ATTACHMENT C

Future Traffic Conditions Technical Memorandum

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TECHNICAL MEMORANDUM

Date:	May 30, 2014	Project #: 17289
To:	Christina Fink, P.E. and Ken Ray Toole Design Group	
From:	Caitlin Doolin and Zachary Horowitz, P.E.	
Project:	Lower King Street Multimodal Feasibility Study	
Subject:	Future Traffic Conditions in Old Town Alexandria	

EXECUTIVE SUMMARY

At the request of the City of Alexandria, Toole Design Group (TDG) and Kittelson & Associates, Inc. (KAI) is conducting a study of a potential pedestrian-only or shared street concept for the 100 block of King Street in the historic Old Town section of the City of Alexandria, Virginia. As part of the existing conditions analysis, KAI studied current vehicle traffic operations along three blocks of King Street and on the surrounding streets, a total of 15 intersections, and the effects of pedestrians and bicyclists on vehicle traffic operations. This technical memorandum summarizes the trip generation, trip assignment, methodology, and results of the analysis of future traffic operational findings for the weekday p.m. peak hour and the weekend midday peak hours for the year 2035.

The future traffic operations analysis describes traffic conditions for the year 2035 within the study area. Synchro and SimTraffic transportation models were developed using future traffic volumes based on background growth in traffic and the effects of trip generation related to planned developments in and near the study area. The transportation models were used to analyze future traffic conditions with and without the 100 block of King Street (between Lee Street and Union Street) closed to traffic. To evaluate the impacts of closing the 100 block of King Street, future traffic volumes were rerouted and reassigned to the street network. The following summarizes the findings and conclusions of the analysis:

- As a result of natural increases and development activity, traffic volumes in the study area would be expected to grow between five and 15 percent between the year 2014 and the year 2035
- The intersection volume-to-capacity (v/c) ratios in the year 2035 indicate that the study intersections have available capacity to accommodate vehicle demands. Conflicting pedestrian volumes are the key impact to traffic operations at these intersections

- The results of the analysis of the year 2035 scenario where the 100 block of King Street remains open to all motorized vehicle traffic suggest that the intersections along King Street would:
  - Experience a decrease in level-of-service during the weekday p.m. peak hour as compared to existing conditions
  - Experience similar levels of traffic congestion as existing conditions during the weekend midday peak hour
- Closing King Street to all motorized traffic would impact travel patterns within the study area in the following ways:
  - Vehicles would be less likely to use King Street as a through street east of Fairfax Street
  - Cameron Street and Duke Street would carry more east-west traffic and Union Street and Lee Street would carry more north-south traffic
- The results for the weekday p.m. peak indicate that closing the 100 block of King Street would:
  - Improve vehicle operations at King Street/Lee Street and King Street/Union Street because a large number of potential conflicts between pedestrians and vehicles would be removed at the new three-legged intersection
  - Improve vehicle operations at King Street/Fairfax Street, because this location would experience fewer effects from spillback queuing associated with vehicle/pedestrian volumes at King Street/Lee Street
- The results for the weekend midday peak indicate that closing the 100 block of King Street would:
  - Improve vehicle operations at King Street/Fairfax Street because lower total entering traffic volumes
  - Improve vehicle operations at King Street/Lee Street by decreasing the number of pedestrian/vehicle conflicts
  - Increase congestion on Union Street because of additional traffic volumes
- Overall, the analysis shows that closing the 100 block of King Street to motorized vehicle traffic would improve traffic operations for intersections along King Street. The closure of the street to non-motorized traffic would provide additional capacity for pedestrians in the section of the study area where there is the highest demand.

INTRODUCTION

This technical memorandum summarizes the trip generation, trip assignment, methodology, and results of the analysis of future traffic operational findings for the weekday p.m. peak hour and the weekend midday peak hours for the year 2035. Similar to existing conditions, the analysis used Synchro and SimTraffic. The locations of the study intersections are shown in Figure 1.

The technical memorandum first describes the analysis methodology. Next, the volume development, trip generation, and trip assignment steps are explained. Following is a description of the traffic analysis results for the two future scenarios, the first with the 100 block of King Street open and the second with the 100 block of King Street closed. The memorandum closes by discussing the conclusions of the year 2035 future conditions traffic analysis.

Figure 1. Lower King Street Pedestrian Study intersections (Source: Google Earth)

ANALYSIS METHODOLOGY

The analysis methodology for this study includes the following steps:

- Development of background traffic growth
- Review of the trip-generating characteristics of the proposed developments within and near the study area
- Application of mode split factors based on the Alexandria Waterfront Traffic Impact Study
- Assignment of traffic volumes to the year 2035 Synchro and SimTraffic networks
- Analysis of the year 2035 scenario where the 100 block of King Street remains open
- Closure of the 100 block of King Street, reassignment of traffic volumes, and analysis of the year 2035 scenario where the 100 block of King Street is closed to motorized vehicle traffic
- Comparison of the scenario results

These steps are described in more detail in the following sections.

VOLUME DEVELOPMENT

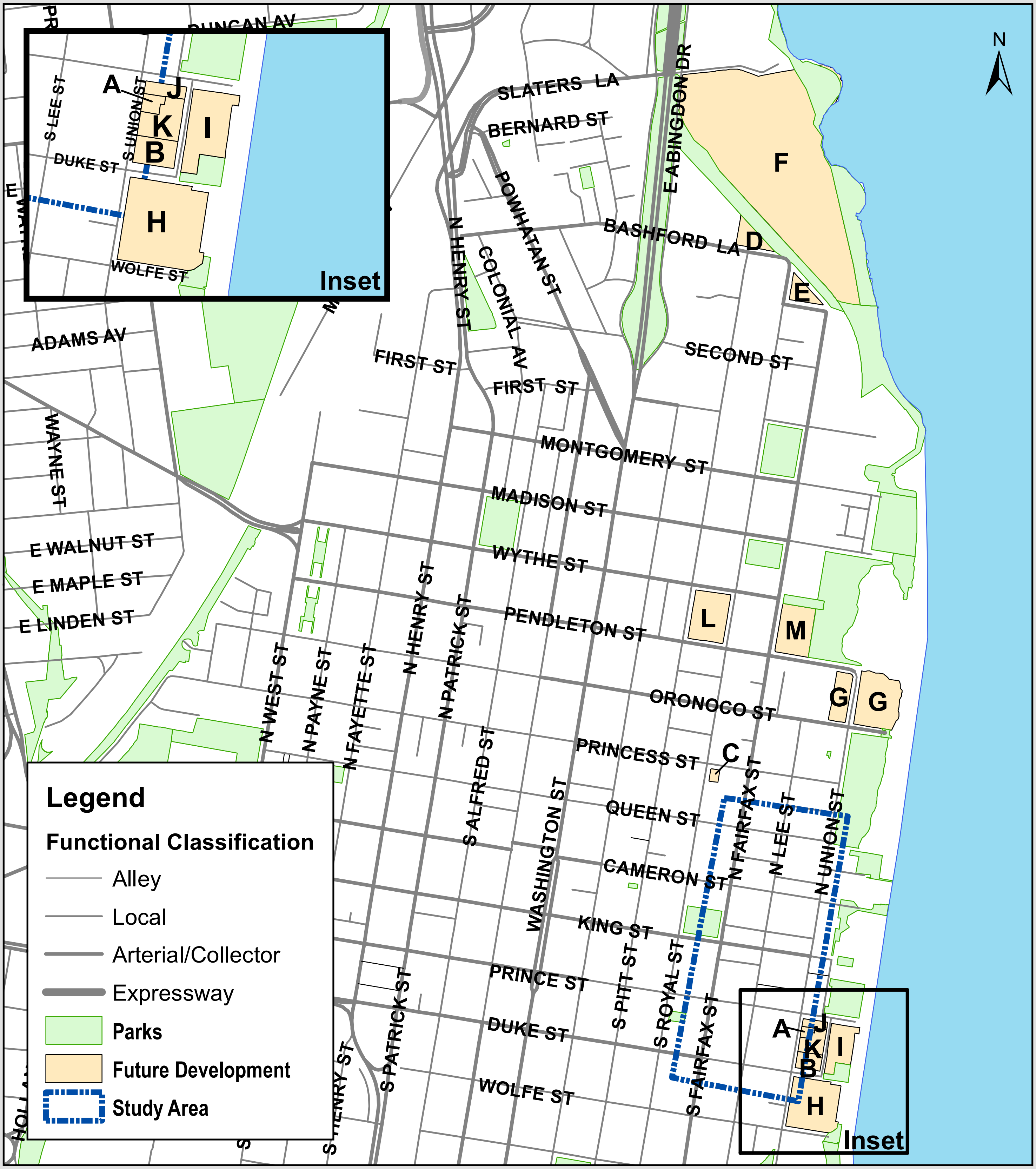
To analyze the traffic conditions for the year 2035, future traffic volumes were developed based on background traffic growth, trip generation for future development and the application of mode split factors. This section describes the process for developing future traffic volumes.

Background Traffic

Based on conversations with City of Alexandria staff and previous traffic studies for the City, a background traffic growth rate of 0.5 percent per annum, with a total growth cap of five percent, was used to calculate the growth in year 2035 traffic volumes. This growth rate is consistent with the Alexandria Waterfront Traffic Impact Study completed in 2010. A 0.5 annual growth rate for the 21 years between the year 2014 and the year 2035 equals 10.5 percent growth (21 years multiplied by 0.5 percent). As this growth exceeds the five percent cap, a total background growth rate of five was used. This growth rate was also applied to pedestrian and bicycle volumes.

Trip Generation for Planned Developments

In addition to developing background traffic growth, KAI completed a trip generation analysis for future planned development expected to occur between today and the year 2035 using the *ITE Trip Generation Manual, 9th Edition*. The City of Alexandria provided the list of future developments and provided feedback on and approved KAI's selection of developments to include in the study. A map of the future planned development parcels can be seen in Figure 2.



2035 Future Development Parcels

Lower King Street Multimodal Study

May 2014

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Table 1, as shown on the next page, includes a summary of the land uses in each of the projects, the development size, and the associated ITE trip generation code for the existing land uses and planned development projects. Each of the project map IDs in Table 1 that correspond to the parcels shown in Figure 2, identifies the existing land uses that would be removed and the new ones that would take their place. Only developments that are planned to be built out by 2035 and were located either within the study or in a nearby location that would reasonably impact the study area were included

As indicated in Table 1, land uses in the planned development descriptions were matched up with corresponding ITE trip generation codes from the ITE Trip Generation Manual, 9th Edition as closely and reasonably as possible. The following assumptions were made when determining which land uses were best to use in the analysis:

- The “Shopping Center” category (ITE code 820) was used for all land uses identified as “General Commercial.” This assumes that the “General Commercial” in the development is likely retail. The “Shopping Center” land use code also has substantially more data points used in developing the formula and trip generation rate than related land uses in the manual
- The “Hotel” category (ITE Code 310) was used for all land uses identified as “Hotel & Motel.” This was because the “Motel” land use in the ITE code assumes a lower occupancy rate than anticipated for the area
- The “Apartment” category (ITE Code 220) was used for all land uses identified as “Mid-Rise” or “High-Rise” apartments. While there are ITE land use codes for “Mid-Rise” and ”High-Rise” apartments categories in the ITE manual, there are limited data for these categories
- The “Government Office Building” category (ITE Code 730) was used for the land use identified as “City-Other”. It is assumed that this is an office building owned by the City

After all the land uses were identified, KAI then determined the trips generated for the weekday p.m. peak hour and the weekend midday peak hour based on the land use type and size (square footage or dwelling units) for both the existing land uses and future developments. The ITE trip generation methodology calculates trips based on either an average trip generation rates, or, where applicable, a formula created from a fitted curve based on previous trip generation studies. For the trip generation analysis, the formula was used to calculate the number of trips generated whenever the formula satisfied an R squared value of 0.80 or higher. Where the R squared value was lower than 0.80 or not provided, the average trip generation rate was used. Table 1 notes whether the formula or average rate was used in each case. The rows highlighted in pink indicate the existing land uses that would be removed in favor of the future development.

Table 1. Summary of Planned Development ITE Trip Generation Codes and Methodology Used

Project Map ID	Project Identifier	Land Use	Floor area (1,000 square feet)	Dwelling Units	ITE Code	ITE Land Use	Method** (Formula or Average Rate)
A	BLD2012-0192	Warehouse/Flex Space	18	0	150	Warehousing	Formula
		Office Bldg (10,000 sf+)	18	0	710	General Office Building	Formula
B	DSP2012-0019	Warehouse/Flex Space	21.2	0	150	Warehousing	Formula
		Hotel & Motel	65	121	310	Hotel	Average Rate
C	DSP2012-0029	General Commercial	2	0	820	Shopping Center	Formula
		Row House Residential	8	4	230	Residential Condominiums/Town house	Average Rate
D	Infill 002	Repair Service/Garage	10.9	0	942	Automobile Care Center	Average Rate
		Row House Residential	0	15	230	Residential Condominiums/Town house	Formula
E	Infill 003	Restaurant	12.5	0	932	High-Turnover (Sit Down) Restaurant	Average Rate
		Row House Residential	0	15	230	Residential Condominiums/Town house	Average Rate
F	LTP-37C	Electric Light And Power (SCC)	221.2	0	170	Utilities	Average Rate
		General Commercial	20	0	820	Shopping Center	Formula
		Office Bldg (10,000 sf+)	200	0	710	General Office Building	Formula
		Hotel & Motel	250	375	310	Hotel	Average Rate
		High-rise Apt (7+ Story)	400	400	220	Apartments	Formula
		Mid-rise Apt (4-6 Story)	400	400	220	Apartments	Formula
G	WF-A	Warehouse/Flex Space	93.6	0	150	Warehousing	Formula
		General Commercial	38	0	820	Shopping Center	Formula
		Mid-rise Apt (4-6 Story)	100	100	220	Apartments	Formula
		Hotel & Motel	100	150	310	Hotel	Average Rate
H	WF-B	Warehouse/Flex Space	102.8	0	150	Warehousing	Formula
		General Commercial	10	0	820	Shopping Center	Formula
		Restaurant	10	0	932	High-Turnover (Sit Down) Restaurant	Average Rate
		Row House Residential	100	60	230	Residential Condominiums/Town house	Average Rate
		Mid-rise Apt (4-6 Story)	150	150	220	Apartments	Formula
I	WF-C1	Warehouse/Flex Space	7.2	0	150	Warehousing	Formula
		Restaurant	4	0	932	High-Turnover (Sit Down) Restaurant	Average Rate
		City Government Building	6	0	730	Government office Building	Formula
J	WF-C2	General Commercial	3	0	820	Shopping Center	Formula
		Jr. Ofc Building <10,000 sf)	8.8	0	710	General Office Building	Formula
		City - Other***	4	0	730	Government office Building	Average Rate
		Jr. Ofc Building <10,000 sf)	5	0	710	General Office Building	Formula
		General Commercial	5	0	820	Shopping Center	Formula
		Mid-rise Apt (4-6 Story)	12.3	12	220	Apartments	Formula
K	WF-C4	General Commercial	6.5	0	820	Shopping Center	Formula
		General Commercial	2	0	820	Shopping Center	Formula
		Mid-rise Apt (4-6 Story)	48	19	220	Shopping Center	Formula
L	Infill 001	Warehouse/Flex Space	48.4	0	150	Warehousing	Formula
		Mid-rise Apt (4-6 Story)	75	56	220	Apartments	Formula
		Row House Residential	72	34	230	Residential Condominiums/Town house	Average Rate
M	BLD2012-0810	Office Bldg (10,000 sf+)	155.3	0	710	General Office Building	Formula
		Mid-rise Apt (4-6 Story)**	155	60	220	Apartments	Formula

*Note: Land uses highlighted in pink indicate land uses that are being removed.

**Note: Formula is used when the R squared value is greater than or equal to 0.80, per ITE Trip Generation Methodology.

To arrive at the total net trips that would be added or subtracted from each of the development parcels, the number of trips generated from the existing land uses was subtracted from the number generated from the future land uses. Table 2 shows the results of the trip generation analysis; the pink rows indicate the parcel IDs that would have fewer trips with new development compared with the existing land uses.

The number of trips that are entering and exiting the site during both analysis periods are shown in Table 2. This data is used for the trip assignment step of the analysis. The complete trip generation analysis can be found in Appendix A.

Table 2. Summary of Trip Generation Calculations (Year 2035)

Project Map Parcel ID	Weekday PM Trips			Weekend Midday Trips		
	In	Out	Total	In	Out	Total
A	13	66	79	3	3	6
B	19	-1	18	47	37	84
C	-18	-21	-39	-12	-13	-25
D	-14	-17	-31	-104	-108	-212
E	-66	-45	-111	-68	-61	-129
F	457	509	966	546	484	1030
G	215	161	376	327	295	622
H	190	100	290	226	206	432
I	71	25	96	31	27	58
J	58	30	88	19	17	36
K	-9	-16	-25	-27	-25	-52
L	31	36	67	88	47	135
M	-202	-13	-215	-23	-13	-36
Total Net Trips	**745**	**814**	**1559**	**1053**	**896**	**1949**

Rows in pink indicate parcels that would have fewer trips with the proposed development than with the current land uses.

Mode Split Adjustments

To account for the non-single occupant vehicle (SOV) trips, the trip generation calculations were reduced based on the mode splits, shown in Table 3 on the following page, for the City of Alexandria that were identified in the Alexandria Waterfront Traffic Impact Study in 2010.

Because the mode splits for non-SOV trip are relatively high, it was assumed that applying the mode splits to the trip generation results eliminated the need to account for pass-by trips or the effects of internal trip capture. This approach likely avoids over-reducing the traffic generated by the future development.

Table 3. Summary of Mode Splits for the City of Alexandria, 2010

Mode	Mode Split
Transit	20%
Walk	9%
Bike	3%
SOV	58%
Carpool	10%

Source: Alexandria Waterfront Traffic Impact Study, 2010

TRIP ASSIGNMENT

Net vehicle trips calculated after the mode split adjustments were assigned to the study area and added to the background traffic to create the year 2035 traffic volumes. This was done by first creating three "clusters" of developments based on the proximity of the parcels to one another. Doing so eliminated the need to compete the trip assignment for each parcel individually and allowed trips to be distributed throughout the network more uniformly. The number of trips in and out of each development "cluster" can be seen in Table 4 below.

Table 4. Summary of Vehicle Trips by Development "Cluster"

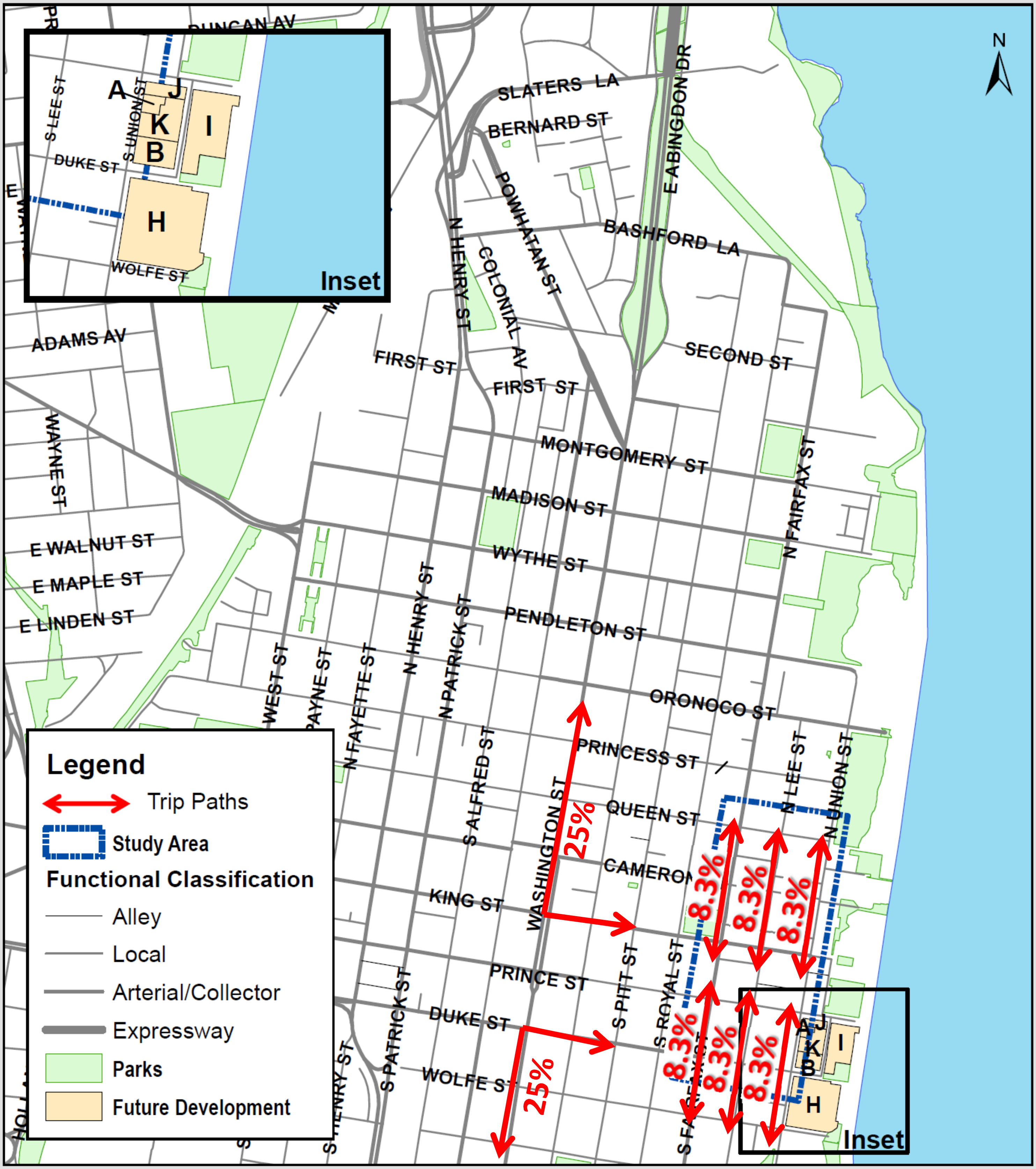
Development "Cluster" Parcel IDs	Weekday PM Trips		Weekend Midday Trips	
	In	Out	In	Out
A, B, H, I, J, K	215	129	188	167
C, G, L, M	16	103	239	199
D, E, F	238	282	236	198
Total Trips	**469**	**515**	**663**	**564**

Vehicle trips to and from the development "clusters" were then assigned to the network based on likely travel paths. In the absence of origin-destination data for travel in Old Town Alexandria, the following assumptions, based on engineering judgment, were made in assigning trips to the network:

- Fifty percent of all the trips originated from north of each development "cluster" and fifty percent originated from south of each development "cluster"
- It was assumed that streets with a higher functional classification such as Washington Street or Fairfax Street would carry a greater percentage of trips than local streets
- It was assumed that traffic would travel to and from the development "cluster" along the same streets

Figure 3, Figure 4, and Figure 5 show the trip assignment patterns for each development "cluster". The percentages shown in these three figures were applied to the data in Table 4 to create the traffic volumes associated with development. The development traffic plus the background and existing traffic were the combined to create the future year 2035 volumes.

Figure 3



Year 2035 Trip Assignment for Development Parcels A, B, H, I, J and K

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Figure 4

Year 2035 Trip Assignment for Development Parcels C, G, L and M

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Figure 5

Year 2035 Trip Assignment for Development Parcels D, E and F

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SYNCHRO AND SIMTRAFFIC ANALYSES

To evaluate the future traffic conditions, the year 2035 volumes calculated through the trip generation, mode split, and trip assignment steps previously discussed were entered into Synchro and SimTraffic for all 15 study intersections. Peak hour factors (PHF) were updated in accordance with accepted Virginia Department of Transportation (VDOT) methodology. The VDOT protocol raises PHFs to 0.92 for approaches that have existing year PHFs less than 0.92. For existing year approaches with PHFs greater than 0.92 (e.g. a PHF of 0.96), the existing year PHFs remain. The signal timing at the intersection of King Street and Fairfax Street was optimized based on the new traffic volumes, though the cycle length remained at 60 seconds.

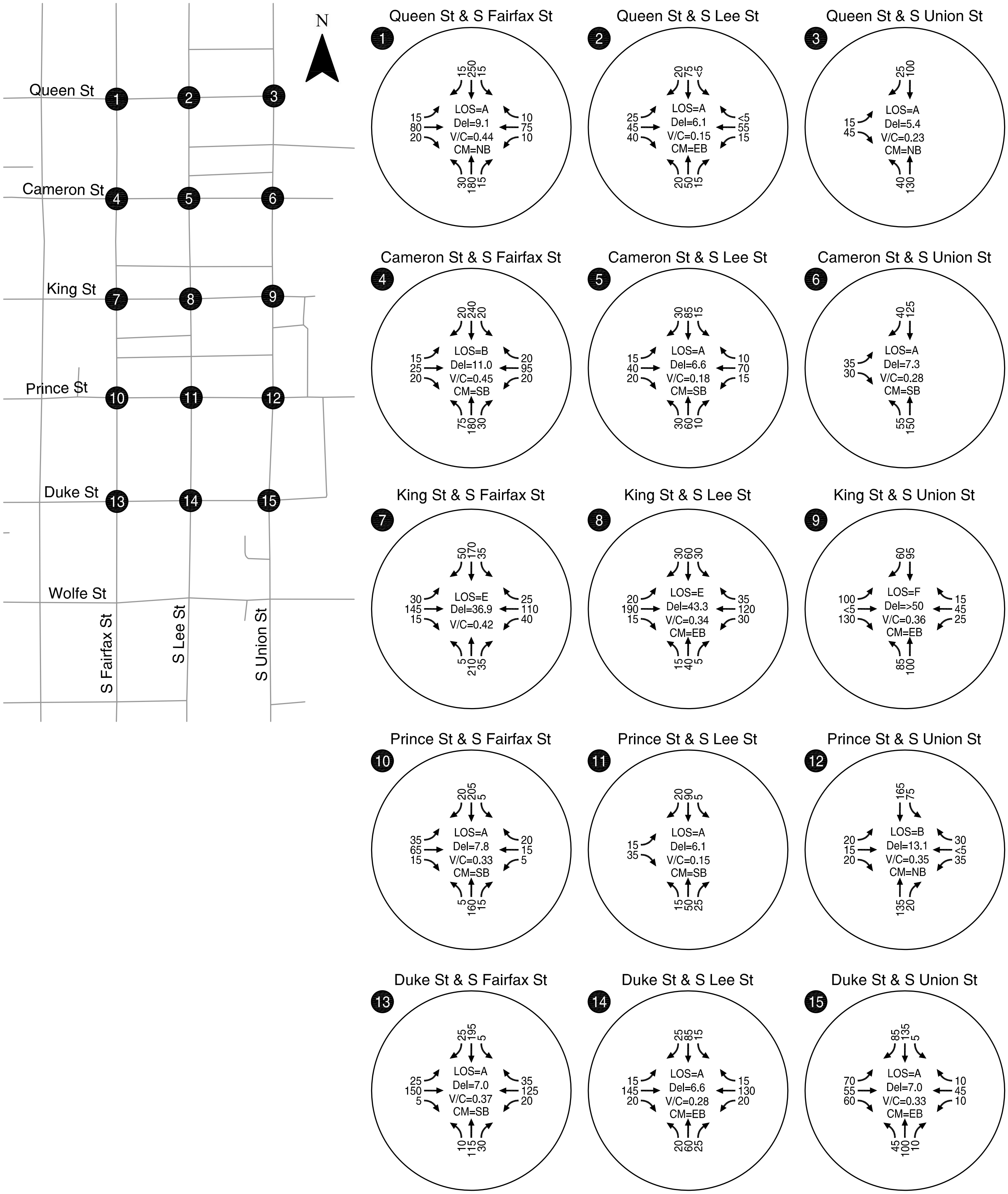
The Synchro and SimTraffic models were run for two year 2035 scenarios: (1) With the 100 block of King Street open to motorized vehicles and (2) With the 100 block of King Street closed to motorized vehicles. For scenario 2, the trips using the 100 block of King Street were redistributed throughout the study area street network.

Synchro was used for the Highway Capacity Manual (HCM) analysis. The HCM methodology was applied to all intersections to calculate the volume-to-capacity (v/c) ratios; a measure of the degree an intersection's capacity is utilized. The models were run for each of these scenarios under both weekday p.m. peak hour and weekend midday peak hour conditions.

The SimTraffic microsimulation models were developed from the Synchro models used to complete the HCM analysis. The SimTraffic models were run following the procedures detailed in the VDOT Traffic Operations Analysis Tools Guidebook, Version 1.1. Model runs were based on the methodology available in SimTraffic, which included using a randomized initial traffic volume for each run in a 15-minute period prior to the peak hour simulation. Ten runs were conducted and reviewed for errors. The final output results (per-vehicle delay, level-of-service, and queuing) of the SimTraffic analysis were based on averages across all applicable runs. Based on observations of actual conditions and engineering judgment, the SimTraffic models and results accurately depict vehicle delay and queuing at the study intersections. The SimTraffic models were run for each of these scenarios under both weekday p.m. peak hour and weekend midday peak hour conditions.

Year 2035 Results - King Street Open to Motorized Vehicles

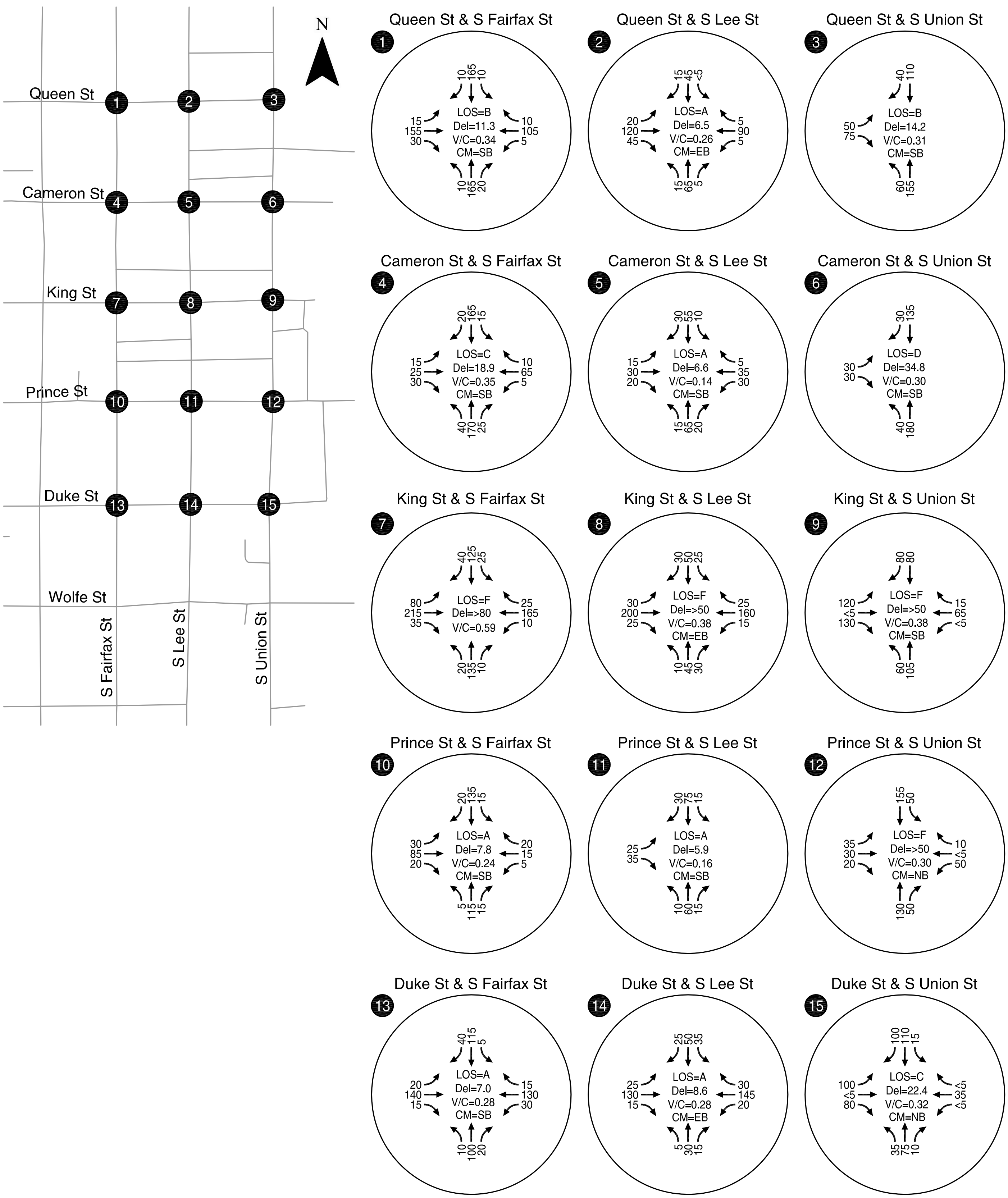
The traffic volumes and operational results for this scenario can be seen in Figure 6 for the weekday p.m. peak hour and in Figure 7 for the weekend midday peak hour. Transportation planning and traffic engineering techniques measure the impacts of "No-Build" or "No-Action" scenarios, such as this one, by comparing them against existing conditions. In this instance the year 2014 existing conditions results are compared against the year 2035 scenario that keeps the 100 block of King Street open to all motorized vehicles. The comparison results for all 15 study intersections for both the weekday p.m. peak hour and the weekend midday peak hour as shown in Table 5 three pages following.



2035 Weekday PM Peak Hour Traffic Operations
King Street Open
Alexandria, VA

Figure 6

LOS = INTERSECTION LEVEL OF SERVICE
Del = INTERSECTION AVERAGE CONTROL DELAY
V/C = INTERSECTION VOLUME-TO-CAPACITY RATIO (SIGNALS) CRITICAL VOLUME-TO-CAPACITY RATIO (AWSC)
CM = CRITICAL MOVEMENT (AWSC)



2035 Weekend Midday Peak Hour Traffic Operations
King Street Open
Alexandria, VA

Figure 7

LOS = INTERSECTION LEVEL OF SERVICE
Del = INTERSECTION AVERAGE CONTROL DELAY
V/C = INTERSECTION VOLUME-TO-CAPACITY RATIO (SIGNALS) CRITICAL VOLUME-TO-CAPACITY RATIO (AWSC)
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Table 5. Comparison Between Year 2014 Existing Conditions and Year 2035 King Street Open to All Motorized Vehicles SimTraffic Results

Intersection	Level-of-Service (LOS)	Per-Vehicle Delay (Seconds)	Volume-to-Capacity (v/c) Ratio
Year 2014 Weekday PM Peak Hour (Year 2035 Weekday PM Peak Hour – King Street Open)			
Queen Street/Fairfax Street	A (A)	7.5 (9.1)	0.28 (0.44)
Queen Street/Lee Street	A (A)	5.9 (6.1)	0.17 (0.15)
Queen Street/Union Street	A (A)	5.5 (5.4)	0.21 (0.23)
Cameron Street/Fairfax Street	A (B)	8.8 (11.0)	0.33 (0.45)
Cameron Street/Lee Street	A (A)	6.3 (6.6)	0.17 (0.18)
Cameron Street/Union Street	A (A)	6.4 (7.3)	0.24 (0.28)
King Street/Fairfax Street	***B (E)***	***11.6 (36.9)***	*0.35 (0.42)*
King Street/Lee Street	**B (E)**	**10.4 (43.3)**	0.26 (0.34)
King Street/Union Street	**E (F)**	**37.6 (> 50)**	0.30 (0.36)
Prince Street/Fairfax Street	A (A)	6.7 (7.8)	0.27 (0.33)
Prince Street/Lee Street	A (A)	5.8 (6.1)	0.16 (0.15)
Prince Street/Union Street	A (B)	6.0 (13.1)	0.33 (0.35)
Duke Street/Fairfax Street	A (A)	6.2 (7.0)	0.28 (0.37)
Duke Street/Lee Street	A (A)	5.9 (6.6)	0.19 (0.28)
Duke Street/Union Street	A (A)	5.8 (7.0)	0.22 (0.33)
Year 2014 Weekend Midday Peak Hour (Year 2035 Weekend Midday Peak Hour– King Street Open)			
Queen Street/Fairfax Street	A (B)	6.9 (11.3)	0.16 (0.34)
Queen Street/Lee Street	A (A)	5.4 (6.5)	0.16 (0.26)
Queen Street/Union Street	A (B)	6.6 (14.2)	0.24 (0.31)
Cameron Street/Fairfax Street	A (C)	8.4 (18.9)	0.27 (0.35)
Cameron Street/Lee Street	A (A)	6.7 (6.6)	0.15 (0.14)
Cameron Street/Union Street	D (D)	28.7 (34.8)	0.29 (0.30)
King Street/Fairfax Street	***E (F)***	***76.4 (> 80)***	*0.47 (0.59)*
King Street/Lee Street	F (F)	> 50 (> 50)	0.35 (0.38)
King Street/Union Street	F (F)	> 50 (> 50)	0.26 (0.38)
Prince Street/Fairfax Street	A (A)	7.1 (7.8)	0.19 (0.24)
Prince Street/Lee Street	A (A)	6.8 (5.9)	0.14 (0.16)
Prince Street/Union Street	F (F)	> 50 (> 50)	0.28 (0.30)
Duke Street/Fairfax Street	A (A)	6.3 (7.0)	0.22 (0.28)
Duke Street/Lee Street	A (A)	6.0 (8.6)	0.20 (0.28)
Duke Street/Union Street	C (C)	15.5 (22.4)	0.24 (0.32)

Italics denote a signalized intersection
Bold indicates intersections that experience notable change between scenarios

The results of the analysis of the year 2035 scenario where the 100 block of King Street remains open to all motorized vehicle traffic suggest that the study intersections along King Street would experience more traffic congestion in terms of level-of-service, especially during the weekday p.m. peak hour. For the weekend midday peak hour, the study intersections along King Street would experience similar levels of traffic congestion as existing conditions in terms of level-of-service. For both time periods, the intersection v/c ratios from the HCM analysis indicate that the study locations have available capacity to accommodate vehicle demands. However, the HCM results do not take into account pedestrian movements and therefore the impacts they have on motorized vehicles along King Street. For both time periods, the study intersections off of King Street would not experience a notable change in v/c ratio, per-vehicle delay, or level-of-service.

Year 2035 Results - King Street Closed to Motorized Vehicles

The process for developing the Synchro and SimTraffic models for the year 2035 scenario when King Street would be closed to motorized vehicles were similar to the prior scenario, with one exception - the closure of the 100 block of King Street to motorized vehicles required that vehicle traffic be rerouted within the study area. The methodology for reassigning traffic is explained below.

Volume Reassignment

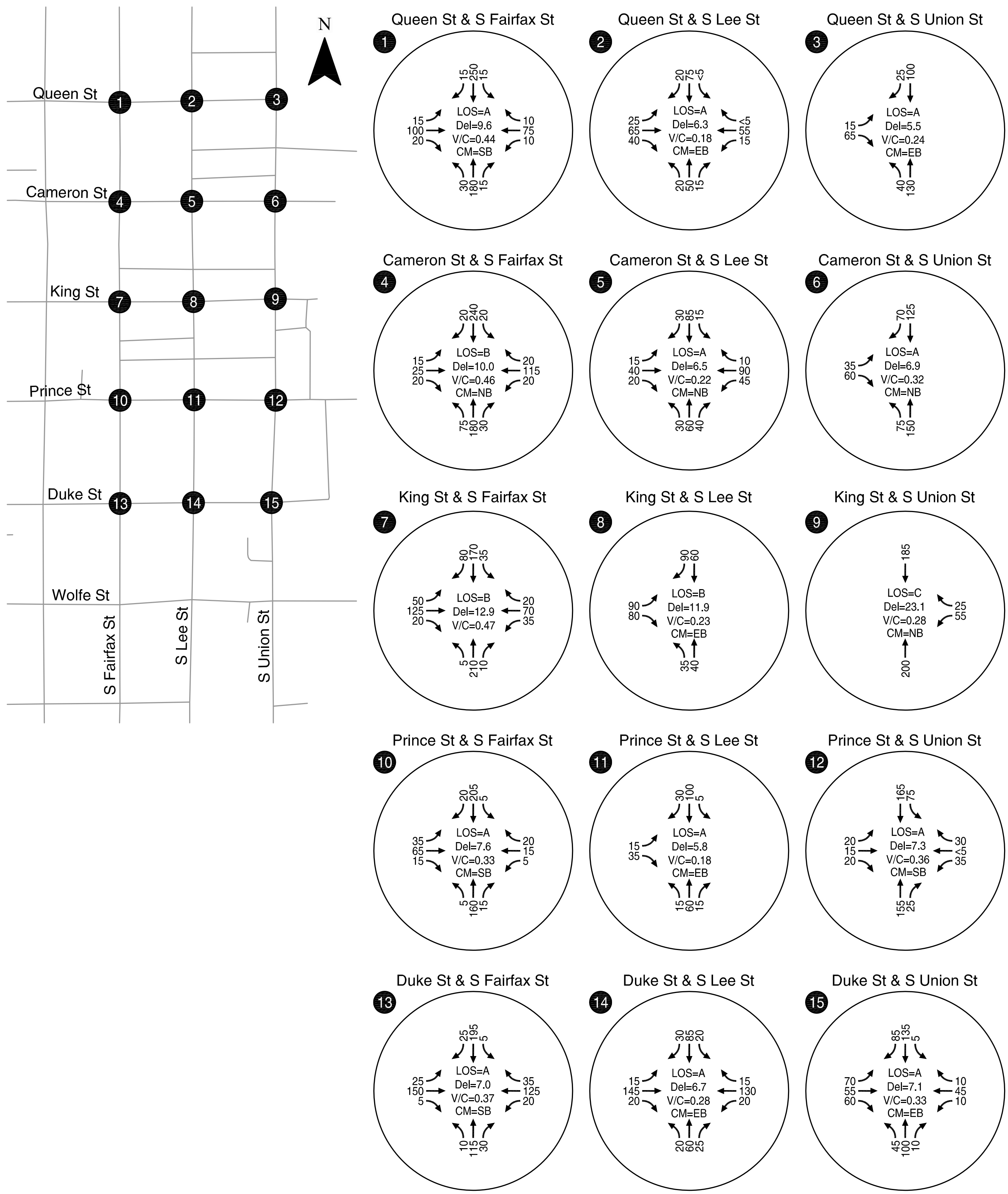
Within the Synchro file, the 100 block of King Street (between Lee Street and Union Street) was removed from the model. Removing this link requires that all vehicles that would travel on the 100 block of King Street need to be rerouted elsewhere in the network. It was assumed that removing the 100 block of King Street would have no effect on traffic volumes entering or leaving the study area. Therefore, the vehicles that were rerouted consisted of exactly the same traffic volumes as the year 2035 scenario where the 100 block of King Street remained open to motorized vehicles.

Removing motorized vehicles access to the 100 block of King Street and transformation of the intersections of King Street/Lee Street and King Street/Union Street into three-leg all-way stop-controlled intersections would have the following effects on vehicle traffic patterns in the study area:

- King Street would function less as a through street for vehicle traffic east of Fairfax Street
- Some eastbound traffic on King Street approaching Fairfax Street, that previously would have continued east on King Street, would instead turn left or right at Fairfax Street
- Lee Street and Union Street would carry more north-south traffic volume
- Duke Street would be expected to carry more diverted east-west traffic than Prince Street because Prince Street is a cobblestoned one-way street between Lee Street and Union Street
- Cameron Street (and other streets) near parking garages would experience higher traffic volumes as vehicles are diverted away from King Street

Results

Transportation planning and traffic engineering techniques measure the impacts of “Build” scenarios by comparing them against the “No-Build” or “No-Action” scenarios. In this instance the year 2035 scenario with 100 Block of King Street closed to all motorized vehicle results is compared against the year 2035 scenario that keeps the 100 Block of King Street open to motorized vehicles. The results for all 15 study intersections for both the weekday p.m. peak hour and the weekend midday peak hour as shown in Table 6 three pages following. Complete results including future year 2035 traffic volumes, intersection v/c ratios, per-vehicle delay, and level-of-service can be seen in Figure 8 for the weekday p.m. peak hour and Figure 9 for the weekend midday peak hour.



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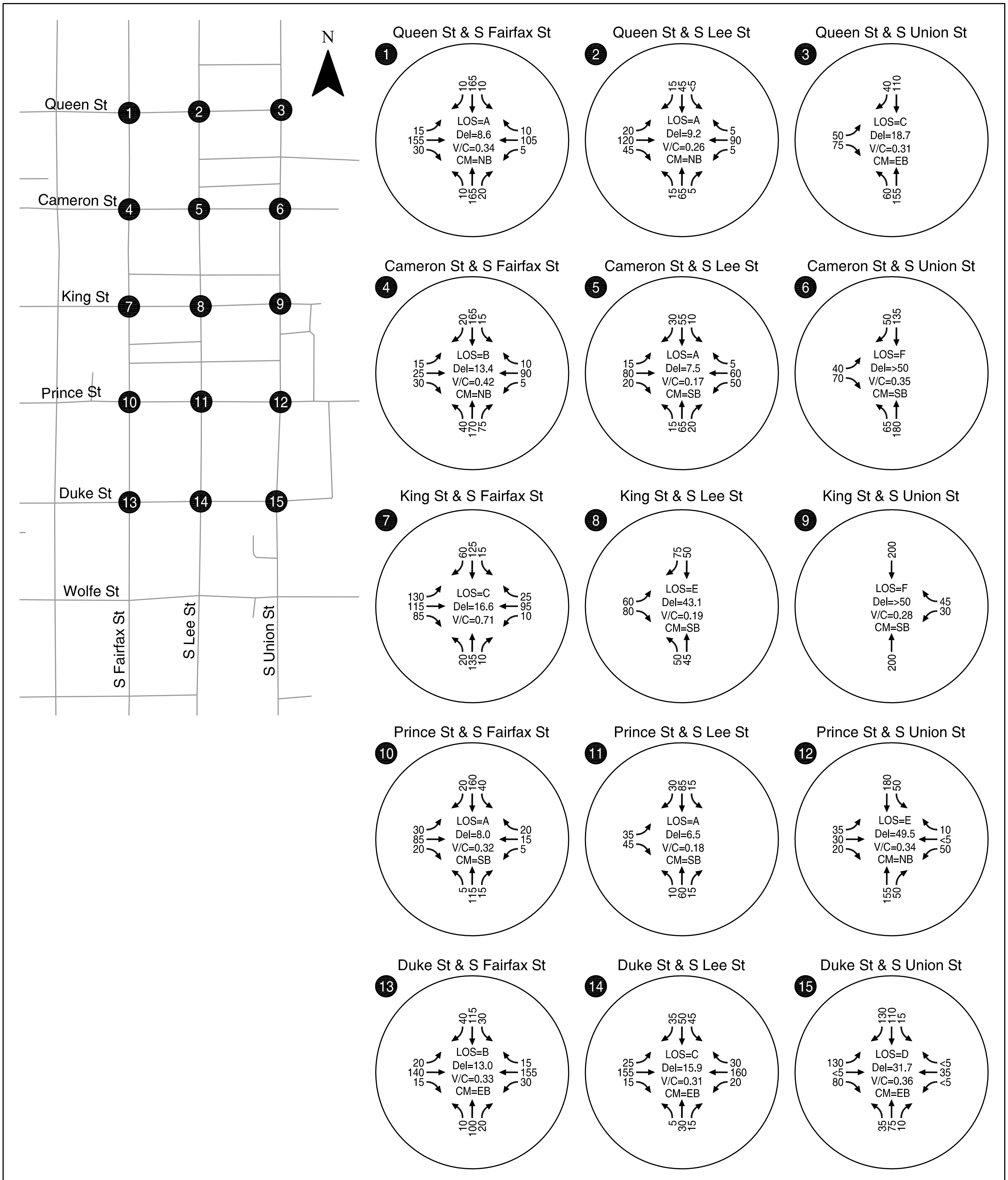
2035 Weekday PM Peak Hour Traffic Operations
King Street Closed
Alexandria, VA

Figure 8



LOS = INTERSECTION LEVEL OF SERVICE
Del = INTERSECTION AVERAGE CONTROL DELAY
V/C = INTERSECTION VOLUME-TO-CAPACITY RATIO (SIGNALS) CRITICAL VOLUME-TO-CAPACITY RATIO (AWSC)
CM = CRITICAL MOVEMENT (AWSC)

2035 Weekend Midday Peak Hour Traffic Operations
King Street Closed
Alexandria, VA

Figure 9

Table 6. Comparison Between Year 2035 King Street Open to All Motorized Vehicles and Year 2035 King Street Closed to All Motorized Vehicles SimTraffic Results

Intersection	Level-of-Service (LOS)	Per-Vehicle Delay (Seconds)	Volume-to-Capacity (v/c) Ratio
Year 2035 Weekday PM Peak Hour – King Street Open (Year 2035 Weekday PM Peak Hour – King Street Closed)			
Queen Street/Fairfax Street	A (A)	9.1 (9.6)	0.44 (0.44)
Queen Street/Lee Street	A (A)	6.1 (6.3)	0.15 (0.18)
Queen Street/Union Street	A (A)	5.4 (5.5)	0.23 (0.24)
Cameron Street/Fairfax Street	B (B)	11.0 (10.0)	0.45 (0.46)
Cameron Street/Lee Street	A (A)	6.6 (6.5)	0.18 (0.22)
Cameron Street/Union Street	A (A)	7.3 (6.9)	0.28 (0.32)
King Street/Fairfax Street	***E (B)***	***36.9* (12.9)**	0.42 (0.47)
King Street/Lee Street	**E (B)**	**43.3 (11.9)**	0.34 (0.23)
King Street/Union Street	**F (C)**	**> 50 (23.1)**	0.36 (0.28)
Prince Street/Fairfax Street	A (A)	7.8 (7.6)	0.33 (0.33)
Prince Street/Lee Street	A (A)	6.1 (5.8)	0.15 (0.18)
Prince Street/Union Street	B (A)	13.1 (7.3)	0.35 (0.36)
Duke Street/Fairfax Street	A (A)	7.0 (7.0)	0.37 (0.37)
Duke Street/Lee Street	A (A)	6.6 (6.7)	0.28 (0.28)
Duke Street/Union Street	A (A)	7.0 (7.1)	0.33 (0.33)
Year 2035 Weekend Midday Peak Hour – King Street Open (Year 2035 Weekend Midday Peak Hour – King Street Closed)			
Queen Street/Fairfax Street	B (A)	11.3 (8.6)	0.34 (0.34)
Queen Street/Lee Street	A (A)	6.5 (9.2)	0.26 (0.26)
Queen Street/Union Street	B (C)	14.2 (18.7)	0.31 (0.31)
Cameron Street/Fairfax Street	C (B)	18.9 (13.4)	0.35 (0.42)
Cameron Street/Lee Street	A (A)	6.6 (7.5)	0.14 (0.17)
Cameron Street/Union Street	**D (F)**	**34.8 (> 50)**	0.30 (0.35)
King Street/Fairfax Street	***F (C)***	**> 80 (16.6)**	0.59 (0.71)
King Street/Lee Street	**F (E)**	**> 50 (43.1)**	0.38 (0.19)
King Street/Union Street	F (F)	> 50 (> 50)	0.38 (0.28)
Prince Street/Fairfax Street	A (A)	7.8 (8.0)	0.24 (0.32)
Prince Street/Lee Street	A (A)	5.9 (6.5)	0.16 (0.18)
Prince Street/Union Street	**F (E)**	**> 50 (49.5)**	0.30 (0.34)
Duke Street/Fairfax Street	A (B)	7.0 (13.0)	0.28 (0.33)
Duke Street/Lee Street	A (C)	8.6 (15.9)	0.28 (0.31)
Duke Street/Union Street	C (D)	22.4 (31.7)	0.32 (0.36)

Italics denote a signalized intersection
Bold indicates intersections that experience notable change between scenarios

The results for the weekday p.m. peak indicate that closing the 100 block of King Street to motorized vehicles would substantially improve vehicle operations at the three King Street study intersections. At King Street/Lee Street and King Street/Union Street, transformation of the existing intersections into three-leg all-way stop-controlled intersections would remove the large number of potential conflicts between pedestrians and vehicles that is the primary cause of delay at these two locations. At King Street/Fairfax Street, lower total entering traffic volumes help contribute to lower overall per-vehicle delay and improved level-of-service. In addition, the closure of the 100 block of King Street generally eliminates spillback eastbound queuing from the intersection of King Street/Lee Street, which is a primary cause of delay at King Street/Fairfax Street. The remaining intersections show little difference between scenarios.

The results for the weekend midday peak indicate that closing the 100 block of King Street to motorized vehicles would substantially improve vehicle operations at King Street/Fairfax Street and King Street/Lee Street intersections by removing the large number of potential conflicts between pedestrians and vehicles that is the primary cause of delay at these two locations. However, the King Street/Union Street intersection would still operate at LOS “F” because of the high volume of pedestrians at that intersection. The additional vehicle volumes on Union Street would have a undesirable effect on vehicle operational results at Cameron Street/Union Street and Duke Street/Union Street.

CONCLUSIONS

The historic Old Town section of Alexandria has been an urbanized area for more than two centuries and the planned future is not expected to change the neighborhood’s transportation character substantially. Scheduled development activity and modest background growth in traffic volume between today and the year 2035, are limited by the urban land uses, historic district, and transportation facilities in Old Town Alexandria. Between today and 2035, there are no major transportation projects within the study area, and total growth in motorized vehicle traffic on most streets is expected to range between approximately five and 15 percent.

Proposed development activity and growth in background traffic in the year 2035 for the scenario where the 100 block of King Street would remain open to motorized vehicles would increase traffic congestion for the three study intersections along King Street during the weekday p.m. peak hour. The primary factor for worsening traffic conditions at these intersections during the weekday p.m. peak hour would lie in the interactions between motorized vehicles and pedestrians. Level-of-service would be expected to remain similar to existing conditions for the three study intersection along King Street during the weekend midday peak hour. Based upon the calculated v/c ratios, forecasted vehicle volumes would not create oversaturated conditions; this is shown through the HCM analysis. However, the SimTraffic microsimulation models that account for the interaction between vehicles and pedestrians clearly indicate that vehicles would need to yield to pedestrian activity throughout the peak hour, and that this is the cause of traffic congestion at these intersections. The result of the pedestrian/vehicle interactions would be LOS “E” or LOS “F” conditions at the three study intersections on King Street in both study time periods, and the formation of queues that would affect traffic operations at adjacent intersections.

Closing the 100 block of King Street to motorized vehicle traffic would create two new three-legged intersections at King Street/Lee Street and King Street/Union Street. The traffic formerly using King Street would be distributed through the Old Town Alexandria street grid with Lee Street and Union Street carrying more north-south traffic, and Cameron Street and Duke Street carrying more east-west traffic. Removing the conflicting vehicle/pedestrian movements at either end of the 100 block of King Street would have a positive impact on traffic operations at the King Street study intersections, particularly during the weekday p.m. peak hour. During the weekend midday peak hour, the intersections of King Street/Fairfax Street and King Street/Lee Street would experience improved traffic operations. The intersections on Union Street adjacent to King Street would see a decrease in level-of-service due to the increased traffic volume and impacts from spillback queuing at the King Street/Union Street intersection.

Overall, the closure of the 100 block of King Street to motorized vehicles would be a net benefit to vehicle traffic operations within Old Town Alexandria. While some intersections in this scenario would experience a decrease in traffic operational performance, this is more than offset by others that would see their operational performance improve. Reducing conflict points between pedestrians and vehicles at intersections would have ancillary safety benefits as well as improving traffic flow for pedestrians and vehicles. The SimTraffic analysis shows that because pedestrian demand is the primary factor affecting vehicle operations, increasing capacity for pedestrians and removing conflict points with vehicles would provide net benefits for both modes of travel.

APPENDIX A

Appendix A. Trip Generation Calculations

							Weekday PM						Weekend Midday					
Project Map ID	Project Identfier	Land Use	Floor Area	Floor area (1,000 square feet)	Dwelling Units	ITE Code	Entering Weekday PM (%)	Exiting Weekday PM (%)	PM Peak Hour Trip Gen Rate	Weekday PM Peak Trips	Entering Weekday PM Peak Trips	Exiting Weekday PM Peak Trips	Entering Weekend Midday (%)	Exiting Weekend Midday (%)	Weekend Midday Trip Gen Rate	Weekend Midday Trips	Entering Weekend PM Peak Trips	Exiting Weekend PM Peak Trips
A	BLD2012-0192	Warehouse/Flex Space	18,000	18.0	0	**150**	0.19	0.81	0.45	20	4	16	0.64	0.36	0.13	2	1	1
	BLD2012-0192	Office Bldg (10,000 sf+)	18,000	18.0	0	**710**	0.17	0.83	1.49	99	17	82	0.54	0.46	0.43	8	4	4
	Net Trips for Site BLD2012-0192									**79**	**13**	**66**				**5**	**3**	**3**
B	DSP2012-0019	Warehouse/Flex Space	21,240	21.2	0	**150**	0.19	0.81	0.45	22	4	18	0.64	0.36	0.13	3	2	1
	DSP2012-0019	Hotel & Motel	65,000	65.0	121	**310**	0.58	0.42	0.61	40	23	17	0.56	0.44	0.72	87	49	38
	Net Trips for Site DSP2012-0019									**17**	**19**	**-1**				**84**	**47**	**37**
C	DSP2012-0029	General Commercial	2,000	2.0	0	**820**	0.48	0.52	3.71	44	21	23	0.52	0.48	4.82	69	36	33
	DSP2012-0029	Row House Residential	8,000	8.0	4	**230**	0.64	0.36	0.52	4	3	2	0.54	0.46	0.47	44	24	20
	Net Trips for Site DSP2012-0029									**-39**	**-18**	**-21**				**-25**	**-12**	**-13**
D	Infill 002	Repair Service/Garage	10,920	10.9	0	**942**	0.49	0.51	3.51	38	19	20	0.50	0.50	23.72	259	130	130
	Infill 002	Row House Residential	0	0.0	15	**230**	0.64	0.36	0.52	8	5	3	0.54	0.46	0.47	47	25	22
	Net Trips for Site Infill 002									**-31**	**-14**	**-17**				**-212**	**-104**	**-108**
E	Infill 003	Restaurant	12,488	12.5	0	**932**	0.6	0.4	9.85	123	74	49	0.53	0.47	14.07	176	93	83
	Infill 003	Row House Residential	0	0.0	15	**230**	0.64	0.36	0.52	13	8	5	0.54	0.46	0.47	47	25	22
	Net Trips for Site Infill 003									**-110**	**-66**	**-45**				**-129**	**-68**	**-61**
F	LTP-37C	Electric Light And Power (SCC)***	221,177	221.2	0	**170**	0.45	0.55	0.76	168	76	92	No Weekend Data			0	0	0
	LTP-37C	General Commercial	20,000	20.0	0	**820**	0.48	0.52	3.71	204	98	106	0.52	0.48	4.82	307	160	147
	LTP-37C	Office Bldg (10,000 sf+)	200,000	200.0	0	**710**	0.17	0.83	1.49	302	51	251	0.54	0.46	0.43	86	46	40
	LTP-37C	Hotel & Motel	250,000	250.0	375	**310**	0.58	0.42	0.61	153	88	64	0.56	0.44	0.72	270	151	119
	LTP-37C	High-rise Apt (7+ Story)	400,000	400.0	400	**220**	0.65	0.35	0.62	238	154	83	0.50	0.50	0.52	183	92	92
	LTP-37C	Mid-rise Apt (4-6 Story)**	400,000	400.0	400	**220**	0.59	0.41	0.44	238	140	97	0.53	0.47	0.31	183	97	86
	Net Trips for Site LTP-37C									**966**	**457**	**509**				**1030**	**546**	**484**

Note:Cells highlighted in pink are landuses being removed and/or replaced.

							Weekday PM						Weekend Midday					
Project Map ID	Project Identfier	Land Use	Floor Area	Floor area (1,000 square feet)	Dwelling Units	ITE Code	Entering Weekday PM (%)	Exiting Weekday PM (%)	PM Peak Hour Trip Gen Rate	Weekday PM Peak Trips	Entering Weekday PM Peak Trips	Exiting Weekday PM Peak Trips	Entering Weekend Midday (%)	Exiting Weekend Midday (%)	Weekend Midday Trip Gen Rate	Weekend Midday Trips	Entering Weekend PM Peak Trips	Exiting Weekend PM Peak Trips
	WF-A	Warehouse/Flex Space	93,612	93.6	0	**150**	0.19	0.81	0.45	71	13	57	0.64	0.36	0.13	12	8	4
	WF-A	General Commercial	38,000	38.0	0	**820**	0.48	0.52	3.71	313	150	163	0.52	0.48	4.82	466	242	224
G	WF-A	Mid-rise Apt (4-6 Story)**	100,000	100.0	100	**220**	0.59	0.41	0.44	73	43	30	0.53	0.47	0.31	60	32	28
	WF-A	Hotel & Motel	100,000	100.0	150	**310**	0.58	0.42	0.61	61	35	26	0.56	0.44	0.72	108	60	48
	Net Trips for Site WF-A									**376**	**215**	**161**				**622**	**327**	**295**
	WF-B	Warehouse/Flex Space	102,839	102.8	0	**150**	0.19	0.81	0.45	76	14	62	0.64	0.36	0.13	13	9	5
	WF-B	General Commercial	10,000	10.0	0	**820**	0.48	0.52	3.71	128	61	67	0.52	0.48	4.82	196	102	94
H	WF-B	Restaurant	10,000	10.0	0	**932**	0.6	0.4	9.85	99	59	39	0.53	0.47	14.07	141	75	66
	WF-B	Row House Residential	100,000	100.0	60	**230**	0.64	0.36	0.52	40	25	14	0.54	0.46	0.47	28	15	13
	WF-B	Mid-rise Apt (4-6 Story)**	150,000	150.0	150	**220**	0.59	0.41	0.44	100	59	41	0.53	0.47	0.31	81	43	38
	Net Trips for Site WF-B									**290**	**190**	**100**				**432**	**226**	**206**
	WF-C1	Warehouse/Flex Space	7,200	7.2	0	**150**	0.19	0.81	0.45	10	2	8	0.64	0.36	0.13	1	1	0
I	WF-C1	Restaurant	4,000	4.0	0	**932**	0.6	0.4	9.85	39	24	16	0.53	0.47	14.07	56	30	26
	WF-C1	City Government Building***	6,000	6.0	0	**730**	0.74	0.26	11.03	66	49	17	0.54	0.46	0.43	3	1	1
	Net Trips for Site WF-C1									**96**	**71**	**25**				**58**	**31**	**27**
	WF-C2	General Commercial	2,960	3.0	0	**820**	0.48	0.52	3.71	57	27	29	0.52	0.48	4.82	89	46	43
	WF-C2	Jr. Ofc Building <10,000 sf)	8,760	8.8	0	**710**	0.17	0.83	1.49	88	15	73	0.54	0.46	0.43	4	2	2
	WF-C2	City - Other***	4,000	4.0	0	**730**	0.74	0.26	11.03	44	33	11	0.54	0.46	0.43	2	1	1
J	WF-C2	Jr. Ofc Building <10,000 sf)	5,000	5.0	0	**710**	0.17	0.83	1.49	84	14	70	0.54	0.46	0.43	2	1	1
	WF-C2	General Commercial	5,000	5.0	0	**820**	0.48	0.52	3.71	81	39	42	0.52	0.48	4.82	125	65	60
	WF-C2	Mid-rise Apt (4-6 Story)**	12,259	12.3	12	**220**	0.59	0.41	0.44	24	14	10	0.53	0.47	0.31	24	0	0
	Net Trips for Site WF-C2									**88**	**58**	**30**				**60**	**19**	**17**
	WF-C4	General Commercial	6,500	6.5	0	**820**	0.48	0.52	3.71	96	46	50	0.52	0.48	4.82	148	77	71
K	WF-C4	General Commercial	2,000	2.0	0	**820**	0.48	0.52	3.71	44	21	23	0.52	0.48	4.82	69	36	33
	WF-C4	Mid-rise Apt (4-6 Story)**	48,000	48.0	19	**220**	0.59	0.41	0.44	28	17	12	0.53	0.47	0.31	27	14	13
	Net Trips for Site WF-C4									**-24**	**-9**	**-16**				**-52**	**-27**	**-25**
	Infill 001	Warehouse/Flex Space	48,442	48.4	0	**150**	0.19	0.81	0.45	42	8	34	0.64	0.36	0.13	6	4	2
L	Infill 001	Mid-rise Apt (4-6 Story)**	75,000	75.0	56	**220**	0.59	0.41	0.44	48	29	20	0.53	0.47	0.31	42	22	20
	Infill 001	Row House Residential	72,000	72.0	34	**230**	0.64	0.36	0.52	25	16	9	0.54	0.46	0.47	52	28	24
	Net Trips for Site Infill 001									**31**	**36**	**-6**				**88**	**47**	**42**
	BLD2012-0810	Office Bldg (10,000 sf+)	155,305	155.3	0	**710**	0.17	0.83	1.49	252	43	209	0.54	0.46	0.43	67	36	31
M	BLD2012-0810	Mid-rise Apt (4-6 Story)**	155,000	155.0	60	**220**	0.59	0.41	0.44	51	30	21	0.53	0.47	0.31	44	23	21
	Net Trips for Site BLD2012-0810									**-202**	**-13**	**-189**				**-23**	**-13**	**-10**

Note:Cells highlighted in pink are landuses being removed and/or replaced.