

TRAFFIC STUDY

W Milwaukee Avenue (IA 7) & 90th Avenue (IA 110)

Storm Lake, Iowa | October 21, 2019

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Storm Lake, Iowa | October 21, 2019

Prepared for:
City of Storm Lake

Snyder & Associates, Inc. Project No. 118.1087.01

Prepared by:

	<p>I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.</p> <p><u>B. J. Willham</u> <u>10/21/19</u> Brian J. Willham, P.E. Date License Number 17122 My License Renewal Date is December 31, 2019 Pages or sheets covered by this seal: <u>ALL</u></p>
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1. INTRODUCTION

This study includes an updated analysis for the W Milwaukee Avenue (IA 7) and 90th Avenue (IA 110) intersection that was previously studied as a part of the Traffic Engineering Assistance Program (TEAP) study that was completed in November 2013. This analysis includes updated capacity analyses for existing conditions, opening day conditions for a proposed school and industrial/commercial developments located north of the intersection, and a 20-year projected scenario. Also included in this study is an updated traffic signal warrant analysis, turn lane warrant analysis, and geometric improvement recommendations for the intersection.



Figure 1: Project Location - Source: Google Earth

2. EXISTING CONDITIONS

W Milwaukee Avenue (IA 7) is a two-lane rural roadway with the addition of a 400 ft right turn lane at the intersection for eastbound traffic. 90th Avenue (IA 110) is a two-lane rural roadway and includes a railroad crossing approximately 80 ft south of the intersection. The speed limit is 50 MPH on W Milwaukee Avenue (IA 7) and 45 MPH on 90th Avenue (IA 110) at this location. The intersection is currently stop controlled for north-south movements.

Per Iowa DOT traffic counts completed in 2015, the average daily traffic was approximately 4,130 vehicles per day on W Milwaukee Avenue (IA 7) west of the intersection and 6,500 vehicles per day east of the intersection. The average daily traffic on 90th Avenue (IA 100) was approximately 2,490 vehicles south of the intersection and 940 vehicles per day north of the intersection. The City of Storm Lake recently performed average daily counts and recorded 7,960 vehicles per day on the east leg of the intersection and 3,251 vehicles per day on the south leg of the intersection. The 2015 Iowa DOT counts were factored with a 1% annual growth to determine existing traffic volumes for this analysis.

There is a trend of growth in traffic along IA 7 since 2007 after a decline from 1999 to 2007. However traffic on IA 110/90th Ave has been up and down over the course of a decade. Figure 2 below shows the annual average daily traffic (AADT) over time on approaches at the intersection of IA 7 & IA 110 / 90th Ave.

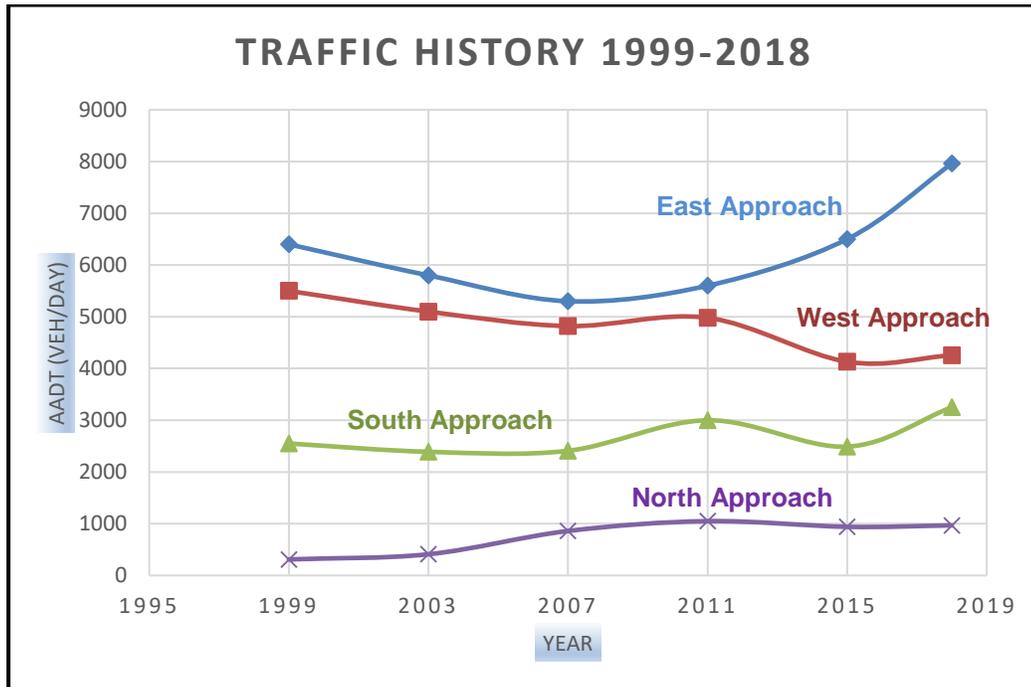


Figure 2: Historic AADT at IA 7 & IA 110/90th Ave

In addition to AADT volumes, turning movement counts at the intersection for the year 2015 were obtained from the Iowa DOT. Existing (2018) turning movement counts were not collected at this intersection. However, 2018 turning movement counts were estimated by applying a one percent annual growth factor to the 2015 traffic counts. Figure 3 below shows turning movement counts during both AM peak hour and PM peak hour.

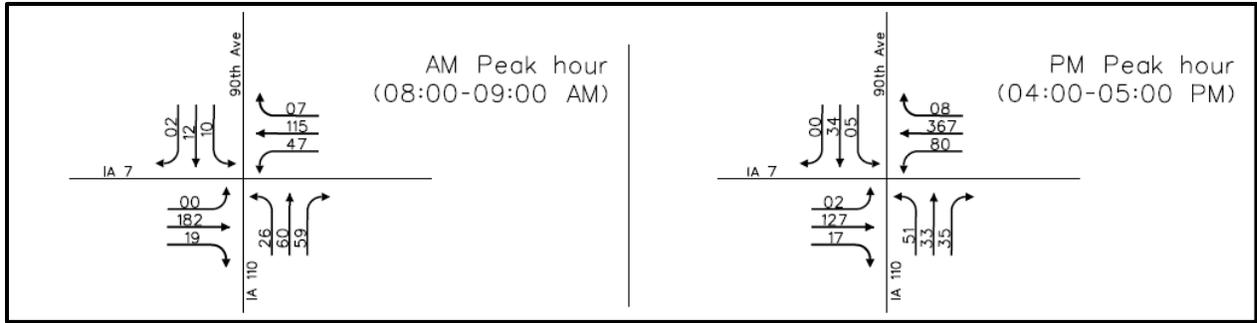


Figure 3: 2018 Peak Hour Turning Movement Counts

3. CRASH DATA

Safety review at the study area was conducted to further understand current conditions and identify any predominant safety issues. Iowa DOT crash data for the 2013-2018 six year period was reviewed. Intersection crash rate was calculated as the number of crashes per million entering vehicles (CR/MEV) for the review period. Compared to the statewide average intersection crash rate established by the Iowa DOT for similar intersections which is 0.9 CR/MEV, intersection of IA 7 & IA 110/90th Ave is above the statewide average at 1.18 CR/MEV.

In comparison to the crash review completed for this intersection in 2013, there is little to no change in crash rate. Manner of crash collisions and the major cause for these crashes were found to be similar in both the crash reviews. Majority of the crashes at this intersection were broadside (front to side) crashes and the major cause of most of these crashes were either running or failing to yield right of way (FTYROW) from a stop sign.

Table 1 summarizes crash frequency by severity, injuries by severity, crash rate, and predominant major causes of reported crashes at the intersection. Refer to the appendix for more crash data and collision diagrams.

Table 1: Crashes by Severity (2013-2018)

Study Intersection	Crash Severity (Injuries)						Crash Rate CR/MEV	Predominant Major Cause (# Crashes)
	Fatal	Major Injury	Minor Injury	Possible Injury	PDO	Total		
IA 7 & IA 110/ 90 th Ave	-	-	3 (3)	3 (7)	14	20 (10)	1.18	FTYROW: From Stop Sign (10) Ran Stop Sign (2) FTYROW: Making Left Turn (1) Over Steering (1)

4. PROPOSED DEVELOPMENT

The schematic site plan for the proposed Storm Lake Early Childhood Center, prepared by DLR group is shown in Figure 4. The proposed site includes two access points to separate parking lots on the site and one access point to a two lane student drop-off/pick-up zone. Access to the parking lots is proposed from 90th Avenue and a single lane roadway is proposed south of the site to access the student drop-off/pick-up zone. The new Early Childhood Center is expected to have a maximum enrollment of approximately 600 students and approximately 100 staff members.



Figure 4: Early Childhood Center Proposed Site plan (per DLR Group)

In addition to the Early Childhood Center, an industrial facility is proposed in the northeast corner of the intersection of 90th Ave & 590th St/C-49, approximately ½ mile north of the proposed school site. Per City of Storm Lake, this industrial facility will have 42 full time employees and is expected to have around 170 trucks entering per day during normal operations. During peak operations, this facility is expected to have around 600 trucks entering per day. Existing site has multiple access points including two from 590th St/C-49. Even though most truck traffic will stay on C-49, the city anticipates that there will be some truck traffic on 90th Ave/IA 110 as well. Figure 5 below shows the location of this proposed industrial/commercial facility.

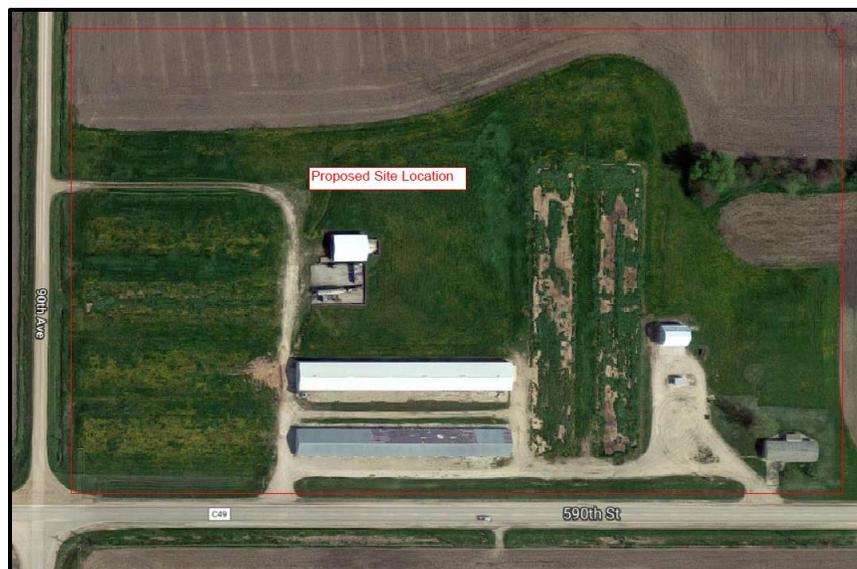


Figure 5: Proposed Industrial/Commercial Site location

5. ANALYSIS OF FUTURE CONDITIONS

a. Trip Generation

Traffic generated by the Early Childhood Center will be a combination of staff vehicle traffic, parent pick-up/drop-off passenger vehicle traffic, and bus traffic. Trip Generation estimates were prepared using a mix of school enrollment data and information from the Institute of Transportation Engineers *Trip Generation Manual, 10th Edition*, which provides national averages of trips generated by many land uses. The Early Childhood Center is anticipated to be constructed in phases with Phase 1 being constructed first and Phases 2 and 3 following in the future. The following tables show the land uses and estimated traffic for the developments for opening year and the design year.

Table 2: Opening Year Trip Generation

Land Use	Year 2021	Mode	AM Peak		PM Peak	
			Enter	Exit	Enter	Exit
(Phase 1) Early Childhood Center (200 Students)	Mode Splits	Student Total	200		200	
		Bus* (25% AM & PM)	-50	n/a	n/a	-50
		Parent Vehicle	200-50= 150		200-50= 150	
	Traffic	<i>Parent Vehicle sub-total**</i>	150	150	150	150
		<i>Bus Vehicle</i>	4	4	4	4
		<i>Staff Vehicle sub-total</i>	40	0	0	40
		Vehicle Total	194	154	154	194
Industrial Facility	Mode Splits	Daily Total Trips	642		642	
		Trucks ***	50	50	50	50
		Employee/Staff Vehicle	42	-	-	42
	Traffic	Vehicle Total	92	50	50	92

* Assume 25% busing with 4 buses

** Assume 1 student per vehicle

*** Assume 50 trucks an hour during peak operations of industrial facility.

Table 3: Ultimate Year (2041) Trip Generation

Land Use	Year 2021	Mode	AM Peak		PM Peak	
			Enter	Exit	Enter	Exit
Early Childhood Center (600 Students)	Mode Splits	Student Total	600		600	
		Bus* (40% AM & PM)	-240	n/a	n/a	-240
		Parent Vehicle	600-240= 360		600-240= 360	
	Traffic	<i>Parent Vehicle sub-total**</i>	240	240	240	240
		<i>Bus Vehicle</i>	8	8	8	8
		<i>Staff Vehicle sub-total</i>	100	0	0	100
		Vehicle Total	348	248	248	348
Industrial Facility	Mode Splits	Daily Total Trips	642		642	
		Trucks ***	50	50	50	50
		Employee/Staff Vehicle	42	-	-	42
	Traffic	Vehicle Total	92	50	50	92

* Assume 40% busing, or 8 full size buses (30 students per bus)
 ** Assume 1.5 students per vehicle
 *** Assume 50 trucks an hour during peak operations of industrial facility.

b. Trip Distribution

In the proposed site layout for the Early Childhood Center, all three access points are closest to the intersection of IA 7 & IA 110/90th Ave. School traffic could also use the intersection of 90th Ave & 590th St/C-49. Most of the residential neighborhood in the City of Storm Lake is located southeast of the school and with IA 7 being the primary road connecting the city, assume that 80% of school traffic goes through the intersection of IA 7 & IA 110/90th Ave. This leaves the remaining 20% of traffic going through the intersection of 90th Ave & 590th St/C-49.

The proposed site for a new industrial facility anticipates about 600 trucks a day during peak operations. Per information provided by the City of Storm Lake, almost all of these trucks enter through county road C-49. However, it is anticipated that some trucks will arrive through the intersection of IA 7 & IA 100/90th Ave and will impact the school traffic as well. Assume 20% of industrial site traffic to enter/exit the intersection of IA 7 & IA 110/90th Ave.

Figure 6 below shows trips added to the study intersection due to proposed developments of an industrial facility and a new Early Childhood Center. Due to the time of day that the new trips are expected to occur, AM & PM peak hour periods of the study intersection were chosen to align with school arrival & dismissal times. To further distribute both the AM & PM trips at the study intersection, assume a 75/20 split of school traffic for westbound and northbound approaches respectively. The remaining 5% percent of school traffic is assumed to enter/exit from the eastbound approach at the intersection.

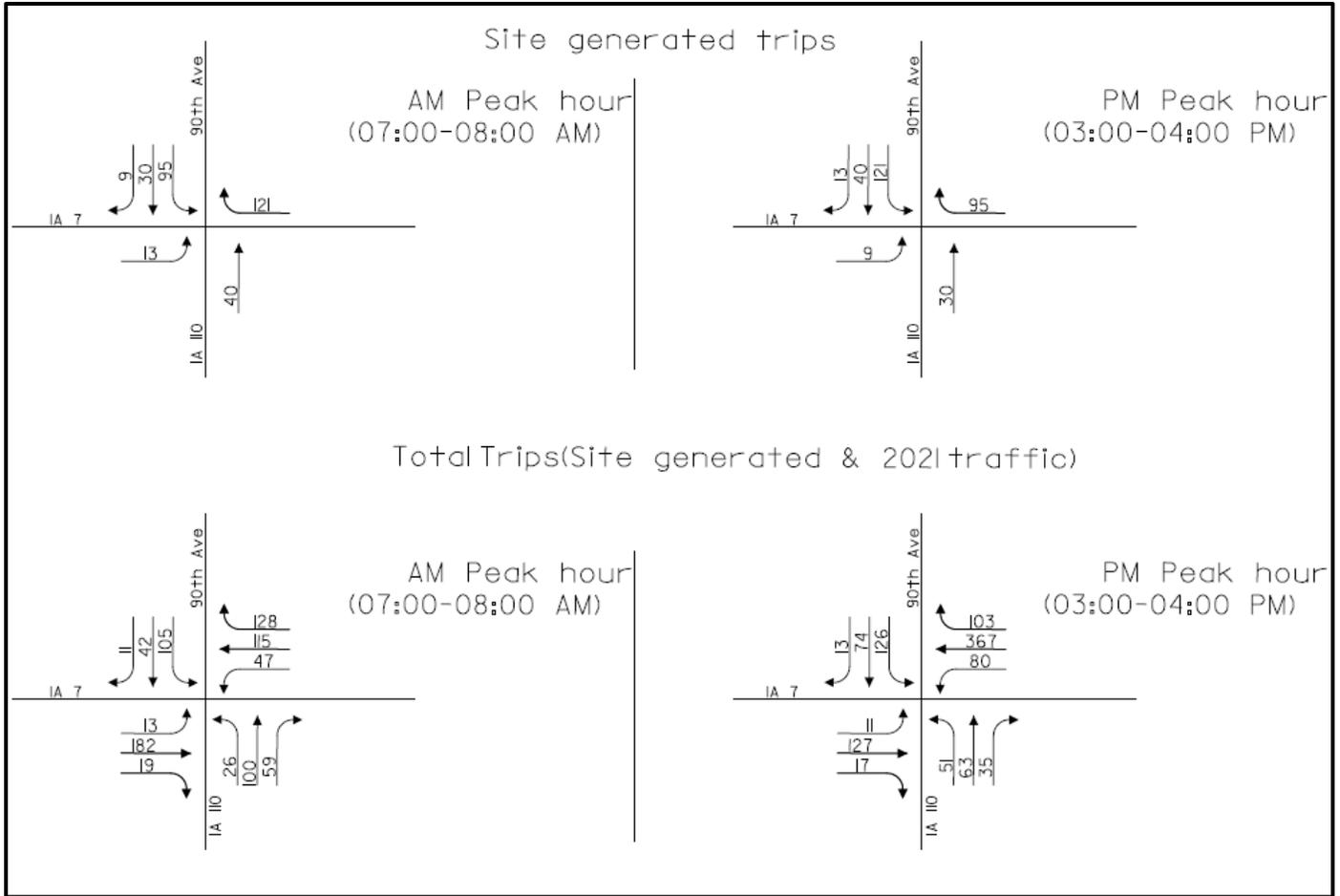


Figure 6: Opening year Traffic at the intersection of IA 7 & IA 110/90th Ave

6. FUTURE TRAFFIC

Per the traffic counts collected by the Iowa DOT, the total approach volumes have been up and down at the study intersection. To analyze future traffic operations at the study intersection, a 1% yearly growth factor was applied to opening year traffic counts to obtain 2041 traffic counts. Figure 7 below shows anticipated turning movement counts at the intersection of IA 7 & IA 110/90th Ave for the year 2041.

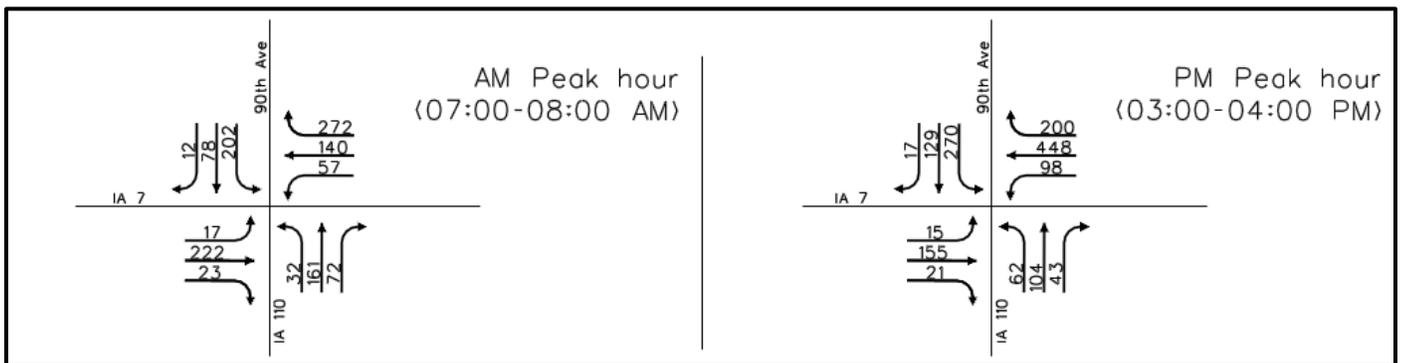


Figure 7: 2041 turning movement counts at the intersection of IA 7 & IA 110/90th Ave

7. SIGNAL WARRANT ANALYSIS

Following the revised 2009 Edition of the Manual on Uniform Traffic Control Devices (MUTCD), traffic signal criteria were evaluated at the intersection of IA 7 & IA 110/ 90th Ave. Traffic data utilized in this analysis included 7-hour turning movement counts collected by the Iowa DOT and the opening year peak hour turning movement counts shown in Figure 6 above. Table 3 below summarizes the results of Traffic Signal Warrant Analysis.

Table 2: MUTCD Signal Warrant Analysis (Using Projected opening day traffic volumes)¹

Traffic Signal Warrant	Warrant MET
Warrant 1 (Eight Hour Vehicular Volume)	No
Warrant 2 (Four Hours Vehicular Volume)	No
Warrant 3(Peak Hour Vehicular Volume)	Yes ²
Warrant 4 (Pedestrian Volume)	No
Warrant 5 (School Crossing)	N/A
Warrant 6 (Coordinated Signal System)	N/A
Warrant 7(Crash Experience)	No
Warrant 8(Roadway Network)	N/A
Warrant 9(At-Grade Crossing)	Not Analyzed

¹ Only 7 hour traffic volumes from 2015 applied with 1% growth factor and Opening year peak hour counts were used for analysis.

² Based on 70% Factor and 2 or more lanes & 1 lane curve due to low percentage of left turning traffic for east and west directions

A traffic signal is anticipated to be warranted at the intersection of IA 7 & IA 110/90th Ave for the opening year 2021 due to drivers experiencing undue traffic delay when entering or crossing the major street during the PM peak hour. Due to the proximity of the railroad crossing south of the intersection, Warrant 9 may be applicable as well depending on traffic volumes during the peak rail traffic period. A traffic signal is currently not warranted at the intersection if there is no development north of the intersection.

8. CAPACITY ANALYSIS

Intersection capacity analysis was completed following the methods outlined in the Highway Capacity Manual, 6th Edition (HCM), incorporated into the traffic analysis software Synchro 10. Intersection delay is a function of traffic factors such as traffic volume, turning vehicles, vehicle types and arrival patterns, as well as geometric factors such as number of lanes and traffic control. Intersection operations are categorized by equating average vehicular delay to level of service (LOS) criteria. LOS A is considered the most desirable level, with the least delay, while LOS F experiences the most delay. LOS C is often considered the acceptable goal for intersection delay while LOS D/E often occurs during peak hour side-street delay. LOS criteria defined by the HCM for unsignalized and signalized intersections are shown in Table 4.

Table 3: Level of Services (LOS) Definition

LOS	Average Delay per Vehicle (sec)	
	Unsignalized Intersection	Signalized Intersection
A	Less than 10	Less than 10
B	10-15	10-20
C	15-25	20-35
D	25-35	35-55
E	35-50	55-80
F	Greater than 50	Greater than 80

Even though the signal warrant analysis indicated that the intersection may meet signalization warrants, the current configuration was analyzed as a stop control and signalized intersection for the development approach for the opening analysis, 2021. Capacity analysis performed on the study intersection indicates that the existing configuration and existing traffic with a North/South (N/S) stop control will operate at acceptable level in both peak periods. However, anticipated area development and related traffic significantly increases delay at the intersection.

Under consistent signal operation and adding left turn lanes to all approaches, the analysis shows improvement in traffic flow and delay for opening year traffic at the intersection of IA 7 & IA 110/90th Ave. Capacity analysis was also performed on the study intersection with proposed geometry and anticipated 2041 traffic. The analysis shows acceptable levels of operation at the intersection with anticipated 2041 traffic.

Results of AM and PM peak hour capacity analyses for these scenarios (existing geometry and traffic, existing geometry and proposed traffic, proposed geometry and traffic) are summarized in Table 5 below.

Table 4: Capacity Analysis Results for intersection of IA 7 & IA 110/90th Ave

Scenario	Operational Control	AM Peak Hour		PM Peak Hour	
		Delay (sec)	LOS	Delay (sec)	LOS
Existing Geometry & Existing 2018 Traffic	N/S Stop*	13.4	B	19.9	C
Existing Geometry & Proposed Opening day traffic	N/S Stop*	28.1	D	103.5	F
Proposed Geometry & Proposed Opening day traffic	Signal & Turn lanes	14.0	B	14.9	B
Proposed Geometry & Proposed 2041 Traffic	Signal & Turn lanes	19.5	B	25.0	C

* Delay and LOS of the worst movement (Northbound or Southbound) is shown.

9. CONCLUSIONS AND RECOMMENDATIONS

Based on analysis performed, the following are recommended improvements for the intersection of IA 7 & IA 110 / 90th Ave:

Recommended improvements with or without new development traffic

- Construct left turn lanes for eastbound and westbound approaches (from 2013 TEAP study and confirmed with this analysis) regardless of new development traffic.

Recommended improvements with the addition new development traffic

- Based on traffic signal warrant analysis performed for opening year traffic, an installation of a traffic signal is anticipated to be warranted. Signalizing the intersection would require improvements to the existing railroad crossing. The traffic signal must be interconnected to the railroad crossing to pre-empt the operation of the signal.
- Construct a left turn lane on 90th Ave (southbound approach) to improve delay and traffic flow at the intersection. Aligning approaches at the intersection will improve line of sight for drivers making left turns or crossing the major approach. To improve safety and reduce the potential for crashes, construct a left turn lane on IA 110 (northbound approach) as well.

Future potential improvements

- Although not recommended at this time, consideration for a westbound right turn lane may need to be studied in the future if traffic volumes are greater than anticipated or rear-end crash issues occur between right turning vehicles and through vehicles.

Refer to the attached exhibits for a concept drawing of the recommended improvements as well as a concept level opinion of probable project costs.

As described in the 2013 TEAP report, there are several potential funding sources available that could be applied for to help offset some of the construction costs including the Iowa DOT Urban-State Traffic Engineering Program, the Iowa DOT Traffic Safety Improvement Program, and the Federal-Aid Highway/Rail Crossing Safety Program.

APPENDIX

- Exhibit - Proposed Intersection Improvements
- Iowa DOT 2015 Turning Movement Counts
- Intersection Crash Summary Report
- MUTCD Signal Warrant Review
- Synchro HCM Analysis Reports



Iowa Department of Transportation
Turning Movement Traffic Count Summary
 Annualized Daily Traffic For All Vehicles

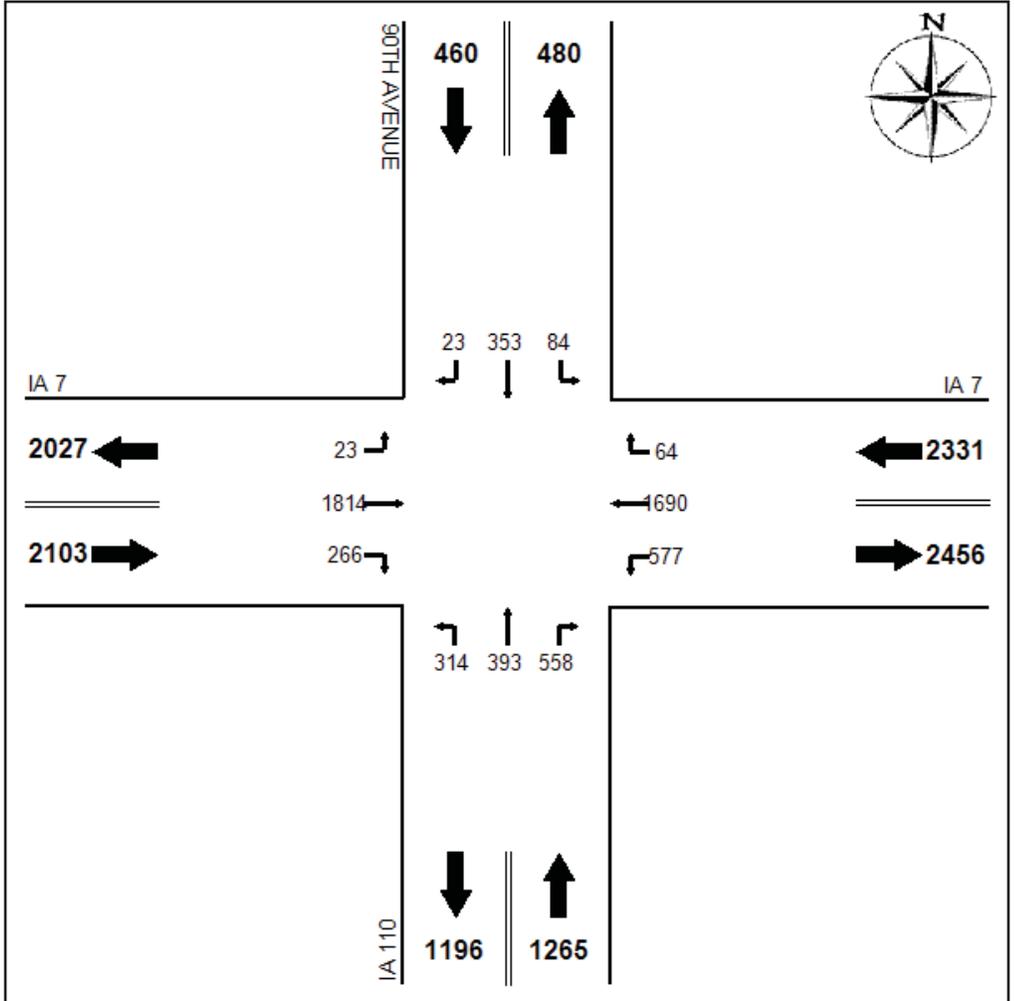
Station Number:
 11220633099

Count Date:
 Thursday, June 11, 2015

County:
 Buena Vista

Location Description:
 IA 7, IA 110 & 90th Ave

Volume Factor: 1.796
Pass Class Factor: 1.831
SU Class Factor: 1.598
Combo Class Factor: 1.528



Raw Data-All Vehicles:

	N Leg			E Leg			S Leg			W Leg		
	L	T	R	L	T	R	L	T	R	L	T	R
07:00	7	14	1	22	59	5	16	43	37	3	188	33
08:00	9	11	2	28	69	4	20	46	45	0	176	28
11:00	7	28	3	40	101	5	15	21	56	1	137	18
12:00	8	28	0	66	141	5	34	37	68	1	139	18
15:00	8	27	2	63	153	6	17	18	37	3	124	14
16:00	4	33	1	48	221	5	39	25	27	2	123	16
17:00	3	52	4	53	191	5	32	26	39	3	118	20

Iowa Department of Transportation
Turning Movement Traffic Count Summary
 Vehicle Type: Passenger Vehicles

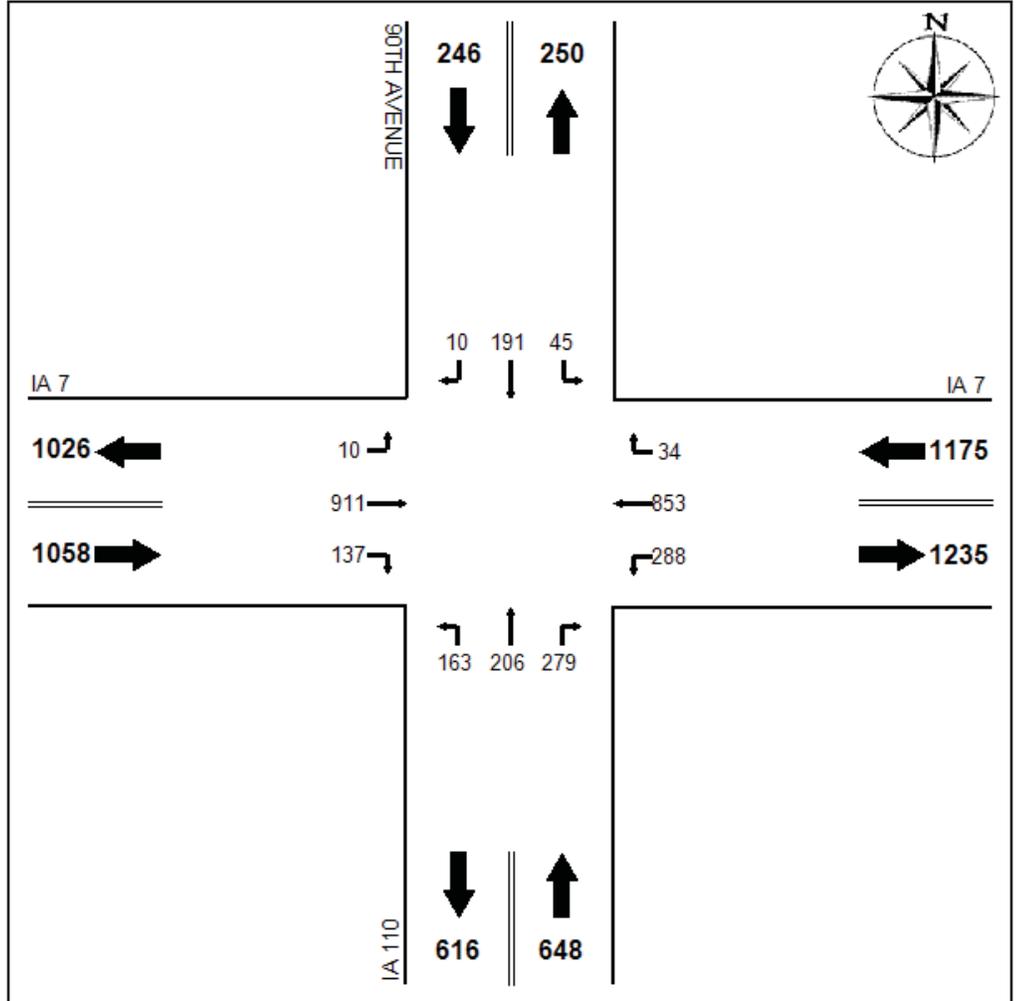
Station Number:
11220633099

Count Date:
Thursday, June 11, 2015

County:
Buena Vista

Location Description:
IA 7, IA 110 & 90th Ave

Volume Factor: N/A
Pass Class Factor: N/A
SU Class Factor: N/A
Combo Class Factor: N/A



Raw Data-Passenger Vehicles:

	N Leg			E Leg			S Leg			W Leg		
	L	T	R	L	T	R	L	T	R	L	T	R
07:00	7	14	1	16	47	5	12	43	31	2	174	33
08:00	9	11	2	23	50	4	19	42	41	0	166	24
11:00	7	28	1	36	88	4	12	19	53	0	115	18
12:00	7	28	0	58	128	5	34	34	58	1	123	15
15:00	8	27	1	56	146	6	16	18	34	2	109	13
16:00	4	31	1	47	211	5	38	24	25	2	110	15
17:00	3	52	4	52	183	5	32	26	37	3	114	19

Iowa Department of Transportation
Turning Movement Traffic Count Summary
 Vehicle Type: Single-Unit Trucks

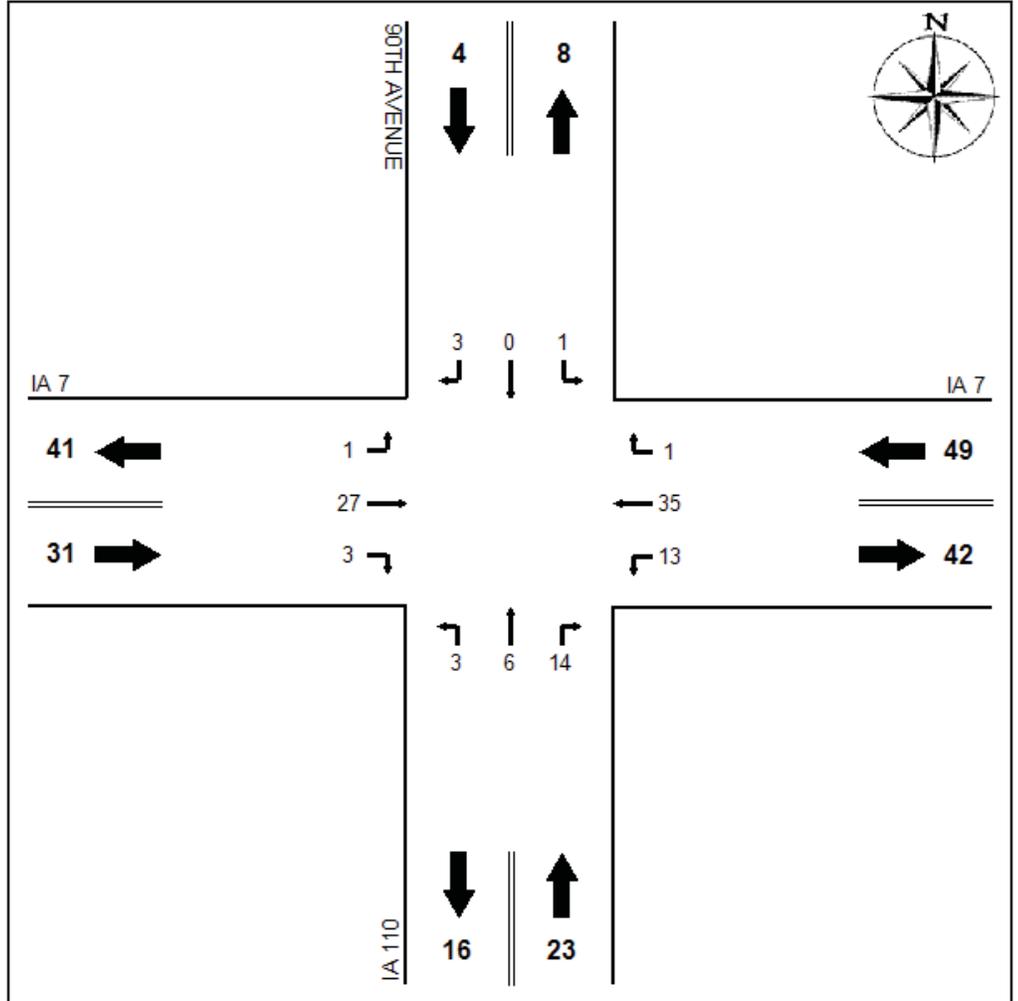
Station Number:
11220633099

Count Date:
Thursday, June 11, 2015

County:
Buena Vista

Location Description:
IA 7, IA 110 & 90th Ave

Volume Factor: N/A
Pass Class Factor: N/A
SU Class Factor: N/A
Combo Class Factor: N/A



Raw Data-Single-Unit Trucks:

	N Leg			E Leg			S Leg			W Leg		
	L	T	R	L	T	R	L	T	R	L	T	R
07:00	0	0	0	3	5	0	1	0	1	0	5	0
08:00	0	0	0	1	9	0	0	3	2	0	3	0
11:00	0	0	2	1	5	1	1	1	2	1	7	0
12:00	1	0	0	4	5	0	0	2	6	0	5	0
15:00	0	0	1	3	4	0	0	0	2	0	5	1
16:00	0	0	0	1	5	0	1	0	1	0	1	1
17:00	0	0	0	0	2	0	0	0	0	0	1	1

Iowa Department of Transportation
Turning Movement Traffic Count Summary
 Vehicle Type: Combination Trucks

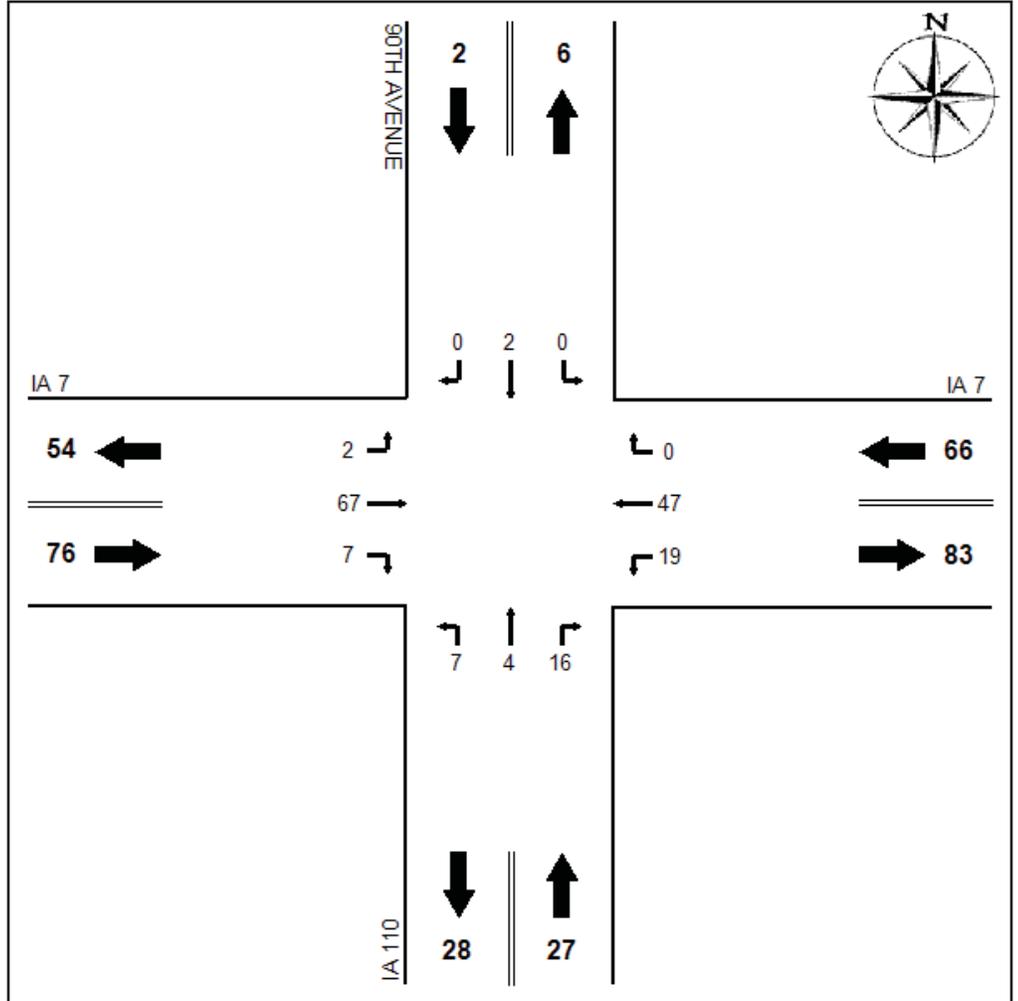
Station Number:
11220633099

Count Date:
Thursday, June 11, 2015

County:
Buena Vista

Location Description:
IA 7, IA 110 & 90th Ave

Volume Factor: N/A
Pass Class Factor: N/A
SU Class Factor: N/A
Combo Class Factor: N/A



Raw Data-Combination Trucks:

	N Leg			E Leg			S Leg			W Leg		
	L	T	R	L	T	R	L	T	R	L	T	R
07:00	0	0	0	3	7	0	3	0	5	1	9	0
08:00	0	0	0	4	10	0	1	1	2	0	7	4
11:00	0	0	0	3	8	0	2	1	1	0	15	0
12:00	0	0	0	4	8	0	0	1	4	0	11	3
15:00	0	0	0	4	3	0	1	0	1	1	10	0
16:00	0	2	0	0	5	0	0	1	1	0	12	0
17:00	0	0	0	1	6	0	0	0	2	0	3	0



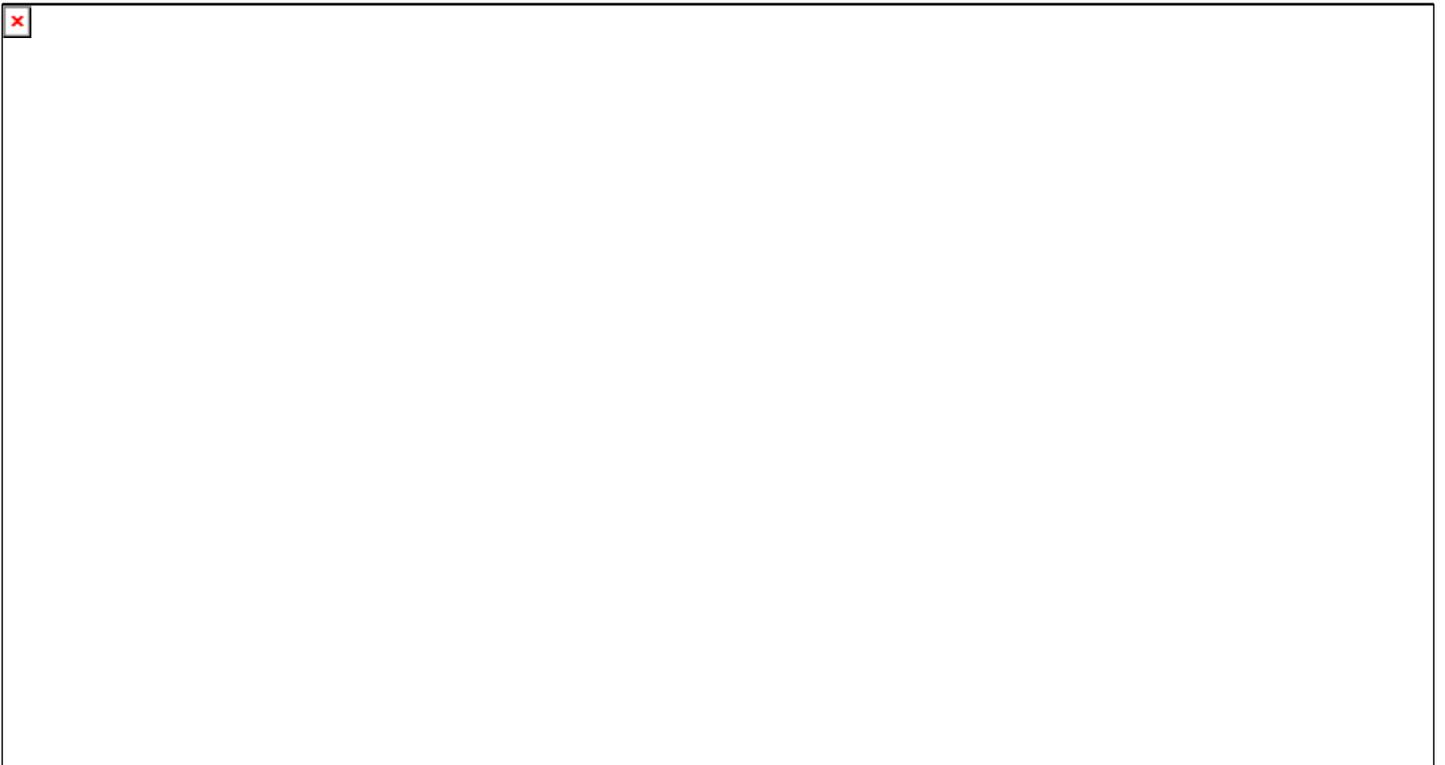
Iowa Crash Analysis Tool
 Quick Report
 2013-2018

Crash Severity		20
Fatal		0
Major Injury		0
Minor Injury		3
Possible/Unknown		3
Property Damage Only		14

Injury Status Summary		10
Fatal		0
Suspected serious/incapacitating		0
Suspected minor/non-incapacitating		3
Possible (complaint of pain/injury)		7
Uninjured		0
Fatal, not crash-related		0
Unknown		0
Not reported		0

Property/Vehicles/Occupants	
Property Damage Total (dollars):	170,630.00
Average (per crash dollars):	8,531.50
Total Vehicles:	35.00
Average (per crash):	1.75
Total Occupants:	50.00
Average (per crash):	2.50

Average Severity	
Fatalities/Fatal Crash:	0.00
Fatalities/Crash:	0.00
Injuries/Crash:	0.50
Major Injuries/Crash:	0.00
Minor Injuries/Crash:	0.15
Possible/Unknown Injuries/Crash:	0.35





Iowa Crash Analysis Tool
Quick Report
2013-2018

Major Cause			20
Animal	0	Ran traffic signal	0
Ran stop sign	2	Failed to yield to emergency vehicle	0
FTYROW: At uncontrolled intersection	0	FTYROW: Making right turn on red signal	1
FTYROW: From stop sign	10	FTYROW: From yield sign	0
FTYROW: Making left turn	1	FTYROW: From driveway	0
FTYROW: From parked position	0	FTYROW: To pedestrian	0
FTYROW: Other	0	Drove around RR grade crossing gates	0
Disregarded RR Signal	0	Crossed centerline (undivided)	0
Crossed median (divided)	0	Traveling wrong way or on wrong side of road	0
Aggressive driving/road rage	0	Driving too fast for conditions	0
Exceeded authorized speed	0	Improper or erratic lane changing	0
Operating vehicle in an reckless, erratic, ca...	0	Followed too close	0
Passing: On wrong side	0	Passing: Where prohibited by signs/markings	0
Passing: With insufficient distance/inadequa...	0	Passing: Through/around barrier	0
Passing: Other passing	0	Made improper turn	0
Driver Distraction: Manual operation of an e...	0	Driver Distraction: Talking on a hand-held d...	0
Driver Distraction: Talking on a hands free ...	0	Driver Distraction: Adjusting devices (radio...	0
Driver Distraction: Other electronic device ...	0	Driver Distraction: Passenger	0
Driver Distraction: Unrestrained animal	0	Driver Distraction: Reaching for object(s)/f...	0
Driver Distraction: Inattentive/lost in thou...	0	Driver Distraction: Other interior distracti...	0
Driver Distraction: Exterior distraction	1	Ran off road - right	0
Ran off road - straight	0	Ran off road - left	0
Lost control	0	Swerving/Evasive Action	0
Over correcting/over steering	1	Failed to keep in proper lane	0
Failure to signal intentions	1	Traveling on prohibited traffic way	0
Vehicle stopped on railroad tracks	0	Other: Vision obstructed	0
Other: Improper operation	0	Other: Disregarded warning sign	0
Other: Disregarded signs/road markings	0	Other: Illegal off-road driving	0
Downhill runaway	0	Separation of units	0
Towing improperly	0	Cargo/equipment loss or shift	0
Equipment failure	0	Oversized load/vehicle	0
Other: Getting off/out of vehicle	0	Failure to dim lights/have lights on	0
Improper backing	0	Improper starting	0
Illegally parked/unattended	0	Driving less than the posted speed limit	0
Operator inexperience	0	Other	3
Unknown	0	Not reported	0
Other: No improper action	0		



**Iowa Crash Analysis Tool
Quick Report
2013-2018**

Time of Day/Day of Week														
Day of Week	12 AM to 2 AM	2 AM to 4 AM	4 AM to 6 AM	6 AM to 8 AM	8 AM to 10 AM	10 AM to Noon	Noon to 2 PM	2 PM to 4 PM	4 PM to 6 PM	6 PM to 8 PM	8 PM to 10 PM	10 PM to 12 AM	Not reported	Total
Sunday	0	1	0	0	0	0	0	0	1	0	0	0	0	2
Monday	0	0	0	0	0	0	0	0	1	1	0	0	0	2
Tuesday	0	0	0	2	0	0	1	0	1	0	0	0	0	4
Wednesday	0	0	0	0	1	0	1	1	1	1	0	0	0	5
Thursday	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Friday	0	0	0	0	2	0	2	0	0	0	0	0	0	4
Saturday	0	0	0	0	0	1	0	1	0	0	0	0	0	2
Total	0	1	0	2	3	1	4	3	4	2	0	0	0	20

Manner of Crash Collision	20
Non-collision (single vehicle)	5
Head-on (front to front)	0
Rear-end (front to rear)	1
Angle, oncoming left turn	0
Broadside (front to side)	14
Sideswipe, same direction	0
Sideswipe, opposite direction	0
Rear to rear	0
Rear to side	0
Not reported	0
Other	0
Unknown	0

Surface Conditions	20
Dry	16
Wet	2
Ice/frost	0
Snow	2
Slush	0
Mud, dirt	0
Water (standing or moving)	0
Sand	0
Oil	0
Gravel	0
Not reported	0
Other	0
Unknown	0

Fixed Object Struck	35		
Bridge overhead structure	0	Bridge pier or support	0
Bridge/bridge rail parapet	0	Curb/island/raised median	0
Ditch	0	Embankment	0
Ground	0	Culvert/pipe opening	0
Guardrail - face	0	Guardrail - end	0
Concrete traffic barrier (median or right sid...	0	Other traffic barrier	0
Cable barrier	0	Impact attenuator/crash cushion	0
Utility pole/light support	0	Traffic sign support	5
Traffic signal support	0	Other post/pole/support	0
Fire hydrant	0	Mailbox	0
Tree	0	Landscape/shrubbery	0
Snow bank	0	Fence	0
Wall	0	Building	0
Other fixed object	0	None (no fixed object struck)	30



Iowa Crash Analysis Tool
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Driver Age/Driver Gender					
Driver Age - 5 year Bins	Female	Male	Not reported	Unknown	Total
< 14	0	0	0	0	0
= 14	0	0	0	0	0
= 15	0	0	0	0	0
= 16	0	0	0	0	0
= 17	1	0	0	0	1
= 18	0	1	0	0	1
= 19	0	1	0	0	1
= 20	0	0	0	0	0
>= 21 and <= 24	0	1	0	0	1
>= 25 and <= 29	3	0	0	0	3
>= 30 and <= 34	5	1	0	0	6
>= 35 and <= 39	2	2	0	0	4
>= 40 and <= 44	2	0	0	0	2
>= 45 and <= 49	0	2	0	0	2
>= 50 and <= 54	1	2	0	0	3
>= 55 and <= 59	0	1	0	0	1
>= 60 and <= 64	0	0	0	0	0
>= 65 and <= 69	1	3	0	0	4
>= 70 and <= 74	1	1	0	0	2
>= 75 and <= 79	0	0	0	0	0
>= 80 and <= 84	1	1	0	0	2
>= 85 and <= 89	0	2	0	0	2
>= 90 and <= 94	0	0	0	0	0
>= 95	0	0	0	0	0
Not reported	0	0	0	0	0
Unknown	0	0	0	0	0
Total	17	18	0	0	35

Alcohol Test Given	35
None	35
Blood	0
Urine	0
Breath	0
Vitreous	0
Refused	0
Not reported	0

Drug Test Given	35
None	35
Blood	0
Urine	0
Breath	0
Vitreous	0
Refused	0
Not reported	0

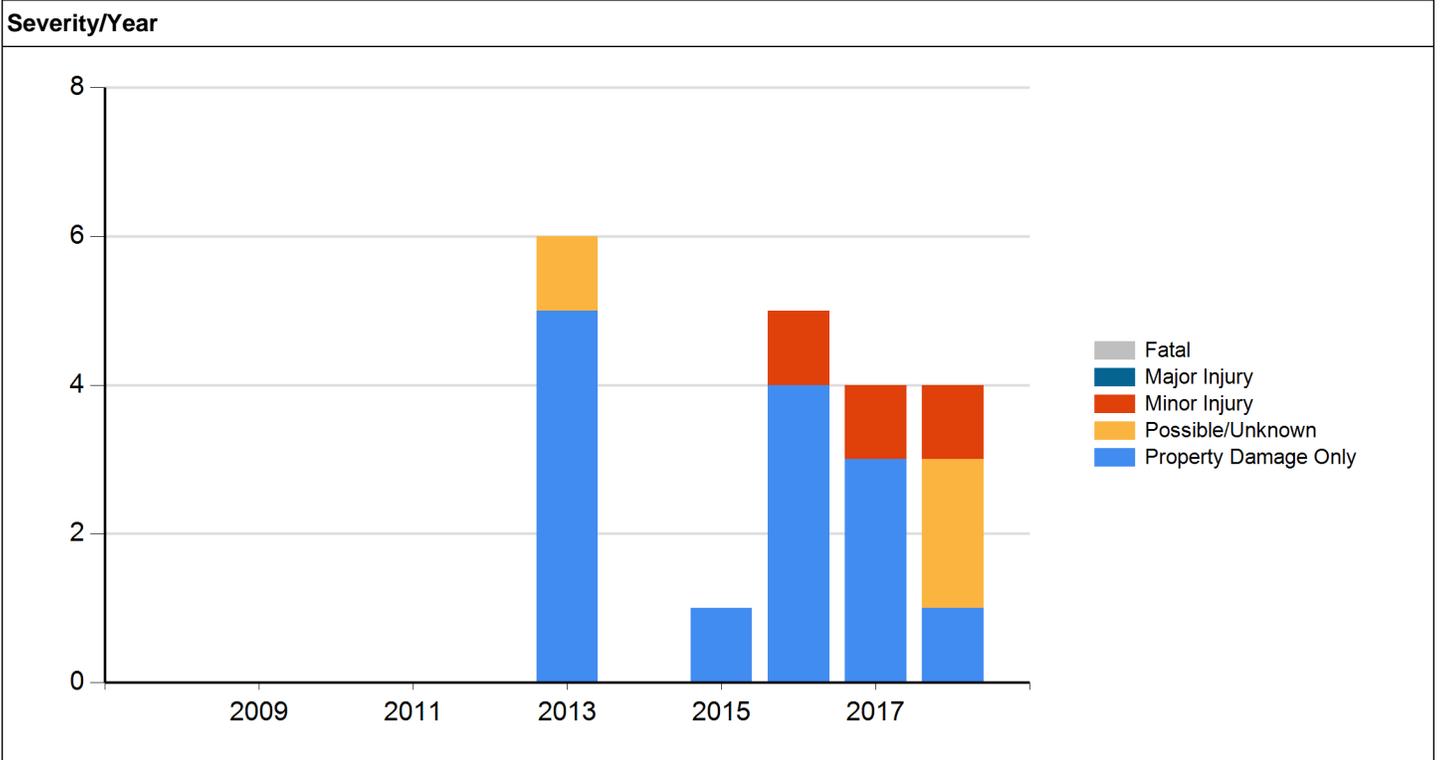
Drug Test Result	35
Negative	0
Cannabis	0
Central Nervous System depressants	0
Central Nervous System stimulants	0
Hallucinogens	0
Inhalants	0
Narcotic Analgesics	0
Dissociative Anesthetic (PCP)	0
Prescription Drug	0
Not reported	35
Other	0

Drug/Alcohol Related	20
Drug	0
Alcohol (< Statutory)	0
Alcohol (Statutory)	0
Drug/Alcohol (< Statutory)	0
Drug/Alcohol (Statutory)	0
Refused	0
Under Influence of Alcohol/Drugs/Medications	0
None Indicated	20



Iowa Crash Analysis Tool
Quick Report
2013-2018

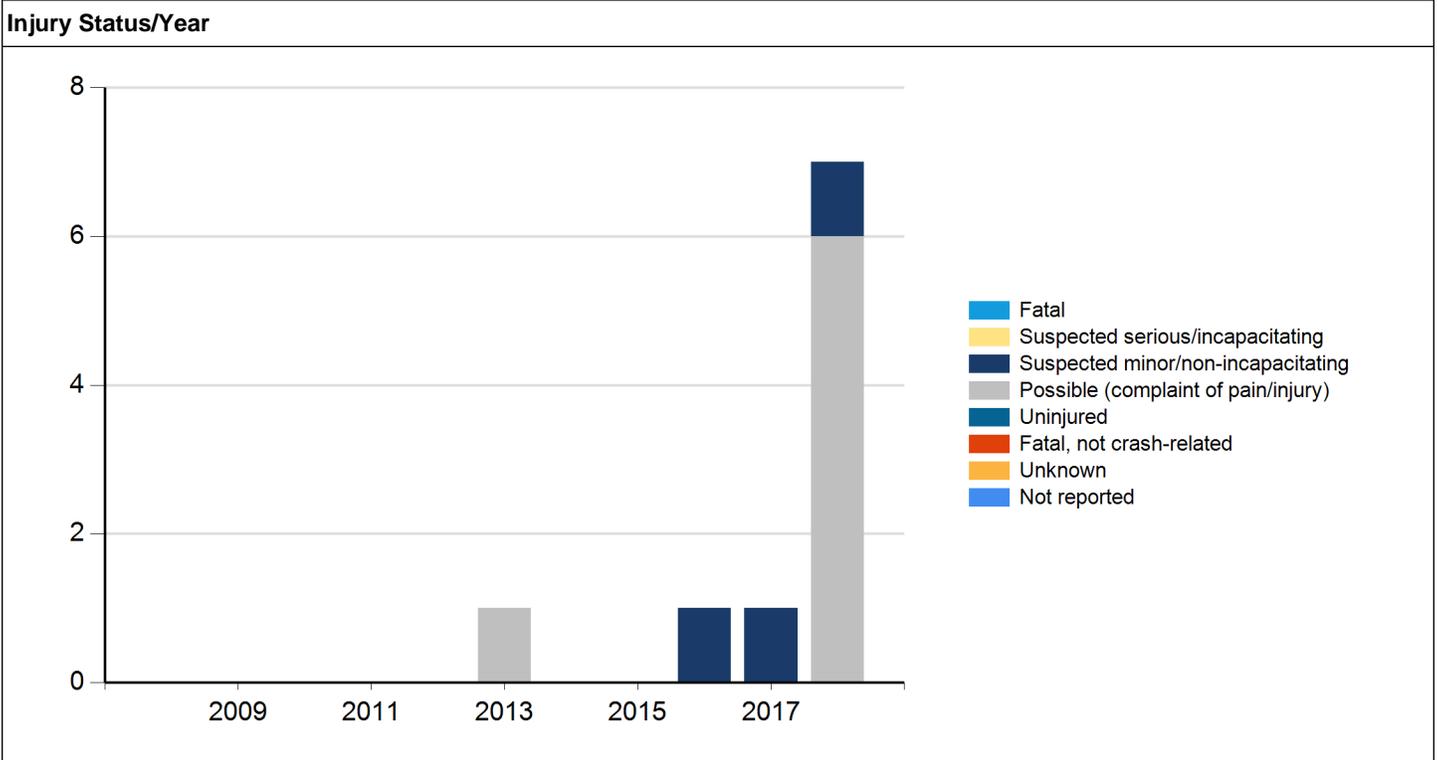
Crash Severity - Annual							
Crash Year	Fatal	Major Injury	Minor Injury	Possible/Unknown	Property Damage Only	Total	
2008	0	0	0	0	0	0	
2009	0	0	0	0	0	0	
2010	0	0	0	0	0	0	
2011	0	0	0	0	0	0	
2012	0	0	0	0	0	0	
2013	0	0	0	1	5	6	
2014	0	0	0	0	0	0	
2015	0	0	0	0	1	1	
2016	0	0	1	0	4	5	
2017	0	0	1	0	3	4	
2018	0	0	1	2	1	4	
Total	0	0	3	3	14	20	





Iowa Crash Analysis Tool
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Injury Status - Annual								
Crash Year	Fatal	Suspected serious/incapacitating	Suspected minor/non-incapacitating	Possible (complaint of pain/injury)	Uninjured	Fatal, not crash-related	Unknown	Total
2008	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0
2013	0	0	0	1	0	0	0	1
2014	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0
2016	0	0	1	0	0	0	0	1
2017	0	0	1	0	0	0	0	1
2018	0	0	1	6	0	0	0	7
Total	0	0	3	7	0	0	0	10





Meeting the following criteria

Jurisdiction: Statewide
Year: 2013, 2014, 2015, 2016, 2017, 2018
Map Selection: Yes
Filter: None

Analyst Information

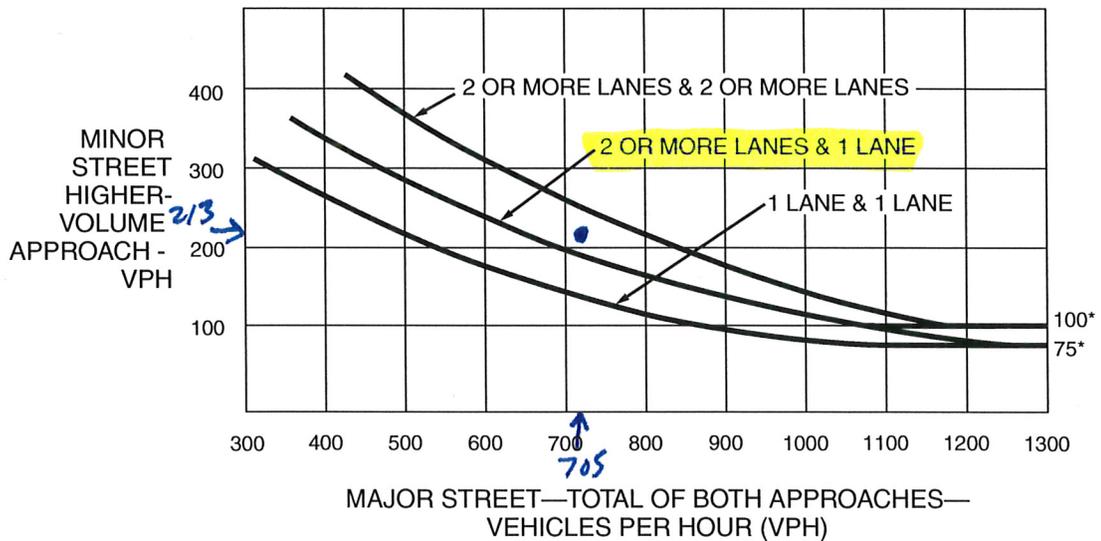
Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Intersection												
Int Delay, s/veh	4.8											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕			↕			↕	
Traffic Vol, veh/h	0	182	19	47	115	7	26	60	59	10	12	2
Future Vol, veh/h	0	182	19	47	115	7	26	60	59	10	12	2
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None									
Storage Length	-	-	300	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	198	21	51	125	8	28	65	64	11	13	2

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	133	0	0	219	0	0	437	433	198	504	450	129
Stage 1	-	-	-	-	-	-	198	198	-	231	231	-
Stage 2	-	-	-	-	-	-	239	235	-	273	219	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1452	-	-	1350	-	-	530	516	843	478	504	921
Stage 1	-	-	-	-	-	-	804	737	-	772	713	-
Stage 2	-	-	-	-	-	-	764	710	-	733	722	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1452	-	-	1350	-	-	502	495	843	385	483	921
Mov Cap-2 Maneuver	-	-	-	-	-	-	502	495	-	385	483	-
Stage 1	-	-	-	-	-	-	804	737	-	772	684	-
Stage 2	-	-	-	-	-	-	717	681	-	617	722	-

Approach	EB			WB			NB			SB		
HCM Control Delay, s	0			2.2			13.2			13.4		
HCM LOS							B			B		

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	597	1452	-	-	1350	-	-	453
HCM Lane V/C Ratio	0.264	-	-	-	0.038	-	-	0.058
HCM Control Delay (s)	13.2	0	-	-	7.8	0	-	13.4
HCM Lane LOS	B	A	-	-	A	A	-	B
HCM 95th %tile Q(veh)	1.1	0	-	-	0.1	-	-	0.2

Intersection												
Int Delay, s/veh	4.9											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕			↕			↕	
Traffic Vol, veh/h	2	127	17	80	367	8	51	33	35	0	34	5
Future Vol, veh/h	2	127	17	80	367	8	51	33	35	0	34	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None									
Storage Length	-	-	250	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	2	138	18	87	399	9	55	36	38	0	37	5

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	408	0	0	156	0	0	741	724	138	766	738	404
Stage 1	-	-	-	-	-	-	142	142	-	578	578	-
Stage 2	-	-	-	-	-	-	599	582	-	188	160	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1151	-	-	1424	-	-	332	352	910	320	346	647
Stage 1	-	-	-	-	-	-	861	779	-	501	501	-
Stage 2	-	-	-	-	-	-	488	499	-	814	766	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1151	-	-	1424	-	-	282	323	910	263	318	647
Mov Cap-2 Maneuver	-	-	-	-	-	-	282	323	-	263	318	-
Stage 1	-	-	-	-	-	-	859	777	-	500	461	-
Stage 2	-	-	-	-	-	-	410	460	-	742	764	-

Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.1			1.4			19.9			17.1		
HCM LOS							C			C		

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	370	1151	-	-	1424	-	-	340
HCM Lane V/C Ratio	0.35	0.002	-	-	0.061	-	-	0.125
HCM Control Delay (s)	19.9	8.1	0	-	7.7	0	-	17.1
HCM Lane LOS	C	A	A	-	A	A	-	C
HCM 95th %tile Q(veh)	1.5	0	-	-	0.2	-	-	0.4

Intersection												
Int Delay, s/veh	9.8											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕			↕			↕	
Traffic Vol, veh/h	13	182	19	47	115	128	26	100	59	105	42	11
Future Vol, veh/h	13	182	19	47	115	128	26	100	59	105	42	11
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None									
Storage Length	-	-	250	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	14	198	21	51	125	139	28	109	64	114	46	12

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	264	0	0	219	0	0	552	592	198	620	544	195
Stage 1	-	-	-	-	-	-	226	226	-	297	297	-
Stage 2	-	-	-	-	-	-	326	366	-	323	247	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1300	-	-	1350	-	-	444	419	843	400	446	846
Stage 1	-	-	-	-	-	-	777	717	-	712	668	-
Stage 2	-	-	-	-	-	-	687	623	-	689	702	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1300	-	-	1350	-	-	385	396	843	279	421	846
Mov Cap-2 Maneuver	-	-	-	-	-	-	385	396	-	279	421	-
Stage 1	-	-	-	-	-	-	768	708	-	703	638	-
Stage 2	-	-	-	-	-	-	601	595	-	532	694	-

Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.5			1.3			18.1			28.1		
HCM LOS							C			D		

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	474	1300	-	-	1350	-	-	323
HCM Lane V/C Ratio	0.424	0.011	-	-	0.038	-	-	0.532
HCM Control Delay (s)	18.1	7.8	0	-	7.8	0	-	28.1
HCM Lane LOS	C	A	A	-	A	A	-	D
HCM 95th %tile Q(veh)	2.1	0	-	-	0.1	-	-	2.9

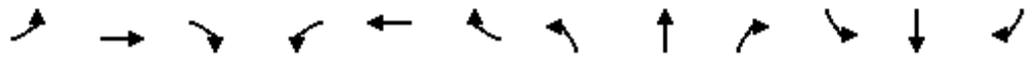
Intersection												
Int Delay, s/veh	26											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕			↕			↕	
Traffic Vol, veh/h	11	127	17	80	367	103	51	63	35	126	74	13
Future Vol, veh/h	11	127	17	80	367	103	51	63	35	126	74	13
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None									
Storage Length	-	-	360	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	12	138	18	87	399	112	55	68	38	137	80	14

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	511	0	0	156	0	0	838	847	138	853	809	455
Stage 1	-	-	-	-	-	-	162	162	-	629	629	-
Stage 2	-	-	-	-	-	-	676	685	-	224	180	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1054	-	-	1424	-	-	286	299	910	279	314	605
Stage 1	-	-	-	-	-	-	840	764	-	470	475	-
Stage 2	-	-	-	-	-	-	443	448	-	779	750	-
Platoon blocked, %	-	-	-	-	-	-	-	-	-	-	-	-
Mov Cap-1 Maneuver	1054	-	-	1424	-	-	202	270	910	199	283	605
Mov Cap-2 Maneuver	-	-	-	-	-	-	202	270	-	199	283	-
Stage 1	-	-	-	-	-	-	830	755	-	464	434	-
Stage 2	-	-	-	-	-	-	322	409	-	671	741	-

Approach	EB			WB			NB			SB		
HCM Control Delay, s	0.6			1.1			33.2			103.5		
HCM LOS							D			F		

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	284	1054	-	-	1424	-	-	232
HCM Lane V/C Ratio	0.57	0.011	-	-	0.061	-	-	0.998
HCM Control Delay (s)	33.2	8.5	0	-	7.7	0	-	103.5
HCM Lane LOS	D	A	A	-	A	A	-	F
HCM 95th %tile Q(veh)	3.3	0	-	-	0.2	-	-	9.3

HCM 6th Signalized Intersection Summary Proposed Geometry & Opening Year Traffic - AM Peak
 3: IA 110/90th Ave & IA 7 10/21/2019



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	13	182	19	47	115	128	26	100	59	105	42	11
Future Volume (veh/h)	13	182	19	47	115	128	26	100	59	105	42	11
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	14	198	21	51	125	139	28	109	64	114	46	12
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	328	351	297	408	182	202	471	170	100	447	308	80
Arrive On Green	0.02	0.19	0.19	0.06	0.22	0.22	0.03	0.15	0.15	0.10	0.22	0.22
Sat Flow, veh/h	1781	1870	1585	1781	809	900	1781	1105	649	1781	1430	373
Grp Volume(v), veh/h	14	198	21	51	0	264	28	0	173	114	0	58
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	0	1708	1781	0	1754	1781	0	1803
Q Serve(g_s), s	0.2	3.4	0.4	0.8	0.0	5.0	0.5	0.0	3.3	1.8	0.0	0.9
Cycle Q Clear(g_c), s	0.2	3.4	0.4	0.8	0.0	5.0	0.5	0.0	3.3	1.8	0.0	0.9
Prop In Lane	1.00		1.00	1.00		0.53	1.00		0.37	1.00		0.21
Lane Grp Cap(c), veh/h	328	351	297	408	0	384	471	0	270	447	0	388
V/C Ratio(X)	0.04	0.56	0.07	0.12	0.00	0.69	0.06	0.00	0.64	0.26	0.00	0.15
Avail Cap(c_a), veh/h	547	950	805	560	0	867	662	0	915	554	0	966
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.5	13.1	11.9	10.6	0.0	12.6	11.9	0.0	14.1	10.8	0.0	11.3
Incr Delay (d2), s/veh	0.1	1.4	0.1	0.1	0.0	2.2	0.1	0.0	2.5	0.3	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	1.0	0.1	0.2	0.0	1.4	0.1	0.0	1.1	0.5	0.0	0.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	11.5	14.5	12.0	10.8	0.0	14.8	11.9	0.0	16.6	11.1	0.0	11.5
LnGrp LOS	B	B	B	B	A	B	B	A	B	B	A	B
Approach Vol, veh/h		233			315			201				172
Approach Delay, s/veh		14.1			14.1			15.9				11.2
Approach LOS		B			B			B				B
Timer - Assigned Phs	1	2	3	4	5	6	7	8				
Phs Duration (G+Y+Rc), s	7.9	10.0	6.5	11.1	5.7	12.1	5.1	12.5				
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5				
Max Green Setting (Gmax), s	5.5	18.5	5.0	18.0	5.0	19.0	5.0	18.0				
Max Q Clear Time (g_c+I1), s	3.8	5.3	2.8	5.4	2.5	2.9	2.2	7.0				
Green Ext Time (p_c), s	0.0	0.6	0.0	0.7	0.0	0.2	0.0	1.0				
Intersection Summary												
HCM 6th Ctrl Delay				14.0								
HCM 6th LOS				B								

HCM 6th Signalized Intersection Summary Proposed Geometry & Opening Year Traffic - PM Peak

3: IA 110/90th Ave & IA 7

10/21/2019



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	11	127	17	80	367	103	51	63	35	126	74	13
Future Volume (veh/h)	11	127	17	80	367	103	51	63	35	126	74	13
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	12	138	18	87	399	112	55	68	38	137	80	14
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	282	544	461	594	494	139	407	127	71	410	234	41
Arrive On Green	0.02	0.29	0.29	0.08	0.35	0.35	0.06	0.11	0.11	0.09	0.15	0.15
Sat Flow, veh/h	1781	1870	1585	1781	1405	394	1781	1127	630	1781	1550	271
Grp Volume(v), veh/h	12	138	18	87	0	511	55	0	106	137	0	94
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	0	1799	1781	0	1757	1781	0	1822
Q Serve(g_s), s	0.2	2.4	0.3	1.4	0.0	10.9	1.1	0.0	2.4	2.8	0.0	2.0
Cycle Q Clear(g_c), s	0.2	2.4	0.3	1.4	0.0	10.9	1.1	0.0	2.4	2.8	0.0	2.0
Prop In Lane	1.00		1.00	1.00		0.22	1.00		0.36	1.00		0.15
Lane Grp Cap(c), veh/h	282	544	461	594	0	632	407	0	198	410	0	275
V/C Ratio(X)	0.04	0.25	0.04	0.15	0.00	0.81	0.14	0.00	0.54	0.33	0.00	0.34
Avail Cap(c_a), veh/h	465	992	841	674	0	958	522	0	807	457	0	837
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.1	11.5	10.7	9.0	0.0	12.4	15.1	0.0	17.7	14.5	0.0	16.1
Incr Delay (d2), s/veh	0.1	0.2	0.0	0.1	0.0	3.1	0.1	0.0	2.3	0.5	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.7	0.1	0.3	0.0	3.1	0.4	0.0	0.9	0.9	0.0	0.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	11.1	11.7	10.8	9.1	0.0	15.5	15.2	0.0	20.0	14.9	0.0	16.8
LnGrp LOS	B	B	B	A	A	B	B	A	B	B	A	B
Approach Vol, veh/h		168			598			161			231	
Approach Delay, s/veh		11.6			14.6			18.3			15.7	
Approach LOS		B			B			B			B	
Timer - Assigned Phs	1	2	3	4	5	6	7	8				
Phs Duration (G+Y+Rc), s	8.5	9.2	7.7	16.8	6.9	10.9	5.2	19.3				
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5				
Max Green Setting (Gmax), s	5.1	19.4	5.1	22.4	5.1	19.4	5.0	22.5				
Max Q Clear Time (g_c+I1), s	4.8	4.4	3.4	4.4	3.1	4.0	2.2	12.9				
Green Ext Time (p_c), s	0.0	0.4	0.0	0.6	0.0	0.3	0.0	2.0				

Intersection Summary

HCM 6th Ctrl Delay	14.9
HCM 6th LOS	B

HCM 6th Signalized Intersection Summary
3: IA 110/90th Ave & IA 7

Proposed Geometry & Future Traffic - AM Peak

10/21/2019



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	17	222	23	57	140	272	32	161	72	202	78	12
Future Volume (veh/h)	17	222	23	57	140	272	32	161	72	202	78	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	18	241	25	62	152	296	35	175	78	220	85	13
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	244	517	438	440	177	345	466	236	105	398	409	63
Arrive On Green	0.02	0.28	0.28	0.06	0.31	0.31	0.04	0.19	0.19	0.10	0.26	0.26
Sat Flow, veh/h	1781	1870	1585	1781	567	1104	1781	1226	546	1781	1584	242
Grp Volume(v), veh/h	18	241	25	62	0	448	35	0	253	220	0	98
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	0	1672	1781	0	1772	1781	0	1827
Q Serve(g_s), s	0.3	5.2	0.6	1.2	0.0	12.3	0.8	0.0	6.6	4.7	0.0	2.1
Cycle Q Clear(g_c), s	0.3	5.2	0.6	1.2	0.0	12.3	0.8	0.0	6.6	4.7	0.0	2.1
Prop In Lane	1.00		1.00	1.00		0.66	1.00		0.31	1.00		0.13
Lane Grp Cap(c), veh/h	244	517	438	440	0	523	466	0	341	398	0	471
V/C Ratio(X)	0.07	0.47	0.06	0.14	0.00	0.86	0.08	0.00	0.74	0.55	0.00	0.21
Avail Cap(c_a), veh/h	387	708	600	519	0	633	579	0	667	398	0	692
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	13.3	14.7	13.0	11.5	0.0	15.8	14.7	0.0	18.6	13.9	0.0	14.2
Incr Delay (d2), s/veh	0.1	0.7	0.1	0.1	0.0	9.7	0.1	0.0	3.2	1.6	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	1.7	0.2	0.3	0.0	4.7	0.3	0.0	2.5	1.6	0.0	0.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	13.4	15.3	13.0	11.6	0.0	25.5	14.8	0.0	21.8	15.5	0.0	14.4
LnGrp LOS	B	B	B	B	A	C	B	A	C	B	A	B
Approach Vol, veh/h		284			510			288			318	
Approach Delay, s/veh		15.0			23.8			20.9			15.2	
Approach LOS		B			C			C			B	
Timer - Assigned Phs	1	2	3	4	5	6	7	8				
Phs Duration (G+Y+Rc), s	9.6	13.9	7.3	18.0	6.4	17.1	5.6	19.8				
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5				
Max Green Setting (Gmax), s	5.1	18.4	5.0	18.5	5.0	18.5	5.0	18.5				
Max Q Clear Time (g_c+I1), s	6.7	8.6	3.2	7.2	2.8	4.1	2.3	14.3				
Green Ext Time (p_c), s	0.0	0.9	0.0	0.9	0.0	0.3	0.0	1.0				

Intersection Summary

HCM 6th Ctrl Delay	19.5
HCM 6th LOS	B

HCM 6th Signalized Intersection Summary
3: IA 110/90th Ave & IA 7

Proposed Geometry & Future Traffic - PM Peak

10/21/2019



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	15	155	21	98	448	200	62	104	43	270	129	17
Future Volume (veh/h)	15	155	21	98	448	200	62	104	43	270	129	17
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	16	168	23	107	487	217	67	113	47	293	140	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	189	744	631	615	540	241	329	147	61	439	389	50
Arrive On Green	0.02	0.40	0.40	0.06	0.44	0.44	0.05	0.12	0.12	0.17	0.24	0.24
Sat Flow, veh/h	1781	1870	1585	1781	1226	546	1781	1255	522	1781	1624	209
Grp Volume(v), veh/h	16	168	23	107	0	704	67	0	160	293	0	158
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	0	1772	1781	0	1776	1781	0	1833
Q Serve(g_s), s	0.4	4.2	0.6	2.4	0.0	26.1	2.3	0.0	6.2	9.6	0.0	5.1
Cycle Q Clear(g_c), s	0.4	4.2	0.6	2.4	0.0	26.1	2.3	0.0	6.2	9.6	0.0	5.1
Prop In Lane	1.00		1.00	1.00		0.31	1.00		0.29	1.00		0.11
Lane Grp Cap(c), veh/h	189	744	631	615	0	781	329	0	209	439	0	439
V/C Ratio(X)	0.08	0.23	0.04	0.17	0.00	0.90	0.20	0.00	0.77	0.67	0.00	0.36
Avail Cap(c_a), veh/h	293	1015	861	643	0	962	359	0	263	578	0	607
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.0	14.1	13.0	10.9	0.0	18.4	25.7	0.0	30.3	20.6	0.0	22.4
Incr Delay (d2), s/veh	0.2	0.2	0.0	0.1	0.0	10.0	0.3	0.0	10.0	1.8	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	1.5	0.2	0.8	0.0	10.3	0.9	0.0	3.0	3.7	0.0	2.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	16.2	14.3	13.1	11.0	0.0	28.3	26.0	0.0	40.3	22.4	0.0	22.9
LnGrp LOS	B	B	B	B	A	C	C	A	D	C	A	C
Approach Vol, veh/h		207			811			227			451	
Approach Delay, s/veh		14.3			26.1			36.1			22.6	
Approach LOS		B			C			D			C	
Timer - Assigned Phs	1	2	3	4	5	6	7	8				
Phs Duration (G+Y+Rc), s	16.5	12.8	8.9	32.7	7.8	21.5	5.9	35.8				
Change Period (Y+Rc), s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5				
Max Green Setting (Gmax), s	17.5	10.5	5.5	38.5	4.5	23.5	5.5	38.5				
Max Q Clear Time (g_c+I1), s	11.6	8.2	4.4	6.2	4.3	7.1	2.4	28.1				
Green Ext Time (p_c), s	0.4	0.1	0.0	0.8	0.0	0.6	0.0	3.1				

Intersection Summary

HCM 6th Ctrl Delay	25.0
HCM 6th LOS	C

Notes

- User approved pedestrian interval to be less than phase max green.
- User approved volume balancing among the lanes for turning movement.