Metropolitan Planning Organization of Johnson County

Date: April 16th, 2015

To: Dan Holderness; Coralville City Engineer
Scott Larson; Coralville Assistant City Engineer

From: Darian Nagle-Gamm, Traffic Engineering Planner

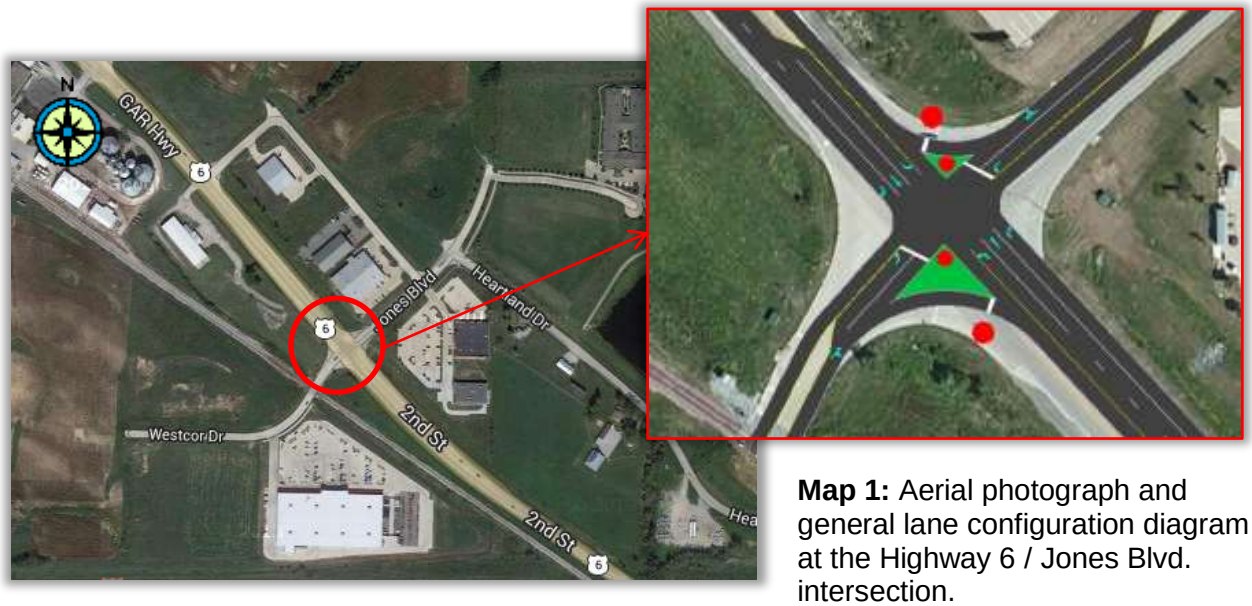
Re: Highway 6 (2nd Street) / Jones Boulevard / Westcor Drive Traffic Signal Warrant and Roundabout Analysis

The City of Coralville has requested an evaluation of existing traffic conditions, a traffic signal warrant study, and roundabout analysis for the intersection of Highway 6 (2nd Street), Jones Boulevard, and Westcor Drive.

Existing Conditions

The study intersection is located in west Coralville. Highway 6 is an east-west state highway that provides regional access to the metropolitan area and local arterial access between Iowa City, Coralville, and Tiffin. Jones Boulevard, to the north of the study intersection, will eventually be extended further north and function as a north-south arterial corridor parallel to Highway 965. As built today, this segment of Jones Boulevard functions as a two lane collector road that services several businesses and provides access to Heartland Drive. Westcor Drive is a private two-lane local road that terminates approximately 800' south of Highway 6. There is an at-grade rail crossing on Westcor Drive just south of the study intersection.

The intersection is currently stop controlled for north-south traffic only. Each has a dedicated left-turn lane and through lanes with channelized, stop-controlled right-turn lanes. Both Jones Boulevard and Westcor Drive are posted at 25 mph. Highway 6 has dedicated right and left-turn lanes and a single through lane in both directions. Highway 6 is posted at 55 mph.



Map 1: Aerial photograph and general lane configuration diagram at the Highway 6 / Jones Blvd. intersection.

Traffic Counts

Average daily traffic counts were taken at the intersection April 8th – April 11th, 2014. Highway 6 carries approximately 8,300 entering vehicles per day, which is 74% of the total entering traffic at the intersection. 85th percentile speeds on Highway 6 range from 58.8 to 59.9 mph.

Figure 1: Average Daily Traffic Counts (Entering Traffic)

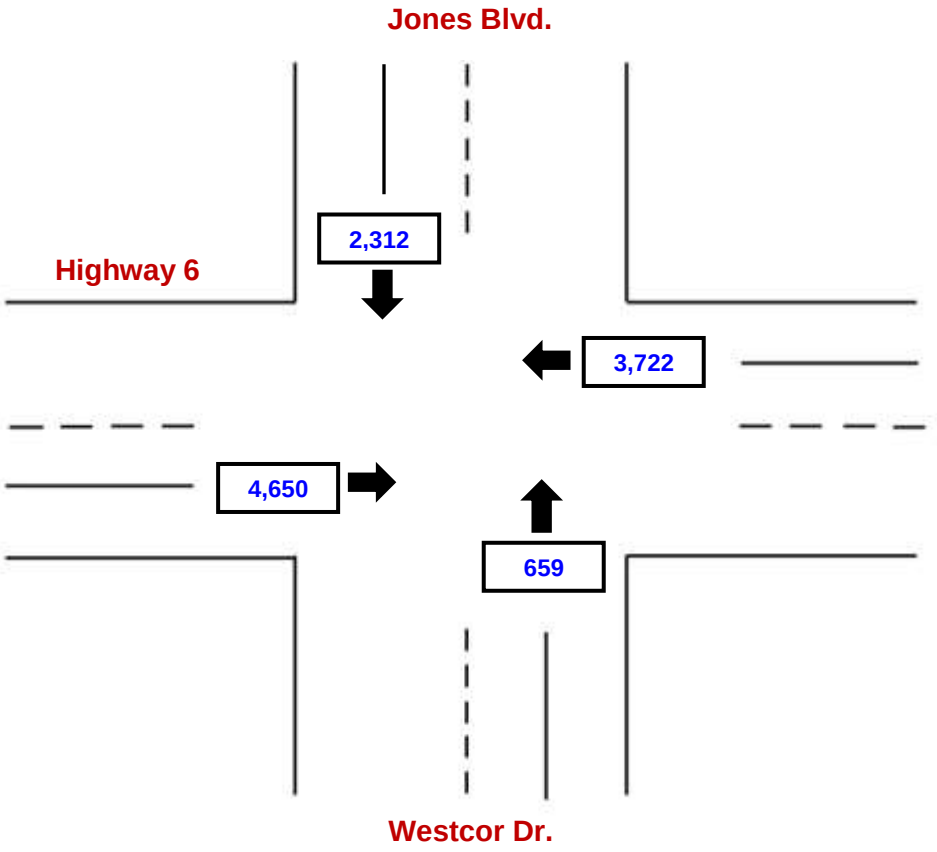
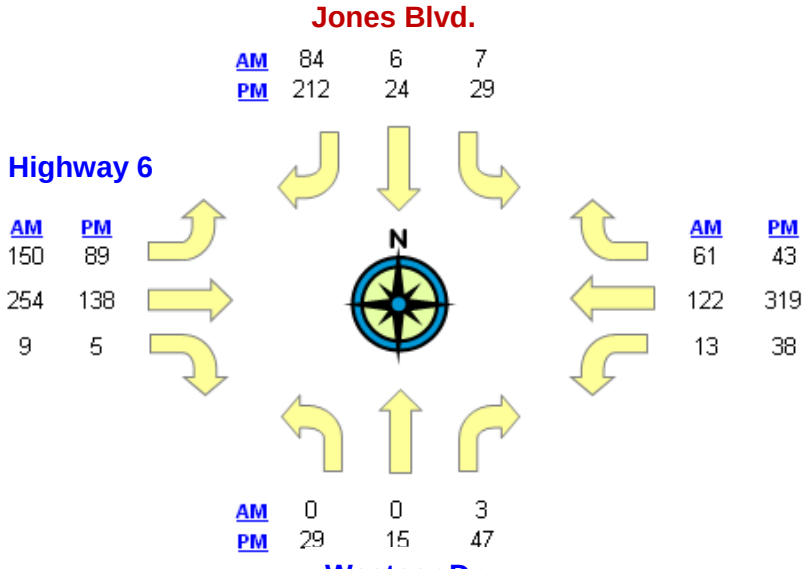


Figure 2: Existing Peak Hour Traffic Counts (May 21st and 22nd, 2013)



Traffic Signal Warrant Study

A traffic signal warrant analysis is performed to determine the need for a traffic signal. At a minimum, at least one of the eight warrants must be met, but the satisfaction of a warrant does not in itself require the installation of a traffic signal.

The eight traffic signal warrants are as follows:

1) Eight-Hour Vehicular Volume
2) Four-Hour Vehicular Volume
3) Peak Hour
4) Pedestrian Volume (not evaluated)
5) School Crossing (not evaluated)
6) Coordinated Signal System (not evaluated)
7) Crash Experience
8) Roadway Network

Please see the Manual on Uniform Traffic Control Devices (MUTCD) for further information on each warrant. Traffic signal warrants 1, 2, 3, 7, and 8 were evaluated here with respect to the observed traffic volumes. Twenty-four hour traffic counts used in this analysis were performed April 8th – 11th, 2014.

Warrants 4, 5, and 6 were not applicable to this intersection due to the following:

- Warrant 4 was not evaluated due to the absence of pedestrians in the observed traffic counts.
- Warrant 5 was not evaluated due to a lack of a school in the area.
- Warrant 6 was not evaluated because current traffic control at this intersection functions independently of other signalized intersections.

Warrant 1 – Eight Hour Vehicular Volume

Warrant 1A examines whether the intersection meets the minimum vehicular volume per hour to warrant a traffic signal. Warrant 1B examines whether the traffic on the major street is so heavy that traffic on a minor street suffers excessive delay or conflict in entering or crossing the major street.

Two one-hour periods meet the traffic volume criteria for Warrant 1A, and no one-hour periods meet the traffic volume criteria for Warrant 1B. Eight one-hour periods must meet both the minimum volume criteria for either warrant; therefore **Warrant 1A and Warrant 1B are not met.**

Table 1: Warrant 1 Criteria

Highway 6 / Jones Blvd / Westcor Drive				
Movement	**Warrant 1A[c]**		**Warrant 1B[c]**	
	Required volume	# Hours Met	Required volume	# Hours Met
Major Street Total (Highway 6)	500	**2**	750	**0**
Highest Vol. Minor Street Approach	150		75	
Warrant Met?		**No**		**No**

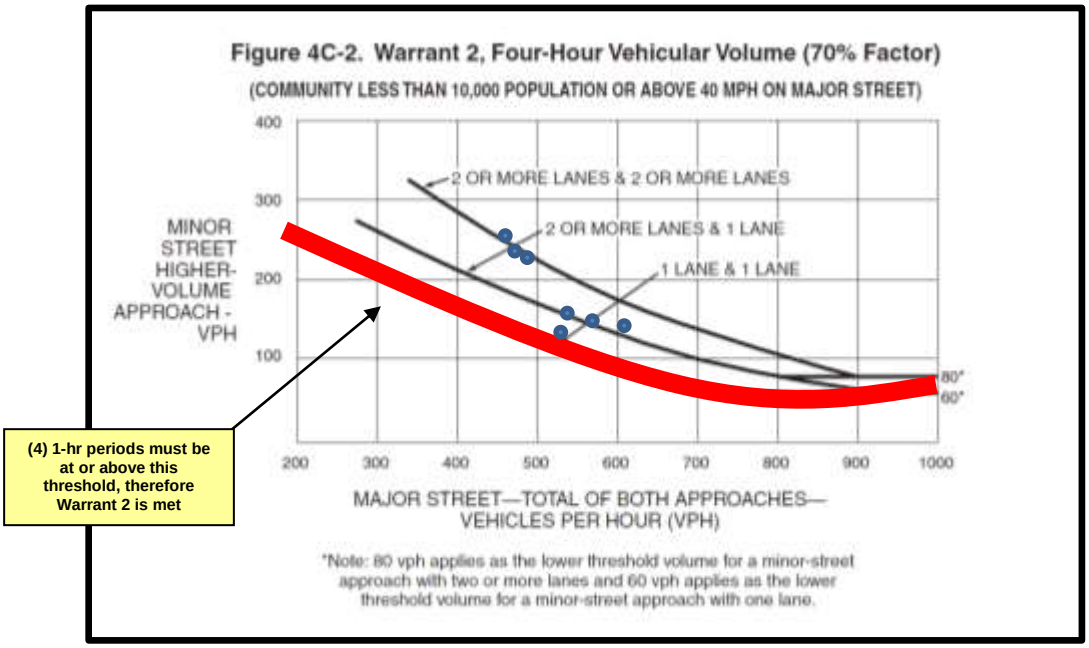
Table 2: Hourly Traffic Volumes

Warrant 1 – Eight-Hour Vehicular Volume Condition A - Minimum Vehicular Volume Condition B - Interruption of Continuous Traffic					
Highway 6 & Jones Blvd. / Westcor Dr.					
Coralville, IA		*April 8th – 11th, 2014*			
Time	Total Entering Traffic	Major Street Total	Highest Volume Minor Approach	Warranted?	
				1A[c]	1B[c]
0100	124	118	7		
0200	14	279	6		
0300	21	496	4		
0400	28	341	4		
0500	74	278	13		
0600	214	379	51		
0700	338	480	77		
0800	300	417	89		
0900	297	459	83		
1000	353	450	100		
1100	397	525	133		
1200	467	577	161	YES	
1300	445	606	145		
1400	485	538	166	YES	
1500	556	497	213		
1600	636	462	259		
1700	638	487	237		
1800	424	291	171		
1900	331	212	143		
2000	239	168	106		
2100	146	107	54		
2200	75	56	34		
2300	55	64	18		
2400	34	71	0		

Warrant 2 – Four Hour Vehicular Volume

The four-hour vehicle volume signal warrant is applied where the volume of intersecting traffic is a principal reason to consider installing a traffic control signal. To meet Warrant 2, traffic volumes on both streets must meet the required volume threshold for four one-hour periods. Figure 3 graphically depicts the required vehicular volume threshold for the major and minor streets (red line). Seven one-hour periods meet this criterion, therefore **Warrant 2 is met.**

Figure 3: Four-Hour Vehicular Volume Warrant – 70%



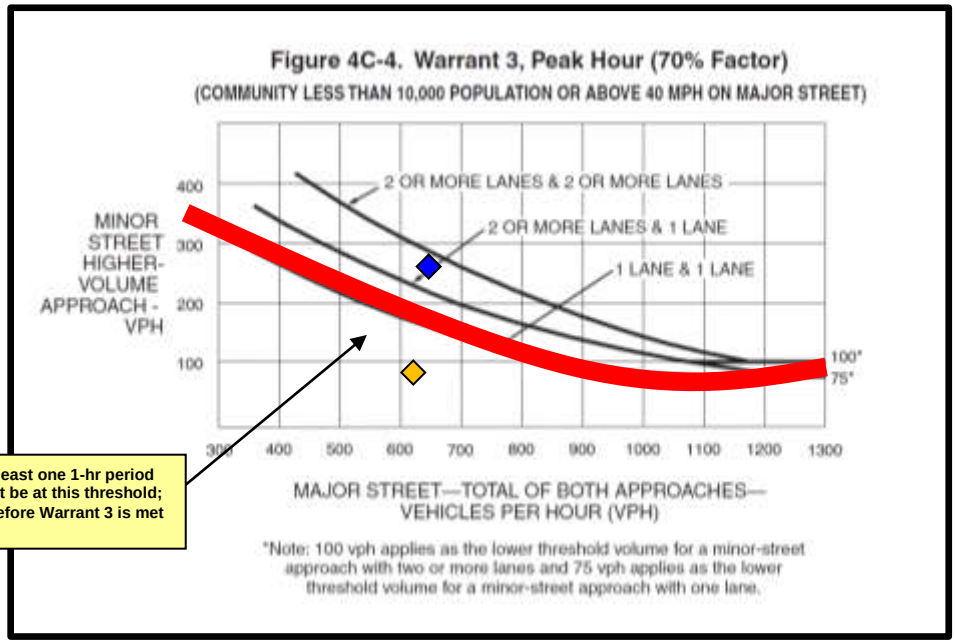
Warrant 3 – Peak Hour Vehicular Volume

The peak hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of one hour on an average day, the minor street traffic suffers undue delay when entering or crossing the major street. Peak hour traffic volumes on both streets must meet required thresholds under Warrant 3. Figure 4 graphically depicts the required vehicular volume threshold for the major and minor streets (red line). As the PM peak hour meets the required thresholds, **Warrant 3 is met.**

Table 3: Peak Hour Traffic Volumes – 70%

Warrant 3 Highway 6 / Jones Blvd / Westcor Drive							
Highway 6 (Total of both approaches)		Jones Blvd / Westcor Dr (Highest vol. approach)		Warranted?		Legend	
AM	PM	AM	PM	AM	PM	AM	PM
609	632	97	265	No	YES	◇	◆

Figure 4: Peak Hour Warrant



Warrant 7 – Collisions

Because the installation of traffic signals often results in a trade of one type of collision for another, Warrant 7 states that there must be five crashes of a type correctable by a signal in twelve consecutive months. Between 2011 and 2014 there were ten total collisions, seven of which would be correctable by a traffic signal. The first five collisions reported below fell within the same twelve month period, therefore **Warrant 7 is met.**

Table 4: Collision Experience

Warrant 7 Highway 6 / Jones Blvd / Westcor Drive (2011-2014)			
Date of Collision	**Major Cause**	**Manner of Crash**	**Same 12 Month Period?**
08/07/2011	FTY from Stop Sign	Broadside	**YES**
10/20/2011	Ran Stop Sign	Broadside	**YES**
12/27/2011	Ran Stop Sign	Broadside	**YES**
07/10/2012	FTY from Stop Sign	Broadside	**YES**
08/24/2012	FTY from Stop Sign	Angle, oncoming left-turn	**YES***
12/18/2012	FTY from Stop Sign	Broadside	No
01/02/2013	FTY from Stop Sign	Broadside	No

* Collision within 17 days of falling in the same 12 month period. Because it falls in the same calendar month, it was counted towards the collision warrant.

Warrant 8 – Roadway Network

Warrant 8 is used when evaluating whether a traffic signal at an intersection might be justified to encourage concentration and organization of traffic flow on a roadway network. Warrant 8 is met when one or both of the following criteria are met:

A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2 and 3 during an average weekday; or

B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).

A major route as used in this signal warrant shall have one or more of the following characteristics:

A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow; or

B. It includes rural or suburban highways outside, entering, or traversing a City; or

C. It appears as a major route on an official plan, such as a major street plan in an urban traffic and transportation study.

The Highway 6 / Jones Blvd. intersection has approximately 1,000 entering vehicles per hour during the PM peak hour; therefore the intersection meets Criterion A. Based on the adjacent land uses including large scale commercial activities in the area), it is highly likely that the intersection has more than 1,000 vehicles per hour for any five hours on a Saturday or Sunday, therefore the intersection meets Criterion B.

The intersection is part of the Highway 6 / 2nd Street arterial street system. Highway 6 is a state highway and east-west arterial street linking Coralville and Iowa City. Jones Blvd. is a north-south collector street which is projected (upon its completion) to become an arterial street running parallel to the Highway 965 corridor. Currently, Highway 6 serves as part of the principal roadway network for through traffic flow in Coralville, therefore major route Characteristic A is met.

Highway 6 is a state highway in Iowa, therefore Characteristic B is met.

Highway 6 appears in the adopted MPOJC Long Range Transportation Plan as part of the official arterial street network, and Jones Blvd. is projected to be a part of the official arterial street network, therefore Characteristic C is met.

As the Highway 6 / Jones Blvd/ Westcor Drive intersection meets all criteria and characteristics of Warrant 8, **Warrant 8 is met.**

Capacity Analysis: Delay and Level of Service (LOS)

EXISTING CONDITIONS

Existing intersection delay and Level of Service (LOS) was evaluated using the Synchro 8.0 traffic modeling software. Traffic congestion is expressed in terms of LOS as defined by the Highway Capacity Manual (HCM). LOS is a letter code ranging from "A" for free-flow conditions to "F" for extreme congestion.

The intersection overall functions well at LOS A on Highway 6 during both peak periods as Highway 6 runs "free" and carries 74% of entering traffic. That said, southbound and northbound traffic experiences significant delay during the PM peak hour as displayed in **Table 5**. The northbound movement performs at LOS E. Northbound left-turn traffic experiences LOS F during the PM peak hour while the through/right-turn movements experiences LOS D. The southbound movement as a whole experiences LOS C during the PM peak hour while the southbound left-turn movement experiences LOS E. The southbound through/right movement experiences LOS B during the PM peak hour.

Table 5: Existing Delay and LOS

Highway 6 / Jones Boulevard / Westcor Drive				
Movement	AM Peak		PM Peak	
	Delay	LOS	Delay	LOS
Northbound (Westcor Dr)	10.1	**B**	49.8	**E**
- Left	*	*	82.5	**F**
- Through / Right	10.1	**B**	34.5	**D**
Southbound (Jones Blvd)	9.6	**A**	18.0	**C**
- Left	20.4	**C**	47.7	**E**
- Through	19.8	**C**	14.3	**B**
Eastbound (Hwy 6)	7.9	**A**	8.7	**A**
- Left	7.9	**A**	8.7	**A**
- Through	0.0	**A**	0.0	**A**
- Right	0.0	**A**	0.0	**A**
Westbound (Hwy 6)	8.0	**A**	8.1	**A**
- Left	8.0	**A**	8.1	**A**
- Through	0.0	**A**	0.0	**A**
- Right	0.0	**A**	0.0	**A**
Average Delay / Vehicle	**2.9**	**A**	**8.5**	**A**

***** Not enough traffic to produce delay calculations

PROPOSED – SIGNALIZED CONDITIONS

Table 6 reflects delay and level of service under signalized conditions with two left-turn phasing scenarios: 1) protected-only left-turns on Highway 6 with protected / permissive left-turns on Jones Blvd and Westcor Drive, and 2) protected / permissive left-turns on all approaches.

SCENARIO #1: Under signalized conditions with a protected left-turn signaling on Highway 6 and protected / permissive signaling on Jones Boulevard / Westcor Drive, the intersection would function well at LOS B during both peak periods. The majority of individual movements would perform at LOS A or LOS B, with eastbound / westbound movements on Highway 6 performing at LOS C or better.

SCENARIO #2: If protected / permissive left turn signaling is implemented on all approaches, overall intersection delay would improve by a few seconds during each peak period and the intersection's overall level of service would improve to LOS A. If this scenario is pursued, it is recommended that the *flashing yellow arrow* signal indication be used. The *flashing yellow arrow* indication has been proven to reduce oncoming left-turn collisions where permissive left-turns are allowed.

Table 6: Signalized Delay and LOS (optimized)

Highway 6 / Jones Boulevard / Westcor Drive								
Movement	**SCENARIO #1:** Protected-Only Left Turns Hwy 6; Protected / Permissive Left Turns on Jones / Westcor				**SCENARIO #2**: Protected / Permissive Left Turns on all Approaches			
	AM Peak		PM Peak		AM Peak		PM Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Northbound (Westcor Dr)	12.3	**B**	15.7	**B**	12.1	**B**	15.1	**B**
- Left	*	*	15.3	**B**	*	*	14.7	**B**
- Through	*	*	16.6	**B**	*	*	16.0	**B**
- Right	12.3	**B**	0.0	**A**	12.1	**B**	0.0	**A**
Southbound (Jones Blvd)	9.5	**A**	16.1	**B**	9.2	**A**	15.5	**B**
- Left	10.4	**B**	15.3	**B**	10.1	**B**	14.7	**B**
- Through	8.7	**A**	17.2	**B**	8.4	**A**	16.6	**B**
- Right	9.5	**A**	0.0	**A**	9.2	**A**	0.0	**A**
Eastbound (Hwy 6)	11.5	**B**	12.7	**B**	7.9	**A**	7.6	**A**
- Left	17.6	**B**	21.9	**C**	6.8	**A**	7.2	**A**
- Through	8.4	**A**	7.8	**A**	8.6	**A**	8.0	**A**
- Right	6.4	**A**	6.2	**A**	6.5	**A**	6.4	**A**
Westbound (Hwy 6)	11.2	**B**	13.2	**B**	9.4	**A**	10.2	**B**
- Left	28.1	**C**	26.9	**C**	7.9	**A**	6.8	**A**
- Through	10.0	**B**	12.2	**B**	9.6	**A**	11.1	**B**
- Right	9.7	**A**	8.6	**A**	9.3	**A**	8.0	**A**
Average Delay / Vehicle	**11.2**	**B**	**13.2**	**B**	**9.4**	**A**	**9.5**	**A**

***** Not enough traffic to produce delay calculations

PROPOSED – SINGLE LANE ROUNDABOUT

An alternative to signalization is the construction of a roundabout. Roundabouts have been found to perform as good as or better than traffic signals during peak hours and are significantly more efficient than traffic signals during the off-peak hours.

Table 7 reflects level of service if the intersection was reconstructed as a single lane roundabout. In this scenario, the intersection would function well at LOS A during the AM and LOS B during the PM peak hour. The westbound movement experiencing the greatest delay at LOS C during the PM peak hour.

Table 7: Single Lane Roundabout Delay and LOS by movement

Highway 6 / Jones Boulevard / Westcor Drive				
Movement	AM Peak		PM Peak	
	Delay	LOS	Delay	LOS
Northbound (Westcor Dr)	5.4	**A**	6.6	**A**
Southbound (Jones Blvd)	5.0	**A**	6.6	**A**
Eastbound (Hwy 6)	8.9	**A**	10.5	**B**
Westbound (Hwy 6)	7.8	**A**	16.2	**C**
Average Delay / Vehicle	**8.1**	**A**	**10.3**	**B**

PROPOSED – DUAL-LANE ROUNDABOUT WITH DUAL-ENTRY

Table 8 reflects delay and LOS if the intersection was reconstructed as a dual lane roundabout with a dedicated left-turn lanes (150' on the east, west, and north legs, and 100' on the south leg) and through/right lanes. The intersection would function well at LOS A during both peak periods. During the PM peak hour, the westbound movement experiences the greatest delay at LOS B.

Table 8: Dual Lane Roundabout Delay and LOS by movement

Highway 6 / Jones Boulevard / Westcor Drive				
Movement	AM Peak		PM Peak	
	Delay	LOS	Delay	LOS
Northbound (Westcor Dr)				
- Left	4.7	**A**	5.4	**A**
- Through/Right	4.6	**A**	5.2	**A**
Southbound (Jones Blvd)				
- Left	3.7	**A**	5.4	**A**
- Through/Right	4.6	**A**	5.1	**A**
Eastbound (Hwy 6)				
- Left	4.8	**A**	5.3	**A**
- Through/Right	6.5	**A**	7.0	**A**
Westbound (Hwy 6)				
- Left	4.0	**A**	4.7	**A**
- Through/Right	6.9	**A**	12.0	**B**
Average Delay / Vehicle	**6.0**	**A**	**6.8**	**A**

DELAY AND LOS COMPARISON

Table 9 shows a comparison of the delay and level of service experienced today, if signalized with protected / permissive left-turn signaling, and if a single-lane roundabout was constructed. Overall, the intersection will experience the *least* average delay per vehicle if it remains unsignalized with stop control on the minor streets. This is because Highway 6 "runs free" and carries 74% of the daily traffic at the intersection. That said, the northbound and southbound minor street movements experience significant delay today during the PM peak hour. This delay is expected to increase as the area further develops.

If the intersection is signalized with protected / permissive left-turns on all approaches, overall delay will increase negligibly during both peak hours, but would still perform very well at LOS A. The northbound and southbound movements, which experience the greatest delays today, would experience significant reduction in delay. Northbound delay would improve from LOS E to LOS B during the PM peak hour. The northbound left turn movement would experience an even greater reduction in delay, from LOS F to LOS B. Southbound delay would improve from LOS C to LOS B with the left-turn movement improving from LOS E to LOS B.

If a single-lane roundabout were constructed, delay would remain LOS A during both peak hours. Most individual movements would experience very little delay - between 4 and 10 seconds per vehicle. The westbound movement would experience the greatest delay at LOS C during the PM peak hour. The northbound and southbound movements, which experience the greatest delay today, would experience significant improvement in delay. Northbound delay would improve from LOS E to LOS A during the PM peak hour. Southbound delay would improve from LOS C to LOS A during the PM peak hour. A dual-lane roundabout with dual entry would provide virtually the same delay and level of service today, but may be better suited to handle future traffic growth.

Table 9: Delay and LOS Comparison

Hwy 6 / Jones Blvd / Westcor Dr – Average Delay per Vehicle and LOS												
Movement	Existing – Two-Way Stop Control				Signalized – Protected / Permissive Left Turns				Single Lane Roundabout			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Northbound - Westcor Dr	10.1	**B**	49.8	**E**	12.1	**B**	15.1	**B**	5.4	**A**	6.6	**A**
- Left	*	*	82.5	**F**	0.0	**A**	14.7	**B**				
- Through	10.1	**B**	34.5	**D**	0.0	**A**	16.0	**B**				
- Right	**	**	**	****	12.1	**B**	0.0	**A**				
Southbound - Jones Blvd	9.6	**A**	18.0	**C**	9.2	**A**	15.5	**B**	5.0	**A**	6.6	**A**
- Left	20.4	**C**	47.7	**E**	10.1	**B**	14.7	**B**				
- Through	19.8	**C**	14.3	**B**	8.4	**A**	16.6	**B**				
- Right	**	**	**	****	9.2	**A**	0.0	**A**				
Eastbound - Hwy 6	7.9	**A**	8.7	**A**	7.9	**A**	7.6	**A**	8.9	**A**	10.5	**B**
- Left	7.9	**A**	8.7	**A**	6.8	**A**	7.2	**A**				
- Through	0.0	**A**	0.0	**A**	8.6	**A**	8.0	**A**				
- Right	0.0	**A**	0.0	**A**	6.5	**A**	6.4	**A**				
Westbound - Hwy 6	8.0	**A**	8.1	**A**	9.4	**A**	10.2	**B**	**7.8**	**A**	**16.2**	**C**
- Left	8.0	**A**	8.1	**A**	7.9	**A**	6.8	**A**				
- Through	0.0	**A**	0.0	**A**	9.6	**A**	11.1	**B**				
- Right	0.0	**A**	0.0	**A**	9.3	**A**	8.0	**A**				
Average Delay / Veh	**2.9**	**A**	**8.5**	**A**	**9.4**	**A**	**9.5**	**A**	**8.1**	**A**	**10.3**	**A**

* Not enough traffic to generate results

** Through / right lanes combined -- Through / right lane delay and level of service combined for existing conditions

Conclusion

Based on analysis of the MUTCD traffic signal warrants; Warrant 2, 3, 7, and 8 are met at the intersection of Highway 6 / Jones Boulevard / Westcor Drive, while Warrants 1A and 1B (8-hour vehicle warrants) are not met (**Table 10**). This indicates that the minor approaches are likely experiencing excessive delay or conflict in entering or crossing the major street during a few hours each day and that side-street drivers may be taking inadequate gaps in traffic due to these delays.

The capacity analysis shows that while *overall* intersection delay and level of service is very good at LOS A (because Highway 6 "runs free" and carries 74% of the daily traffic), Jones Boulevard / Westcor Drive traffic experiences significant delays at times. Today, the northbound movement performs at LOS E during the PM peak hour with the northbound left-turn movement performing at LOS F. The southbound movement performs at LOS C during the PM peak hour with the southbound left-turn movement performing at LOS E. As the area continues to develop and traffic volumes increase, lengthening delays on the side street may contribute to drivers continuing to take inadequate gaps in traffic when turning onto Highway 6. This could lead to an increase in collisions.

Table 10: Summary of Examined Warrants

Warrant	Description	Warrant Met?
1a	Minimum Vehicular Volume	No
1b	Interruption of Continuous Traffic	No
2	Four Hour Vehicular Volumes	**Yes**
3	Peak Hour Volumes	**Yes**
4	Pedestrian Volume	n/a
5	School Crossing	n/a
6	Coordinated Signal System	n/a
7	Crash Experience	**Yes**
8	Roadway Network	**Yes**

Recommendation

Signalizing the intersection would redistribute delay more equitably amongst all approaches. The northbound and southbound movements, which experience the greatest delays today, would experience significant reduction in delay with a relatively modest increase in delay for Highway 6 drivers. Traditionally, protected-only left-turn phasing is recommended for a 55 mph speed limit. However, the guidelines were established before the advent of the *flashing yellow arrow* signal indication which has proven to reduce left-turn collisions where permissive left-turns are allowed. This provides some flexibility to the municipality in left-turn signal phasing selection. As such, if signalization is pursued, we recommend that Coralville further evaluate if protected / permissive signal phasing with a *flashing yellow arrow* is appropriate at this location. The MPO could assist with such an analysis. It should be noted today that all left-turns from Highway 6 are "permissive" as there is currently no stop control at the intersection.

As an alternative to signalization, the City could consider the installation of a roundabout. A single-lane roundabout would significantly improve delay and level of service for the northbound and southbound movements while level of service on Highway 6 would remain acceptable at LOS C or greater.

While roundabouts offer similar delay and level of service to signals during peak hours, roundabouts offer significant off-peak delay savings and emissions reductions as vehicles

entering the intersection are not required stop unless a vehicle is approaching from the left within the roundabout. Our analysis shows that current volumes would support a single-lane roundabout with single-entry lanes. That said, the study intersection is located on a state highway in a growth area therefore the City may wish to consider sizing the roundabout to support dual interior lanes with dual-entry lanes to support future growth.

In addition to the inherent efficiency of a roundabout intersection, there are also pronounced safety benefits. Roundabouts have fewer conflict points than traditional intersections and, due to the slower speeds, have less severe collisions. Research indicates there would be fewer collisions with a roundabout versus the existing intersection stop control or a proposed signalized scenario.

Signalizing the intersection or constructing a roundabout would distribute delay more equitably amongst all legs of the intersection; however a roundabout would provide the best level of service, least amount of delay and unnecessary stopping, least fuel consumption/emissions, and would likely have fewer (and less severe) collisions. As such, it is recommended that an engineering study be completed to determine if adequate land is available for the construction of a roundabout at the study intersection.