Traffic Impact Study SR 8 and DeBence Dr / Polk Cut-Off Final Report

Sandycreek Township, PA 06.15.2016



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Project Description and Purpose

The purpose of this study is to perform a Traffic Impact Study (TIS) for the intersection SR 8 (Pittsburgh Road) and Polk Cut-Off (SR 3024) / DeBence Drive. Operations of this intersection could be impacted by Oil Region Alliance (ORA) further developing the Sandycreek Industrial Park, located on DeBence Drive, over the next five years. The intersection will be studied under base 2016 conditions and future 2021 conditions (with and without development). Whitman, Requardt & Associates (WRA) will develop and analyze three alternatives under this study to mitigate potential traffic impacts.

Location and Study Area

The study intersection of SR 8 and Polk Cut-Off / DeBence Drive is located in Sandycreek Township, Venango County, Pennsylvania. The intersection currently operates as two-way stop controlled intersection with SR 8 unrestricted. SR 8 is a state route designated with a Rural – Other Principal Arterial (Regional Arterial typology) distinction and is a four lane undivided highway posted at 50 mph. Just south of this intersection, SR 8 is a limited access, four-lane, divided highway posted at 65 mph. The city of Franklin, PA is approximately 4 miles north of this intersection. Polk Cut-Off is a state route designated with a rural collector distinction (Neighborhood Collector) and is a two lane highway posted at 45 mph. There are Pennsylvania State Game Lands located along Polk Cut-Off and also provides a direct access to US 62 and to Polk, PA. DeBence Drive is a township road that primarily serves industrial land uses and is unposted speed limit (assumed 35 mph). The terrain in the study area is rolling terrain.



Data Collection, Field Studies, and Observations

Data Collection

Turning Movement Counts (TMC) were conducted for 12 hours on March 22, 2016 between 7:30 AM and 7:30 PM. Passenger Cars, Buses, Trucks, and Pedestrians were counted during this duration. In terms of this study, three peak hour periods were selected to establish a baseline conditions and to analyze future alternatives. The three peaks are the following:

- AM Peak Hour 7:30 -8:30 AM
- Mid-day Peak Hour 2:30-3:30 PM
- PM Peak Hour 4:00-5:00 PM

There is no pedestrian activity at this intersection. Refer to Figure 1 and Appendix A for 2016 Existing Volumes.



Figure 1: Base Year 2016 Volumes

Speed Study

WRA performed speed studies along SR 8 during the AM and PM peak periods. A speed study was performed utilizing a radar speed gun to collect at least 85 vehicles' speeds in each direction during the peak hour. The results showed different driver behaviors during the two peak periods. Refer to Appendix B for speed study. Drivers were less aggressive and drove close to the speed limit during the AM peak period. During the AM Peak, 5% (northbound) and 14% (southbound) of the recorded drivers were driving in excess of the posted 50 mph speed limit. During the PM Peak, 23% (northbound) and 47% (southbound) of the recorded drivers were speeding. Based on the PM peak data, the 85th percentile speed was 52 mph northbound and 54 mph southbound. This means that the consensus of the commuters drive a few mph above the speed limit during the PM Peak Hour, the heaviest traffic volume hour.

Gap Study

WRA performed gap studies along SR 8 during the three peak periods. A gap study determines the available gaps in traffic passing Polk Cut-Off and DeBence Drive. A gap is defined as the time elapsed from when one car passes a point in the roadway until the time another car passes that same point. For a driver to turn left onto a four lane undivided highway with this grade profile, a passenger car requires 8.0 seconds of gap, a combination truck requires 12.2 seconds of gap. A driver would require this gap or void of traffic in all four lanes to turn left onto SR 8. Figure 2 shows the number of gaps during the peak hour and then how many of gaps are acceptable, greater than 8.0 and 12.2 seconds for a car and truck respectively. Refer to Appendix C for gap study.



Figure 2: Number of Gaps

Of the recorded gaps, approximately 35-45% gap occurrences are acceptable for cars, and only approximately 20-30% acceptable for trucks. Unacceptable gaps may have more occurrence, but this does not necessarily indicate a gap problem at this intersection. The time consumed by unacceptable gaps are less than acceptable gaps due to the time duration for each classification. For example, three "unacceptable" gaps of 3 seconds each is the same amount of time as one "acceptable" 9 second gap. Since an unacceptable gap occurrence in a car is anywhere from 0-8 seconds, for this intersection, cars have approximately 70-80% of a given peak hour to turn onto SR 8. Similarly since each unacceptable gap occurrence for a truck takes anywhere from 0-12.2 seconds, for this intersection, trucks have approximately 45-70% of a given peak hour to enter SR 8. Figure 3 shows that for majority of the time the peak hours have adequate gaps in traffic. This intersection does not have a gap problem.



Figure 3: Gap Usage

Observations

A few key observations of note at the SR 8 and Polk Cut-Off / DeBence Drive are the following:

• SR 8 Southbound right-turns into Polk Cut-Off appear to complete this turn slower than a typical right turn (9 mph) due to the tight radius and depressed inlet in the corner.



- Tractor Trailers on SR 8 Northbound making right-turns into DeBence Drive by utilizing both lanes of northbound SR 8 to complete the turn. The radius is small and there is a utility pole close to the corner.
- DeBence Drive is predominately industrial traffic or employees of the industrial park.
- Polk Cut-Off is predominately passenger car with occasional school bus traffic. During the Midday peak there was three large school buses following each other.

Crash History

Crash History was collected for study intersection from January 1, 2010 through December 31, 2014. It is important to note that only reportable crashes available in PennDOT's CDART database were reviewed as part of this project. A "reportable crash" is defined by PennDOT's 2014 Pennsylvania Crash Facts & Statistics booklet as "a crash resulting in a death within 30 days of the crash; or injury in any degree, to any person involved; or crashes resulting in damage to any vehicle serious enough to require towing". Based on anecdotal evidence, there may be additional minor, "non-reportable", or unreported crashes that may have occurred. If so, it would be expected that those crashes have or follow characteristics similar to the data that was reviewed.

There were ten reportable crashes in total with three reportable crashes each year during the calendar years of 2010, 2012, and 2014. There were eight angle crashes, one rear-end, and one head-on crash during the five years of crash data. Of the eight angle crashes, six of the vehicles were turning from Polk Cut-Off and two were from DeBence Drive. There were no fatalities or pedestrian crashes, and one major and two moderate crashes during this time frame. Based on a memorial at the intersection, there was a fatality, but not within this time period.

Sight Distance Evaluation

WRA performed sight distance evaluations for both Polk Cut-Off and DeBence Drive approaches. In order for a driver to have appropriate sight distance they must have clear sight lines from the point where they stop to required down/upstream length (see below). This is considered a sight triangle and there must be unobstructed sight lines throughout the whole triangle. Table 1 is the required sight distance for the 85th Percentile Speed and Speed Limit for left and right turns from DeBence Drive or Polk Cut-Off.



Speed	Passenger Car Left Turn	Combination Truck Left Turn	Passenger Car Right Turn	Combination Truck Right Turn	
54 MPH (85 th SB Speed)	635′	970'	560'	890′	
52 MPH (85 th NB Speed)	615′	935'	535′	860'	
50 MPH (Speed Limit)	590'	900'	515′	825′	

Table 1: Required Sight Distance

DeBence Drive – Looking North

From the position and height of a truck stopping and looking for a gap in traffic, a truck driver can see 1,025 feet away (yellow arrow) which meets any of the required distances for a left turn. However as seen below, numerous utility poles, signs, and trees prevents there from being a continuous sight triangle. They may see an approaching vehicle at 1,025 feet, however a vehicle at 200 feet would be obstructed and out of sight. As a truck driver pulls up, these objects will continue to block the sight line but different distance downstream will be blocked. Sight distance is obstructed after 1,025 feet because of the geometry of the road and not necessarily a physical obstruction like a utility pole or tree.



For a passenger car's perspective, which is lower than a truck, the knoll combined with the utility poles and trees restricts sight distance. At the point where a car would typically sit and look for a gap in traffic, they cannot see the required 600-635 feet downstream. Garden Drive which is a little over 500 feet away is not visible.



DeBence Drive – Looking South

From the position and height of a truck stopping and looking for a gap in traffic, a truck driver can see 1,000 feet away (yellow arrow) which meets any of the required distances for a left turn.



From the position a passenger car would stop and look for a gap in traffic, a driver can see at least 900 feet away (yellow arrow) which meets any of the required distances for a left turn.



However, as a driver moves closer to the intersection, the utility pole, memorial, knoll, and mailbox all obstruct the view of the turning vehicle and therefore does not provide a continuous sight triangle.

Polk Cut-Off – Looking North

At the stop bar, which is offset over 25 feet from the edge of SR 8, a temporary business sign obstructs the sight lines. If removed or relocated, adequate sight distance for cars and trucks is met.



Moving closer to the edge of SR 8 or looking with the sign removed, drivers can clearly see the chevron sign, 1,000 feet away.



Polk Cut-Off – Looking South

Drivers sitting at the stop bar can see northbound vehicles over a 1,000 feet, the horizontal curve coming from the freeway section is visible.



SR 8 North and South

The sight obstructions for this corridor are located on the sides of the road and not because of the horizontal or vertical curvature of the roadway. The required sight distance turning left from the mainline is less than turning from the minor approaches. Looking north, drivers can see over 1,000 feet (the chevron).



Looking south, drivers also can see over 1,000 feet well into the horizontal curve coming out of the freeway section of SR 8.



<u>Summary</u>

Besides the temporary sign, Polk Cut-Off has adequate sight distance. DeBence Drive has inadequate sight distance because of trees, utility poles, and knolls in the sight triangles. SR 8 has adequate sight distance for left turning vehicles.

Capacity Analysis and Model Development

Synchro 9 was used to perform the capacity analysis for the intersection for this study. Synchro is a macroscopic capacity analysis program that evaluates the intersection and measures performances based on HCM 2010.

The base model of existing conditions was developed using field inventory data (lane widths, approach grades, speed limits, etc.) collected along the study area. A model was developed for the AM, Midday, and PM peak hour traffic scenarios. Additional information such as traffic volumes and vehicle composition collected were from the TMCs. The model included the defaults for saturation flow rates and headways for rural areas directed by PennDOT Publication 46.

Base Year 2016 Analysis

	AM Peak				Midday Peak			PM Peak		
Approach	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	
NB Left SR 8	8.1	А	1′	8.0	А	1′	8.2	А	2′	
NB SR 8	0.2	А	-	0.4	А	-	0.5	А	-	
SB Left SR 8	8.1	А	3′	8.5	А	1′	9.0	А	1′	
SB SR 8	0.7	А	-	0.4	А	-	0.3	А	-	
EB Polk Cut-Off	14.2	В	20′	15.3	С	27′	15.0	С	20′	
WB DeBence Drive	11.6	В	8'	11.0	В	5′	11.4	В	4′	

Table 2: 2016 Base Year Analysis

(1) The delay and level of service are based on Synchro's HCM 2010 Two-Way Stop Intersection Capacity Analysis Report

(2) The queue lengths are based on Synchro's 95th percentile queue lengths.

All controlled movements at the SR 8 and Polk Cut-Off / DeBence Drive have acceptable Level of Service (LOS), which is a grade D or better. The left turns into the side streets are LOS "A" and DeBence Drive is LOS "B". Polk Cut-Off is a LOS "A" in the AM and borderline LOS "C" in the other two peaks. The cutoff between a LOS "B" and "C" for an unsignalized intersection is 15.0 seconds of delay. Queuing is not a concern as 95th percentile queues for the un-controlled movements are less than 30 feet. Overall the intersection operates acceptably in terms of delay and LOS. Refer to Appendix D for Base Year Results.

Future Volumes

According to PennDOT District 1-0, Sandycreek Township is expected to have a 0.42 % growth over the next five years. ORA has 65 acres of developable land on DeBence Drive zoned for industrial use. However, there are no prospective tenants looking to move or expand into the 65 acres in the foreseeable future. An existing tenant, FedEx Corporation, recently doubled their facility to 43,000 square feet and has no plans for further expansion. Liberty Electronics, a potential tenant, had considered relocating to DeBence Drive in the past few years but currently they do not anticipate moving from their current location. Since there is some interest and the land is ready to develop, WRA assumed that an industrial park similar to the size of FedEx, 40,000 square feet, would come by 2021. Institute of Transportation Engineers' (ITE) 9th Generation of Trip Generation Manual predicts 32 and 34 additional trips in the AM and PM peak respectively for an Industrial Park. Since the ITE Trip Generation Manual does not provide midday trip generation, the Saturday trip generation was used for the midday peak. 14 trips are generated for the midday peak. Figure 4 is with development volume and Figure 5 is 2021 Future Volume with and without development. Refer Appendix A for additional Volume Information.



Figure 4: Development Volume Generation



Figure 5: 2021 Future Year Volumes

Future Year 2021 No-Build Analysis

	AM Peak				Midday Peak			PM Peak		
Approach	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	
NB Left SR 8	8.1	А	1′	8.1	А	1′	8.2	А	2′	
NB SR 8	0.2	А	-	0.4	А	-	0.5	А	-	
SB Left SR 8	8.1	А	3′	8.5	А	1′	9.0	А	1′	
SB SR 8	0.7	А	-	0.4	А	-	0.3	А	-	
EB Polk Cut-Off	14.5	В	20′	15.6	С	29′	15.2	С	21′	
WB DeBence Drive	11.7	В	8′	11.0	В	6′	11.5	В	4'	

Without Development Traffic

Table 3: Future Year 2021 Without Development Traffic Analysis

(1) The delay and level of service are based on Synchro's HCM 2010 Two-Way Stop Intersection Capacity Analysis Report

(2) The queue lengths are based on Synchro's 95th percentile queue lengths.

With the small growth over five years, operations for this intersection has marginal change for all three peak hours. It is estimated that the intersection will operate similar as it does today if there is no development along DeBence Drive.

	AM Peak				Midday Peak			PM Peak		
Approach	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	
NB Left SR 8	8.1	А	1′	8.1	А	1′	8.2	А	2′	
NB SR 8	0.2	А	-	0.4	А	-	0.5	А	-	
SB Left SR 8	8.2	А	6′	8.5	А	2′	9.0	А	2′	
SB SR 8	1.4	А	-	0.4	А	-	0.4	А	-	
EB Polk Cut-Off	15.8	С	25′	16.0	С	31′	15.9	С	24′	
WB DeBence Drive	12.2	В	9′	11.2	В	7′	12.0	В	8′	

With Development Traffic

Table 4: Future Year 2021 With Development Traffic Analysis

(1) The delay and level of service are based on Synchro's HCM 2010 Two-Way Stop Intersection Capacity Analysis Report

(2) The queue lengths are based on Synchro's 95th percentile queue lengths.

The assumed development traffic does not add significant delay to any of the controlled movements. All of the movements still operate with acceptable LOS and the intersection still has no traffic operation issues.

Signal Warrant Analysis

The Manual of Uniform Traffic Control Devices (MUTCD) by the Federal Highway Administration has developed nine separate warrant evaluations to determine if an intersection should be considered for a traffic signal. PennDOT also has two additional signal warrants. Of the eleven signal warrants, five warrant evaluations are applicable for this study intersection. Signal warrants were analyzed using future volumes. Refer to Appendix E for Traffic Signal Warrant Analysis.

Warrant 1, Eight-Hour Vehicular Volume

In order for this warrant to be met, any 8 hours of an average day must satisfy the warrant. Since this intersection is located within an isolated community having less than 10,000 people and speed limit greater than 40 mph on SR 8, a lesser threshold of volume is allowed. This warrant looks at both SR 8 approaches and the higher of the two minor streets, Polk Cut-Off. Of the various conditions and criteria, Warrant 1 does <u>not</u> meet. Only 1 hour of the day satisfies this warrant.

Warrant 2, Four-Hour Vehicular Volume

In order for this warrant to be met, any 4 hours of an average day must satisfy the warrant. Since this intersection is located within an isolated community having less than 10,000 people and speed limit greater than 40 mph on SR 8, a lesser threshold of volume is allowed. This warrant looks at both SR 8 approaches and the higher of the two minor streets, Polk Cut-Off. Of the various conditions and criteria, Warrant 2 does not meet.



Figure 6: Four Hour Warrant

Warrant 3, Peak Hour

In order for this warrant to be met three conditions have to be satisfied during the same hour. Total stopped delay on one stop-controlled minor street approach (one direction only) equals or exceeds 4 vehicle-hours for a one-lane approach (it does <u>not</u>); volume on the same minor street approach (one direction only) equals or exceeds 100 vehicles per hour (it does <u>not</u>); and total entering volume during the hour equals or exceeds 800 vehicles per hour (it does). Just like Warrant 2, there is also a warrant figure that compares the major and minor street flows to determine if the peak hours warrant a traffic signal. Since this intersection is located within an isolated community having less than 10,000 people and speed limit greater than 40 mph on SR 8 a lesser threshold of volume allowed. This warrant looks at both major street approaches and the higher of the two (Polk Cut-Off) minor streets. Of the various conditions and criteria, Warrant 3 does <u>not</u> meet.



Figure 7: Peak Hour Warrant

Warrant 7, Crash Experience

For crash history to warrant a traffic signal, there must be five correctable crashes within in a twelve month period. Of the ten crashes highlighted in the Crash History section, nine (angle and head-on) can be corrected with a signal. Warrant 7 does <u>not</u> meet because the frequency of these types of crashes does not meet the requirements.

Warrant PA-1, ADT Volume

In order for this warrant to be met, ADT volume on SR 8 would need to be greater than 8,400 and either DeBence Drive or Polk Cut-Off needs an ADT of 2,100. Since this intersection is located within an isolated community having less than 10,000 people and speed limit greater than 40 mph on the main road a lesser threshold of volume is allowed (listed above). WRA did not conduct ATR count at this location, however WRA collected TMC counts during the 12 heaviest hours, 7:30 AM to 7:30 PM. SR 8 had less than 6,000 vehicles, DeBence Drive had less than 300 vehicles, and Polk Cut-Off had less than 550 vehicles during that 12 hour period. Based on this data, it is presumed that this Warrant, PA-1 does <u>not</u> meet.

None of the five signal warrants met the requirements for a traffic signal.

Turning Lane Warrant Analysis

PennDOT Publication 46 provides warrants for left and right turn lanes, however the turning lane warrants is only applicable for the free moving movements. Due to the operational analysis and traffic demand on DeBence Drive and Polk Cut-Off, WRA would not recommend any additional lanes on the side streets.

Future volumes with and without the assumed development growth were used to analyze the turning lane warrants. Refer to Appendix F for Turning Lane Warrant Analysis. Turning lane warrant analysis takes the topography, the percentage of trucks, speed, and volume (left/right, advancing, and opposing volume).

The northbound turn lane during the PM peak, with and without development traffic is warranted and therefore it is recommended to include a northbound left turn lane. Refer to Figure 8 and use 4.85% left turns in advancing volume line. Due to the speed of the roadway, a 175 foot storage lane is required.



Figure 8: PM Northbound Left Turn Lane Warrant

The southbound turn lane during the AM peak, with development traffic is warranted and therefore it is recommended to include a southbound left turn lane. Refer to Figure 9 and use the 15% left turns in advancing volume line. Due to the speed of the roadway, a 175 foot storage lane is required.



Figure 9: AM Southbound Left Turn Lane Warrant

Environmental Constraints

WRA performed a preliminary windshield survey of potential environmental constraints within the study area. The windshield survey found these potential constraints:

Utilities

There are overhead and underground utility lines on both sides of SR 8, Polk Cut-Off, and DeBence Drive. The intersection's corners, except for the northwest corner, have a utility pole. Some of the underground utilities are telephone, water (fire hydrants), sanitary sewer, and natural gas. Overhead utilities appear to be electric and telephone.





Culverts, Wetlands, and Drainage

There did not appear to be any roadway culverts along SR 8, Polk Cut-Off, and DeBence Drive. There was a drainage ditch along the north side of DeBence Drive and a man-made pond / wetland in the northeast corner of the study intersection.



In addition to these two water features, there is another drainage ditch about 330 feet north of the intersection on the east side of SR 8.



The east side of SR 8 near the southern limits of the project, there is a ditch that flows under driveways via a large pipes to a creek and eventually to a pond/wetlands. These features are approximately 50 feet from the SR 8's edge of the shoulder.





Along both sides of SR 8, there are large drainage inlets off the road next to the shoulder. Also a couple driveways on the eastern side of SR 8 have large pipes parallel to SR 8.





Build Alternatives

As part of this study, three alternatives were developed and analyzed for the future year, 2021, with and without development traffic. Each alternative builds off of each other and provides additional measures to mitigate the traffic impacts. Refer to Appendix G for Concept Drawings.

Alternative 1 – Remove Sight Obstructions and Improve Intersection Approaches

The intersection today has sight obstructions, especially for the DeBence Drive approach. This alternative will remove/soften the knolls adjacent to the intersection, relocate utility poles, and remove the trees on the northeast corner of the intersection. The turning radius entering Polk Cut-Off and DeBence Drive will be softened to allow vehicles turning into these roads to stay in their lane of traffic and perform the movement within typical right turning speeds. In addition, DeBence Drive has no pavement markings and the lanes are narrow for the truck traffic entering/exiting the industrial parks. DeBence Drive will be widened to provide 12 foot lane widths with lane delineation. Lastly, the inlet that is located in the northwest corner of the intersection will be relocated outside the wheel tracks of right turning vehicles.



Alternative 2 – Alternative 1 + Left Turn Lanes on SR 8

In addition to the improvements identified under Alternative 1, this alternative will include a left turn lane for both Northbound and Southbound directions of traffic on SR 8. The turn lane warrant analysis showed that both directions warranted or nearly warranted a left turn lane, especially if there is continued growth of development traffic on DeBence Drive. Due to the speed of SR 8, a 175 feet storage length is required for both left turn lanes.



Alternative 3 – Alternative 1 & 2 + Traffic Signal Control

This alternative includes the previous two alternatives and converts this intersection from a two-way stop controlled intersection to an uncoordinated, fully actuated traffic signal controlled intersection. As stated earlier, this intersection does not warrant a traffic signal under existing conditions, future growth, or under the assumed development growth along DeBence Drive. The intersection is assumed to have two phase operations and with the improved sight lines, right turns on red permitted. Due to no traffic signals in the proximity of this intersection and with SR 8 posted 65 mph to the south, drivers will need advance notification of this traffic signal. This alternative assumes a LED "Signal Ahead" with flashing beacons mounted over SR 8 via a mast arm on both northbound and southbound approaches of SR 8. Electricity will have to be extended to the south to power the northbound advance warning sign and beacons.

Future Year 2021 Build Analysis

Without Development Traffic

	AM Peak			Midday Peak			PM Peak			
Approach	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	Delay (sec/ veh) ⁽¹⁾	Level of Service ⁽¹⁾	Queue Length (feet) ⁽²⁾	
No-Build										
NB Left SR 8	8.1	А	1′	8.1	А	1′	8.2	А	2′	
NB SR 8	0.2	А	-	0.4	А	-	0.5	А	-	
SB Left SR 8	8.1	А	3′	8.5	А	1′	9.0	А	1′	
SB SR 8	0.7	А	-	0.4	А	-	0.3	А	-	
EB Polk Cut-Off	14.5	В	20′	15.6	С	29′	15.2	С	21′	
WB DeBence Drive	11.7	В	8′	11.0	В	6'	11.5	В	4′	
		Alternati	ve 1: Sight Lir	ne Improvem	nents and Ap	proach Work				
NB Left SR 8	8.1	А	1′	8.1	А	1′	8.2	А	2′	
NB SR 8	0.2	А	-	0.4	А	-	0.5	А	-	
SB Left SR 8	8.1	А	3′	8.5	А	1′	9.0	А	1′	
SB SR 8	0.7	А	-	0.4	А	-	0.3	А	-	
EB Polk Cut-Off	14.5	В	20′	15.6	С	29′	15.2	С	21′	
WB DeBence Drive	11.7	В	8′	11.0	В	6′	11.5	В	4′	
		1	Alterna	tive 2: SR 8 1	Furn Lanes	1		1		
NB Left SR 8	8.1	А	1′	8.1	А	1′	8.2	А	2′	
NB SR 8	0.2	А	-	0.3	А	-	0.4	А	-	
SB Left SR 8	8.1	А	3′	8.5	А	1′	9.0	А	1′	
SB SR 8	0.6	А	-	0.3	А	-	0.2	А	-	
EB Polk Cut-Off	14.4	В	20′	15.5	С	29′	15.2	С	21'	
WB DeBence Drive	11.7	В	8′	11.0	В	6'	11.5	В	4′	
ND L (I			Alternative	e 3: Signalize	d Intersection	n		[
NB Left SR 8	6.1	А	7′	6.5	А	10′	6.4	А	13′	
NB SR 8	5.9	А	47′	5.9	A	52′	5.7	А	54′	
SB Left SR 8	6.4	А	14′	6.3	А	10′	6.1	А	9′	
SB SR 8	5.8	А	42′	6.1	А	55′	5.9	А	58′	
EB Polk Cut-Off	14.2	В	32′	14.6	В	45′	14.5	В	33′	
WB DeBence Drive	14.8	В	20′	14.0	В	18′	13.9	В	7′	

Table 5: Future Year 2021 Without Development Traffic Alternative Analysis

The delay and level of service are based on Synchro's HCM 2010 Two-Way Stop Intersection Capacity Analysis Report
The queue lengths are based on Synchro's 95th percentile queue lengths.

With Development Traffic

	AM Peak			Midday Peak			PM Peak				
Approach	Delay	Level	Queue	Delay	Level	Queue	Delay	Level	Queue		
	(sec/ veh) ⁽¹⁾	01 Service ⁽¹⁾	Length (feet) ⁽²⁾	(sec/ veh) ⁽¹⁾	of Service ⁽¹⁾	Length (feet) ⁽²⁾	(sec/ veh) ⁽¹⁾	01 Service ⁽¹⁾	Length (feet) ⁽²⁾		
No-Build											
NB Left	8.1	А	1′	8.1	А	1′	8.2	А	2′		
NB SP 8	0.2	А	-	0.4	A	-	0.5	А	-		
SB Left	8.2	А	6′	8.5	А	2′	9.0	А	2′		
SB SR 8	1.4	А	-	0.4	А	-	0.4	А	-		
EB Polk Cut-Off	15.8	С	25′	16.0	С	31′	15.9	С	24′		
WB DeBence Drive	12.2	В	9′	11.2	В	7′	12.0	В	8′		
		Alternati	ve 1: Sight Lir	ne Improven	ients and Ap	proach Work		1	-		
NB Left SR 8	8.1	А	1′	8.1	А	1′	8.2	А	2′		
NB SR 8	0.2	А	-	0.4	А	-	0.5	А	-		
SB Left SR 8	8.2	А	6'	8.5	А	2′	9.0	А	2′		
SB SR 8	1.4	А	-	0.4	А	-	0.4	А	-		
EB Polk Cut-Off	15.8	С	25′	16.0	С	31′	15.9	С	24′		
WB DeBence Drive	12.2	В	9′	11.2	В	7′	12.0	В	8′		
	I	1	Alterna	tive 2: SR 8 1	Furn Lanes		I	Γ			
NB Left SR 8	8.1	А	1′	8.1	А	1′	8.2	А	2′		
NB SR 8	0.2	А	-	0.3	А	-	0.4	А	-		
SB Left SR 8	8.2	А	6′	8.5	А	2′	9.0	А	2′		
SB SR 8	1.2	А	-	0.3	А	-	0.3	А	-		
EB Polk Cut-Off	15.7	С	25′	15.9	С	31′	15.8	С	24′		
WB DeBence Drive	12.1	В	9′	11.2	В	7′	12.0	В	8′		
			Alternative	e 3: Signalize	d Intersection	n					
NB Left SR 8	6.2	А	7′	6.6	А	10′	6.7	А	13′		
NB SR 8	6.0	А	47′	6.0	А	52′	6.0	А	55′		
SB Left SR 8	6.7	А	24′	6.4	А	12′	6.4	А	11′		
SB SR 8	6.0	А	43′	6.1	А	56′	6.1	А	58′		
EB Polk Cut-Off	14.2	В	33′	14.5	В	46'	14.2	В	34′		
WB DeBence Drive	14.9	В	21′	14.3	В	21′	14.4	В	18′		

Table 6: Future Year 2021 With Development Traffic Alternative Analysis(1) The delay and level of service are based on Synchro's HCM 2010 Two-Way Stop Intersection Capacity Analysis Report

(2) The queue lengths are based on Synchro's 95th percentile queue lengths.

As shown in the above tables and Appendix H, Alternative 1 does not really provide any operational benefits. The improvements are all safety related benefits. DeBence Drive and Polk Cut-off now have better sight lines and turning radii in and out of them. This alternative provides improvement generally for the side streets.

Alternative 2 provides minor operation improvements as the throughput no longer gets stuck behind a vehicles turning left. This alternative provides improvement for northbound and southbound SR 8 traffic by allowing the queued vehicle(s) turning left to be removed from the flow of traffic going through and reduce the probability of rear end collisions. This alternative, however, adds another lane for exiting side street to account for when turning left. Vehicles will need a larger gap in traffic and therefore additional sight distance. A truck would require 1,025 feet of sight distance. With the sight improvements from Alternative 1, the side streets will have enough sight distance to accommodate this additional lane. The arrow below is pointing to approximately 1,025 feet, which is the end of the fence.



Since Alternate 3 removes the uncontrolled movement for northbound and southbound (though and right), the average delay of these approaches increases from approximately 1 second to 6-7 seconds. Everything else relatively stays in the same range, with a change in delay by 2 or 3 seconds. In the overall picture, the LOS or delay does not change much, but northbound and southbound are now stopping on occasion where under existing and alternative 1 and 2 they are unrestricted.

Cost Estimate and Impacts

Alternative 1 – Remove Sight Obstructions and Improve Intersection Approaches

The total cost for Alternative 1 is \$300,000 with minor Right of Way Impacts. There are utility impacts as overhead lines on the western side of the intersection will need relocated.

Alternative 2 – Alternative 1 + Left Turn Lanes on SR 8

The total cost for Alternative 2 is \$1.3 million with minor Right of Way Impacts. There are utility impacts as overhead lines on the western side of the intersection will need relocated.

Alternative 3 – Alternative 1 & 2 + Traffic Signal Control

The total cost for Alternative 3 is \$1.8 million with minor Right of Way Impacts. This alternative has more utility impacts as electric lines will need to be connected to the traffic signal and advance warning signs/beacons. Additionally the traffic signal will accrue a maintenance and electric cost annually for the township.

Refer to Appendix I for Cost Estimates.

Locally Preferred Alterative

The Locally Preferred Alternative (LPA) is Alternative 1. This alternative provides better turning radii and sight lines out of DeBence Drive and Polk Cut-Off. This intersection does not have a gap or operation problem, however, due to obstructions along the sides of SR 8 there are limited sight lines. Alternative 1 removes these obstructions.

Overall, this alternative makes little improvement to the operations and level of service of the intersection. Alternative 1 should improve the trucks turning into DeBence Drive because the turning radii will be designed for WB-67 trucks. Turning out of DeBence Drive will be easier because there will be clear and continuous sight lines.

The proposed NWRPO 2017 TIP includes a planned study to investigate if SR 8 can go through a road diet. The four lanes on SR 8 would be converted to a three lane section, one lane in each direction with a center turn lane. The LPA would accommodate this road diet if it was a viable option. However, if the study found that SR 8 still required four lanes, Alternative 2 could be incorporated/combined with the LPA.