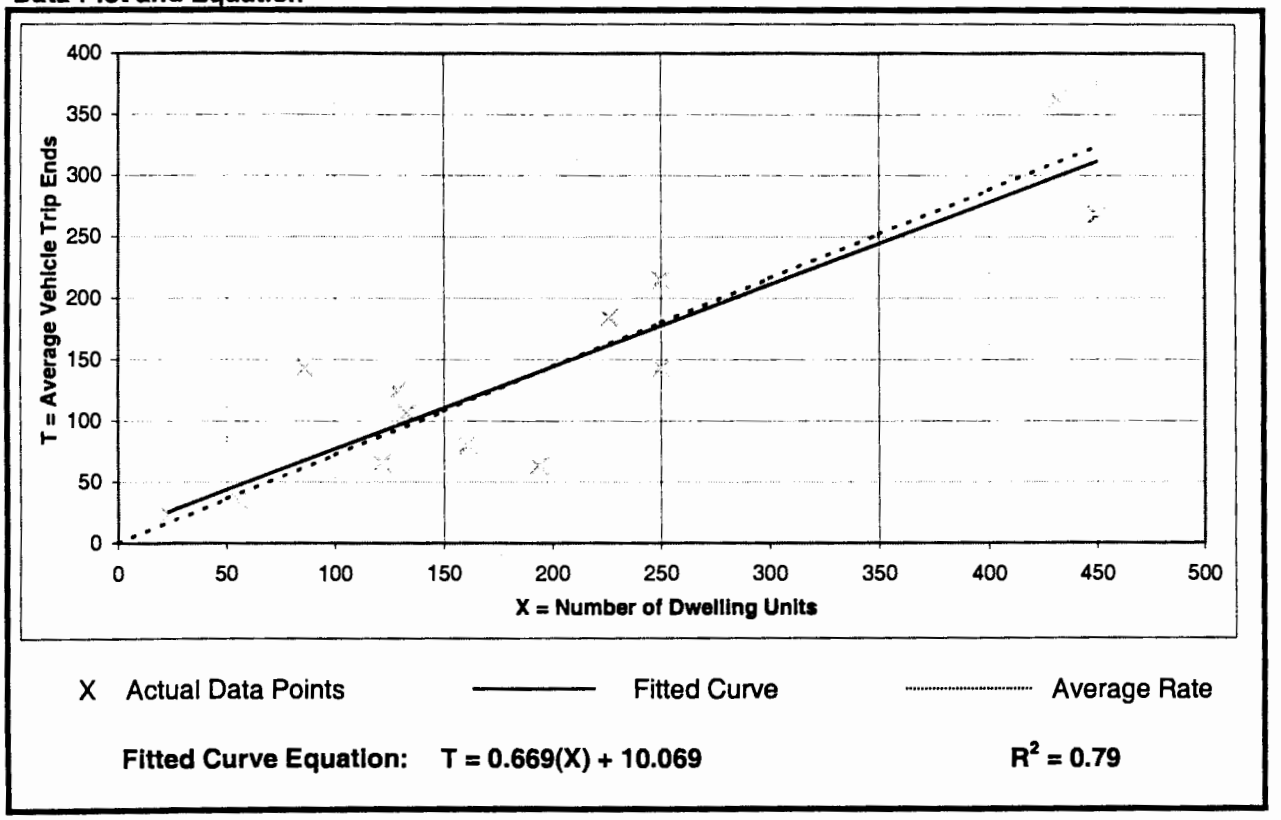
Local Apartment
Trip Generation Study

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



X Actual Data Points ——— Fitted Curve ····· Average Rate

Fitted Curve Equation: T = 0.669(X) + 10.069 **R^2 = 0.79**

Single-Family Detached Housing
(210)

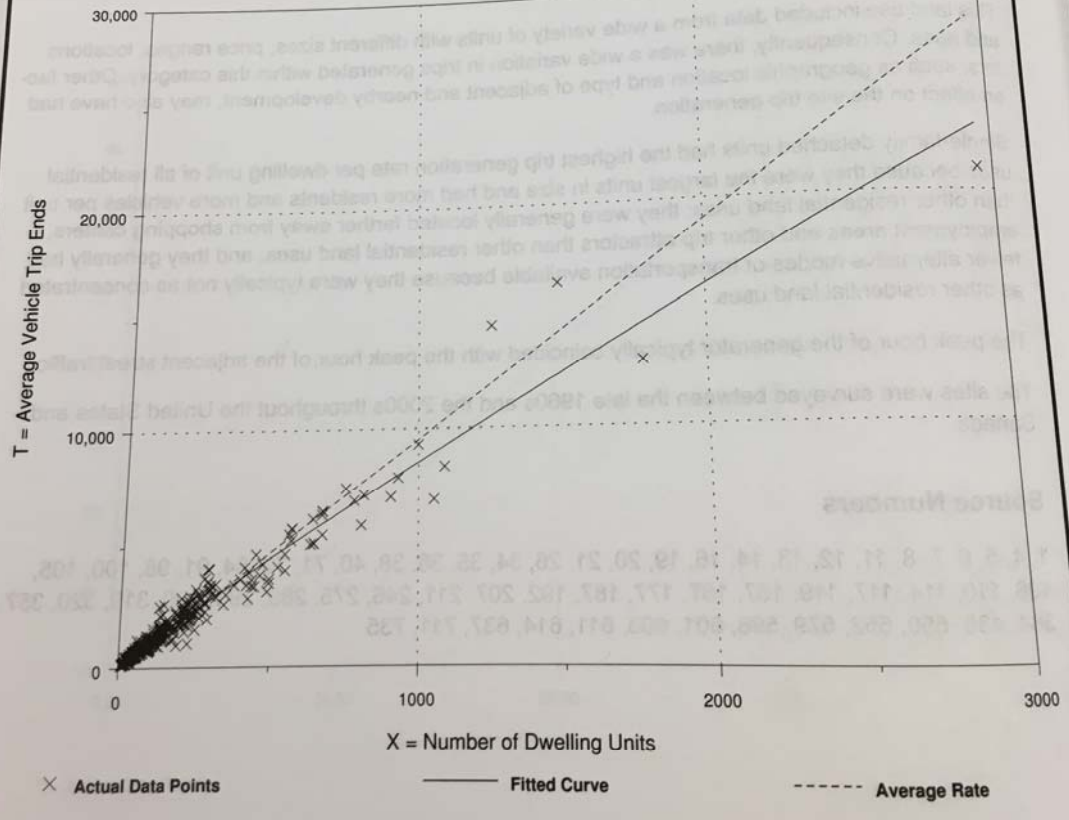
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 355
Avg. Number of Dwelling Units: 198
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.52	4.31 - 21.85	3.70

Data Plot and Equation



Fitted Curve Equation: $Ln(T) = 0.92\ Ln(X) + 2.72$

$R^2 = 0.95$

Single-Family Detached Housing
(210)

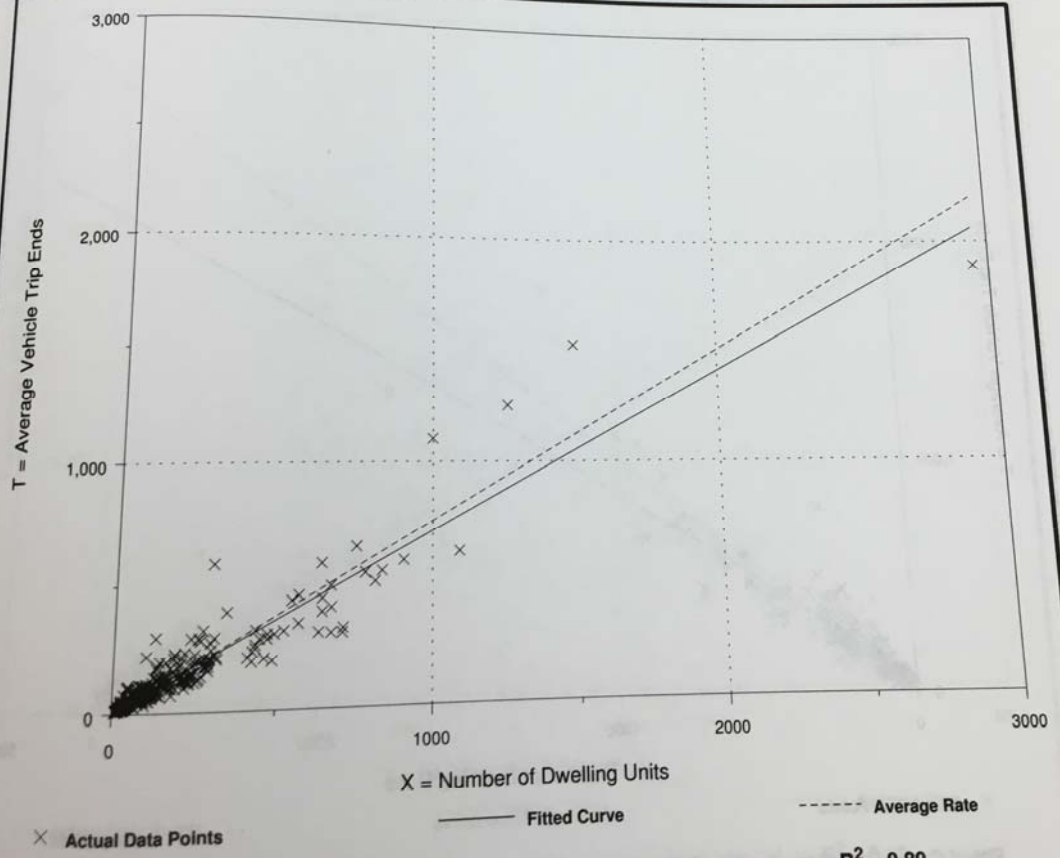
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Number of Studies: 292
Avg. Number of Dwelling Units: 194
Directional Distribution: 25% entering, 75% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.75	0.33 - 2.27	0.90

Data Plot and Equation



$R^2 = 0.89$

Fitted Curve Equation: T = 0.70(X) + 9.74

Single-Family Detached Housing
(210)

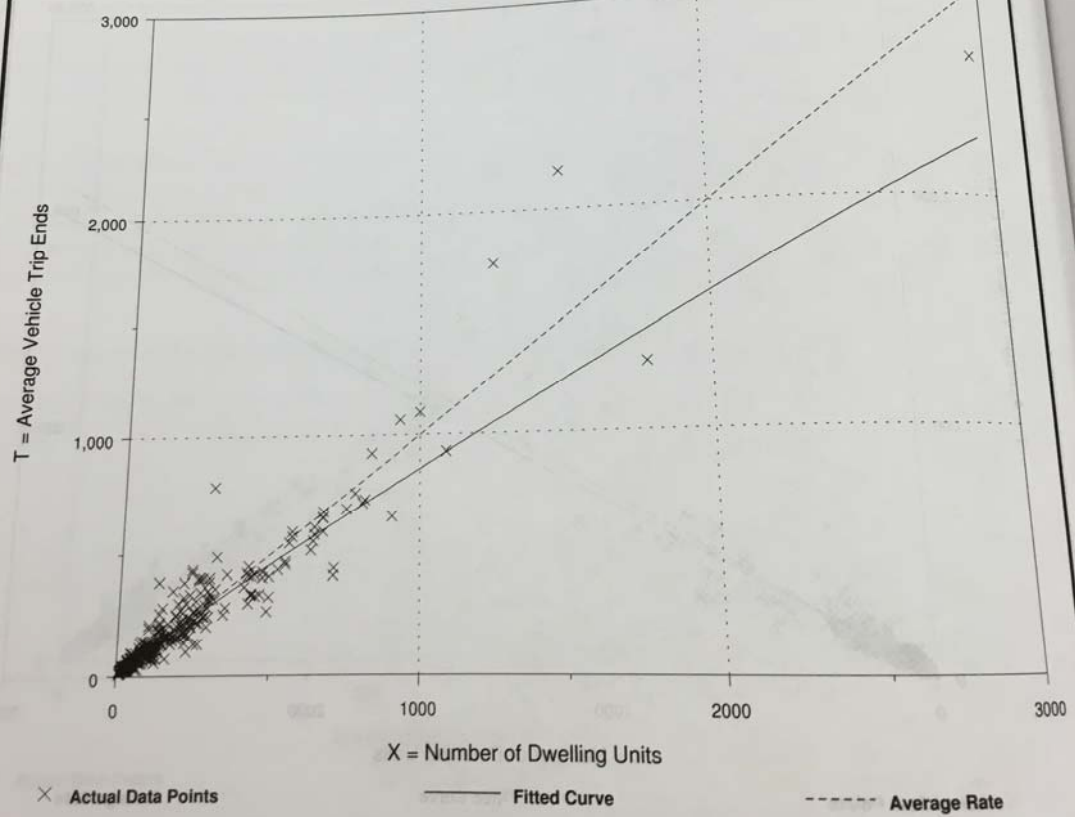
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 321
Avg. Number of Dwelling Units: 207
Directional Distribution: 63% entering, 37% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
1.00	0.42 - 2.98	1.05

Data Plot and Equation



Fitted Curve Equation: $Ln(T) = 0.90\ Ln(X) + 0.51$

$R^2 = 0.91$

Attachment 4
Signal Timing

Database Printout of 1880EL Local
Filename: DATA\INT#1101.EL
Intersection: WASHINGTON/MILL 11/22/11 Tue Nov 15 13:18:22 2016

Startup Data:

	Ring 1	2
Start Phases	2	6
UCF Entry Phases	4	0
UCF Exit Phases	2	6

Start Overlaps Yellow at Power-up?	NO	
Start in All Red at Power-up?	NO	
Zone ID:	9	
Controller ID:	2	
Hold 2 sec. Minimum Red Revert?	YES	Red Revert Time: 4.0 sec.
Override Holds if Uniform Code Flash Active?	YES	
Dual Entry 1256?	NO	
Dual Entry 3478?	NO	
Passage Interval Sequential?	YES	
Simultaneous Gap?	NO	
Conditional Service set by Input?	NO	
Conditional Service 1256?	NO	
Conditional Service 3478?	NO	

Timing Data:

Interval	Time by Phase (sec.)							
	1	2	3	4	5	6	7	8
Initial	8	12	10	10	10	12	10	10
Passage	3.0	3.0	2.5	3.0	2.5	3.0	2.5	2.5
Yellow	4.0	4.5	4.0	4.0	4.0	4.5	4.0	4.0
Red Clear	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Max 1	20	50	15	20	15	70	15	41
Max 2	20	0	20	50	20	0	20	50
Walk	0	0	0	0	0	0	0	0
Ped Clear	0	0	0	0	0	0	0	0

Max 3 Parameters

	1	2	3	4	5	6	7	8
Adjust (sec.)	10	0	0	10	0	0	0	0
Limit (sec.)	40	0	0	40	0	0	0	0
Set (max outs)	2	0	0	2	0	0	0	0
Clr (gap outs)	1	0	0	1	0	0	0	0

Functions:

	1	2	3	4	5	6	7	8
Min. Recall	N	Y	N	N	N	Y	N	N
Max. Recall	N	Y	N	N	N	Y	N	N
Ped. Recall	N	N	N	N	N	N	N	N
Det. Non-lock	Y	N	N	Y	N	N	N	N
CNA I Active	N	Y	N	N	N	Y	N	N

CNA II Active	N	N	N	N	N	N	N	N
Flashing Walks	N	N	N	N	N	N	N	N
Phase Omitted	N	N	Y	N	Y	N	Y	Y
Ped Omitted	Y	Y	Y	Y	Y	Y	Y	Y
Soft Recall	N	N	N	N	N	N	N	N

Ped Cl thru Yel	N	N	N	N	N	N	N	N
Ped Cl thru Red	N	N	N	N	N	N	N	N

Density:

Last Car Passage Active: NO

	1	2	3	4	5	6	7	8
Density Active	N	N	N	N	N	N	N	N
Added Initial	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max. Initial	0	0	0	0	0	0	0	0
Time to Reduce	0	0	0	0	0	0	0	0
Time bef. Red.	0	0	0	0	0	0	0	0
Minimum Gap	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Begin Daylight Savings in week: 15
End Daylight Savings in week: 45

Time of Day Changepoints:
Base Day Plan 0

Time	Cycle	Offset	Ckt 1 (Flash)	Ckt 0 (Free)	Ckt 9
00:00	1	3	.	X	.
06:30	1	1	.	.	.
09:30	1	3	.	X	.
11:30	2	2	.	.	.
13:00	1	3	.	X	.
15:00	3	3	.	.	.
18:30	1	3	.	X	.

Base Day Plan 1

Time	Cycle	Offset	Ckt 1 (Flash)	Ckt 0 (Free)	Ckt 9
00:00	1	3	.	X	.

Week Plan:

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Plan: 0	1	0	0	0	0	0	1
Plan: 1	0	0	0	0	0	0	0
Plan: 2	0	0	0	0	0	0	0
Plan: 3	0	0	0	0	0	0	0
Plan: 4	0	0	0	0	0	0	0
Plan: 5	0	0	0	0	0	0	0
Plan: 6	0	0	0	0	0	0	0♀

Plan: 7	0	0	0	0	0	0	0
Plan: 8	0	0	0	0	0	0	0
Plan: 9	0	0	0	0	0	0	0

Week Plan Implementation:

Week 1: 0	Week 14: 0	Week 27: 0	Week 40: 0
Week 2: 0	Week 15: 0	Week 28: 0	Week 41: 0
Week 3: 0	Week 16: 0	Week 29: 0	Week 42: 0
Week 4: 0	Week 17: 0	Week 30: 0	Week 43: 0
Week 5: 0	Week 18: 0	Week 31: 15	Week 44: 0
Week 6: 0	Week 19: 0	Week 32: 0	Week 45: 0
Week 7: 0	Week 20: 0	Week 33: 0	Week 46: 0
Week 8: 0	Week 21: 0	Week 34: 0	Week 47: 0

Week 9: 0	Week 22: 0	Week 35: 0	Week 48: 15
Week 10: 0	Week 23: 0	Week 36: 0	Week 49: 0
Week 11: 0	Week 24: 0	Week 37: 0	Week 50: 0
Week 12: 0	Week 25: 0	Week 38: 0	Week 51: 0
Week 13: 0	Week 26: 0	Week 39: 0	Week 52: 0

Special Day Plan Implementation (Plan-Week-Day):

Slot 1	0 - 0 - 0	Slot 18	0 - 0 - 0	Slot 35	0 - 0 - 0
Slot 2	0 - 0 - 0	Slot 19	0 - 0 - 0	Slot 36	0 - 0 - 0
Slot 3	0 - 0 - 0	Slot 20	0 - 0 - 0	Slot 37	0 - 0 - 0
Slot 4	0 - 0 - 0	Slot 21	0 - 0 - 0	Slot 38	0 - 0 - 0
Slot 5	0 - 0 - 0	Slot 22	0 - 0 - 0	Slot 39	0 - 0 - 0
Slot 6	0 - 0 - 0	Slot 23	0 - 0 - 0	Slot 40	0 - 0 - 0
Slot 7	0 - 0 - 0	Slot 24	0 - 0 - 0	Slot 41	0 - 0 - 0
Slot 8	0 - 0 - 0	Slot 25	0 - 0 - 0	Slot 42	0 - 0 - 0
Slot 9	0 - 0 - 0	Slot 26	0 - 0 - 0	Slot 43	0 - 0 - 0
Slot 10	0 - 0 - 0	Slot 27	0 - 0 - 0	Slot 44	0 - 0 - 0
Slot 11	0 - 0 - 0	Slot 28	0 - 0 - 0	Slot 45	0 - 0 - 0
Slot 12	0 - 0 - 0	Slot 29	0 - 0 - 0	Slot 46	0 - 0 - 0
Slot 13	0 - 0 - 0	Slot 30	0 - 0 - 0	Slot 47	0 - 0 - 0
Slot 14	0 - 0 - 0	Slot 31	0 - 0 - 0	Slot 48	0 - 0 - 0
Slot 15	0 - 0 - 0	Slot 32	0 - 0 - 0	Slot 49	0 - 0 - 0
Slot 16	0 - 0 - 0	Slot 33	0 - 0 - 0	Slot 50	0 - 0 - 0
Slot 17	0 - 0 - 0	Slot 34	0 - 0 - 0		

Coordination Operating Modes:

4 Splits / 4 Cycles?	NO
Unused Cycle Time to Side St.?	NO
Ckt 4 enables Aux TOD?	NO
Offset Interruption?	NO
Cycle 4 = 2 A.M. Sync?	NO
Split 2 = 2 A.M. Sync?	NO

♀

Flash with Ckt 1?	NO
Invert Free Output?	NO
Auto Permissive?	NO
Cycle 4 = Flash?	NO
Enable Max 2 with Ckt 9?	YES
Conditional Service with Ckt 9?	NO
Invert Free Input?	NO
Activate CNA 1?	YES
Activate Walk Rest Modifier?	NO
Inhibit Max Termination?	YES
Enhanced Permissive?	NO
Use Split Matrix?	YES
Use Yellow Offset Timer?	NO
Interconnect?	YES
Maximum Dwell Time:	25 sec.
Full Dwell?	NO
Short Route?	YES

Phase Relationships:

	Ring 1 - 2
Hold 1 Phases	2 - 6
Hold 1 Omit Phases	0 - 0
Hold 2 Omit Phases	0 - 0

Hold 3 Omit Phases	0 - 0
Hold 3 Omit Phases	0 - 0
Hold 3 Omit Phases	0 - 0
Hold 3 Ped Omit	0 - 0
Non Early Release Phases	0 - 0
Non Early Release Phases	0 - 0
Non Early Release Phases	0 - 0
Phases Omitted w/ Ckt 9	0 - 0
Phases Omitted w/ Ckt 9	0 - 0
Peds Omitted w/ Ckt 9	0 - 0

Phase Reverse by	Cyc - Ofst
1 - 2	0 - 0
1 - 2	0 - 0
5 - 6	0 - 0
5 - 6	0 - 0
3 - 4	0 - 0
3 - 4	0 - 0
7 - 8	0 - 0
7 - 8	0 - 0

Split Plans:

	Percent per Phase							Permissives					
	1	2	3	4	5	6	7	8	Begin	End	Begin	End	Begin	End
Split 1	45	30	0	25	0	75	0	0	0	20	0	30	0	40
Split 2	29	40	0	31	0	69	0	0	0	20	0	30	0	40
Split 3	16	52	0	32	0	68	0	0	0	20	0	30	0	40
Split 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Split 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Split Matrix:

	Offset				
Cycle	1	2	3	4	5
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6

Offset Times:

	Offset				
Cycle	1	2	3	4	5

♀

1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0

Cycle Times:

Cycle	
1	90 sec.
2	70 sec.
3	150 sec.
4	0 sec.
5	0 sec.
6	0 sec.

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Sync Reference:

Time: 00:00
Sync with Event Time? NO

City Zero:

Active? NO

Cycle	Reference Time
1	0
2	0
3	0
4	0
5	0
6	0

Closed Loop Options:

TOD Flash/Aux? NO
Free w/ Ckt 0? YES

Report Channel Failures to Central

Conflict Flash	(3) Occurence and Resume Normal
Manual/Auto Flash	(3) Occurence and Resume Normal
MCE	(3) Occurence and Resume Normal
Preempt	(3) Occurence and Resume Normal
Channel # 5	(0) Auto-log only
Channel # 6	(0) Auto-log only
Channel # 7	(0) Auto-log only
Channel # 8	(0) Auto-log only
Door Open	(3) Occurence and Resume Normal

Main Street Phs for Out of Step Test
Ring 1 - 2
2 - 0

Speed Trap Sensor Pairs

1-2	3-4	5-6	7-8
NO	NO	NO	NO

Standard Overlaps:

Internal Overlap Program? YES

Program	Phase 1	2	3	4	5	6	7	8
Ovl A	X	X	.	.	.	.	.	.
Ovl B	X	.	.	X	.	.	.	.
Ovl C	.	.	.	.	.	.	.	.

♀

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Intersection: WASHINGTON/MILL 11/22/11 Tue Nov 15 13:18:22 2016

Ovl D	.	.	.	.	.	.	.	.

Reverse Phases	1 - 2	3 - 4	5 - 6	7 - 8
	NO	NO	NO	NO

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Attachment 5
Intersection Worksheets – Existing AM/PM Peaks

HCS7 Two-Way Stop-Control Report

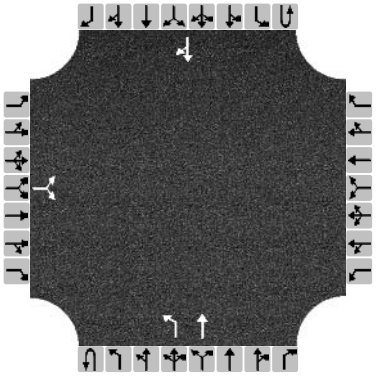
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	6/3/2018
Analysis Year	2018
Time Analyzed	Existing AM Peak
Intersection Orientation	North-South
Project Description	616.001 Legends at Washington Pike - Phase 2

Site Information

Intersection	Washington @ Rising Oak
Jurisdiction	City of Knoxville
East/West Street	Rising Oak Way
North/South Street	Washington Pike
Peak Hour Factor	0.95
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	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, V (veh/h)		38		55						5	228				963	16
Percent Heavy Vehicles (%)		2		2						2						
Proportion Time Blocked		0.000		0.000						0.000						
Percent Grade (%)		0														
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								5						

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.42		6.22						4.12						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.52		3.32						2.22						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			98							5						
Capacity, c (veh/h)			306							674						
v/c Ratio			0.32							0.01						
95% Queue Length, Q_{95} (veh)			1.3							0.0						
Control Delay (s/veh)			22.2							10.4						
Level of Service, LOS			C							B						
Approach Delay (s/veh)		22.2								0.2						
Approach LOS		C														

HCS7 Two-Way Stop-Control Report

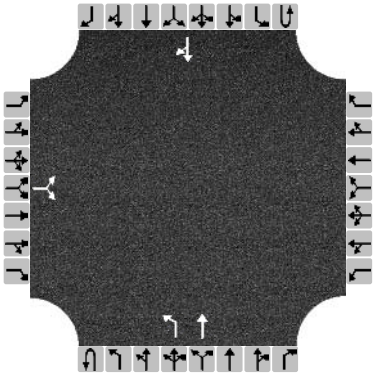
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	6/3/2018
Analysis Year	2018
Time Analyzed	Existing PM Peak
Intersection Orientation	North-South
Project Description	616.001 Legends at Washington Pike - Phase 2

Site Information

Intersection	Washington @ Rising Oak
Jurisdiction	City of Knoxville
East/West Street	Rising Oak Way
North/South Street	Washington Pike
Peak Hour Factor	0.84
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	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, V (veh/h)		7		21						36	923				459	16
Percent Heavy Vehicles (%)		2		2						2						
Proportion Time Blocked		0.100		0.000						0.000						
Percent Grade (%)		0														
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								5						

Critical and Follow-up Headways

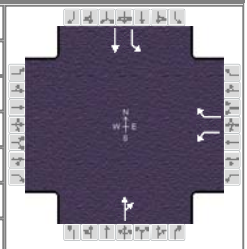
Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.42		6.22						4.12						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.52		3.32						2.22						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			33							43						
Capacity, c (veh/h)			431							1006						
v/c Ratio			0.08							0.04						
95% Queue Length, Q_{95} (veh)			0.2							0.1						
Control Delay (s/veh)			14.0							8.7						
Level of Service, LOS			B							A						
Approach Delay (s/veh)		14.0								0.3						
Approach LOS		B														

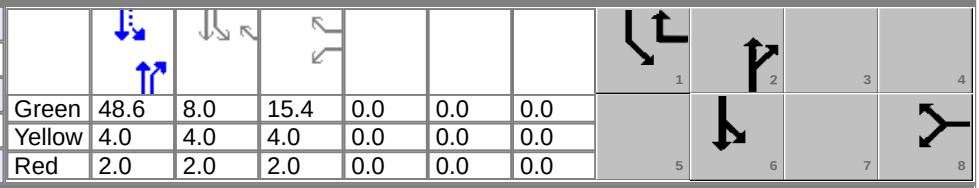
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	FMA			Duration, h	0.25
Analyst	Addie Kirkham	Analysis Date	Jun 3, 2018	Area Type	Other
Jurisdiction	City of Knoxville	Time Period	Existing AM Peak	PHF	0.97
Urban Street	Washington Pike	Analysis Year	2018	Analysis Period	1> 7:00
Intersection	Washington Pike at Mill…	File Name	Existing AM Peak Mill Road.xus		
Project Description	616.001 Legends at Washington Pike - Phase 2				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				46		249		257	58	549	923	

Signal Information			
Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	48.6	8.0	15.4	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0

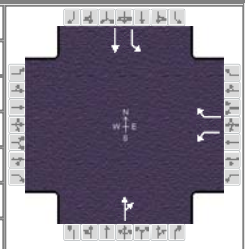
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2	1	6
Case Number				9.0		8.3	1.0	4.0
Phase Duration, s				21.4		54.6	14.0	68.6
Change Period, ($Y+R_c$), s				6.0		6.0	6.0	6.0
Max Allow Headway (*MAH*), s				3.8		0.0	3.6	0.0
Queue Clearance Time (g_s), s				14.6			2.0	
Green Extension Time (g_e), s				0.8		0.0	5.5	0.0
Phase Call Probability				1.00			1.00	
Max Out Probability				0.00			0.14	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18		2	12	1	6	
Adjusted Flow Rate (*v*), veh/h				47		257		325		566	952	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810		1610		1839		1810	1900	
Queue Service Time (g_s), s				2.0		12.6		8.9		0.0	27.5	
Cycle Queue Clearance Time (g_c), s				2.0		12.6		8.9		0.0	27.5	
Green Ratio (*g/C*)				0.17		0.26		0.54		0.61	0.70	
Capacity (*c*), veh/h				310		419		993		690	1321	
Volume-to-Capacity Ratio (*X*)				0.153		0.613		0.327		0.820	0.720	
Back of Queue (*Q*), ft/ln (95 th percentile)				39.2		210.4		159.9		433.3	375.5	
Back of Queue (*Q*), veh/ln (95 th percentile)				1.6		8.4		6.4		17.3	15.0	
Queue Storage Ratio (*RQ*) (95 th percentile)				0.26		0.00		0.00		0.00	0.00	
Uniform Delay (d_1), s/veh				31.7		29.3		11.6		22.4	8.4	
Incremental Delay (d_2), s/veh				0.2		1.1		0.9		3.6	3.4	
Initial Queue Delay (d_3), s/veh				0.0		0.0		0.0		0.0	0.0	
Control Delay (*d*), s/veh				31.9		30.4		12.4		26.0	11.8	
Level of Service (LOS)				C		C		B		C	B	
Approach Delay, s/veh / LOS	0.0			30.6		C	12.4		B	17.1		B
Intersection Delay, s/veh / LOS	18.3						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.1	B	2.3	B	2.3	B	0.7	A
Bicycle LOS Score / LOS				F	1.0	A	3.0	C

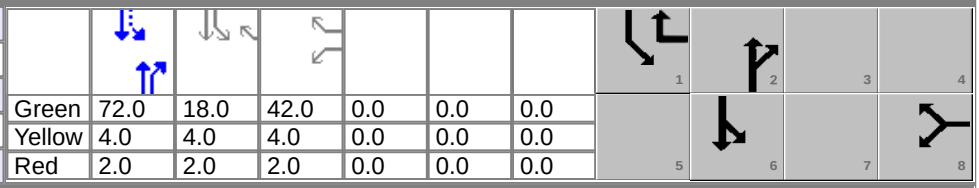
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	FMA			Duration, h	0.25
Analyst	Addie Kirkham	Analysis Date	Jun 3, 2018	Area Type	Other
Jurisdiction	City of Knoxville	Time Period	Existing PM Peak	PHF	0.94
Urban Street	Washington Pike	Analysis Year	2018	Analysis Period	1> 7:00
Intersection	Washington Pike at Mill…	File Name	Existing PM Peak Mill Road.xus		
Project Description	616.001 Legends at Washington Pike - Phase 2				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				67		555		777	87	250	371	

Signal Information			
Cycle, s	150.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	72.0	18.0	42.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2	1	6
Case Number				9.0		8.3	1.0	4.0
Phase Duration, s				48.0		78.0	24.0	102.0
Change Period, ($Y+R_c$), s				6.0		6.0	6.0	6.0
Max Allow Headway (*MAH*), s				3.8		0.0	3.6	0.0
Queue Clearance Time (g_s), s				44.0			20.0	
Green Extension Time (g_e), s				0.0		0.0	0.0	0.0
Phase Call Probability				1.00			1.00	
Max Out Probability				1.00			1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18		2	12	1	6	
Adjusted Flow Rate (*v*), veh/h				71		590		919		266	395	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810		1610		1866		1810	1900	
Queue Service Time (g_s), s				4.4		42.0		72.0		18.0	14.2	
Cycle Queue Clearance Time (g_c), s				4.4		42.0		72.0		18.0	14.2	
Green Ratio (*g/C*)				0.28		0.40		0.48		0.59	0.64	
Capacity (*c*), veh/h				507		644		896		265	1216	
Volume-to-Capacity Ratio (*X*)				0.141		0.917		1.026		1.003	0.325	
Back of Queue (*Q*), ft/ln (95 th percentile)				90.3		550.5		1320.5		510.6	256.1	
Back of Queue (*Q*), veh/ln (95 th percentile)				3.6		22.0		52.8		20.4	10.2	
Queue Storage Ratio (*RQ*) (95 th percentile)				0.60		0.00		0.00		0.00	0.00	
Uniform Delay (d_1), s/veh				40.5		42.6		39.0		64.4	12.3	
Incremental Delay (d_2), s/veh				0.1		17.9		36.9		56.1	0.7	
Initial Queue Delay (d_3), s/veh				0.0		0.0		0.0		0.0	0.0	
Control Delay (*d*), s/veh				40.6		60.5		75.9		120.4	13.0	
Level of Service (LOS)				D		E		F		F	B	
Approach Delay, s/veh / LOS	0.0			58.4		E	75.9		E	56.2		E
Intersection Delay, s/veh / LOS	64.9						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.2	B	2.3	B	2.3	B	0.7	A
Bicycle LOS Score / LOS				F	2.0	B	1.6	B

Attachment 6
Intersection Worksheets – Background AM/PM Peaks

HCS7 Two-Way Stop-Control Report

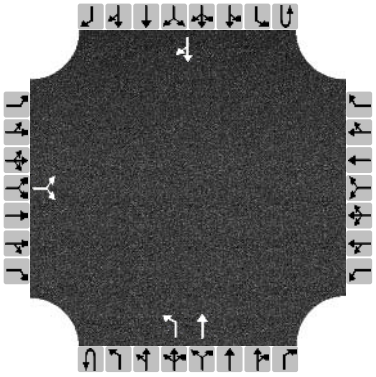
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	6/3/2018
Analysis Year	2021
Time Analyzed	Background AM Peak
Intersection Orientation	North-South
Project Description	616.001 Legends at Washington Pike - Phase 2

Site Information

Intersection	Washington @ Rising Oak
Jurisdiction	City of Knoxville
East/West Street	Rising Oak Way
North/South Street	Washington Pike
Peak Hour Factor	0.95
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	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, V (veh/h)		40		58						5	242				1022	17
Percent Heavy Vehicles (%)		2		2						2						
Proportion Time Blocked		0.000		0.000						0.000						
Percent Grade (%)		0														
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								5						

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.42		6.22						4.12						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.52		3.32						2.22						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			103							5						
Capacity, c (veh/h)			283							638						
v/c Ratio			0.36							0.01						
95% Queue Length, Q_{95} (veh)			1.6							0.0						
Control Delay (s/veh)			24.8							10.7						
Level of Service, LOS			C							B						
Approach Delay (s/veh)		24.8								0.2						
Approach LOS		C														

HCS7 Two-Way Stop-Control Report

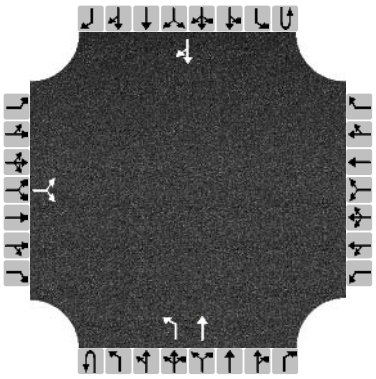
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	6/3/2018
Analysis Year	2021
Time Analyzed	Background PM Peak
Intersection Orientation	North-South
Project Description	616.001 Legends at Washington Pike - Phase 2

Site Information

Intersection	Washington @ Rising Oak
Jurisdiction	City of Knoxville
East/West Street	Rising Oak Way
North/South Street	Washington Pike
Peak Hour Factor	0.84
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	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, V (veh/h)		7		22						38	979				487	17
Percent Heavy Vehicles (%)		2		2						2						
Proportion Time Blocked		0.100		0.000						0.000						
Percent Grade (%)		0														
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								5						

Critical and Follow-up Headways

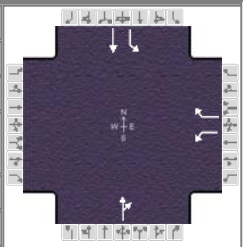
Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.42		6.22						4.12						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.52		3.32						2.22						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			34							45						
Capacity, c (veh/h)			409							976						
v/c Ratio			0.08							0.05						
95% Queue Length, Q_{95} (veh)			0.3							0.1						
Control Delay (s/veh)			14.6							8.9						
Level of Service, LOS			B							A						
Approach Delay (s/veh)		14.6								0.3						
Approach LOS		B														

HCS7 Signalized Intersection Results Summary

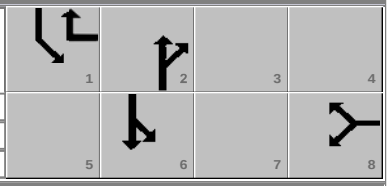
General Information				Intersection Information	
Agency	FMA			Duration, h	0.25
Analyst	Addie Kirkham	Analysis Date	Jun 3, 2018	Area Type	Other
Jurisdiction	City of Knoxville	Time Period	Background AM Peak	PHF	0.97
Urban Street	Washington Pike	Analysis Year	2021	Analysis Period	1> 7:00
Intersection	Washington Pike at Mill…	File Name	Background AM Peak Mill Road.xus		
Project Description	616.001 Legends at Washington Pike - Phase 2				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				49		264		273	62	583	979	

Signal Information			
Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	46.8	9.2	16.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



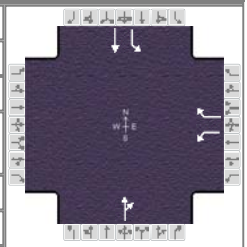
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2	1	6
Case Number				9.0		8.3	1.0	4.0
Phase Duration, s				22.0		52.8	15.2	68.0
Change Period, (*Y+R c*), s				6.0		6.0	6.0	6.0
Max Allow Headway (*MAH*), s				3.8		0.0	3.6	0.0
Queue Clearance Time (*g s*), s				15.2			5.9	
Green Extension Time (*g e*), s				0.8		0.0	3.3	0.0
Phase Call Probability				1.00			1.00	
Max Out Probability				0.00			0.28	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18		2	12	1	6	
Adjusted Flow Rate (*v*), veh/h				51		272		345		601	1009	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810		1610		1839		1810	1900	
Queue Service Time (*g s*), s				2.1		13.2		10.0		3.9	31.7	
Cycle Queue Clearance Time (*g c*), s				2.1		13.2		10.0		3.9	31.7	
Green Ratio (*g/C*)				0.18		0.28		0.52		0.60	0.69	
Capacity (*c*), veh/h				321		450		957		672	1309	
Volume-to-Capacity Ratio (*X*)				0.157		0.605		0.361		0.895	0.771	
Back of Queue (*Q*), ft/ln (95 th percentile)				41.5		216.6		182.7		478.7	431.2	
Back of Queue (*Q*), veh/ln (95 th percentile)				1.7		8.7		7.3		19.1	17.2	
Queue Storage Ratio (*RQ*) (95 th percentile)				0.28		0.00		0.00		0.00	0.00	
Uniform Delay (*d 1*), s/veh				31.3		28.1		12.7		24.7	9.3	
Incremental Delay (*d 2*), s/veh				0.2		1.0		1.1		8.3	4.4	
Initial Queue Delay (*d 3*), s/veh				0.0		0.0		0.0		0.0	0.0	
Control Delay (*d*), s/veh				31.5		29.1		13.8		33.0	13.7	
Level of Service (LOS)				C		C		B		C	B	
Approach Delay, s/veh / LOS	0.0			29.5		C	13.8		B	20.9		C
Intersection Delay, s/veh / LOS	21.0						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.1	B	2.3	B	2.3	B	0.7	A
Bicycle LOS Score / LOS				F	1.1	A	3.1	C

HCS7 Signalized Intersection Results Summary

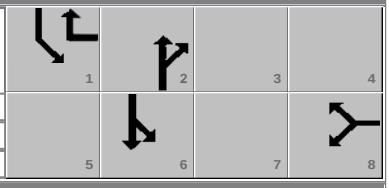
General Information				Intersection Information	
Agency	FMA			Duration, h	0.25
Analyst	Addie Kirkham	Analysis Date	Jun 3, 2018	Area Type	Other
Jurisdiction	City of Knoxville	Time Period	Background PM Peak	PHF	0.94
Urban Street	Washington Pike	Analysis Year	2021	Analysis Period	1> 7:00
Intersection	Washington Pike at Mill…	File Name	Background PM Peak Mill Road.xus		
Project Description	616.001 Legends at Washington Pike - Phase 2				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				71		589		825	92	265	394	

Signal Information			
Cycle, s	150.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	72.0	18.0	42.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2	1	6
Case Number				9.0		8.3	1.0	4.0
Phase Duration, s				48.0		78.0	24.0	102.0
Change Period, ($Y+R_c$), s				6.0		6.0	6.0	6.0
Max Allow Headway (*MAH*), s				3.8		0.0	3.6	0.0
Queue Clearance Time (g_s), s				44.0			20.0	
Green Extension Time (g_e), s				0.0		0.0	0.0	0.0
Phase Call Probability				1.00			1.00	
Max Out Probability				1.00			1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18		2	12	1	6	
Adjusted Flow Rate (*v*), veh/h				76		627		976		282	419	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810		1610		1866		1810	1900	
Queue Service Time (g_s), s				4.7		42.0		72.0		18.0	15.3	
Cycle Queue Clearance Time (g_c), s				4.7		42.0		72.0		18.0	15.3	
Green Ratio (*g/C*)				0.28		0.40		0.48		0.59	0.64	
Capacity (*c*), veh/h				507		644		896		265	1216	
Volume-to-Capacity Ratio (*X*)				0.149		0.973		1.089		1.063	0.345	
Back of Queue (*Q*), ft/ln (95 th percentile)				96		669.1		1534.9		563	272.5	
Back of Queue (*Q*), veh/ln (95 th percentile)				3.8		26.8		61.4		22.5	10.9	
Queue Storage Ratio (*RQ*) (95 th percentile)				0.64		0.00		0.00		0.00	0.00	
Uniform Delay (d_1), s/veh				40.6		44.2		39.0		64.4	12.5	
Incremental Delay (d_2), s/veh				0.1		28.6		57.2		73.0	0.8	
Initial Queue Delay (d_3), s/veh				0.0		0.0		0.0		0.0	0.0	
Control Delay (*d*), s/veh				40.7		72.8		96.2		137.3	13.2	
Level of Service (LOS)				D		E		F		F	B	
Approach Delay, s/veh / LOS	0.0			69.3		E	96.2		F	63.2		E
Intersection Delay, s/veh / LOS	78.6						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.2	B	2.3	B	2.3	B	0.7	A
Bicycle LOS Score / LOS				F	2.1	B	1.6	B

Attachment 7
Intersection Worksheets – Full Buildout AM/PM Peaks

HCS7 Two-Way Stop-Control Report

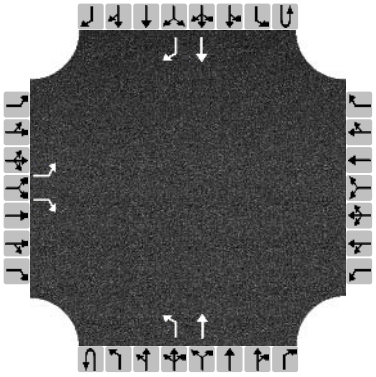
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	6/3/2018
Analysis Year	2021
Time Analyzed	Full Buildout AM Peak
Intersection Orientation	North-South
Project Description	616.001 Legends at Washington Pike - Phase 2

Site Information

Intersection	Washington @ Rising Oak
Jurisdiction	City of Knoxville
East/West Street	Rising Oak Way
North/South Street	Washington Pike
Peak Hour Factor	0.95
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	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		1	0	1		0	0	0	0	1	1	0	0	0	1	1
Configuration		L		R						L	T				T	R
Volume, V (veh/h)		96		138						16	242				1022	50
Percent Heavy Vehicles (%)		2		2						2						
Proportion Time Blocked		0.000		0.000						0.000						
Percent Grade (%)		0														
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								5						

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.42		6.22						4.12						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.52		3.32						2.22						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		101		145						17						
Capacity, c (veh/h)		321		266						619						
v/c Ratio		0.31		0.54						0.03						
95% Queue Length, Q_{95} (veh)		1.3		3.0						0.1						
Control Delay (s/veh)		21.3		33.5						11.0						
Level of Service, LOS		C		D						B						
Approach Delay (s/veh)		28.5								0.7						
Approach LOS		D														

HCS7 Two-Way Stop-Control Report

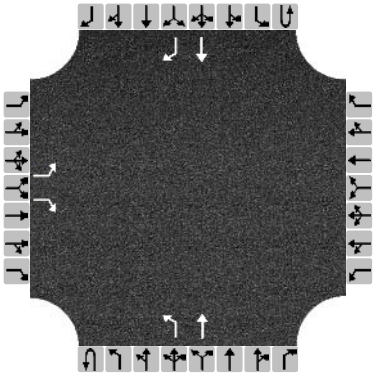
General Information

Analyst	Addie Kirkham
Agency/Co.	FMA
Date Performed	6/3/2018
Analysis Year	2021
Time Analyzed	Full Buildout PM Peak
Intersection Orientation	North-South
Project Description	616.001 Legends at Washington Pike - Phase 2

Site Information

Intersection	Washington @ Rising Oak
Jurisdiction	City of Knoxville
East/West Street	Rising Oak Way
North/South Street	Washington Pike
Peak Hour Factor	0.84
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	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		1	0	1		0	0	0	0	1	1	0	0	0	1	1
Configuration		L		R						L	T				T	R
Volume, V (veh/h)		30		93						140	979				487	63
Percent Heavy Vehicles (%)		2		2						2						
Proportion Time Blocked		0.100		0.000						0.000						
Percent Grade (%)	0															
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Left Only								5							

Critical and Follow-up Headways

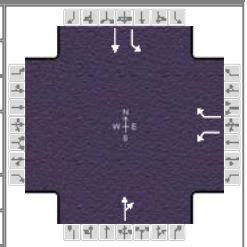
Base Critical Headway (sec)		7.1		6.2						4.1						
Critical Headway (sec)		6.42		6.22						4.12						
Base Follow-Up Headway (sec)		3.5		3.3						2.2						
Follow-Up Headway (sec)		3.52		3.32						2.22						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		36		111						167						
Capacity, c (veh/h)		164		514						932						
v/c Ratio		0.22		0.22						0.18						
95% Queue Length, Q_{95} (veh)		0.8		0.8						0.7						
Control Delay (s/veh)		32.9		13.9						9.7						
Level of Service, LOS		D		B						A						
Approach Delay (s/veh)	18.6								1.2							
Approach LOS	C															

HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	FMA			Duration, h	0.25
Analyst	Addie Kirkham	Analysis Date	Jun 3, 2018	Area Type	Other
Jurisdiction	City of Knoxville	Time Period	Full Buildout AM Peak	PHF	0.97
Urban Street	Washington Pike	Analysis Year	2021	Analysis Period	1> 7:00
Intersection	Washington Pike at Mill…	File Name	Full Buildout AM Peak Mill Road.xus		
Project Description	616.001 Legends at Washington Pike - Phase 2				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				51		264		319	72	583	1010	

Signal Information			
Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

							1	2	3	4
Green	44.7	11.8	15.5	0.0	0.0	0.0	5	6	7	8
Yellow	4.0	4.0	4.0	0.0	0.0	0.0				
Red	2.0	2.0	2.0	0.0	0.0	0.0				

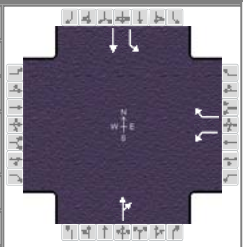
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2	1	6
Case Number				9.0		8.3	1.0	4.0
Phase Duration, s				21.5		50.7	17.8	68.5
Change Period, ($Y+R_c$), s				6.0		6.0	6.0	6.0
Max Allow Headway (*MAH*), s				3.8		0.0	3.6	0.0
Queue Clearance Time (g_s), s				14.8			10.2	
Green Extension Time (g_e), s				0.7		0.0	1.6	0.0
Phase Call Probability				1.00			1.00	
Max Out Probability				0.02			0.46	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18		2	12	1	6	
Adjusted Flow Rate (*v*), veh/h				53		272		403		601	1041	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810		1610		1839		1810	1900	
Queue Service Time (g_s), s				2.2		12.8		12.7		8.2	33.3	
Cycle Queue Clearance Time (g_c), s				2.2		12.8		12.7		8.2	33.3	
Green Ratio (*g/C*)				0.17		0.30		0.50		0.61	0.69	
Capacity (*c*), veh/h				311		488		914		649	1320	
Volume-to-Capacity Ratio (*X*)				0.169		0.557		0.441		0.925	0.789	
Back of Queue (*Q*), ft/ln (95 th percentile)				43.6		209.4		226		503.4	447.9	
Back of Queue (*Q*), veh/ln (95 th percentile)				1.7		8.4		9.0		20.1	17.9	
Queue Storage Ratio (*RQ*) (95 th percentile)				0.29		0.00		0.00		0.00	0.00	
Uniform Delay (d_1), s/veh				31.8		26.3		14.6		26.4	9.3	
Incremental Delay (d_2), s/veh				0.2		0.7		1.5		13.1	4.9	
Initial Queue Delay (d_3), s/veh				0.0		0.0		0.0		0.0	0.0	
Control Delay (*d*), s/veh				32.0		27.0		16.1		39.5	14.1	
Level of Service (LOS)				C		C		B		D	B	
Approach Delay, s/veh / LOS	0.0			27.8		C	16.1		B	23.4		C
Intersection Delay, s/veh / LOS	22.8						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.1	B	2.3	B	2.3	B	0.7	A
Bicycle LOS Score / LOS				F	1.2	A	3.2	C

HCS7 Signalized Intersection Results Summary

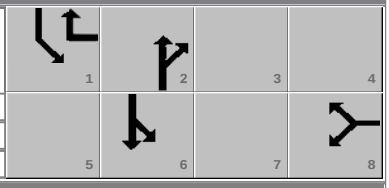
General Information				Intersection Information	
Agency	FMA			Duration, h	0.25
Analyst	Addie Kirkham	Analysis Date	Jun 3, 2018	Area Type	Other
Jurisdiction	City of Knoxville	Time Period	Full Buildout PM Peak	PHF	0.94
Urban Street	Washington Pike	Analysis Year	2021	Analysis Period	1> 7:00
Intersection	Washington Pike at Mill…	File Name	Full Buildout PM Peak Mill Road.xus		
Project Description	616.001 Legends at Washington Pike - Phase 2				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				78		589		846	94	265	433	

Signal Information			
Cycle, s	150.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	72.0	18.0	42.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	2.0	2.0	2.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8		2	1	6
Case Number				9.0		8.3	1.0	4.0
Phase Duration, s				48.0		78.0	24.0	102.0
Change Period, (*Y+R c*), s				6.0		6.0	6.0	6.0
Max Allow Headway (*MAH*), s				3.8		0.0	3.6	0.0
Queue Clearance Time (*g s*), s				44.0			20.0	
Green Extension Time (*g e*), s				0.0		0.0	0.0	0.0
Phase Call Probability				1.00			1.00	
Max Out Probability				1.00			1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18		2	12	1	6	
Adjusted Flow Rate (*v*), veh/h				83		627		1000		282	461	
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1810		1610		1866		1810	1900	
Queue Service Time (*g s*), s				5.2		42.0		72.0		18.0	17.3	
Cycle Queue Clearance Time (*g c*), s				5.2		42.0		72.0		18.0	17.3	
Green Ratio (*g/C*)				0.28		0.40		0.48		0.59	0.64	
Capacity (*c*), veh/h				507		644		896		265	1216	
Volume-to-Capacity Ratio (*X*)				0.164		0.973		1.116		1.063	0.379	
Back of Queue (*Q*), ft/ln (95 th percentile)				105.9		669.2		1639.1		563	301.3	
Back of Queue (*Q*), veh/ln (95 th percentile)				4.2		26.8		65.6		22.5	12.1	
Queue Storage Ratio (*RQ*) (95 th percentile)				0.71		0.00		0.00		0.00	0.00	
Uniform Delay (*d 1*), s/veh				40.7		44.2		39.0		64.4	12.8	
Incremental Delay (*d 2*), s/veh				0.1		28.6		67.3		73.0	0.9	
Initial Queue Delay (*d 3*), s/veh				0.0		0.0		0.0		0.0	0.0	
Control Delay (*d*), s/veh				40.9		72.8		106.3		137.3	13.7	
Level of Service (LOS)				D		E		F		F	B	
Approach Delay, s/veh / LOS	0.0			69.1		E	106.3		F	60.7		E
Intersection Delay, s/veh / LOS	81.7						F					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.2	B	2.3	B	2.3	B	0.7	A
Bicycle LOS Score / LOS				F	2.1	B	1.7	B

Attachment 8
Turn Lane Warrant Analysis

Project: Legends at Washington Pike - Phase 2

Washington Pike
at Rising Oak Way

RIGHT TURN	VOLUMES			
	Thru	RT	RT MAX	Warrant Met
AM	1022	50	25	YES
PM	487	63	49	NO

Washington Pike at Rising Oak Way

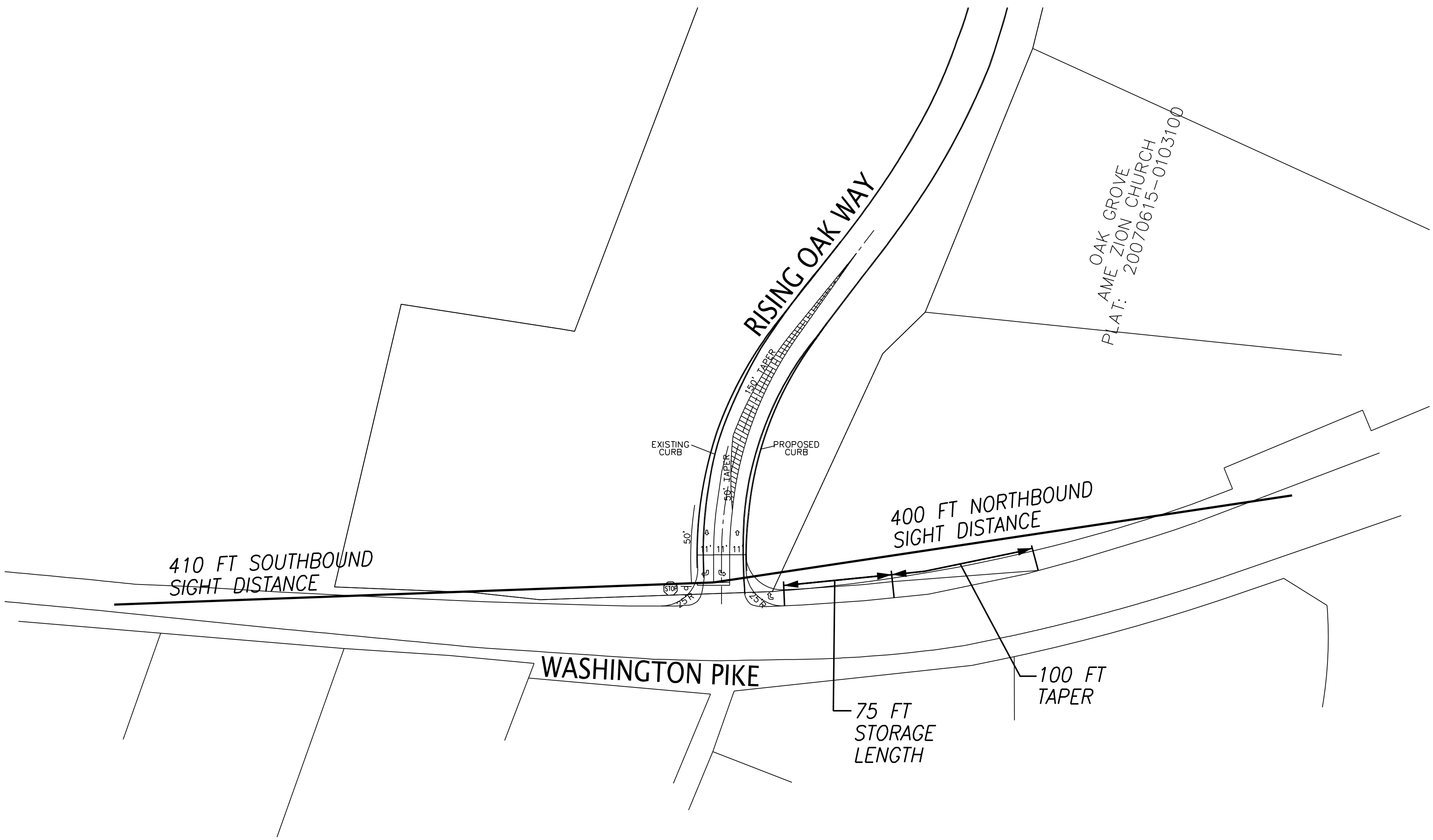
TABLE 5B

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 Yes
300 - 349 350 - 399			Yes	Yes Yes	Yes Yes	Yes Yes
400 - 449 450 - 499		Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes
500 - 549 550 - 599	Yes	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		PM Peak 63 RT		Yes	Yes Yes	Yes Yes
100 - 149 150 - 199		Yes	Yes Yes	Yes Yes	Yes	AM Peak 50 RT Yes
200 - 249 250 - 299	Yes 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.


RISING OAK WAY
OAK GROVE
AME ZION CHURCH
PLAT: 20070615-0103100
150' TAPER
EXISTING CURB
PROPOSED CURB
50' TAPER
50'
11'
11'
11'
STOP
25'R
25'R
410 FT SOUTHBOUND
SIGHT DISTANCE
400 FT NORTHBOUND
SIGHT DISTANCE
WASHINGTON PIKE
75 FT
STORAGE
LENGTH
100 FT
TAPER

Attachment 9
Aerial Photos

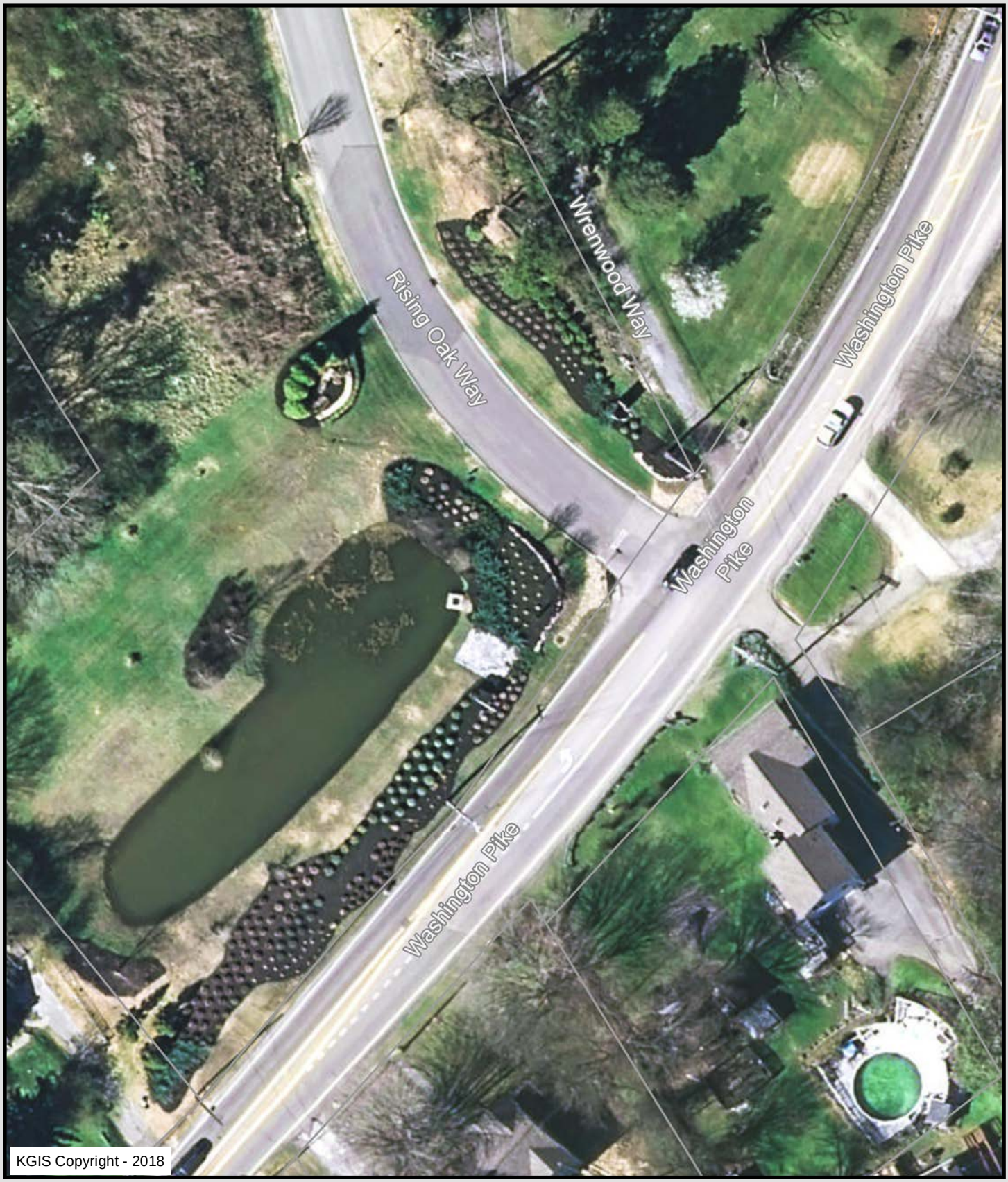
Washington Pike at Mill Road

Printed: 6/3/2018 at 12:22:37 PM

0 25 50 100

ft

Knoxville - Knox County - KUB Geographic Information System



Washington Pike at Rising Oak Way

Printed: 6/3/2018 at 12:21:27 PM

0 25 50 100

ft

Knoxville - Knox County - KUB Geographic Information System

Date: August 6, 2018

Project Name: Legends at Washington Pike – Phase 2

To: MPC and City of Knoxville Engineering Department

Subject: TIS Comment Response Document for the Legends at Washington Pike – Phase 2 Review Comments Dated August 2, 2018.

Dear MPC and City of Knoxville staff,

The following comment response document is submitted to address comments dated August 2, 2018:

Reviewer Comment: On page 3 under Washington Pike at Rising Oak Way, correct the first paragraph to read "the eastbound approach exiting the development will operate at a LOS F". In the second paragraph capitalize 'Pike'.

Response: Added "exiting the development" and capitalized "Pike".

Reviewer Comment: In the last paragraph of this page, the report says a LOS E during the PM at the signalized intersection of Washington Pike and Mill Road. With a delay of this type, there needs to be recommended mitigations if this is due to the development. Also, existing timing should be used at the signal and should not be optimized.

Response: Removed the optimized signal timing from the report and added "FMA does not recommend any improvements to the intersection of Washington Pike at Mill Road as a part of the Legends at Washington Pike – Phase 2 development. The highest delay from this intersection is a result of the southbound left turn lane on Washington Pike which is not affected by this development."

Reviewer Comment: On page 7, mention that Rising Oak Way is a private road. Mention in the third paragraph what the required sight distance is for the intersection of Washington Pike at Rising Oak Way. At the end of this paragraph, remove the last sentence discussing sight distance measured 20 ft back from the edge of pavement. City of Knoxville policy is 15 ft from the edge of pavement and that is already discussed.

Response: Added "Rising Oak Way is a two-lane private road" and "The minimum required sight distance for a road with a posted speed limit of 40 mph is 400 feet in each direction in accordance with the "Subdivision Regulations" for Knoxville and Knox County." to page 7 and removed the last sentence regarding sight distance measured from 20 ft back.

Reviewer Comment: In Figure 3 (pg 9), correct the through AM westbound traffic at the intersection of Washington Pike and Rising Oak Way. The TMC for this direction is different than what is in the Figure.

Response: Revised Figure 3 to match the TMC at the intersection of Washington Pike at Rising Oak Way.

Reviewer Comment: On page 10 fourth paragraph, the report mentioned 2% annual growth rate was used at the intersection of Washington Pike at Rising Oak Way. After review of this in the appendix, the review team noticed 3% was used. Please check.

Response: The 2% growth rate at the intersection of Washington Pike at Rising Oak Way is correct. I updated Figure 4 to reflect the changes.

Reviewer Comment: Figure 4 on page 11 needs to be corrected if this is the case.

Response: Revised Figure 4 to show 2% growth rate at the intersection of Washington Pike at Rising Oak Way.

Reviewer Comment: In Table 4-1 (pg 12), correct the Weekday Total Local Apartment Trips. The table says 573 trips, but the equation gives 754 trips. This would also change the Total Combined trips.

Response: Revised Table 4-1 with the correct weekday total local apartment trips.

Reviewer Comment: For Full Buildout in Table 5-1, show LOS summary for existing and optimized timing plans. Please provide signal timing plan for optimized if used.

Response: Removed the optimized signal timing from the report.

Reviewer Comment: For Washington Pike at Rising Oak Way (Full Buildout 2021), please correct the approach in the PM Peak from SB to NB. This would be consistent with the HCS worksheets.

Response: Revised Table 5-1 for Washington Pike at Rising Oak Way (Full Buildout 2021) to NB approach.

Reviewer Comment: In the Turn Lane Warrant Analysis (pg 20), please provide discussion on if there is enough ROW for the recommended right-turn lane. What are storage and bay taper dimensions?

Response: Added "The right-of-way for Washington Pike at the intersection with Rising Oak Way is 88 feet per the Major Road Plan. There is approximately 10 feet between the edge of pavement and the property line for the Oak Grove Zion Church therefore; the owner may need to acquire property from the Oak Grove Zion Church in order to install a right turn lane. Per AASHTO "A Policy on

Geometric Design of Highways and Streets" the recommended storage length for the right turn lane is three car lengths (approximately 75 feet) and the recommended taper length is 100 feet." to the turn lane warrant analysis.

Reviewer Comment: In the Conclusions and Recommendations second paragraph (pg 20), please provide a queue length for the blocked driveway.

Response: Added the following to the Conclusions and Recommendations "The signalized intersection capacity analysis for the intersection of Washington Pike at Mill Road shows an existing 95% queue length for the northbound approach of 159.9 feet during the AM peak hour and 1320.5 feet during the PM peak hour."

Reviewer Comment: On page 21 first paragraph first sentence, which right-turn lane is being discussed?

Response: Revised to say "A turn lane warrant is met for a southbound right turn lane on Washington Pike"

Reviewer Comment: In second paragraph, remove "Minimum" from "Minimum Subdivision Regulations".

Response: Removed the word "Minimum".

Reviewer Comment: In third paragraph, the report recommends landscaping to be minimum to keep sight distance at intersection. Does the sight distance line extend onto private property? Show in a diagram with the turn lane and dimensions.

Response: Added a diagram to Attachment 8.

Reviewer Comment: Under Washington Pike at Mill Road, mention if there are improvements recommended or not and use the existing timing plan at this location, not optimized. This can be received through the City of Knoxville Traffic Office.

Response: Added "FMA does not recommend any improvements to the intersection of Washington Pike at Mill Road as a part of the Legends at Washington Pike – Phase 2 development. The highest delay from this intersection is a result of the southbound left turn lane on Washington Pike which is not affected by this development."

Sincerely,

Addie Kirkham, P.E.