Evaluation and Improvement of Al-Assaf Signalized Intersections in Amman City

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Abstract

Traffic Simulation studies the interaction between the traffic stream elements, which consist of road users (drivers & pedestrians), roadways (streets and highways), vehicles, and traffic control devices, to better help plan, design, and operate transportation systems. In this paper, a study to evaluate and improve the traffic operations at one of the important intersections in Amman is presented. Al-Assaf signalized intersection was chosen for this study. It is located at Wasfi Al-Tall Street; the evaluation shows that the intersection is operating at LOS F with a high delay time. Two solutions were introduced to improve the traffic conditions. The first one is to optimize the signal traffic, this showed a little improvement in delay and the level of service of the intersection remained F. The second solution is to add another lane to the left and through movement by changing and optimizing the timing plan of the signalized intersections, this solution showed a good improvement in the delay time but the intersection's LOS remained F.

Keywords: Traffic Simulation Modeling, Level of Service, Delay, Signalized Intersection, Synchro Software.

Introduction

An intersection is an area, shared by two or more roads, whose main function is to provide for the change of route directions (Texas Department of Transportation 2021). Intersections vary in complexity from a simple intersection, which has only two roads crossing at a right angle to each other, to a more complex intersection, at which three or more roads cross within the same area (Garber and Hoel 2014).

Intersections are classified into three general categories: grade-separated without ramps, grade-separated with ramps (commonly known as interchanges), and at-grade. Grade-separated intersections usually consist of structures that provide for traffic to cross at different levels (vertical distances) without interruption. The potential for crashes at grade-separated intersections is reduced because many potential conflicts between intersecting streams of traffic are eliminated. At-grade intersections do not provide for the flow of traffic at different levels and therefore there exist conflicts between intersecting streams of traffic (Garber and Hoel 2014).

The signalized at-grade intersection is a critical part of a highway because the efficiency, safety, speed, cost of operation, and capacity of the facility depend on the intersection design. the intersection design should facilitate the convenience, ease, and comfort of people traveling through the intersection. the intersection must have sufficient capacity to accommodate the current and future demand with a high level of service, Since the intersection is the junction point of two or more roads which results in conflict point of vehicle movement due to left turning volumes, this leads to congestion, delays, reduction in intersection capacity and level of service.

Level of service is a qualitative measure, ranging from A to F that characterizes both operational conditions within a traffic stream and highway users' perception. The level of service LOS is the measure of the quality of flow. The level of service is a measure of how well the facility is operating. Factors that affect the level of service at intersections include the flow and distribution of traffic, the geometric characteristics, and the signalization system (Shaaban and Kim 2015; Sillén 2019).

Literature Review

Msallam et al. (2016) presented a management study system to improve the traffic Network system in the Al Shmeisani district in Amman; the study was conducted on two main arterials with eight signalized intersections. they collected the traffic data from Amman Municipality and the Directorate of Public Security. For the traffic condition evaluation, they used highway capacity software HCS2000 and Synchro-8 programs software, they concluded that the intersection is operating at LOS F with high delay and high flow saturation, and then they came up with two suggestions to improve the traffic conditions at the intersection; the first one is to change the timing of a traffic signal, the second is to change the geometry condition combined with the first solution their solutions improved the intersection LOS from F to LOS C, D and E, in addition they enhanced the delay, saturation flow and the fuel consumption at all intersections.

Msallam (2014) studied and described the evaluation and the improvement of the traffic operations at signalized intersections in Amman; the study was conducted on Wadi-Saqra signalized intersections. they collected the traffic data in two periods of time, morning and evening peak, for the traffic simulation they used highway capacity software HCS2000, and Synchro-8 programs software, they found that the current delay is 473 sec/veh and Level of Service F (LOS-F). They suggested Four recommendations: prevent left turning at all approaches, optimize the process of the existing traffic signals, Construct one through overpass for one direction, and Construct two overpasses or one overpass and tunnel for two directions. They found that the fourth solution will improve the level of service from LOS F with (473 sec/veh) delay to the level of service LOS C with (27 sec/veh) delay and will change the cycle length from 190 seconds to 90 seconds.

Awad, Mohammed, and Mahmood (2010) studied was improvement of the traffic operation of the Al-Zeoat intersection in Al-Ramadi city in Iraq by analyzing and evaluating this intersection and using accepted solutions to improve the traffic operation of Al-Zeoat intersection under local existing conditions and present a best proposal to enhance the performance at the intersection by SIDRA simulation program, the proposal to enhance the performance was executing flyover, it reduce the level of service from E to C.

Al-Ubaidy, Al-Azzawi, and Dawood (2010) studied the evaluation of the performance of the Al-Thawra - grade Intersection Using The HCS2000 Computer Package. This intersection is in Al-hilla city in Iraq. The proposal to enhance the performance was to bridge the overpass in a North-South direction because The traffic survey shows that the high traffic volume of through movement in the North-South direction, reduces the level of service from F to C.

Naghawi, AlSoud, and AlHadidi (2018) examined the assessment of the possibility of implementing an unconventional arterial intersection design, the Superstreet, to improve the safety and operational characteristics of an existing signalized intersection. The signalized intersection selected for analysis was Tabarbour, located in Amman, Jordan. SYNCHRO microscopic simulation software was used for signal optimization of the current conventional intersection. VISSIM microscopic simulation software was used to analyze and compare the Superstreet design to the conventional design, it was found that the proposed Superstreet reduced the average delay per vehicle by up to 87% and reduced the maximum queue length by almost 97%. This resulted in improving the level of service from F to C.

Methodology

Study area

Al-Assaf intersection is a congested intersection located in the center of Amman City, the capital of Jordan. The intersection connects the major arterial roads: Wasfi Al-Tall Street runs East and West bounds, Almohamadeiah Street runs north and Mirza Wasfi Street runs southbound of the intersection. Wasfi Al-Tall Street is a six-lane divided arterial road with a posted speed of 70 km/h, Almohamadeiah Street has six lanes and Mirza Wasfi Street has four lanes. Al-Assaf intersection is a significant location and high traffic volume can be related to the important location and the existence of different public activities near Al-Assaf intersection that result a high traffic leading to a high delay at peak hour.

Figure 1: Aerial View of the Selected Intersection. Source: (Google Earth Pro, 2023).

Objectives

The main objective of this study is to evaluate and improve the traffic operations at the intersections in Amman city in Jordan. The al-Assaf intersection was chosen for this study. It has heavy traffic volume, with higher delay and heavy congestion traffic more than any other similar intersections in Amman.

1 - Evaluate the existing level of service (LOS) at the intersection under study.

2 - Evaluate all proposals that can solve the problem of congestion at the Al-Assaf intersection and calculate the level of service for the proposal.

3 - Select the best proposal that solves the congestion problem and provides a good performance within the design period.

Data collection

Traffic Volumes

Real traffic data were made available by the Department of Traffic Operations at GAM. Traffic volumes including turning movements, were collected at the Al-Assaf intersection from 18 January to 24 January 2019 at fifteen-minute intervals. The two peak periods are from 7:30 -8:30 AM, and 3-4 PM on all approaches. The Traffic volume of all approaches is shown in Table 1.

Table 1: Summary of traffic PEAK hourly volume for the intersection(veh/hr).

Movement	Almohamadeiah St. NB	Mirza St. SB	Wasfi Al Tall St. EB	Wasfi Al Tall St. WB
L	325	185	502	414
T	394	181	905	1628
R	59	27	135	244

Existing geometric design

The evaluation of the existing level of service needs to specify the number of lanes in addition to the direction of each movement as shown in Figure 2 & Table 2.

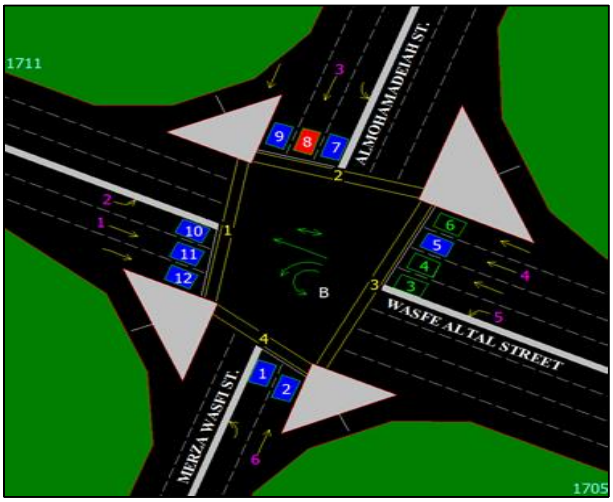

Figure 2: Al-Assaf intersection existing geometric layout.

Figure 3: shows the AL-Assaf signalized intersection from synchro 8.

Table 2: The Geometric data for all streets in the Al-Assaf intersection.

Name of Street	#No. of lanes	Lane width (m)	Speed (Km/h)
Wasfi At-Tall St. (Gardens)	4	3.5	70
Wasfi At-Tall St. (Khalda)	4	3.5	70
Mirza Wasfi St. (Tlaa Al-Ali)	2	3.5	50
Al-Mahammedeyah St. (Sweileh)	3	3.5	40

Simulation Software

Synchro 8 program software was used to measure total delay, level of service (LOS), and improvement through the optimization process in the study area. the method consists of collecting the hourly volume of traffic, length of each approach, number of lanes, and speed of Link roads. the AL-Assaf signalized intersection from synchro 8 as shown in Figure 3.

Analysis and Results

The Simulation results of prevailing conditions, adding another lane for left movement and adding another lane for through movement with optimizing signal traffic appear as follows :

- Current level of service of the intersection

Before studying any proposal at the Al-Assaf intersection, it is very important to specify the existing level of service (LOS) at the base year. By using the Synchro 8 program, it was found that the delay of the intersection is 238.5 sec/veh and the existing level of service is LOS (F), Table 3 shows the level of service and delay for each approach :

Table 3: Level of service and delay for each approach.

Approach	Delay(sec/veh)	LOS
EB	440.5	F
WB	206.3	F
NB	25.9	C
SB	39.5	D

- Signal Optimization

Signal optimization is the best solution for delay at the intersection, after optimization the results indicated that the total intersection delay is reduced from 238.5 sec/veh to 225.8 sec/veh, and the intersection LOS remains F, Table 4 shows the level of service and delay for each approach after optimization :

Table 4: Level of service and delay for each approach after optimization.

Approach	Delay(sec/veh)	LOS
EB	405.4	F
WB	206.1	F
NB	21	C
SB	30.7	C

- Adding another left lane

The results indicated that the total intersection delay was reduced from 238.5 sec/veh to 90 sec/veh, the intersection LOS remains F, and the delay was reduced for all approaches but the level of service improved just north-south approach. Table 5 shows the level of service and delay for each approach after adding the left lane :

Table 5: Level of service and delay for each approach after adding left lane.

Approach	Delay(sec/veh)	LOS
EB	149.4	F
WB	89.2	F
NB	12.6	B
SB	12.2	B

-Adding an extra lane for all approaches for through movement

The results indicated that the total intersection delay is reduced from 238.5 sec/veh to 88 sec/veh, and the intersection LOS remains F, Table 6 shows the level of service and delay for each approach after adding another lane through lane :

Table 6: Level of service and delay for each approach after adding through lane.

Approach	Before optimization		After optimization	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
EB	144	F	127.8	F
WB	89.2	F	52.4	D
NB	11.2	B	13.9	B
SB	12.4	B	15.4	B

Model validation

Model validation is usually conducted during the development of the simulation model to check the extent to which the model is representing reality. There are two methods for simulation model validation; visual validation and statistical validation. The most popular goodness of fit measure is the root mean square percent error (RMSPE). The RMSPE is used to replicate the error as a percentile rate (Daiheng et al., 2004).

The RMSPE can be calculated using the following equation:

$$\text{RMSPE}=\sqrt{\frac{1}{N}\sum\left(\frac{Y_{sim}-Y_{observed}}{Y_{observed}}\right)^2} \quad \text{……..Eq.1}$$

Where:

N: the number of simulation Runs.

Ysim: the simulation runs throughput volume.

Yobserved: the real throughput volume.

Table 7: simulation and observed volumes & RMSPE calculations.

Approach	Observed Volume (veh/hr)	Simulation Volume (veh/hr)	$(\frac{Y_{sim}-Y_{observed}}{Y_{observed}})^2$
EB	1543	1677	0.0075
W B	2286	2485	0.0076
NB	393	427	0.0075
SB	778	845	0.0074
		Sumation	0.0300
		RMSPE	0.0866

Based on Eq. (1) the RMSPE was found to be 0.0866 this value is less than 0.15 which is the RMSPE threshold (Hourdakis and Michalopoulos 2002). This indicates that the model replicates reality with high accuracy.

Conclusion

The main aim of the study is the evaluation and improvement of the traffic operations at one of the important intersections in Amman. Al-Assaf signalized intersection was chosen for this study. It is located at Wasfi Al-Tall Street; the evaluation shows that the intersection is operating at LOS F with a high delay time. Two solutions were introduced to improve the traffic conditions.

1. The first one is to optimize the signal traffic, this showed a little improvement in delay and the level of service of the intersection remained F.
2. The second solution is to add another lane to the left and through movement by changing and optimizing the timing plan of the signalized intersections, this solution showed a good improvement in the delay time but the intersections' LOS remained F.

Several remarkable points were concluded by doing this study; such as:

1. It has been concluded that optimization or adding extra lanes for through or left movement at the Al-Assaf intersection isn't the best proposal to improve the capacity and traffic operation in the Al-Assaf intersection. Median U-Turns one of the Unconventional ways should be installed in the West-East direction (Wasfi Al-tall Street) since the traffic survey shows that the high traffic volume of the left movement in the West-East direction has a major effect on the intersection to improve the LOS and capacity of the intersection.
2. The suitable alternative to improve the level of service of the intersection is the construction tunnel in the direction of Wasfi Al-Tall Street and the remaining intersection in all approaches.

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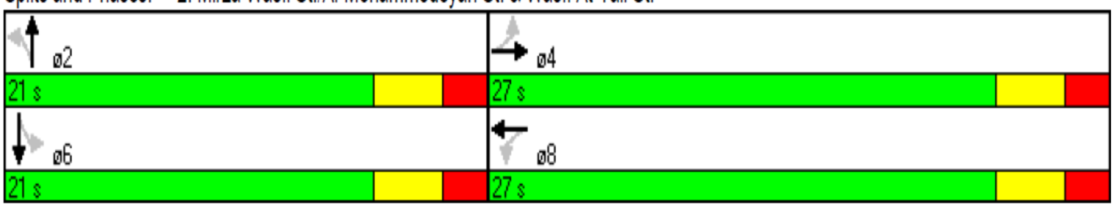
Appendix 1

- **The results of simulation for the intersection under prevailing conditions.**

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	1321.9	15.0		1018.6	26.7		39.3	14.0		74.7	14.3	
LOS	F	B		F	C		D	B		E	B	
Approach Delay		440.5			206.3			25.9			39.5	
Approach LOS		F			F			C			D	
Stops (vph)	739	774		511	1464		145	141		250	331	
Fuel Used(l)	548	56		352	127		13	9		31	22	
CO Emissions (g/hr)	10140	1043		6520	2356		237	174		581	405	
NOx Emissions (g/hr)	1973	203		1269	458		46	34		113	79	
VOC Emissions (g/hr)	2351	242		1512	546		55	40		135	94	
Dilemma Vehicles (#)	0	108		0	185		0	22		0	47	
Queue Length 50th (m)	~80.1	37.2		~61.4	54.4		14.9	13.1		~30.0	16.6	
Queue Length 95th (m)	#127.7	57.0		#105.5	#91.4		#43.3	27.0		#71.6	27.1	
Internal Link Dist (m)		98.6			137.7			33.0			40.8	
Turn Bay Length (m)	60.0			60.0								
Base Capacity (vph)	141	1471		141	2117		260	565		348	1054	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	3.87	0.77		3.19	0.96		0.77	0.40		1.01	0.47	

Intersection Summary	
Area Type: CBD	
Cycle Length: 48	
Actuated Cycle Length: 48	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 45	
Control Type: Pretimed	
Maximum v/c Ratio: 3.87	
Intersection Signal Delay: 238.5	Intersection LOS: F
Intersection Capacity Utilization 121.0%	ICU Level of Service H
Analysis Period (min) 15	
~ Volume exceeds capacity, queue is theoretically infinite.	
Queue shown is maximum after two cycles.	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 2: Mirza Wasfi St./Al-Mohammedeyah St. & Wasfi At-Tall St.



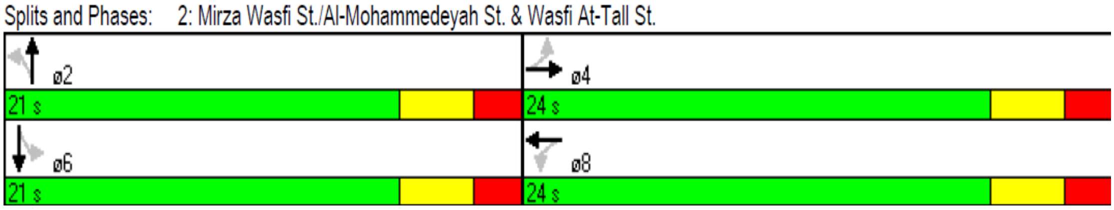
Appendix 2

- **The results of simulation for the intersection after optimizing signal traffic.**

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	1206.4	18.7		923.5	47.5		30.9	12.2		56.1	12.5	
LOS	F	B		F	D		C	B		E	B	
Approach Delay		405.4			206.1			21.0			30.7	
Approach LOS		F			F			C			C	
Stops (vph)	731	793		506	1475		144	134		247	319	
Fuel Used(l)	503	60		322	158		12	9		27	21	
CO Emissions (g/hr)	9309	1114		5955	2921		214	163		492	384	
NOx Emissions (g/hr)	1811	217		1159	568		42	32		96	75	
VOC Emissions (g/hr)	2159	258		1381	677		50	38		114	89	
Dilemma Vehicles (#)	0	112		0	188		0	23		0	50	
Queue Length 50th (m)	~73.5	37.2		~56.1	~59.5		13.1	11.6		25.9	14.7	
Queue Length 95th (m)	#119.9	#70.6		#99.0	#92.0		#39.3	24.3		#65.9	24.4	
Internal Link Dist (m)		98.6			137.7			33.0			40.8	
Turn Bay Length (m)	60.0			60.0								
Base Capacity (vph)	151	1359		151	1957		284	602		372	1123	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	3.62	0.83		2.98	1.04		0.71	0.38		0.95	0.44	

Intersection Summary	
Area Type: CBD	
Cycle Length: 45	
Actuated Cycle Length: 45	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 45	
Control Type: Pretimed	
Maximum v/c Ratio: 3.62	
Intersection Signal Delay: 225.8	Intersection LOS: F
Intersection Capacity Utilization 121.0%	ICU Level of Service H
Analysis Period (min) 15	
~ Volume exceeds capacity, queue is theoretically infinite.	
Queue shown is maximum after two cycles.	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 2: Mirza Wasfi St./Al-Mohammedeyah St. & Wasfi At-Tall St.



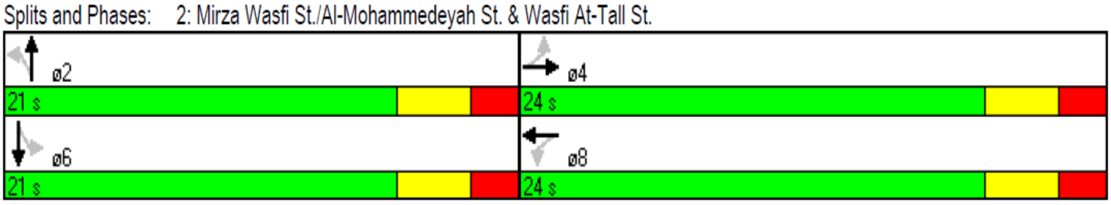
Appendix 3

- **The results of the simulation for the intersection after adding another left lane.**

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	420.2	18.7		277.8	47.5		13.2	12.2		14.2	12.5	
LOS	F	B		F	D		B	B		B	B	
Approach Delay		149.4			89.2			12.6			13.2	
Approach LOS		F			F			B			B	
Stops (vph)	443	793		329	1475		131	134		238	319	
Fuel Used(l)	187	60		108	158		8	9		16	21	
CO Emissions (g/hr)	3456	1114		2005	2921		157	163		291	384	
NOx Emissions (g/hr)	672	217		390	568		31	32		57	75	
VOC Emissions (g/hr)	801	258		465	677		36	38		67	89	
Dilemma Vehicles (#)	0	112		0	188		0	23		0	50	
Queue Length 50th (m)	~35.7	37.2		~27.1	~59.5		5.7	11.6		10.7	14.7	
Queue Length 95th (m)	#49.3	#70.6		#48.1	#92.0		12.1	24.3		19.6	24.4	
Internal Link Dist (m)		98.6			137.7			33.0			40.8	
Turn Bay Length (m)	60.0			60.0								
Base Capacity (vph)	293	1359		293	1957		551	602		721	1123	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	1.86	0.83		1.54	1.04		0.36	0.38		0.49	0.44	

Intersection Summary	
Area Type: CBD	
Cycle Length: 45	
Actuated Cycle Length: 45	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 45	
Control Type: Pretimed	
Maximum v/c Ratio: 1.86	
Intersection Signal Delay: 90.0	Intersection LOS: F
Intersection Capacity Utilization 96.3%	ICU Level of Service F
Analysis Period (min) 15	
~ Volume exceeds capacity, queue is theoretically infinite.	
Queue shown is maximum after two cycles.	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 2: Mirza Wasfi St./Al-Mohammedeyah St. & Wasfi At-Tall St.



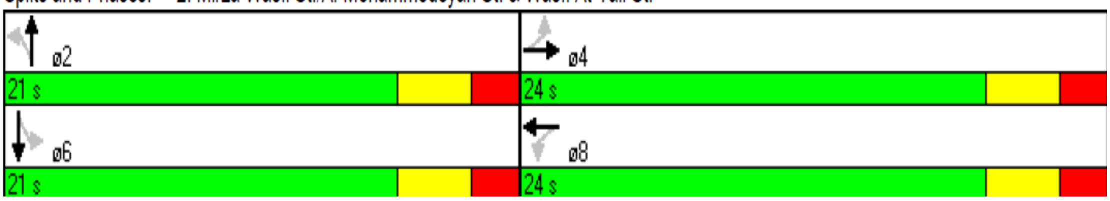
Appendix 4

- **The results of the simulation for the intersection after adding a through lane.**

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	420.2	10.7		277.8	47.5		13.3	9.3		14.3	11.1	
LOS	F	B		F	D		B	A		B	B	
Approach Delay		144.0			89.2			11.2			12.4	
Approach LOS		F			F			B			B	
Stops (vph)	443	677		329	1475		132	115		239	298	
Fuel Used(l)	187	49		108	158		9	8		16	19	
CO Emissions (g/hr)	3456	900		2005	2921		158	139		292	358	
NOx Emissions (g/hr)	672	175		390	568		31	27		57	70	
VOC Emissions (g/hr)	801	209		465	677		37	32		68	83	
Dilemma Vehicles (#)	0	116		0	188		0	23		0	50	
Queue Length 50th (m)	~35.7	21.2		~27.1	~59.5		5.8	5.3		10.7	9.7	
Queue Length 95th (m)	#49.3	31.2		#48.1	#92.0		12.2	10.8		19.7	15.6	
Internal Link Dist (m)		98.6			137.7			33.0			40.8	
Turn Bay Length (m)	60.0			60.0								
Base Capacity (vph)	293	1958		293	1957		539	1141		714	1613	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	1.86	0.58		1.54	1.04		0.37	0.20		0.49	0.31	

Intersection Summary	
Area Type: CBD	
Cycle Length: 45	
Actuated Cycle Length: 45	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 50	
Control Type: Pretimed	
Maximum v/c Ratio: 1.86	
Intersection Signal Delay: 88.0	Intersection LOS: F
Intersection Capacity Utilization 90.4%	ICU Level of Service E
Analysis Period (min) 15	
~ Volume exceeds capacity, queue is theoretically infinite.	
Queue shown is maximum after two cycles.	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 2: Mirza Wasfi St./Al-Mohammedeyah St. & Wasfi At-Tall St.



Appendix 5

- **The results of the simulation for the intersection after adding a through lane and optimizing signal traffic.**

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	511.6	9.3		195.1	20.8		16.6	11.5		18.0	13.6	
LOS	F	A		F	C		B	B		B	B	
Approach Delay		172.8			52.4			13.9			15.4	
Approach LOS		F			D			B			B	
Stops (vph)	445	607		314	1460		140	123		256	316	
Fuel Used(l)	222	44		81	119		9	8		17	21	
CO Emissions (g/hr)	4110	823		1506	2196		173	152		323	389	
NOx Emissions (g/hr)	800	160		293	427		34	30		63	76	
VOC Emissions (g/hr)	953	191		349	509		40	35		75	90	
Dilemma Vehicles (#)	0	104		0	181		0	21		0	45	
Queue Length 50th (m)	~41.4	21.2		~28.3	54.4		7.0	6.5		13.0	11.7	
Queue Length 95th (m)	#55.7	30.3		#50.5	#91.0		14.3	12.7		23.2	18.3	
Internal Link Dist (m)		98.6			137.7			33.0			40.8	
Turn Bay Length (m)	60.0			60.0								
Base Capacity (vph)	264	2216		334	2214		485	1030		642	1454	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	2.07	0.51		1.35	0.92		0.41	0.22		0.55	0.34	

Intersection Summary	
Area Type: CBD	
Cycle Length: 50	
Actuated Cycle Length: 50	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 50	
Control Type: Pretimed	
Maximum v/c Ratio: 2.07	
Intersection Signal Delay: 80.8	Intersection LOS: F
Intersection Capacity Utilization 90.4%	ICU Level of Service E
Analysis Period (min) 15	
~ Volume exceeds capacity, queue is theoretically infinite.	
Queue shown is maximum after two cycles.	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 2: Mirza Wasfi St./Al-Mohammedeyah St. & Wasfi At-Tall St.