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MEMORANDUM

To: Raymond Hayhurst, Complete Street Coordinator
City of Alexandria

From: David Samba, P.E.
Mike Shindledecker, E.I.T.
Kimley-Horn and Associates, Inc.

Date: August 10, 2017

Subject: King-Callahan-Russell Access to Transit Improvement Study
VISSIM Analysis of Intersection Concept with Alternate Phasing

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This technical memorandum has been prepared to summarize a VISSIM microsimulation analysis of the intersection of King Street, Callahan Drive, and Russell Road in the City of Alexandria. The analysis considers the implementation of the King-Callahan-Russell Access to Transit Improvements Project, a grant funded effort to redesign the intersection with the goal of improving pedestrian and bicycle access to the King Street Metrorail Station. Included in this technical memorandum is a discussion of the project background, the analysis of existing and future conditions with alternate traffic signal timing and phasing, and conclusions regarding the VISSIM microsimulation analysis.

Project Background

As part of the Access to Transit Improvement project, the City of Alexandria developed a preliminary intersection design plan. The study area is shown in **Figure 1**. Existing lane designations are shown in **Figure 2**. The design plans, included **Attachment A,** contain the following elements:

- Eastbound bike lanes across the King-Callahan-Russell intersection
- Reconstruction of curb between southbound Russell Road and eastbound King Street
- Restriction of eastbound right turns into the Masonic Temple from King Street
- Westbound bike lane and left turn queue jump
- Exclusive northbound left turn lane.
- Restriction of southbound right turns from Russell Road
- Removal of intersection islands
- Pedestrian upgrades (crosswalks, signal heads, ADA compliant ramps)
- Modification of lane widths on all approaches.
- Consideration of leading pedestrian intervals for all crossing movements

The City has requested Kimley-Horn to provide traffic engineering services to evaluate the proposed concept and determine the impacts of alternate signal timing and phasing with the design.

Analysis Methodology

The following methodology was used to evaluate the traffic impacts of the proposed design:

- The City collected existing conditions pedestrian, bicycle, and traffic data at the King-Callahan-Russell intersection and at the north entrance to the Masonic Temple along King Street. The counts were conducted on September 15, 2016. Traffic count data is included in **Attachment B.**
- The City provided Synchro files which contained existing traffic counts and signal timing data for study area intersections. Synchro files are included as an electronic attachment.
- Kimley-Horn developed balanced traffic volumes at the area intersections. Volumes were balanced away from the King-Callahan-Russell intersection. Balanced existing conditions volumes are included in **Figure 3**.
- Kimley-Horn calibrated a VISSIM 8 microsimulation model for use in the analysis. The VISSIM model was calibrated to the existing volumes and also to the observed queuing at the intersection of the King-Callahan-Russell intersection. Existing vehicle queues, by approach, were collected by the City on January 11, 2017. Vehicle queue observations are included in **Attachment C**. Calibration results are included in **Attachment D**.
- Using the calibrated VISSIM model, Kimley-Horn analyzed existing conditions (based on the average simulation results of 10 runs)
- Kimley-Horn developed 2040 future balanced traffic volumes by applying an annual growth rate of 1 percent, as directed by the City, and balancing the grown volumes to area intersections. Balanced future baseline volumes are shown in **Figure 4**.
- Kimley-Horn developed and analyzed a future condition “baseline” model. This model assumes 2040 traffic volumes with existing signal timing and existing lane configurations.
- Kimley-Horn developed and analyzed future conditions with the design concept geometry. Future conditions assume 2040 traffic volumes with reassignments to account for the proposed concept design plan. Balanced future build volumes are shown in **Figure 5**. The three alternative future scenarios are described as follows:
    - Alternative 1: Build geometry with concurrent protected/permissive left turn phases for northbound Callahan and southbound Russell with an exclusive pedestrian phase and no turn on red (NTOR) when pedestrians are present signs
    - Alternatives 2a and 2b: Protected Only “lead-lag” left turns for northbound Callahan and southbound Russell with the conventional pedestrian phases and NTOR when pedestrians are present signs. Alternative 2a includes leading pedestrian intervals (LPI) of 5 seconds for all approaches, while alternative 2b does not.
    - Alternative 3: Existing split phase signal operation, with LPI and NTOR for the northern leg crosswalk, in addition to retaining the existing LPI in place for the southern leg crosswalk

Analysis Results

AM PEAK HOUR

AM peak hour delay and level of service (LOS) results are presented in **Table 1**. AM peak hour queuing results are presented in **Table 2.**

Existing Conditions

The existing conditions AM analysis indicates that the overall intersection operates at an acceptable LOS D. The eastbound and westbound approaches operate at LOS D or better, while the northbound and southbound approaches each operate at LOS E, which is generally acceptable for the minor street approaches to an intersection. Movements with significant delays included the northbound left and through movements (currently being made out of a single shared lane), the southbound through and right movements (currently being made out of a single shared lane), and the westbound left turn movement.

The existing maximum queuing at the intersection is significant along the northbound, southbound, and eastbound directions. Assuming an average vehicle length of 25 feet, the northbound maximum queues nearly spill back to the Duke Street intersection, the southbound queues spill back approximately 400 feet to W. Cedar Street, and the eastbound queues spill back 1,075 feet to just beyond Park Road.

2040 Baseline Conditions

The 2040 baseline conditions AM analysis indicates that overall intersection level of service would worsen to LOS E with future traffic, which is generally considered to be approaching unacceptable delay for motorists outside of dense urban areas. Only the eastbound approach of King Street operates at an acceptable LOS B, while the westbound, northbound, and southbound approaches operate at LOS E, F, and F, respectively. Movements of significant delays include those previously mentioned in the discussion of existing conditions, as well as the southbound left turn movement which worsens from LOS D to LOS F.

Queuing also worsens on all approaches to the intersection compared to existing conditions. The eastbound approach increases to a maximum queue length of 2,500 feet, extending through the Upland Place intersection. The southbound approach also increases to a maximum queue of approximately 1,050 feet, extending to W. Linden Street. The northbound and westbound queues also increase approximately 50 percent in length compared to existing conditions.

The existing intersection geometry, lane use, and signal operation does not appear appropriate for the future traffic volumes considered under the baseline scenario, resulting in increased delays and queuing. The existing split phase operation of the intersection results in a small share of green time that can be allocated to eastbound and westbound approaches. Additionally, the existing shared lane configuration creates delay as through vehicles must occasionally wait behind turning vehicles.

Alternative 1 Conditions

Alternative 1 (which includes an exclusive pedestrian phase), results in similar delay to baseline conditions. Concurrent northbound and southbound left-turn movements improve the southbound approach significantly, while also allowing for the reallocation of green time among the different approaches.

Queuing remains generally consistent with baseline conditions. The exclusive pedestrian phase, while provided good LOS for pedestrian crossings, would result in additional vehicle delays at the intersection for cycles where the pedestrian phase is called.

Alternative 2a/2b

Alternative 2a and 2b (north-south lead-lag phasing with and without LPI), produce LOS results that are significantly better that the baseline condition and consistent with existing conditions, despite the 2040 traffic volumes. The overall intersection level of service improves to LOS D compared to baseline conditions LOS E. Significant delay is reductions are achieved on the southbound approach, and on the southbound through, northbound through, and northbound left-turn movements. Alternative 2b operates with slightly improved LOS compared to alternative 2a, due to the additional green time an LPI uses to serve pedestrians.

Queuing is improved compared to baseline conditions on the northbound, southbound, and eastbound approaches. The eastbound queue reduces by nearly 1,000 feet compared to the baselined conditions.

Alternative 3

Analysis of alternative 3 (LPI on north and south leg crosswalks with current split phasing) shows an improvement over baseline conditions for the northbound and southbound approaches due to timing adjustments. Overall intersection delay is reduced to LOS D compared to baseline LOS E.

Queuing is improved on northbound and southbound approaches; however eastbound and westbound queuing remains consistent with baseline conditions.

AM Summary

The analysis demonstrates that with timing and phasing adjustments, the design concept can be implemented and provide acceptable levels of service for vehicles as well providing bicycle facilities. Alternative 2 (with or without LPI) appears to be the most appropriate signal phasing operation.

PM PEAK HOUR

PM peak hour delay and level of service results are presented in **Table 3**. PM peak hour queuing results are presented in **Table 4.**

Existing Conditions

The existing conditions PM analysis indicates that the overall intersection operates at an acceptable LOS D. The eastbound and westbound approaches operate at LOS D or better, while the northbound and southbound approaches operate at LOS E and LOS F, respectively. LOS E is generally considered acceptable for a minor street approach to an intersection. Movements with significant delays include the northbound left and through movements (currently being made from a single shared lane) and both southbound movements.

The existing maximum queuing at the intersection is significant along all directions. Assuming an average vehicle length of 25 feet the northbound maximum queues nearly spill back to the Duke Street intersection, the southbound queues spill back approximately 600 feet past W. Cedar Street, the eastbound queues spill back 1,075 feet to just beyond Park Road, and the westbound queues spill back nearly 600 feet to the overpass.

2040 Baseline Conditions

The 2040 baseline conditions PM analysis indicates that overall intersection level of service worsens to LOS E, which is generally considered to be approaching unacceptable delay for motorists outside of dense urban areas. The eastbound and westbound approaches operate at LOS D or better, while the northbound and southbound approaches operate at LOS F. Movements of significant delays include those previously identified under existing conditions, as well as the eastbound left which worsens from LOS D to LOS F.

Queuing also worsens on all approaches to the intersection. The eastbound approach increases to a maximum queue length of 2,500 feet through the intersection with Upland Place. The southbound approach increases to a maximum queue length of approximately 2,000 feet to W. Oak Street. The northbound and westbound queues also increase approximately 50 percent in length. Queuing in the eastbound direction remains significant

Baseline PM conditions are similar to AM conditions; during the PM the existing intersection geometry, lane use, and signal operation does not appear appropriate for the future traffic volumes considered under the baseline scenario, resulting in increased delays and queuing. The existing split phase operation of the intersection results in a small share of green time that can be allocated to eastbound and westbound approaches. Additionally, the existing shared lane configuration creates delay as through vehicles must occasionally wait behind turning vehicles.

Alternative 1 Conditions

Alternative 1 results in similar delay to baseline conditions. Concurrent northbound and southbound left turn movements improve the southbound approach significantly, while also allowing for the reallocation of green time among the different approaches.

Queuing remains generally consistent with baseline conditions.

Alternative 2a/2b

Alternative 2a and 2b, (north-south lead-lag phasing with and without LPI), produce LOS results that are significantly better that the baseline condition and consistent with existing conditions, despite 2040 traffic volumes. The overall intersection level of service improves to LOS D for alternative 2b and. Alternative 2a delay is reduced to 55 seconds. Delay is reduced most significantly on the southbound approach to the intersection. Alternative 2b operates better than alternative 2a, due to the additional green time an LPI uses to serve pedestrians.

Queuing is improved compared to baseline conditions on the northbound, southbound, and eastbound approaches with 40 to 50 percent reduction in queue length

Alternative 3

The overall intersection delay remains LOS E consistent with baseline conditions with significant delays in the southbound approach.

Queuing is minorly improved on northbound, southbound and eastbound approaches; however westbound queuing increases.

PM Summary

The analysis demonstrates that with timing and phasing adjustments, the design concept can be implemented and provide acceptable levels of service for vehicles as well providing bicycle facilities. Alternative 2 (with or without LPI) appears to be the most appropriate signal phasing operation.

Conclusions

This analysis has demonstrated that the proposed intersection improvement concept can be implemented in a manner that does not greatly impact vehicular operations. Additionally, with signal timing, phasing adjustments the level of service offered under future years can be as good as the existing conditions. Results indicate that a north-south lead-lag phasing alternative would result in the least delay for vehicles compared to other future alternatives.

The build conditions present the opportunity to implement LPI, with minimal additional delays to motorists.

A change from split phasing to concurrent phasing would improve the operation of the entire intersection and allow for green time to be reallocated to movements that are currently underserved which would also have the ancillary benefit of managing queue spill back.

The signal timing at this intersection could be further refined to find a balance in the acceptable operation of vehicles and the safe and convenient passage of bicycles and pedestrians through the intersection. Shortening the length of the left turn lane to allow for a greater length of bike lane may result in further queuing. This tradeoff should be reviewed to find the appropriate balance between the LOS provided to bicycles and to vehicles and consistency with the City's multimodal initiatives.

Tables

1 – AM Peak Hour Delay and Level of Service Results

2 – AM Peak Hour Average (Maximum) VISSIM Queue Results

3 – PM Peak Hour Delay and Level of Service Results

4 – PM Peak Hour Average (Maximum) VISSIM Queue Results

Figures

1 – Study Intersection

2 – Existing Lane Designations

3 – Existing Peak Hour Traffic Volumes

4 – Future Baseline Peak Hour Traffic Volumes

5 – Future Build Peak Hour Traffic Volumes

Attachments

A – Concept Plans

B – Traffic Counts

C – Queue Observations

D – Calibration Results

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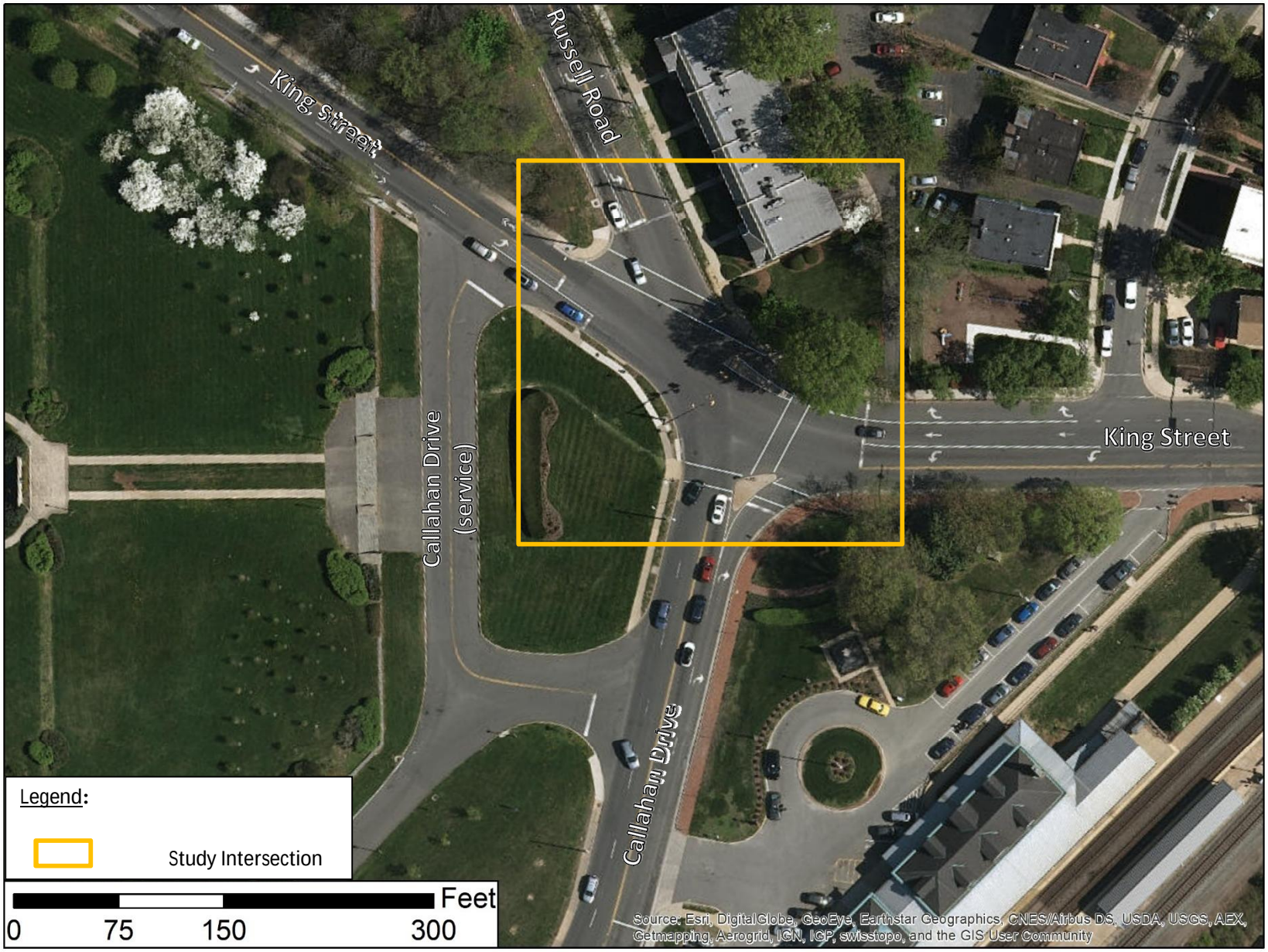
Table 1: AM Peak Hour Delay and Level of Service Results (Seconds)														
Intersection	Approach	Movement	Existing Conditions		Baseline		Alternative 1		Alternative 2a		Alternative 2b		Alternative 3	
King St at Callahan/Russell	Northbound Callahan	LT	69.1 (E)		94.9 (F)		115.7 (F)		88.7 (F)		53.6 (D)		86.1 (F)	
		TH	69.5 (E)		92.6 (F)		98.9 (F)		68.5 (E)		61.2 (E)		95 (F)	
		RT	15.9 (B)	58.1 (E)	40.8 (D)	82.3 (F)	30.4 (C)	88.6 (F)	23.3 (C)	64.2 (E)	15 (B)	49.9 (D)	31 (C)	79.2 (E)
	Southbound Russell	LT	50.2 (D)		104.4 (F)		44.9 (D)		70.9 (E)		44.5 (D)		136 (F)	
		TH	62.3 (E)		116.8 (F)		48.5 (D)		8.4 (A)		48.1 (D)		10.7 (B)	
		RT	68.3 (E)	59.4 (E)	82.4 (F)	113.5 (F)	0 (A)	47.6 (D)	0 (A)	24.2 (C)	0 (A)	47.2 (D)	0 (A)	43.3 (D)
	Eastbound King	LT	26.4 (C)		23.9 (C)		36.5 (D)		38.2 (D)		38.6 (D)		32.3 (C)	
		TH	10.4 (B)		10.5 (B)		7.9 (A)		5.4 (A)		5.3 (A)		7.3 (A)	
		RT	5 (A)	11.4 (B)	5.6 (A)	11.3 (B)	12.3 (B)	12.6 (B)	7.5 (A)	10.1 (B)	8.4 (A)	10.3 (B)	10.1 (B)	11.1 (B)
	Westbound King	LT	63.3 (E)		119.5 (F)		271.9 (F)		141.1 (F)		115.1 (F)		181.8 (F)	
		TH	35.1 (D)		40 (D)		51.4 (D)		28.3 (C)		29.8 (C)		36.5 (D)	
		RT	35.5 (D)	42.9 (D)	36.8 (D)	61.3 (E)	50.4 (D)	106 (F)	25.8 (C)	58.8 (E)	27.7 (C)	53 (D)	33.8 (C)	74.4 (E)
	Intersection		41.1 (D)		62.5 (E)		64.6 (E)		40.4 (D)		39 (D)		52.9 (D)	

Table 2: AM Peak Hour Average (Maximum) VISSIM Queue Results (Vehicles)									
Intersection	Approach	Movement	Field Observed	Existing Conditions	Baseline	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3
King St at Callahan/Russell	Northbound Callahan	LT	31	13 (30)	29 (47)	12 (36)	3 (23)	1 (17)	9 (53)
		TH	31	13 (30)	29 (47)	23 (45)	11 (31)	11 (31)	21 (40)
		RT	31	1 (10)	13 (38)	7 (30)	1 (11)	0 (9)	2 (20)
	Southbound Russell	LT	6	2 (13)	12 (41)	3 (19)	4 (21)	2 (17)	21 (55)
		TH	6	4 (15)	14 (42)	4 (19)	3 (17)	4 (17)	5 (15)
		RT	6	5 (16)	15 (42)	0 (0)	0 (0)	0 (0)	0 (0)
	Eastbound King	LT	38	10 (43)	69 (100)	73 (100)	11 (57)	15 (59)	64 (98)
		TH	38	14 (45)	70 (101)	74 (101)	14 (58)	18 (60)	66 (99)
		RT	38	14 (45)	70 (101)	74 (101)	14 (58)	18 (60)	66 (99)
	Westbound King	LT	6	3 (18)	8 (26)	25 (33)	12 (29)	8 (26)	16 (30)
		TH	6	4 (19)	8 (26)	25 (33)	11 (29)	7 (26)	15 (30)
		RT	6	1 (7)	1 (11)	9 (18)	1 (11)	1 (7)	1 (11)

Table 3: PM Peak Hour Delay and Level of Service Results (Seconds)														
Intersection	Approach	Movement	Existing Conditions		Baseline		Alternative 1		Alternative 2a		Alternative 2b		Alternative 3	
King St at Callahan/Russell	Northbound Callahan	LT	73.3 (E)		106.2 (F)		105.3 (F)		122.1 (F)		54.9 (D)		81.3 (F)	
		TH	74.4 (E)		103.5 (F)		70.3 (E)		75.2 (E)		62.3 (E)		88.2 (F)	
		RT	13.6 (B)	62.4 (E)	44.9 (D)	93.1 (F)	12.6 (B)	69.1 (E)	13.9 (B)	76.3 (E)	9.9 (A)	50.6 (D)	17.5 (B)	73.1 (E)
	Southbound Russell	LT	94.1 (F)		211.8 (F)		103.8 (F)		46.2 (D)		57.4 (E)		177.9 (F)	
		TH	100 (F)		177.3 (F)		106.6 (F)		44.7 (D)		65.8 (E)		155.5 (F)	
		RT	94.8 (F)	99.3 (F)	158.8 (F)	181.7 (F)	0 (A)	106.3 (F)	0 (A)	44.9 (D)	0 (A)	64.8 (E)	0 (A)	158.4 (F)
	Eastbound King	LT	41.1 (D)		39.3 (D)		54.2 (D)		49.4 (D)		54.1 (D)		49.3 (D)	
		TH	13.3 (B)		13.3 (B)		7.5 (A)		6.4 (A)		6.3 (A)		6.6 (A)	
		RT	5.8 (A)	11.6 (B)	6.3 (A)	11.7 (B)	11.4 (B)	11.9 (B)	9.3 (A)	10.2 (B)	9.5 (A)	10.5 (B)	10.9 (B)	11 (B)
	Westbound King	LT	53.5 (D)		81.6 (F)		188.1 (F)		158.9 (F)		126.1 (F)		204.5 (F)	
		TH	30.9 (C)		36 (D)		46.1 (D)		39.7 (D)		34.9 (C)		42.7 (D)	
		RT	26.6 (C)	39.3 (D)	34.5 (C)	53.2 (D)	41.3 (D)	99.2 (F)	34.6 (C)	84.6 (F)	32.1 (C)	68.5 (E)	41.7 (D)	102.4 (F)
	Intersection		48 (D)		72.3 (E)		70 (E)		55.2 (E)		48.8 (D)		78.9 (E)	

Table 4: PM Peak Hour Average (Maximum) VISSIM Queue Results (Vehicles)									
Intersection	Approach	Movement	Field Observed	Existing Conditions	Baseline	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3
King St at Callahan/Russell	Northbound Callahan	LT	22	13 (32)	36 (48)	8 (28)	9 (35)	2 (18)	6 (36)
		TH	22	13 (32)	36 (48)	11 (35)	12 (35)	8 (29)	15 (33)
		RT	22	0 (7)	25 (46)	1 (10)	0 (5)	0 (4)	1 (16)
	Southbound Russell	LT	12	4 (22)	51 (81)	7 (33)	1 (15)	2 (21)	34 (72)
		TH	12	9 (24)	52 (81)	14 (38)	5 (16)	7 (23)	37 (71)
		RT	12	9 (25)	53 (81)	0 (0)	0 (0)	0 (0)	0 (0)
	Eastbound King	LT	35	7 (43)	85 (100)	87 (100)	56 (96)	59 (97)	79 (100)
		TH	35	15 (46)	87 (101)	88 (101)	60 (97)	63 (98)	82 (101)
		RT	35	15 (46)	87 (101)	88 (101)	60 (97)	63 (98)	82 (101)
	Westbound King	LT	10	5 (23)	13 (31)	30 (33)	29 (33)	26 (33)	30 (33)
		TH	10	4 (23)	13 (32)	30 (33)	29 (33)	24 (33)	30 (33)
		RT	10	0 (3)	0 (4)	0 (3)	0 (3)	0 (3)	0 (3)



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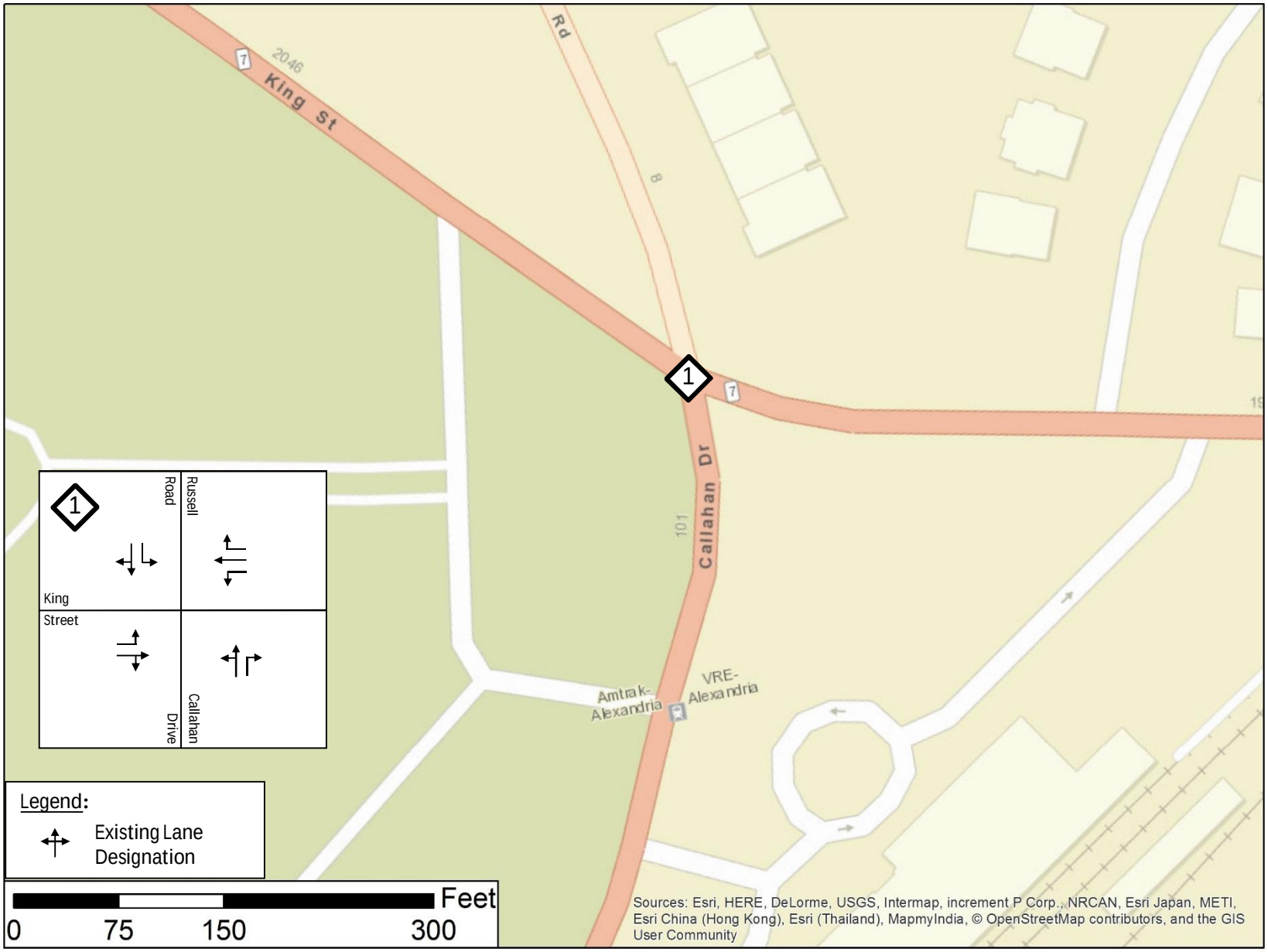
Study Intersection

Intersection of King Street and Callahan Drive/Russel Road

Figure 1



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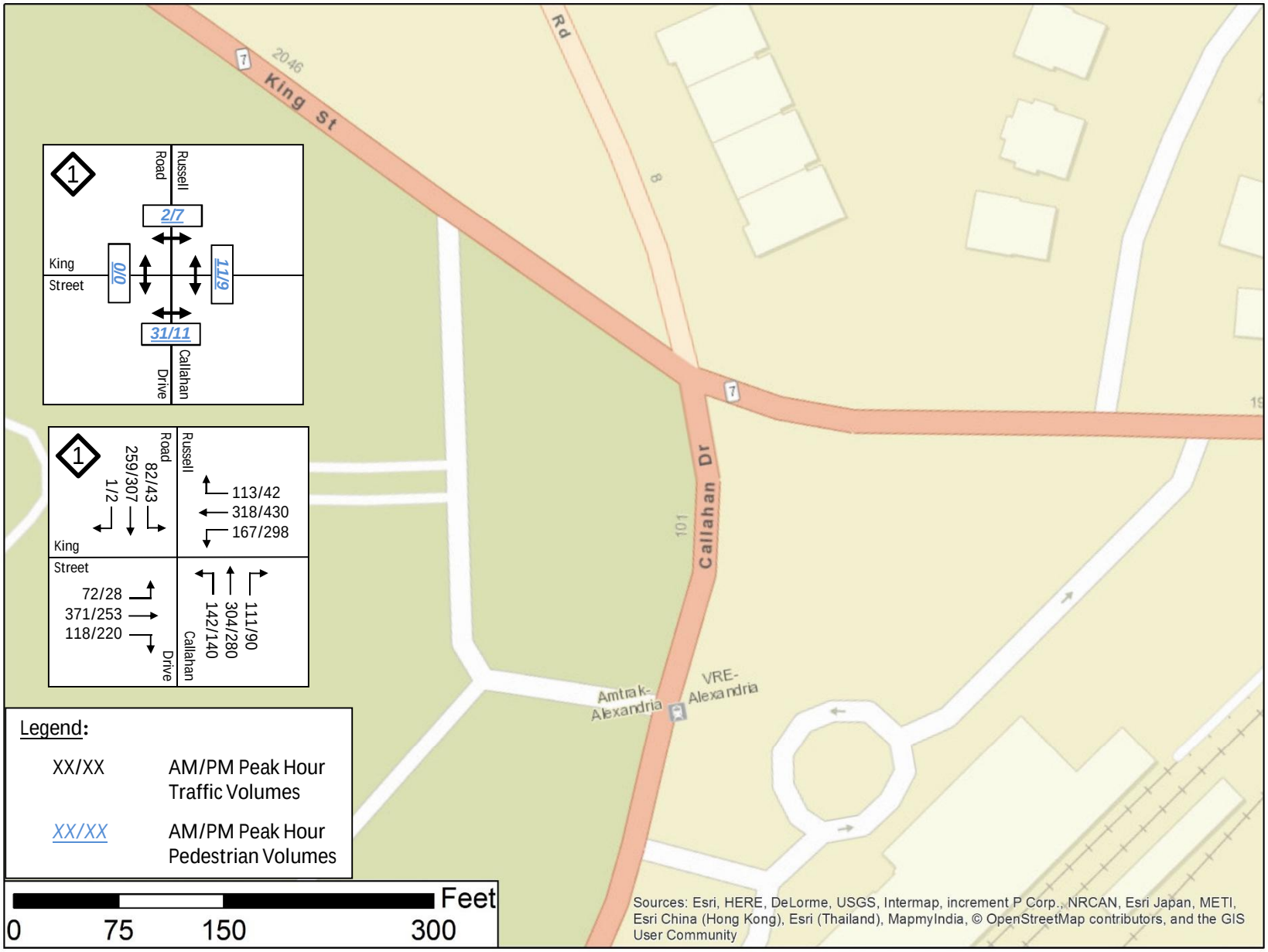
Existing Lane Designations

Intersection of King Street and Callahan Drive/Russel Road

Figure 2



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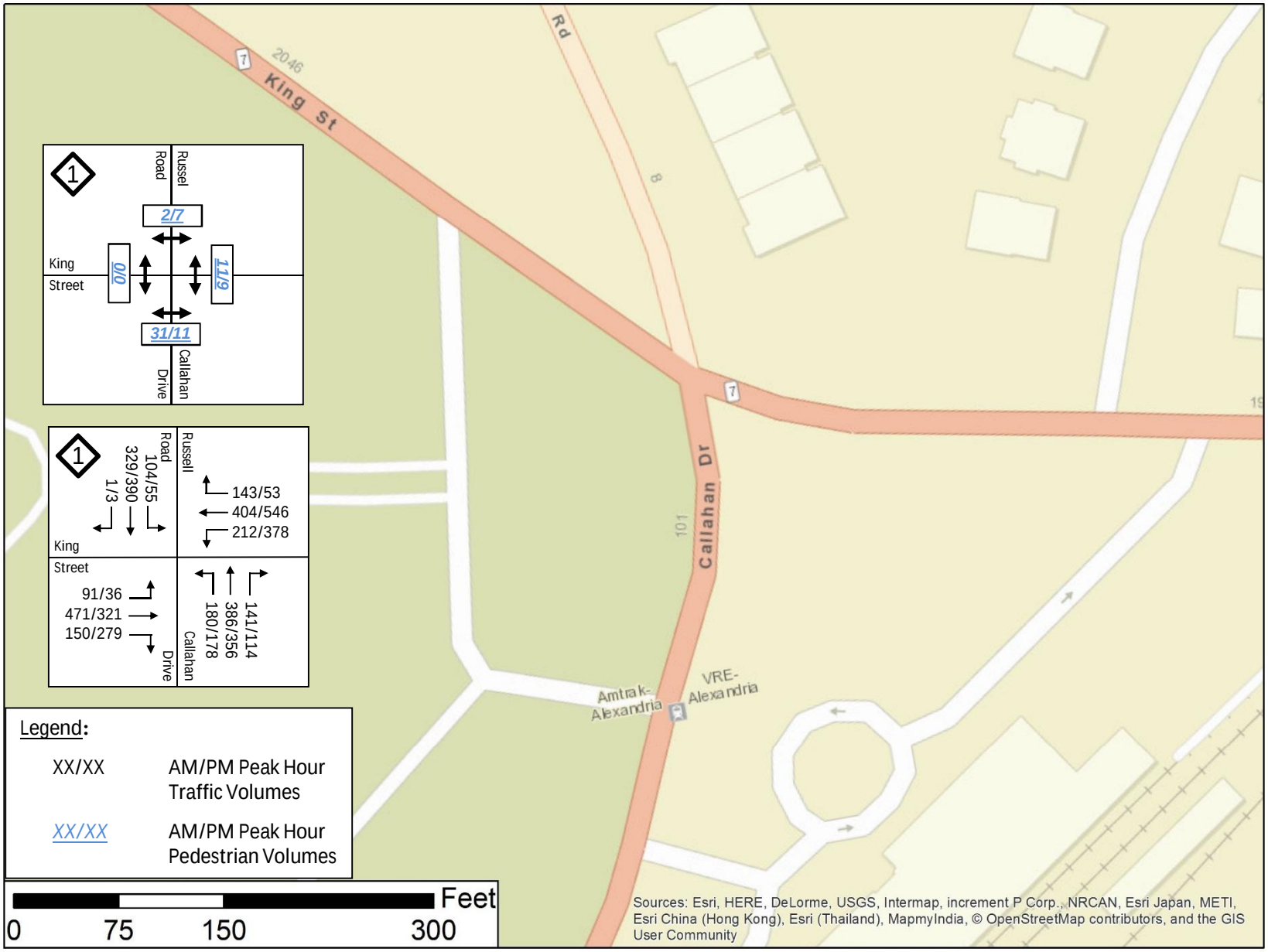
Existing Peak Hour Traffic Volumes

Intersection of King Street and Callahan Drive/Russel Road

Figure 3



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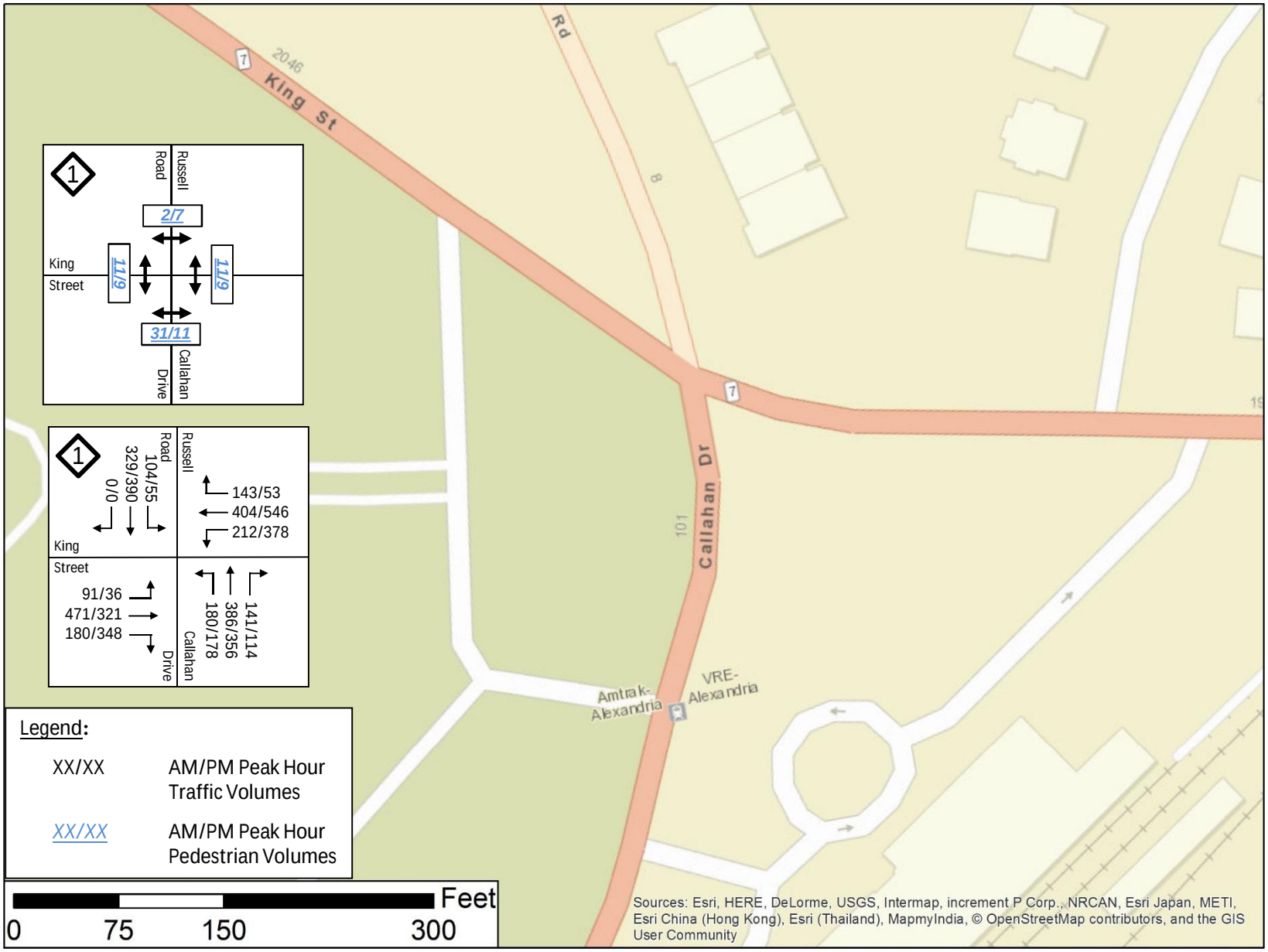
Future Baseline Peak Hour Traffic Volumes

Intersection of King Street and Callahan Drive/Russel Road

Figure 4



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Future Build Peak Hour Traffic Volumes

Intersection of King Street and Callahan Drive/Russel Road

Figure 5

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ATTACHMENT A

0 20' 40'

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N

KING-CALLAHAN-RUSSELL ACCESS TO TRANSIT IMPROVEMENTS

CONCEPT DESIGN

SHEET 03 OF 03

SCALE 1" = 20'

PROPOSED CONDITIONS

ALEXANDRIA PROJECT NO.: 1603034
DATE OF PLAN ISSUANCE: -
CONSULTANT PROJECT ID.: -
DESIGNED BY: - DATE: -
DRAWN BY: - DATE: -
CHECKED BY: - DATE: -
APPROVED BY: - DATE: -

REVISIONS

DATE	BY	DESCRIPTION

CITY OF ALEXANDRIA, VIRGINIA
DEPARTMENT OF PROJECT IMPLEMENTATION
301 KING STREET
ALEXANDRIA, VIRGINIA 22313

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ATTACHMENT B

City of Alexandria
301 King Street

Alexandria, Virginia, United States 22314
703-746-4087 cuong.nguyen@alexandriava.gov
"Working Today for a Better Tomorrow"

Count Name: King Russell and Calahan
09/15/16
Site Code:
Start Date: 09/15/2016
Page No: 1

Turning Movement Data

Start Time	Southbound St. Southbound						Westbound St. Westbound						Northbound St. Northbound						Eastbound St. Eastbound						
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Int. Total
7:00 AM	0	43	7	0	0	50	22	57	25	0	4	104	22	80	46	0	1	148	15	62	5	0	0	82	384
7:15 AM	1	36	9	0	0	46	18	62	36	0	1	116	19	62	44	0	2	125	18	86	4	0	0	108	395
7:30 AM	0	57	17	0	0	74	26	90	50	0	1	166	18	74	37	0	3	129	26	100	11	0	0	137	506
7:45 AM	0	60	15	0	2	75	47	91	41	0	3	179	20	76	34	0	4	130	23	108	28	0	0	159	543
Hourly Total	1	196	48	0	2	245	113	300	152	0	9	565	79	292	161	0	10	532	82	356	48	0	0	486	1828
8:00 AM	0	73	22	0	0	95	22	80	39	0	4	141	23	74	42	0	13	139	29	88	22	0	0	139	514
8:15 AM	1	69	28	0	0	98	18	57	37	0	3	112	50	80	29	0	11	159	40	75	11	0	0	126	495
8:30 AM	0	57	12	0	2	69	22	59	48	0	5	129	35	82	23	0	5	140	25	102	10	0	0	137	475
8:45 AM	0	52	26	0	0	78	18	67	36	0	3	121	27	72	24	0	8	123	31	100	7	0	0	138	460
Hourly Total	1	251	88	0	2	340	80	263	160	0	15	503	135	308	118	0	37	561	125	365	50	0	0	540	1944
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4:00 PM	0	67	12	0	1	79	8	83	77	0	3	168	20	71	31	0	4	122	34	65	6	0	0	105	474
4:15 PM	1	65	9	0	0	75	14	65	71	0	2	150	21	59	30	0	5	110	60	71	5	0	1	136	471
4:30 PM	0	76	7	0	0	83	7	67	65	0	2	139	15	67	35	0	14	117	39	83	9	0	0	131	470
4:45 PM	0	74	8	0	1	82	10	96	79	0	0	185	23	68	31	0	3	122	64	61	5	0	0	130	519
Hourly Total	1	282	36	0	2	319	39	311	292	0	7	642	79	265	127	0	26	471	197	280	25	0	1	502	1934
5:00 PM	0	74	6	0	0	80	13	103	73	0	5	189	18	65	40	0	0	123	53	60	9	0	0	122	514
5:15 PM	1	83	16	0	2	100	13	114	79	0	1	206	20	69	28	0	2	117	57	65	9	0	0	131	554
5:30 PM	1	76	13	0	4	90	6	117	67	0	3	190	29	78	41	0	6	148	46	67	5	0	0	118	546
5:45 PM	1	69	12	0	2	82	15	97	76	0	6	188	18	76	30	0	7	124	51	64	1	0	0	116	510
Hourly Total	3	302	47	0	8	352	47	431	295	0	15	773	85	288	139	0	15	512	207	256	24	0	0	487	2124
6:00 PM	0	72	12	0	1	84	13	98	66	0	0	177	16	81	31	0	1	128	50	67	4	0	0	121	510
6:15 PM	0	78	4	0	0	82	7	91	79	0	1	177	12	65	31	0	4	108	47	68	1	0	0	116	483
6:30 PM	2	65	9	0	4	76	8	74	43	0	0	125	13	67	35	0	13	115	27	62	0	0	0	89	405
6:45 PM	0	56	14	0	1	70	7	62	46	0	0	115	16	73	34	0	7	123	43	73	1	0	1	117	425
Hourly Total	2	271	39	0	6	312	35	325	234	0	1	594	57	286	131	0	25	474	167	270	6	0	1	443	1823
Grand Total	8	1302	258	0	20	1568	314	1630	1133	0	47	3077	435	1439	676	0	113	2550	778	1527	153	0	2	2458	9653
Approach %	0.5	83.0	16.5	0.0	-	-	10.2	53.0	36.8	0.0	-	-	17.1	56.4	26.5	0.0	-	-	31.7	62.1	6.2	0.0	-	-	-
Total %	0.1	13.5	2.7	0.0	-	16.2	3.3	16.9	11.7	0.0	-	31.9	4.5	14.9	7.0	0.0	-	26.4	8.1	15.8	1.6	0.0	-	25.5	-
Lights	8	1277	255	0	-	1540	307	1550	1116	0	-	2973	396	1409	652	0	-	2457	763	1442	150	0	-	2355	9325
% Lights	100.0	98.1	98.8	-	-	98.2	97.8	95.1	98.5	-	-	96.6	91.0	97.9	96.4	-	-	96.4	98.1	94.4	98.0	-	-	95.8	96.6
Mediums	0	20	3	0	-	23	6	74	17	0	-	97	35	23	23	0	-	81	15	83	3	0	-	101	302
% Mediums	0.0	1.5	1.2	-	-	1.5	1.9	4.5	1.5	-	-	3.2	8.0	1.6	3.4	-	-	3.2	1.9	5.4	2.0	-	-	4.1	3.1
Articulated Trucks	0	3	0	0	-	3	1	0	0	0	-	1	2	6	0	0	-	8	0	0	0	0	-	0	12
% Articulated Trucks	0.0	0.2	0.0	-	-	0.2	0.3	0.0	0.0	-	-	0.0	0.5	0.4	0.0	-	-	0.3	0.0	0.0	0.0	-	-	0.0	0.1
Bicycles on Road	0	2	0	0	-	2	0	6	0	0	-	6	2	1	1	0	-	4	0	2	0	0	-	2	14

% Bicycles on Road	0.0	0.2	0.0	-	-	0.1	0.0	0.4	0.0	-	-	0.2	0.5	0.1	0.1	-	-	0.2	0.0	0.1	0.0	-	-	0.1	0.1
Bicycles on Crosswalk	-	-	-	-	2	-	-	-	-	-	0	-	-	-	-	-	3	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	10.0	-	-	-	-	-	0.0	-	-	-	-	-	2.7	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	-	18	-	-	-	-	-	47	-	-	-	-	-	110	-	-	-	-	-	2	-	-
% Pedestrians	-	-	-	-	90.0	-	-	-	-	-	100.0	-	-	-	-	-	97.3	-	-	-	-	-	100.0	-	-

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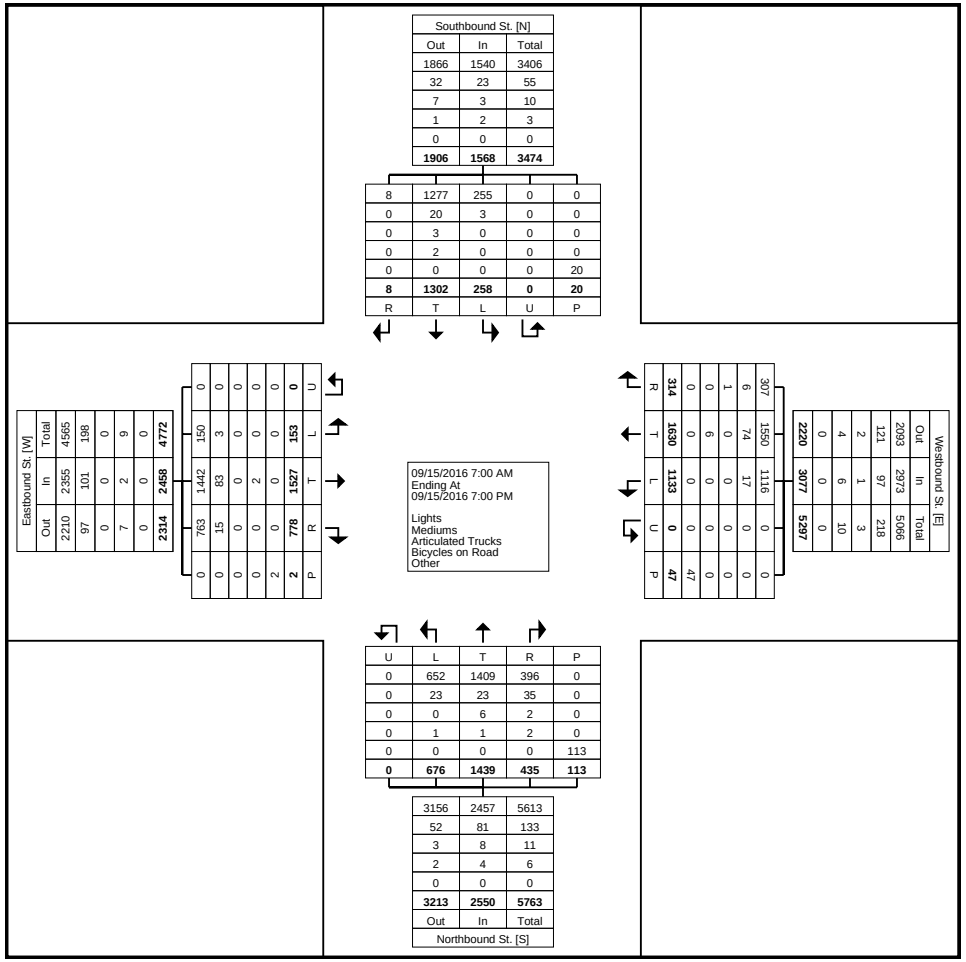

Turning Movement Data Plot

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Turning Movement Peak Hour Data (7:30 AM)

Start Time	Southbound St. Southbound						Westbound St. Westbound						Northbound St. Northbound						Eastbound St. Eastbound						
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Int. Total
7:30 AM	0	57	17	0	0	74	26	90	50	0	1	166	18	74	37	0	3	129	26	100	11	0	0	137	506
7:45 AM	0	60	15	0	2	75	47	91	41	0	3	179	20	76	34	0	4	130	23	108	28	0	0	159	543
8:00 AM	0	73	22	0	0	95	22	80	39	0	4	141	23	74	42	0	13	139	29	88	22	0	0	139	514
8:15 AM	1	69	28	0	0	98	18	57	37	0	3	112	50	80	29	0	11	159	40	75	11	0	0	126	495
Total	1	259	82	0	2	342	113	318	167	0	11	598	111	304	142	0	31	557	118	371	72	0	0	561	2058
Approach %	0.3	75.7	24.0	0.0	-	-	18.9	53.2	27.9	0.0	-	-	19.9	54.6	25.5	0.0	-	-	21.0	66.1	12.8	0.0	-	-	-
Total %	0.0	12.6	4.0	0.0	-	16.6	5.5	15.5	8.1	0.0	-	29.1	5.4	14.8	6.9	0.0	-	27.1	5.7	18.0	3.5	0.0	-	27.3	-
PHF	0.250	0.887	0.732	0.000	-	0.872	0.601	0.874	0.835	0.000	-	0.835	0.555	0.950	0.845	0.000	-	0.876	0.738	0.859	0.643	0.000	-	0.882	0.948
Lights	1	250	81	0	-	332	110	305	159	0	-	574	104	298	137	0	-	539	115	353	69	0	-	537	1982
% Lights	100.0	96.5	98.8	-	-	97.1	97.3	95.9	95.2	-	-	96.0	93.7	98.0	96.5	-	-	96.8	97.5	95.1	95.8	-	-	95.7	96.3
Mediums	0	7	1	0	-	8	2	12	8	0	-	22	4	4	5	0	-	13	3	17	3	0	-	23	66
% Mediums	0.0	2.7	1.2	-	-	2.3	1.8	3.8	4.8	-	-	3.7	3.6	1.3	3.5	-	-	2.3	2.5	4.6	4.2	-	-	4.1	3.2
Articulated Trucks	0	2	0	0	-	2	1	0	0	0	-	1	2	2	0	0	-	4	0	0	0	0	-	0	7
% Articulated Trucks	0.0	0.8	0.0	-	-	0.6	0.9	0.0	0.0	-	-	0.2	1.8	0.7	0.0	-	-	0.7	0.0	0.0	0.0	-	-	0.0	0.3
Bicycles on Road	0	0	0	0	-	0	0	1	0	0	-	1	1	0	0	0	-	1	0	1	0	0	-	1	3
% Bicycles on Road	0.0	0.0	0.0	-	-	0.0	0.0	0.3	0.0	-	-	0.2	0.9	0.0	0.0	-	-	0.2	0.0	0.3	0.0	-	-	0.2	0.1
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	2	-	-	-	-	-	11	-	-	-	-	-	31	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-

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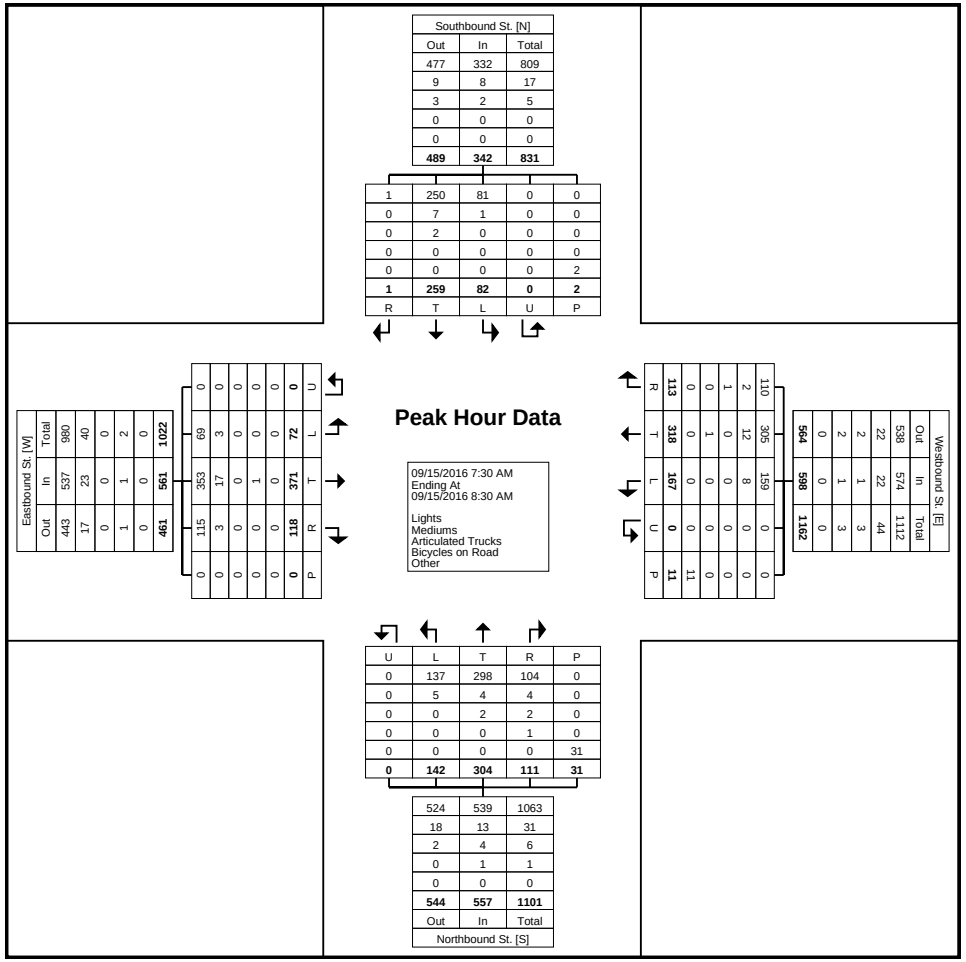

Turning Movement Peak Hour Data Plot (7:30 AM)

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Start Date: 09/15/2016

Turning Movement Peak Hour Data (4:45 PM)

Start Time	Southbound St. Southbound						Westbound St. Westbound						Northbound St. Northbound						Eastbound St. Eastbound						
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Int. Total
4:45 PM	0	74	8	0	1	82	10	96	79	0	0	185	23	68	31	0	3	122	64	61	5	0	0	130	519
5:00 PM	0	74	6	0	0	80	13	103	73	0	5	189	18	65	40	0	0	123	53	60	9	0	0	122	514
5:15 PM	1	83	16	0	2	100	13	114	79	0	1	206	20	69	28	0	2	117	57	65	9	0	0	131	554
5:30 PM	1	76	13	0	4	90	6	117	67	0	3	190	29	78	41	0	6	148	46	67	5	0	0	118	546
Total	2	307	43	0	7	352	42	430	298	0	9	770	90	280	140	0	11	510	220	253	28	0	0	501	2133
Approach %	0.6	87.2	12.2	0.0	-	-	5.5	55.8	38.7	0.0	-	-	17.6	54.9	27.5	0.0	-	-	43.9	50.5	5.6	0.0	-	-	-
Total %	0.1	14.4	2.0	0.0	-	16.5	2.0	20.2	14.0	0.0	-	36.1	4.2	13.1	6.6	0.0	-	23.9	10.3	11.9	1.3	0.0	-	23.5	-
PHF	0.500	0.925	0.672	0.000	-	0.880	0.808	0.919	0.943	0.000	-	0.934	0.776	0.897	0.854	0.000	-	0.861	0.859	0.944	0.778	0.000	-	0.956	0.963
Lights	2	306	43	0	-	351	42	413	298	0	-	753	79	278	135	0	-	492	217	237	28	0	-	482	2078
% Lights	100.0	99.7	100.0	-	-	99.7	100.0	96.0	100.0	-	-	97.8	87.8	99.3	96.4	-	-	96.5	98.6	93.7	100.0	-	-	96.2	97.4
Mediums	0	1	0	0	-	1	0	16	0	0	-	16	11	2	5	0	-	18	3	15	0	0	-	18	53
% Mediums	0.0	0.3	0.0	-	-	0.3	0.0	3.7	0.0	-	-	2.1	12.2	0.7	3.6	-	-	3.5	1.4	5.9	0.0	-	-	3.6	2.5
Articulated Trucks	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0
% Articulated 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	-	-	0.0	0.0
Bicycles on Road	0	0	0	0	-	0	0	1	0	0	-	1	0	0	0	0	-	0	0	1	0	0	-	1	2
% Bicycles on Road	0.0	0.0	0.0	-	-	0.0	0.0	0.2	0.0	-	-	0.1	0.0	0.0	0.0	-	-	0.0	0.0	0.4	0.0	-	-	0.2	0.1
Bicycles on Crosswalk	-	-	-	-	2	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	28.6	-	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-
Pedestrians	-	-	-	-	5	-	-	-	-	-	9	-	-	-	-	-	11	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	71.4	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-

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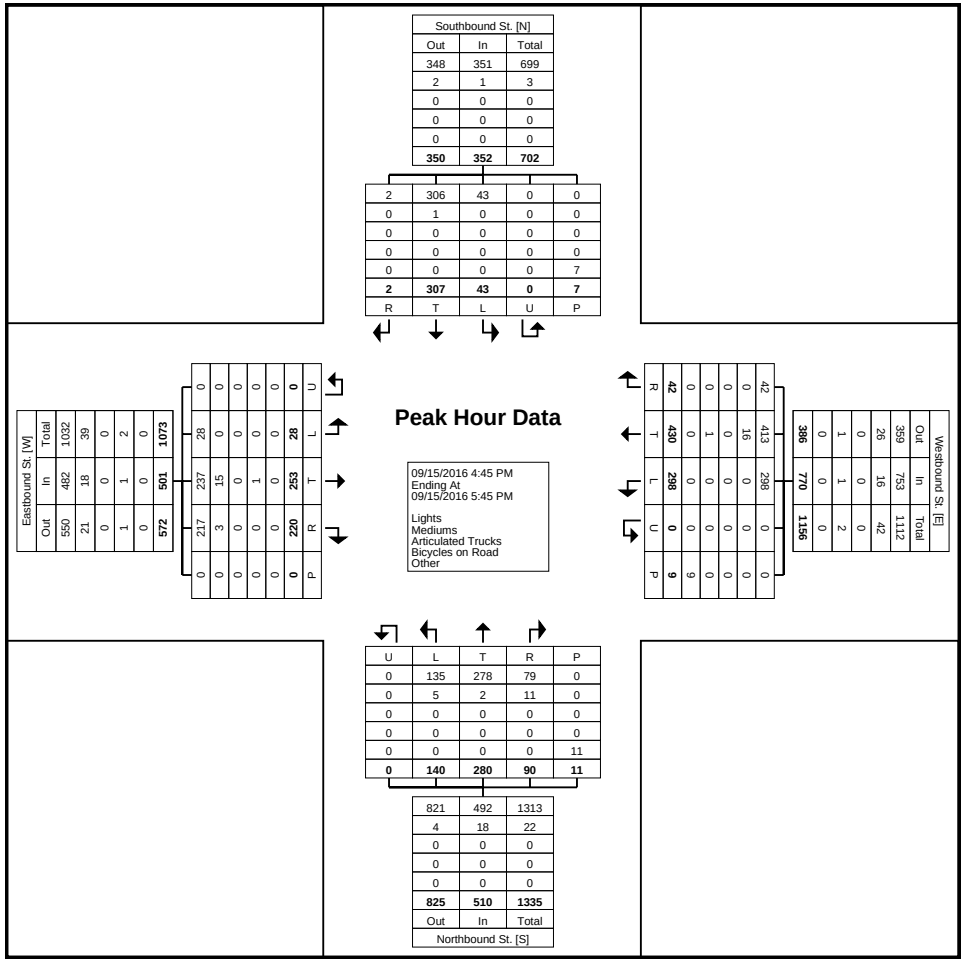

Turning Movement Peak Hour Data Plot (4:45 PM)

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Turning Movement Data

Start Time	Westbound St. Westbound					Northbound St. Northbound					Eastbound St. Eastbound					
	Thru	Left	U-Turn	Peds	App. Total	Right	Left	U-Turn	Peds	App. Total	Right	Thru	U-Turn	Peds	App. Total	Int. Total
7:00 AM	98	0	0	0	98	0	7	0	4	7	4	67	0	0	71	176
7:15 AM	113	0	0	0	113	0	5	0	6	5	3	126	0	0	129	247
7:30 AM	117	0	0	0	117	0	6	0	10	6	6	138	0	0	144	267
7:45 AM	121	0	0	0	121	0	6	0	4	6	5	151	0	0	156	283
Hourly Total	449	0	0	0	449	0	24	0	24	24	18	482	0	0	500	973
8:00 AM	119	0	0	0	119	1	1	0	6	2	4	149	0	0	153	274
8:15 AM	87	0	0	0	87	0	2	0	9	2	9	137	0	0	146	235
8:30 AM	72	0	0	0	72	0	2	0	3	2	9	139	0	0	148	222
8:45 AM	95	0	0	0	95	0	2	0	6	2	1	139	0	0	140	237
Hourly Total	373	0	0	0	373	1	7	0	24	8	23	564	0	0	587	968
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4:00 PM	120	0	0	0	120	1	0	0	2	1	20	121	0	0	141	262
4:15 PM	83	2	0	0	85	0	3	0	1	3	11	129	0	0	140	228
4:30 PM	99	0	0	0	99	0	1	0	10	1	13	124	0	0	137	237
4:45 PM	119	0	0	0	119	0	4	0	2	4	9	135	0	0	144	267
Hourly Total	421	2	0	0	423	1	8	0	15	9	53	509	0	0	562	994
5:00 PM	147	0	0	1	147	0	1	0	4	1	17	112	0	0	129	277
5:15 PM	138	0	0	0	138	2	4	0	8	6	14	145	0	0	159	303
5:30 PM	159	1	0	0	160	1	2	0	5	3	14	108	0	0	122	285
5:45 PM	138	3	0	0	141	0	0	0	5	0	12	125	0	0	137	278
Hourly Total	582	4	0	1	586	3	7	0	22	10	57	490	0	0	547	1143
6:00 PM	115	0	0	0	115	0	2	0	4	2	8	112	0	0	120	237
6:15 PM	130	1	0	0	131	1	1	0	5	2	12	121	0	0	133	266
6:30 PM	109	0	0	1	109	0	2	0	3	2	10	88	0	0	98	209
6:45 PM	92	0	0	1	92	0	0	0	2	0	8	108	0	0	116	208
Hourly Total	446	1	0	2	447	1	5	0	14	6	38	429	0	0	467	920
Grand Total	2271	7	0	3	2278	6	51	0	99	57	189	2474	0	0	2663	4998
Approach %	99.7	0.3	0.0	-	-	10.5	89.5	0.0	-	-	7.1	92.9	0.0	-	-	-
Total %	45.4	0.1	0.0	-	45.6	0.1	1.0	0.0	-	1.1	3.8	49.5	0.0	-	53.3	-
Lights	2169	7	0	-	2176	6	51	0	-	57	186	2367	0	-	2553	4786
% Lights	95.5	100.0	-	-	95.5	100.0	100.0	-	-	100.0	98.4	95.7	-	-	95.9	95.8
Mediums	96	0	0	-	96	0	0	0	-	0	1	103	0	-	104	200
% Mediums	4.2	0.0	-	-	4.2	0.0	0.0	-	-	0.0	0.5	4.2	-	-	3.9	4.0
Articulated Trucks	2	0	0	-	2	0	0	0	-	0	0	1	0	-	1	3
% Articulated Trucks	0.1	0.0	-	-	0.1	0.0	0.0	-	-	0.0	0.0	0.0	-	-	0.0	0.1
Bicycles on Road	4	0	0	-	4	0	0	0	-	0	2	3	0	-	5	9
% Bicycles on Road	0.2	0.0	-	-	0.2	0.0	0.0	-	-	0.0	1.1	0.1	-	-	0.2	0.2

Bicycles on Crosswalk	-	-	-	1	-	-	-	-	4	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	33.3	-	-	-	-	4.0	-	-	-	-	-	-	-
Pedestrians	-	-	-	2	-	-	-	-	95	-	-	-	-	0	-	-
% Pedestrians	-	-	-	66.7	-	-	-	-	96.0	-	-	-	-	-	-	-

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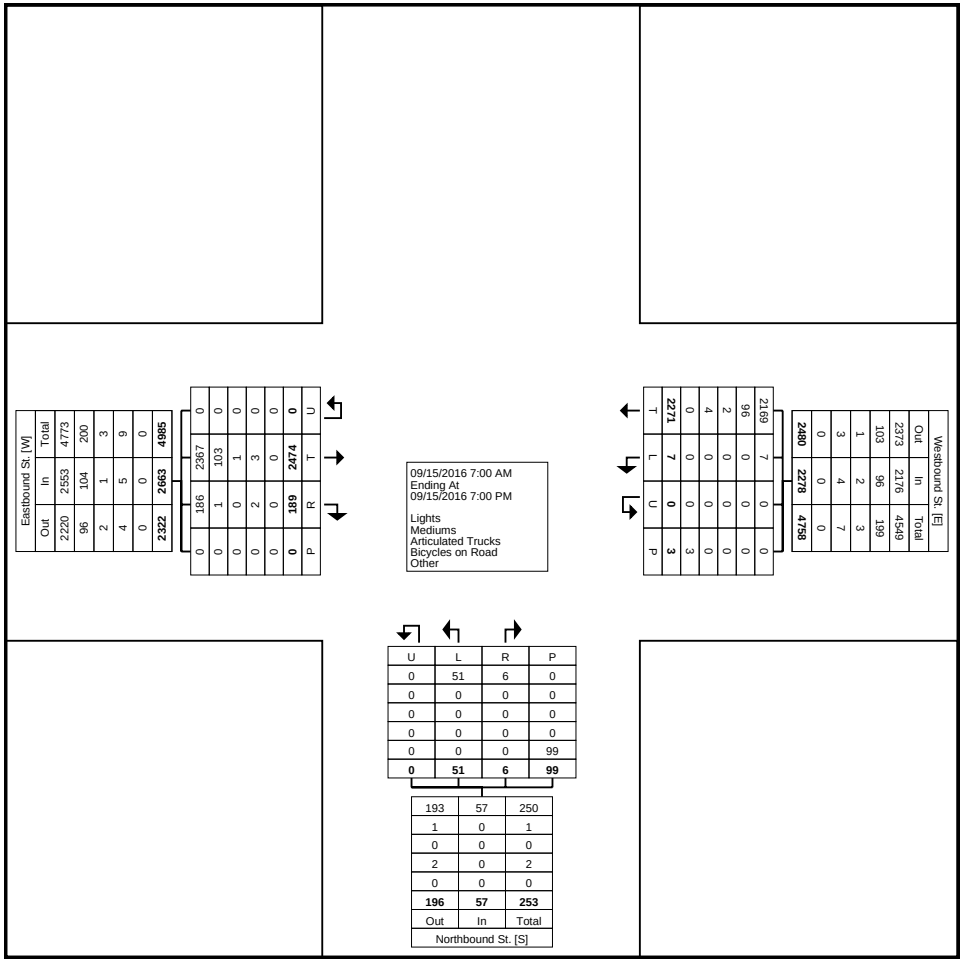

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Turning Movement Peak Hour Data (7:15 AM)

Start Time	Westbound St. Westbound					Northbound St. Northbound					Eastbound St. Eastbound					
	Thru	Left	U-Turn	Peds	App. Total	Right	Left	U-Turn	Peds	App. Total	Right	Thru	U-Turn	Peds	App. Total	Int. Total
7:15 AM	113	0	0	0	113	0	5	0	6	5	3	126	0	0	129	247
7:30 AM	117	0	0	0	117	0	6	0	10	6	6	138	0	0	144	267
7:45 AM	121	0	0	0	121	0	6	0	4	6	5	151	0	0	156	283
8:00 AM	119	0	0	0	119	1	1	0	6	2	4	149	0	0	153	274
Total	470	0	0	0	470	1	18	0	26	19	18	564	0	0	582	1071
Approach %	100.0	0.0	0.0	-	-	5.3	94.7	0.0	-	-	3.1	96.9	0.0	-	-	-
Total %	43.9	0.0	0.0	-	43.9	0.1	1.7	0.0	-	1.8	1.7	52.7	0.0	-	54.3	-
PHF	0.971	0.000	0.000	-	0.971	0.250	0.750	0.000	-	0.792	0.750	0.934	0.000	-	0.933	0.946
Lights	452	0	0	-	452	1	18	0	-	19	18	540	0	-	558	1029
% Lights	96.2	-	-	-	96.2	100.0	100.0	-	-	100.0	100.0	95.7	-	-	95.9	96.1
Mediums	17	0	0	-	17	0	0	0	-	0	0	21	0	-	21	38
% Mediums	3.6	-	-	-	3.6	0.0	0.0	-	-	0.0	0.0	3.7	-	-	3.6	3.5
Articulated Trucks	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0
% Articulated Trucks	0.0	-	-	-	0.0	0.0	0.0	-	-	0.0	0.0	0.0	-	-	0.0	0.0
Bicycles on Road	1	0	0	-	1	0	0	0	-	0	0	3	0	-	3	4
% Bicycles on Road	0.2	-	-	-	0.2	0.0	0.0	-	-	0.0	0.0	0.5	-	-	0.5	0.4
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	3	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	11.5	-	-	-	-	-	-	-
Pedestrians	-	-	-	0	-	-	-	-	23	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	-	-	-	-	88.5	-	-	-	-	-	-	-

City of Alexandria
301 King Street

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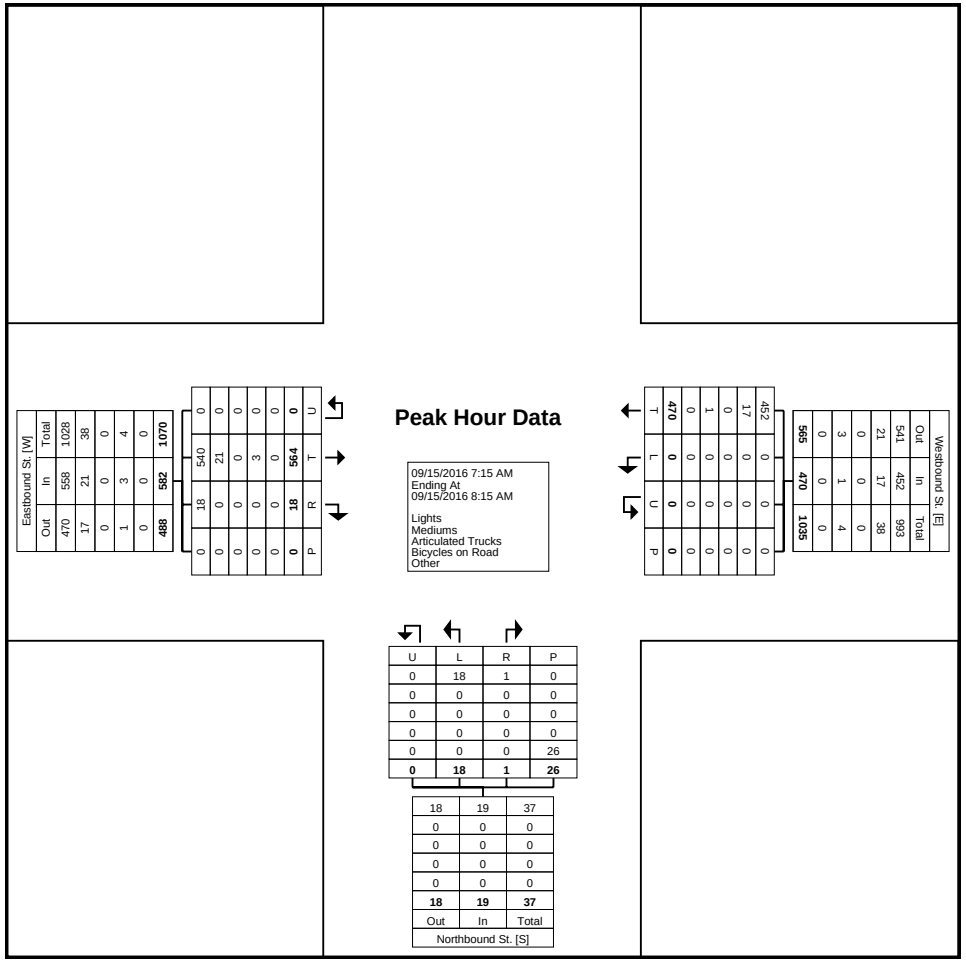
703-746-4087 cuong.nguyen@alexandriava.gov
"Working Today for a Better Tomorrow"

Count Name: King Russell and Calahan service
09/15/16
Site Code:
Start Date: 09/15/2016
Page No: 5



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Turning Movement Peak Hour Data (5:00 PM)

Start Time	Westbound St. Westbound					Northbound St. Northbound					Eastbound St. Eastbound					
	Thru	Left	U-Turn	Peds	App. Total	Right	Left	U-Turn	Peds	App. Total	Right	Thru	U-Turn	Peds	App. Total	Int. Total
5:00 PM	147	0	0	1	147	0	1	0	4	1	17	112	0	0	129	277
5:15 PM	138	0	0	0	138	2	4	0	8	6	14	145	0	0	159	303
5:30 PM	159	1	0	0	160	1	2	0	5	3	14	108	0	0	122	285
5:45 PM	138	3	0	0	141	0	0	0	5	0	12	125	0	0	137	278
Total	582	4	0	1	586	3	7	0	22	10	57	490	0	0	547	1143
Approach %	99.3	0.7	0.0	-	-	30.0	70.0	0.0	-	-	10.4	89.6	0.0	-	-	-
Total %	50.9	0.3	0.0	-	51.3	0.3	0.6	0.0	-	0.9	5.0	42.9	0.0	-	47.9	-
PHF	0.915	0.333	0.000	-	0.916	0.375	0.438	0.000	-	0.417	0.838	0.845	0.000	-	0.860	0.943
Lights	562	4	0	-	566	3	7	0	-	10	57	470	0	-	527	1103
% Lights	96.6	100.0	-	-	96.6	100.0	100.0	-	-	100.0	100.0	95.9	-	-	96.3	96.5
Mediums	19	0	0	-	19	0	0	0	-	0	0	20	0	-	20	39
% Mediums	3.3	0.0	-	-	3.2	0.0	0.0	-	-	0.0	0.0	4.1	-	-	3.7	3.4
Articulated Trucks	0	0	0	-	0	0	0	0	-	0	0	0	0	-	0	0
% Articulated Trucks	0.0	0.0	-	-	0.0	0.0	0.0	-	-	0.0	0.0	0.0	-	-	0.0	0.0
Bicycles on Road	1	0	0	-	1	0	0	0	-	0	0	0	0	-	0	1
% Bicycles on Road	0.2	0.0	-	-	0.2	0.0	0.0	-	-	0.0	0.0	0.0	-	-	0.0	0.1
Bicycles on Crosswalk	-	-	-	0	-	-	-	-	1	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	0.0	-	-	-	-	4.5	-	-	-	-	-	-	-
Pedestrians	-	-	-	1	-	-	-	-	21	-	-	-	-	0	-	-
% Pedestrians	-	-	-	100.0	-	-	-	-	95.5	-	-	-	-	-	-	-

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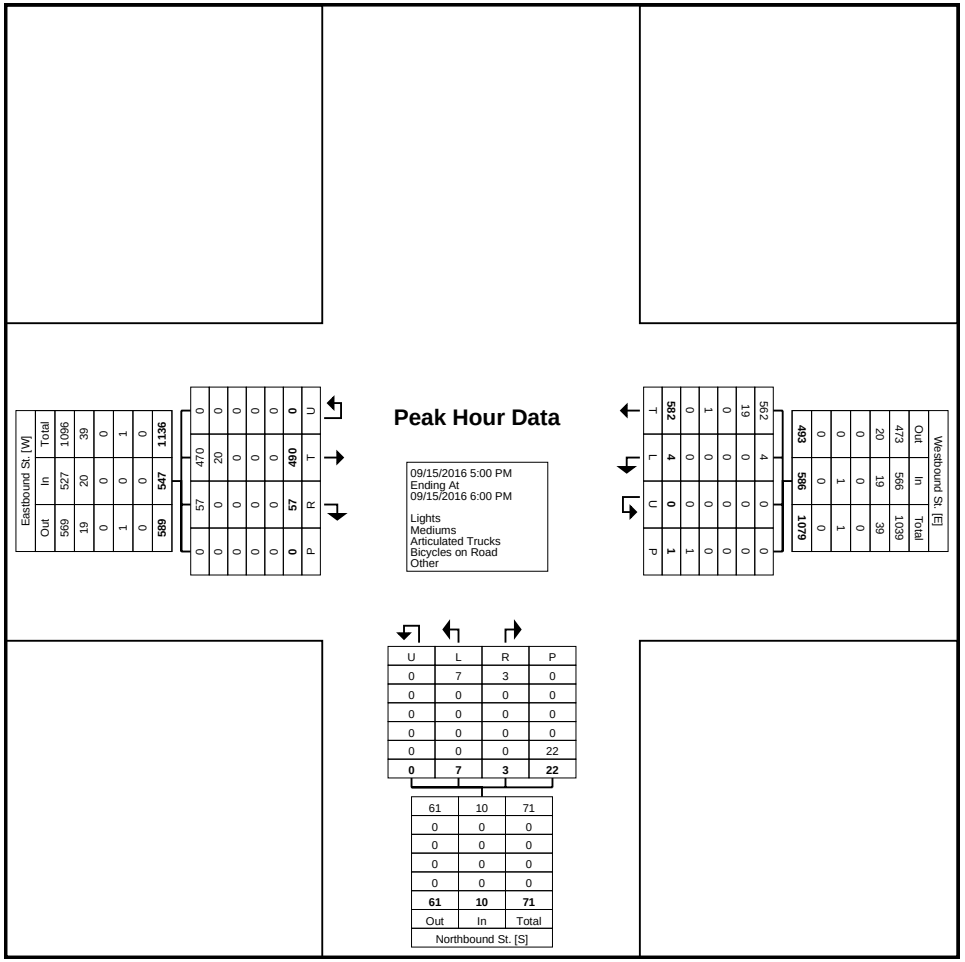

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Kimley»Horn

ATTACHMENT C

Queue observation at the intersection of King, Callahand and Russell
Date: 01/11/2017
935 feet = full

Time	Eastbound	Westbound	Southbound	Northbound
7:00	Full	5	Full	5
7:15	Full	4	Full	7
7:30	Full	6	Full	4
7:45	Full	5	Full	6
8:00	Full	5	Full	7
8:15	Full	7	Full	6
8:30	Full	8	Full	8
8:45	Full	5	Full	4
4:00	20	14	15	13
4:15	20	10	13	9
4:30	21	10	13	10
4:45	25	11	20	11
5:00	Full	10	22	13
5:15	Full	10	23	13
5:30	Full	9	21	11
5:45	Full	9	20	11

Units = Cars
Full in the EB direction indicates the queue extended to Park Road, past Rosemont Ave
Full in the SB direction indicates the queue starts from the King-Callahan-Russell intersection and extends to Duke at southbound of King-(

Callahan-Russell intersection

Kimley»Horn

ATTACHMENT D

King Street at Callahan Drive/ Russel Road
VISSIM Calibration Results

Volume Calibration Results

AM Peak Volume Calibration: 7:30 AM – 8:30 AM				
Approach (Vehicles)	Movement	Model Volume	Field Volume	% Difference
Northbound	Left	134	137	-2%
	Through	290	298	-3%
	Right	114	104	10%
Westbound	Left	84	81	4%
	Through	258	250	3%
	Right	1	1	0%
Eastbound	Left	74	69	7%
	Through	369	353	5%
	Right	115	115	0%
Westbound	Left	164	159	3%
	Through	324	305	6%
	Right	111	110	1%

PM Peak Volume Calibration: 4:45 PM – 5:45 PM				
Approach (Vehicles)	Movement	Model Volume	Field Volume	% Difference
Northbound	Left	131	135	-3%
	Through	270	278	-3%
	Right	93	79	18%
Westbound	Left	41	43	-5%
	Through	299	306	-2%
	Right	2	2	0%
Eastbound	Left	29	28	4%
	Through	247	237	4%
	Right	213	217	-2%
Westbound	Left	291	298	-2%
	Through	427	413	3%
	Right	41	42	-2%

Legend

Met +/- 10% Calibration Range
Exceeded +/- 10% Calibration Range

Queue Calibration Results

AM Peak Queue Calibration: 7:30 AM – 8:30 AM			
Approach (Vehicles)	Model Max	Field Observation	% Difference
Northbound	31	31	0%
Southbound	16	6	167%
Eastbound	44	38	16%
Westbound	21	6	250%
PM Peak Queue Calibration: 4:45 PM – 5:45 PM			
Approach (Vehicles)	Model Max	Field Observation	% Difference
Northbound	31	22	41%
Southbound	20	12	67%
Eastbound	37	35	6%
Westbound	23	10	130%

Legend

Met +30% Calibration Range
Exceeded +30% Calibration Range