Intersection Control Evaluation

Stadium Road at Pohl Road

in Mankato, Blue Earth County, Minnesota

Mankato/North Mankato Area Planning Organization

SRF Consulting Group, Inc. | Engineers Planners Designers

October 2016

SRF No. 016 09243

Intersection Control Evaluation

Stadium Road at Pohl Road

Proposed Letting Date: TBD

Report Certification:

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Scott C. Poska — 47068

Print Name — Reg. No.

Signature — 10-31-16

Date

Approved:

City of Mankato — 12-13-16

City Engineer — Date

Blue Earth County — 12-13-2016

Public Works Director — Date

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Introduction

This report contains the intersection control evaluation results for the Stadium Road (CSAH 60) at Pohl Road intersection in Mankato, Blue Earth County, Minnesota (see Figure 1). The purpose of the evaluation was to analyze the intersection control alternatives for the intersection to identify the long-term preferred intersection control. The following intersection control alternatives were considered applicable and are analyzed within this report:

- All-Way Stop Control
- Roundabout Control
- Traffic Signal Control

A mini-roundabout variation was also explored. According to *Mini-Roundabouts Technical Summary* (Federal Highway Administration, 2010), mini-roundabouts are best suited/most efficient in lower speed environments (30 mph or less), and are generally recommended for intersections where the total entering daily traffic volume does not exceed approximately 15,000 vehicles. The intersection currently has 17,700 entering vehicles and Stadium Road has a posted speed of 40 mph. Large vehicles are typically required to over-run the fully traversable central island, and high volumes of large vehicles will significantly reduce the capacity of a mini-roundabout, and may lead to rapid wear of the roadway markings. Based on these factors, the mini-roundabout option was not analyzed further at the study intersection.

A detailed warrants analysis, operational analysis, safety analysis, and planning-level cost analysis were performed to determine the preferred intersection control alternative. In addition to these analyses, other factors considered for this evaluation that were applicable to determining the long-term preferred intersection control included:

- Right-of-Way Considerations
- Transportation System Considerations
- Pedestrian and Bicycle Considerations
- Local Acceptance

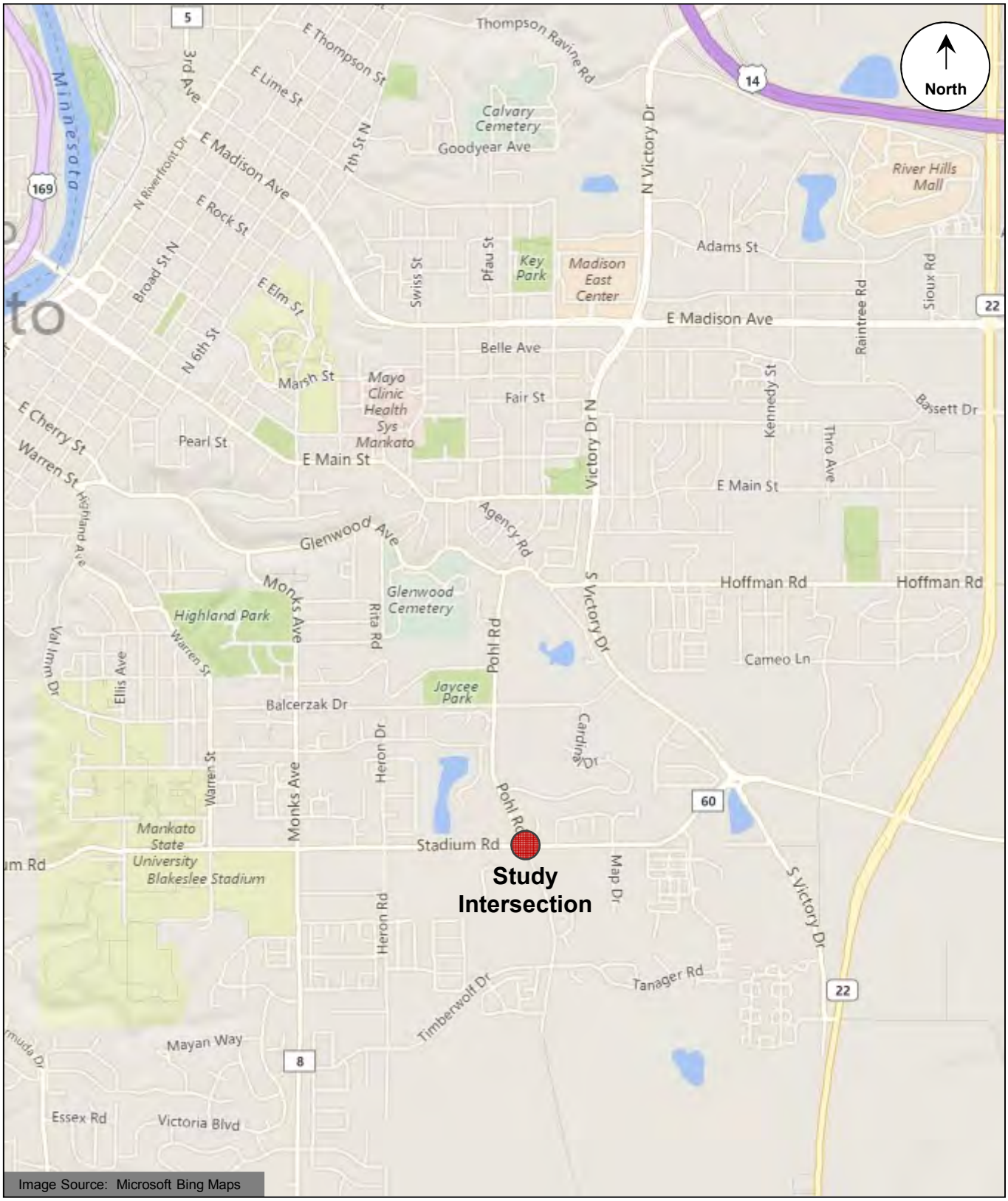

Image Source: Microsoft Bing Maps

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Study Intersection

Intersection Control Evaluation
Stadium Road at Pohl Road

Figure 1

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Existing Intersection Characteristics

Existing Conditions

The study intersection is located in the City of Mankato, Blue Earth County, as shown in Figure 1. Stadium Road (CSAH 60) is a three-lane undivided county road with a speed limit of 40 mph and is functionally classified as a Minor Arterial. Pohl Road was recently restriped from a four-lane to a three-lane undivided roadway. Pohl Road is a city street with a speed limit of 30 mph and is functionally classified as a Major Collector north of Stadium Road and a Local road to the south of Stadium Road. The intersection of Stadium Road and Pohl Road is skewed and is currently all-way stop controlled. There are bicycle and pedestrian accommodations on both sides of Stadium Road and the west side of Pohl Road. There are marked pedestrian crossings that cross Pohl Road on both sides of Stadium Road. The adjacent area has primarily residential land uses with some industrial to the south and east. Minnesota State University is located approximately one mile to the west. The existing lane configurations for the Stadium Road and Pohl Road intersection are listed in Table 1 below and are shown in Figure 2.

Table 1. Existing Conditions

Leg	Configuration
Eastbound Stadium Road	One left-turn lane and one shared thru/right-turn lane
Westbound Stadium Road	One left-turn lane and one shared thru/right-turn lane
Northbound Pohl Road	One left-turn lane and one shared thru/right-turn lane
Southbound Pohl Road	One left-turn lane and one shared thru/right-turn lane

Crash History

Crash data was obtained from the Minnesota Crash Mapping Analysis Tool (MnCMAT) database for a five-year period from 2011 to 2015. There were thirteen recorded crashes at the study intersection during the analysis period. Detailed crash data is provided in the Appendix. This results in a crash rate of 0.40 crashes per million entering vehicles, which is slightly above the statewide average of 0.35 for all-way stop controlled intersections, but is still well below the critical crash rate of 0.54 (0.95 level of confidence) for this intersection.

H:\Projects\09000\9243\CAD_BIM\Graphics\9243 Figure 2 - Existing Conditions.dgn

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Existing Conditions

Intersection Control Evaluation
Stadium Road at Pohl Road

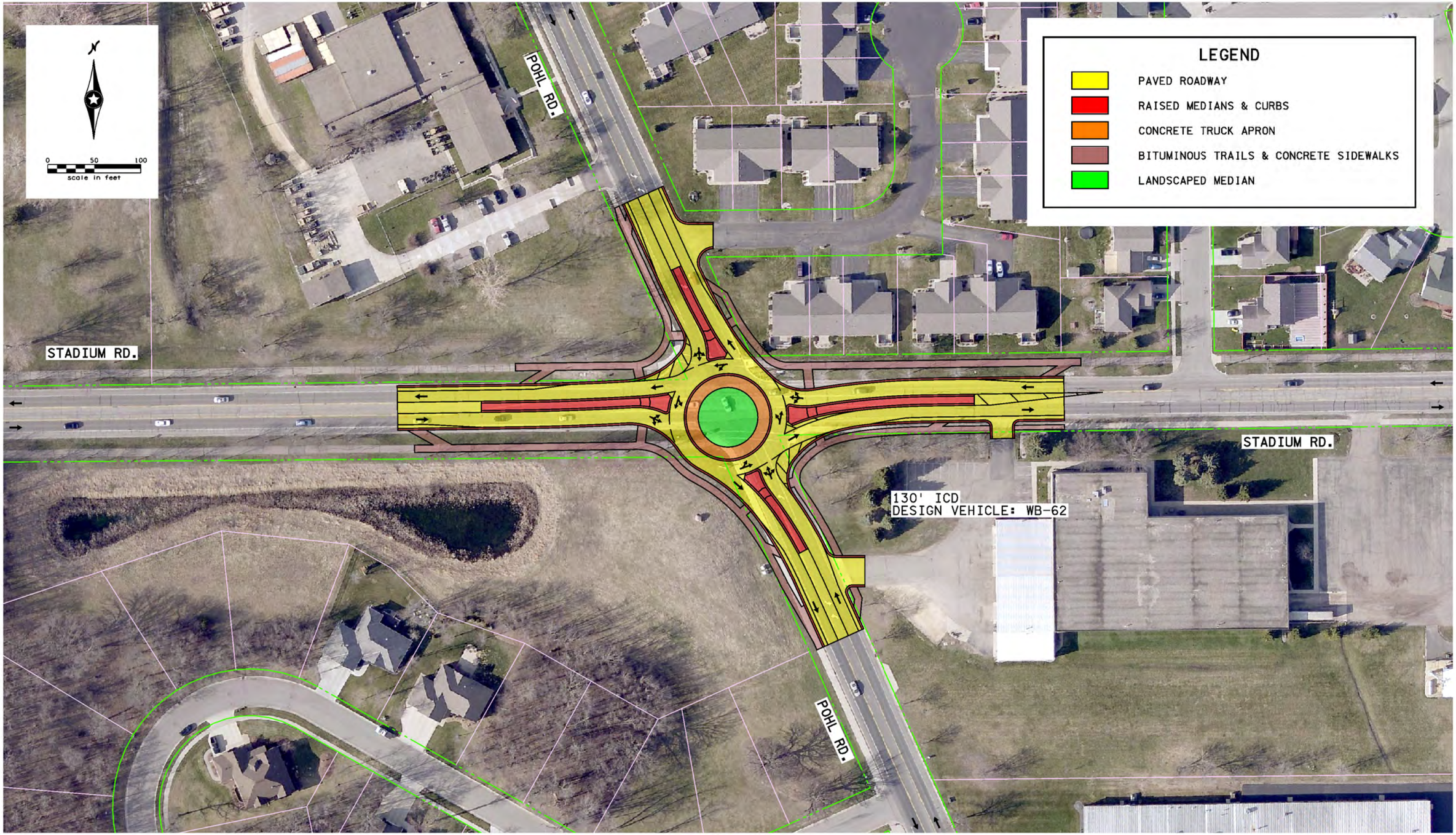
Figure 2

Future Conditions

Based on discussions with city staff in the summer of 2016, no short-term improvements to Stadium Road, Pohl Road, or the study intersection are planned. Future development south of the study intersection will likely necessitate an intersection control change to support traffic growth. For the alternatives analysis, the existing lane configurations under all-way stop control (listed in Table 1 and shown in Figure 2) were assumed to be the same for the traffic signal control alternative. The lane configurations for the roundabout control alternative are listed in Table 2 below and are shown in Figure 3. The roundabout concept shown is offset from the center of the existing intersection to minimize impacts to the property in the northeast quadrant.

Table 2. Proposed Lane Configurations for Roundabout Control Alternative

Leg	Configuration
Eastbound Stadium Road	One shared lane (all movements)
Westbound Stadium Road	One shared lane (all movements)
Northbound Pohl Road	One shared lane (all movements)
Southbound Pohl Road	One shared lane (all movements)



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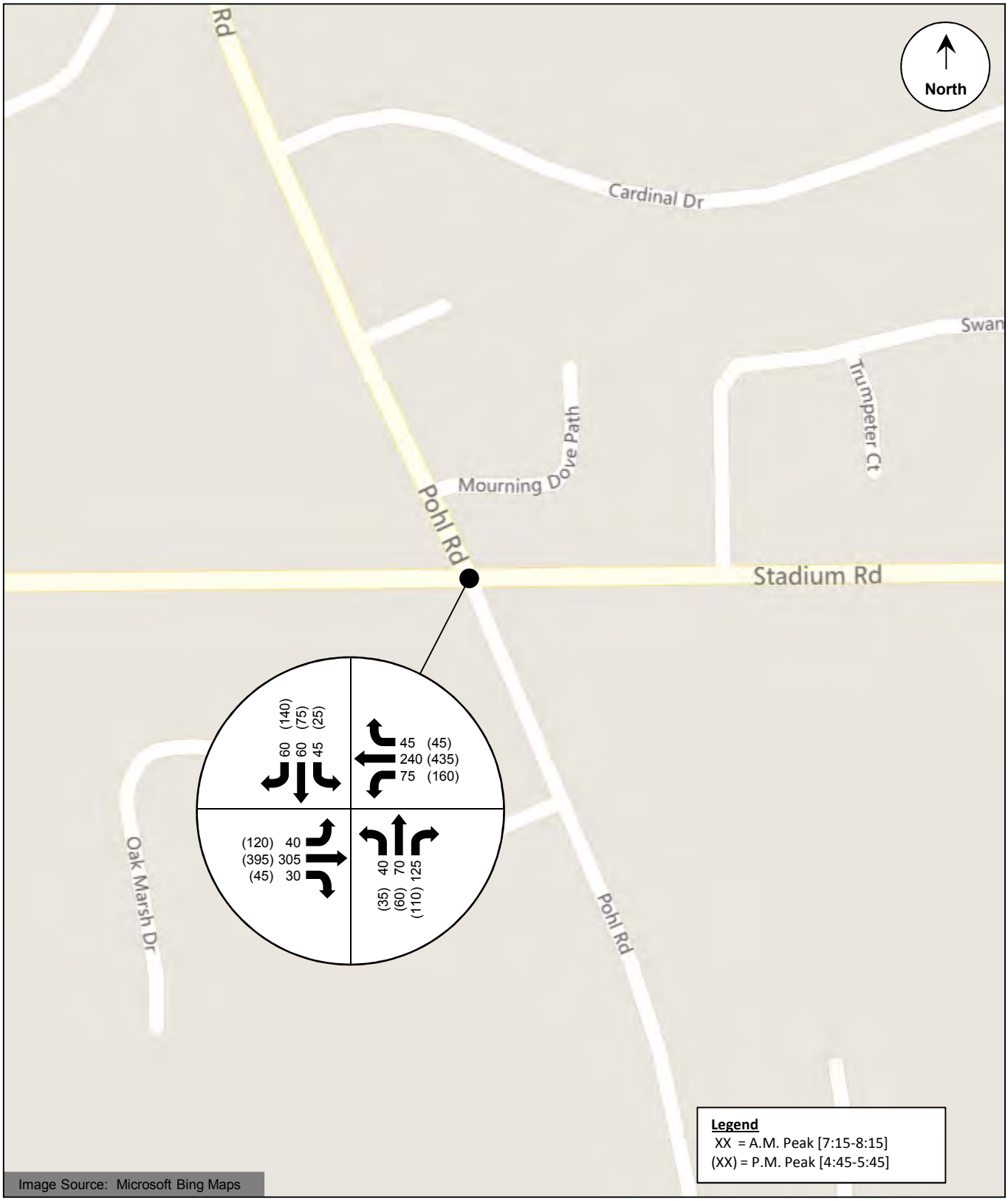
Roundabout Control Alternative

Intersection Control Evaluation
Stadium Road at Pohl Road

Figure 3

Traffic Volumes

Hourly traffic volumes including the existing a.m. and p.m. peak hour were collected in early May 2016 by the City of Mankato prior to the conclusions of the spring term at Minnesota State University and are shown in Figure 4. Pedestrian and bicycle volumes were also collected. Growth rates from the MAPO 2045 Transportation Plan (1.6% for the north leg, 1.3% for the east leg, 2.5% for the south leg, and 1.0% for the west leg) were used to determine Forecasted Year 2036 peak hour turning movement volumes, which are shown in Figure 5.



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Existing Year 2016 Volumes

Figure 4

Intersection Control Evaluation
Stadium Road at Pohl Road

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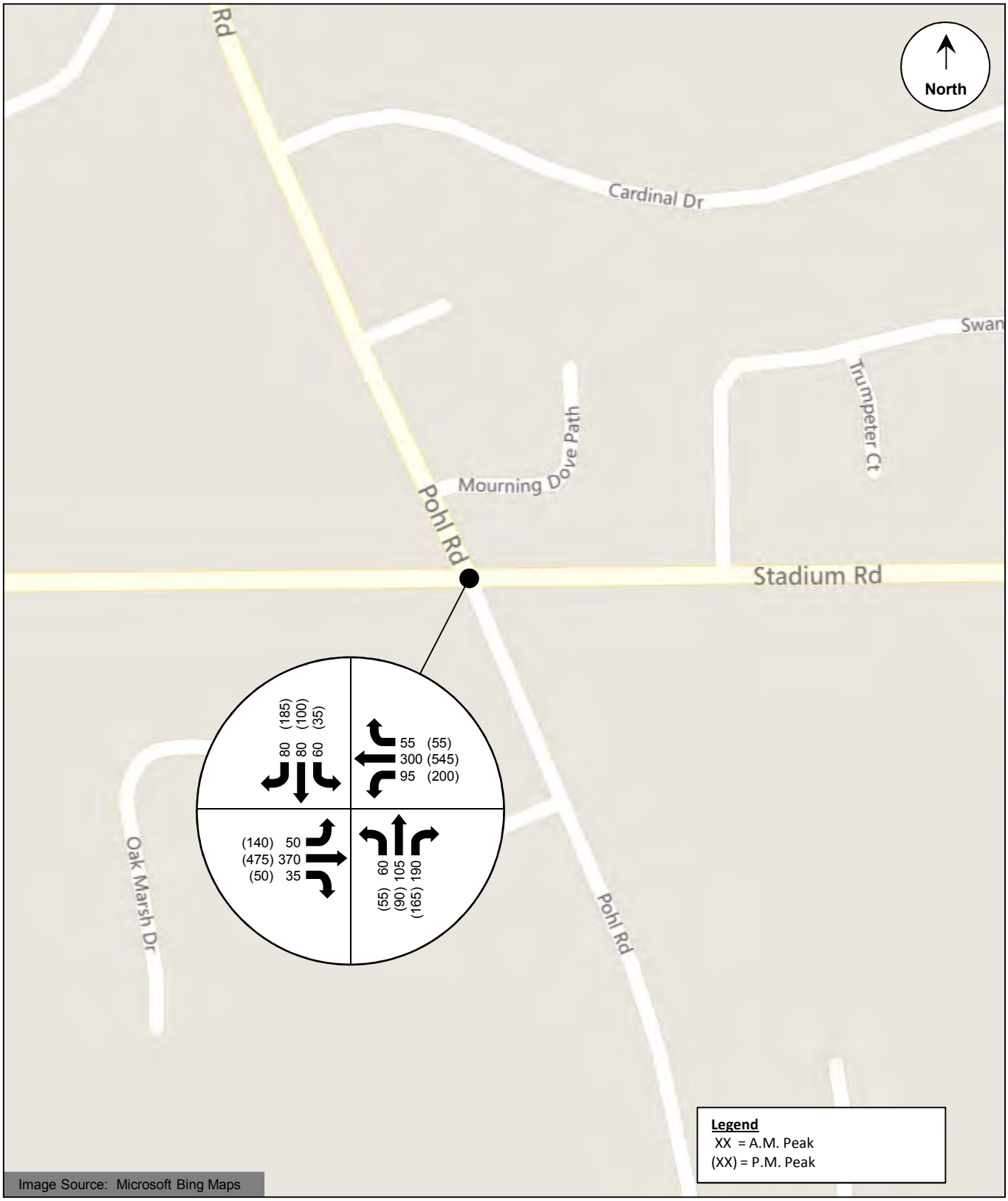

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Forecasted Year 2036 Volumes

Figure 5

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Stadium Road at Pohl Road

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Analysis of Alternatives

The analysis of the all-way stop control, traffic signal control, and roundabout control alternatives included a warrants analysis, operational analysis, planning-level crash analysis, and a planning-level cost analysis. Existing Year 2016 and Forecasted Year 2036 volumes with proposed lane configurations discussed previously were used for the analysis.

Warrants Analysis

A warrants analysis was performed for the traffic signal control alternative as outlined in the February 2015 *Minnesota Manual on Uniform Traffic Control Devices* (MN MUTCD). The signal warrants analysis was based on the assumptions shown in Table 3.

Table 3. Warrants Analysis Assumptions

Leg	Geometry	Speed
Eastbound Mainline (Stadium Road)	2 or more approach lanes	40 mph
Westbound Mainline (Stadium Road)	2 or more approach lanes	40 mph
Northbound Minor Street (Pohl Road)	2 or more approach lanes	30 mph
Southbound Minor Street (Pohl Road)	2 or more approach lanes	30 mph

Because of the shared northbound and southbound thru/right-turn lanes, minor approach right turns were included in the analysis. Table 4 provides a summary of the results of the warrants analysis. The detailed warrants analysis can be found in the Appendix.

Table 4. Warrants Analysis Results

MN MUTCD Warrant	Hours Required	Year 2016 Volumes		Forecasted Year 2036 Volumes	
		Hours Met	Warrant Met	Hours Met	Warrant Met
Warrant 1A: Minimum Vehicular Volume	8	3	No	10	Yes
Warrant 1B: Interruption of Continuous Traffic	8	4	No	8	Yes
Warrant 1C: Combination of Warrants	8	9	Yes	11	Yes
Warrant 2: Four-Hour Volume	4	2	No	9	Yes
Warrant 3B: Peak-Hour Volume	1	0	No	2	Yes
Multi-way Stop Applications Condition C	8	14	Yes	15	Yes

Warrants 4-9 were investigated but were determined to be not applicable. Results of the warrants analysis indicate that Existing Year 2016 volumes satisfy the MN MUTCD warrant requirements for traffic signal Warrant 1 (Condition C), while Forecasted Year 2036 volumes satisfy the MN MUTCD warrant requirements for traffic signal Warrants 1 (Conditions A, B, and C), 2, and 3B.

Operational Analysis

An initial planning-level analysis was performed for the roundabout control alternative based on Highway Capacity Manual methods found in *NCHRP Report 672 Roundabouts: An Informational Guide, Second Edition* (Transportation Research Board, 2010). The analysis involved testing the theoretical capacity of a single-lane roundabout against the Forecasted Year 2036 entering and circulating volumes. As shown in Chart 1, the Forecasted Year 2036 volumes do not exceed the theoretical capacity of a single-lane roundabout. Therefore, a single lane roundabout was selected for further analysis.

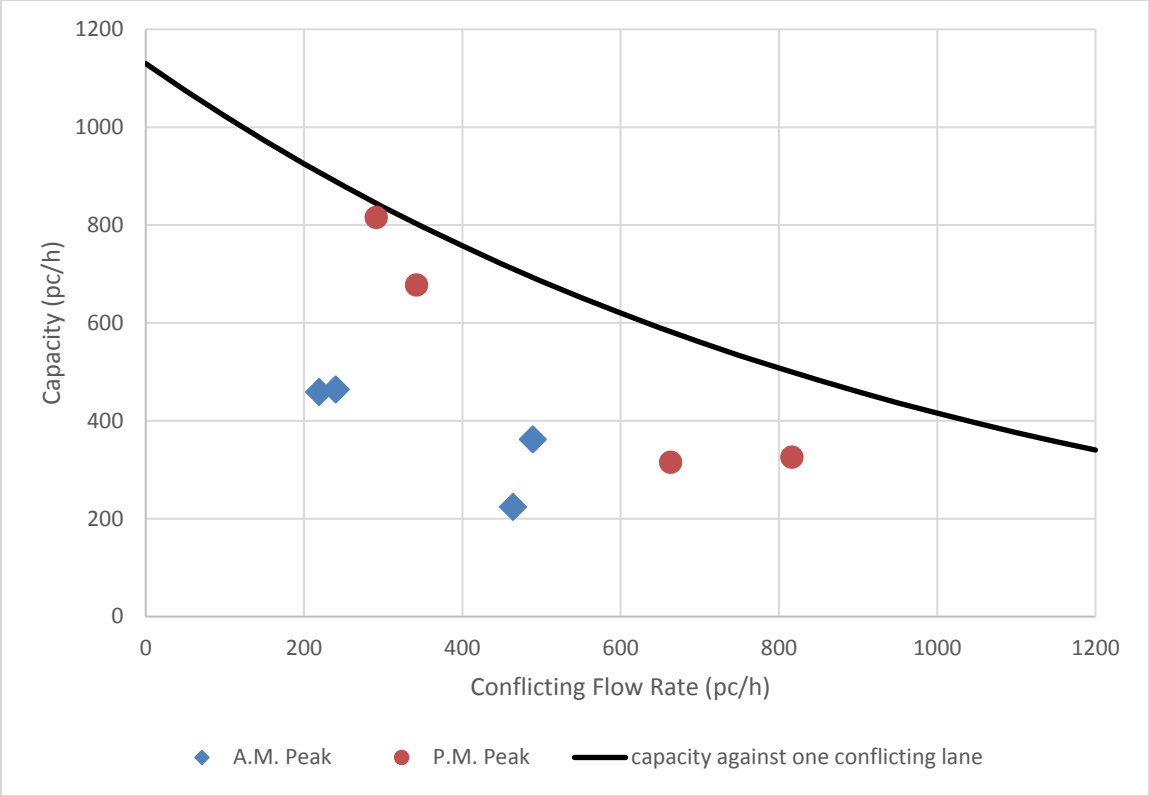


Chart 1. Single-Lane Roundabout Entry Lane Capacity (Forecasted Year 2036 volumes)

Operational analysis of the roundabout control alternative was performed using RODEL and Highway Capacity Software (HCS). RODEL is a software program that is based on existing roundabout operational research and uses an empirical formula method to determine roundabout delay based on geometric features and traffic flows. RODEL is the current MnDOT accepted analysis tool for evaluating roundabouts. HCS is based on methodologies found in the 2010 Highway Capacity Manual (HCM) which is considered a conservative approach to determining the capacity of a roundabout. It is important to note that RODEL and HCS only report "stop" or "control" delay. Therefore, in order to determine the total delay, "geometric" delay, or delay due to vehicle deceleration and acceleration through an intersection, must be added to the "stop" or "control" delay.

The detailed operational analysis of all-way stop control and traffic signal control was performed using methods outlined in the 2010 HCM using Synchro/SimTraffic. Synchro/SimTraffic is capable of calculating various measures of effectiveness such as control delay, queuing, and total travel time impacts. SimTraffic results are reported for the analysis.

The operational analysis identified a Level of Service (LOS), which indicates how well an intersection is operating based on average delay per vehicle. Intersections are given a ranking from LOS A to LOS F. LOS A indicates the best traffic operation and LOS F indicates an intersection where demand exceeds capacity. LOS A through LOS D are generally considered acceptable. RODEL results for a Confidence Level (CL) of 50% and 85% were determined.

50% CL results are typically used for roundabout analysis while the 85% CL results indicate the sensitivity of the roundabout design. When a substantial degradation in LOS is expected from 50% CL to 85% CL, designers should exercise caution in the design of the roundabout to ensure adequate capacity is provided.

Tables 5 and 6 provide a summary of the operational analysis for Existing Year 2016 and Forecasted Year 2036 conditions, respectively. Detailed operational analysis results can be found in the Appendix.

Table 5. Existing Year 2016 Operational Analysis Results

Alternative	Analysis Tool		A.M. Peak		P.M. Peak	
			Delay (1) (sec/veh)	LOS	Delay (1) (sec/veh)	LOS
All-Way Stop Control	Synchro/SimTraffic		5/7	A/A	12/15	B/B
Traffic Signal Control	Synchro/SimTraffic		7/9	A/A	12/13	B/B
Roundabout Control	HCS 2010		9/9	A/A	15/17	B/C
	RODEL	50% CL	5/5	A/A	7/8	A/A
		85% CL	7/7	A/A	13/17	B/C

(1) Control/stop delay is reported. Overall results are followed by the worst approach results.

Table 6. Forecasted Year 2036 Operational Analysis Results

Alternative	Analysis Tool		A.M. Peak		P.M. Peak	
			Delay (1) (sec/veh)	LOS	Delay (1) (sec/veh)	LOS
All-Way Stop Control	Synchro/SimTraffic		14/26	B/D	**>100/>100**	**F/F**
Traffic Signal Control	Synchro/SimTraffic		9/10	A/B	20/22	C/C
Roundabout Control	HCS 2010		11/14	B/B	32/**46**	D/**E**
	RODEL	50% CL	6/6	A/A	12/17	B/C
		85% CL	9/10	A/A	**49/93**	**E/F**

(1) Control/stop delay is reported. Overall results are followed by the worst approach results.

Results of the operational analysis indicate that under the existing all-way stop control, the intersection operates with an acceptable level of service. However, by Forecasted Year 2036, the all-way stop control alternative would operate with an unacceptable level of service during the p.m. peak. Therefore the all-way stop control alternative was not considered further as a viable long-term alternative. The traffic signal control and roundabout control alternatives would operate with acceptable levels of service under forecasted conditions, though the single lane roundabout control alternative would be near capacity during the p.m. peak. The p.m. peak hour factor is 0.95, which indicates this peak hour volume is sustained over the entire peak hour.

Safety Analysis

A crash analysis was performed to determine the projected crashes per year for Year 2016 and Forecasted Year 2036 conditions for the study intersection. Crash rates from the MnDOT Green Sheets (2011 to 2015 data) were used for the crash analysis of the alternatives. According to *NCHRP Report 672 Roundabouts: An Informational Guide, Second Edition* (Transportation Research Board, 2010), the conversion of an all-way stop controlled intersection to a roundabout has an insignificant impact on safety. Therefore, the crash rate for all-way stop control was used for the roundabout control alternative. A summary of the crash analysis is shown in Table 7.

Table 7. Crash Analysis Results

Alternative	Intersection AADT (2016)	Intersection AADT (2036)	Crash Rate	Projected Crashes/Year (2016)	Projected Crashes/Year (2036)
Traffic Signal Control	17,700	22,700	0.52	4	5
Roundabout Control			0.35	2	3

Based on the results of the crash analysis, the roundabout control alternative is anticipated to have slightly less crashes than the traffic signal control alternative.

Studies have determined that the installation of a roundabout can improve overall safety of an intersection when compared to other forms of intersection control. Roundabouts typically have fewer conflict points than conventional intersections and the geometry of a roundabout induces lower speeds for vehicles approaching and traversing an intersection. With lower speeds, the severity of the crashes is decreased. A roundabout virtually eliminates right-angle and left-turn head-on crashes. Studies have shown the frequency of injury crashes is reduced more than property damage only crashes.

At a roundabout, drivers must be aware of traffic traveling around the circle when merging on or off the roundabout. Conversely, drivers at a traditional intersection must be aware of vehicles at all approaches and the movements they are making. This issue is most prevalent at stop-controlled intersections where there is not a traffic signal to control vehicle movements.

Planning-Level Cost Analysis

Capital Costs

The traffic signal control alternative can utilize the existing geometric conditions, therefore the cost for this alternative would only be the cost of installing a traffic signal system, along with ADA improvements. The roundabout control alternative would require substantial reconstruction at and leading up to the intersection, which results in a much higher cost than the traffic signal control alternative.

Operation and Maintenance Costs

Traffic signals typically have higher operation and maintenance costs than roundabouts because of the electricity required to operate the signal and routine maintenance required to keep the signal in operation. Operation and maintenance costs associated with a roundabout can vary depending on the amount of illumination required or landscaping alternatives used for the center island.

A cost analysis summary is shown in Table 8. Detailed cost analysis results can be found in the Appendix.

Table 8. Cost Analysis Summary

Alternative	Capital Costs (1)	Operation/Maintenance Costs (annual)
Traffic Signal Control	$300,000	$4,000-$6,000
Roundabout Control	$1,130,000	$500-$1,000

(1) Does not include engineering or right-of-way costs.

Alternatives Assessment

Right-of-Way Considerations

The intersection geometry for the traffic signal control alternative would use existing conditions and therefore no additional right-of-way would be expected. Construction of a roundabout at the study intersection would require additional right-of-way in all four quadrants of the intersection. As previously stated, the roundabout was designed off center to avoid impacts to the property in the northeast quadrant. Therefore, right-of-way impacts in the other three quadrants are more significant, but do not require building acquisition.

Transportation System Considerations

There are three existing traffic signals two-thirds of a mile west of the study intersection at Monks Avenue, Warren Street, and Ellis Avenue. These three traffic signals are at the Minnesota State University campus and are spaced a quarter mile apart. The traffic signal control alternative would extend the continuity of this intersection control type to the west, however, it would likely not operate in coordination with the three signals to the west. There is an existing roundabout two-thirds of a mile east of the study intersection at the Stadium Road and Victory Drive intersection. The roundabout control alternative would match with the intersection control to the east. The roundabout control alternative could be considered a traffic calming measure for the surrounding residential area.

Pedestrian and Bicycle Considerations

As previously mentioned, there are trails/sidewalks on both sides of Stadium Road and the west side of Pohl Road. Both Stadium Road and Pohl Road also have shoulders that can be utilized as bike lanes. Pedestrian accommodations can be provided regardless of selected intersection control. The design of a roundabout allows pedestrians to cross one direction of traffic at a time with a refuge space in the middle of each leg of the roundabout, and these short crossing distances and reduced travel speeds of traffic improve pedestrian safety. Their route is slightly longer since they are kept to the outside of the inscribed circle. The roundabout concept design shown includes slip ramps to transition bicyclists between on-street bike lanes and multi-use trails around the perimeter of the roundabout. The design of signalized intersections can create a safe environment for pedestrian crossings with the use of pedestrian signal phasing. This phasing allows pedestrians to safely cross an intersection while vehicular movements are served. Although signalized intersections can provide indications showing pedestrian right-of-way, potential conflicts can come from red-light running through vehicles and permissive turning traffic.

Local Acceptance

Drivers are familiar with traveling through signalized intersections since there are many intersections in the area under this type of traffic control. Drivers are also familiar with traveling through roundabout controlled intersections since there are many existing roundabouts throughout the Mankato area including one two-thirds of a mile east at Stadium Road and Victory Drive.

Conclusions and Recommendations

The following conclusions are provided for this intersection control evaluation for the Stadium Road at Pohl Road intersection in Mankato, Blue Earth County, Minnesota:

- *Warrants Analysis*
  Results of the warrants analysis indicate that Existing Year 2016 volumes satisfy the MN MUTCD warrant requirements for traffic signal Warrant 1 (Condition C), while Forecasted Year 2036 volumes satisfy the MN MUTCD warrant requirements for traffic signal Warrants 1 (Conditions A, B, and C), 2, and 3B.

- *Operational Analysis*
  Results of the operational analysis indicate that all-way stop is not a viable alternative long-term. Both the traffic signal control and roundabout control alternatives would operate with acceptable levels of service under forecasted conditions, but the roundabout control alternative would be near capacity during the p.m. peak.

- *Safety Analysis*
  Based on the results of the crash analysis, the roundabout control alternative is anticipated to have slightly less crashes than the traffic signal control alternative. Roundabouts typically have fewer conflict points than conventional intersections and the geometry of a roundabout induces lower speeds for vehicles approaching and traversing an intersection. With lower speeds, the severity of the crashes is decreased.

- *Planning-Level Cost Analysis*
  The traffic signal control alternative can utilize the existing geometric conditions, therefore the cost for this alternative would only be the cost of installing a traffic signal system, along with ADA improvements, which would be approximately $300,000. The roundabout control alternative would require substantial reconstruction at and leading up to the intersection, which results in a much higher cost estimate of approximately $1,130,000. Traffic signals typically have higher operation and maintenance costs because of the electricity required to operate the signal and routine maintenance required to keep the signal in operation. Operation and maintenance costs associated with a roundabout can vary depending on the amount of illumination required or landscaping alternatives used for the center island.

- *Right-of-Way Considerations*
  The intersection geometry for the traffic signal control alternative would use existing conditions and therefore no additional right-of-way would be expected. Construction of a roundabout at the study intersection would require additional right-of-way in all four quadrants of the intersection. The roundabout was designed off center to avoid impacts to the property in the northeast quadrant. Therefore, right-of-way impacts in the other three quadrants are more significant, but do not require building acquisition. The roundabout control alternative could be considered a traffic calming measure for the surrounding residential area.

- *Transportation System Considerations*
  There are three existing traffic signals at Minnesota State University two-thirds of a mile west of the study intersection. The traffic signal control alternative would extend the continuity of this intersection control to the west, however, it would likely not operate in coordinate with the three signals to the west. There is an existing roundabout two-thirds of a mile east of the study intersection at the Stadium Road and Victory Drive intersection. The roundabout control alternative would match with the intersection control to the east through the residential area.

- *Pedestrian and Bicycle Considerations*
  The design of signalized intersections can take pedestrian crossings and safety into consideration with the use of pedestrian signal phasing. The design of a roundabout allows pedestrians to cross one direction of traffic at a time on each leg of the roundabout. Their route is slightly longer since they are kept to the outside of the inscribed circle.

- *Local Acceptance*
  Drivers are familiar with traveling through signalized intersections since there are many intersections in the area under this type of traffic control. Drivers are also familiar with traveling through roundabout controlled intersections since there are many existing roundabouts throughout the Mankato area including one two-thirds of a mile east at Stadium Road and Victory Drive.

A decision matrix was developed to help evaluate the key factors and is provided on the following page. Based on the results of this Intersection Control Evaluation, both the traffic signal control and roundabout control alternatives are viable options for the Stadium Road at Pohl Road intersection. A roundabout would have more capital and right-of-way costs, but would have lower annual operation and maintenance costs. The traffic signal control and roundabout control alternatives have comparable operations near-term and during the forecasted a.m. peak, but the roundabout control alternative would be near capacity during the p.m. peak under forecasted conditions. However, compared to a traffic signal, a roundabout would have more consistent off-peak operations throughout the day when traffic volumes are lower. Therefore, the roundabout control alternative is recommended.

Alternatives Decision Matrix: Stadium Road at Pohl Road

Factor		All-Way Stop Control	Traffic Signal Control	Roundabout Control	Recommended Alternative(s) Based on Factor
Warrants Analysis	2016	• AWSC warrant met	• Existing Year 2016 volumes meet traffic signal control warrants	N/A	All-Way Stop Control Traffic Signal Control Roundabout Control
	2036	• AWSC warrant met	• Forecasted Year 2036 volumes meet traffic signal control warrants	N/A	All-Way Stop Control Traffic Signal Control Roundabout Control
Operational Analysis	2016	• Acceptable LOS	• Acceptable LOS	• Acceptable LOS • Consistent off-peak operations	Traffic Signal Control Roundabout Control
	2036	• Unacceptable p.m. peak LOS with Forecasted Year 2036 volumes	• Acceptable LOS	• Near capacity during the p.m. peak under forecasted conditions	
Safety Analysis	Pro(s):	N/A	• Signal indications show vehicle right-of-way	• Least number of crashes expected • Lower vehicle speeds through intersection	Roundabout Control
	Con(s):	N/A	• Slightly more crashes expected than roundabout	• Drivers select acceptable gaps	
Cost Analysis	Pro(s):	N/A	• Lower capital costs ($300,000) than roundabout control	• Lower operation/maintenance costs than traffic signal control	Traffic Signal Control
	Con(s):	N/A	• Higher operation/maintenance costs than roundabout control	• Higher capital costs ($1,130,000) than traffic signal control • Requires substantial reconstruction	
Right-of-Way	Pro(s):	N/A	• No ROW impacts	none	Traffic Signal Control
	Con(s):	N/A	none	• Requires additional ROW in all four quadrants	
Transportation System Considerations	Pro(s):	N/A	• Provides control continuity along Stadium Road to the west	• Provides control continuity along Stadium Road to the east	Traffic Signal Control Roundabout Control
	Con(s):	N/A	• Would likely not operate in coordination with other signals	none	
Pedestrian and Bicycle Considerations	Pro(s):	N/A	• Pedestrian pushbuttons and signal phasing	• Pedestrian Refuge islands • Bike slip ramps • Lower vehicle speeds thru intersection	Traffic Signal Control Roundabout Control
	Con(s):	N/A	• Pedestrian signal phasing can lead to a false sense of security	• Longer route • No pedestrian phase	
Local Acceptance	Pro(s):	N/A	• Familiar to drivers	• Familiar to drivers	Traffic Signal Control Roundabout Control
	Con(s):	N/A	none	none	

Appendix

- 2011-2015 Crash History
- Existing Year 2016 Warrants Analysis
- Forecasted Year 2036 Warrants Analysis
- Existing Year 2016 Detailed Operational Analysis
- Forecasted Year 2036 Detailed Operational Analysis
- Detailed Cost Analysis

2011-2015 Crash History

Crash Detail Report

Stadium Road and Pohl Road

Report Version 1.0 March 2010

Crash ID: 112110156 **Date:** 07/30/2011 **Time:** 2156
County: BLUE EARTH **City:** MANKATO

Sys: 05-MSAS
Route: 24200140 000+00.363

Severity: POSSIBLE INJURY
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DARK - STREET LIGHTS ON
Weather 1: CLEAR
Weather 2: CLEAR

First Event: ON ROADWAY
To Junction: 4-LEGGED INTERSECTION
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 40
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	EAST	E	
Veh Act:	STOPPED TRAFFIC	STRAIGHT AHEAD	
Veh Type:	PASSENGER CAR	PASSENGER CAR	
Age:	18	17	
Gender:	M	M	
Cond:	NORMAL	NORMAL	
Cont Fact 1	NO IMPROPER DRIVING	DISTRACTION	
Cont Fact 2	NO IMPROPER DRIVING	FAIL TO YIELD ROW	

Crash ID: 112410226 **Date:** 08/23/2011 **Time:** 0555
County: BLUE EARTH **City:** MANKATO

Sys: 04-CSAH
Route: 07000060 001+00.650

Severity: POSSIBLE INJURY
Road Type: NOT SPECIFIED
Road Char: NOT SPECIFIED
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DARK - STREET LIGHTS ON
Weather 1: CLOUDY
Weather 2: NOT SPECIFIED

First Event: NOT SPECIFIED
To Junction: NOT SPECIFIED
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 40
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	W	MC	
Veh Act:	STRAIGHT AHEAD	00	
Veh Type:	PASSENGER CAR	PASSENGER CAR	
Age:	45	20	
Gender:	M	M	
Cond:	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 1	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 122900077 **Date:** 10/16/2012 **Time:** 0936
County: BLUE EARTH **City:** MANKATO

Sys: 05-MSAS
Route: 24200140 000+00.364

Severity: PROPERTY DAMAGE
Road Type: 4_6 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: WET
Light Cond: DAYLIGHT
Weather 1: CLOUDY
Weather 2: CLOUDY

First Event: ON ROADWAY
To Junction: 4-LEGGED INTERSECTION
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 30
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	S	S	
Veh Act:	RIGHT TURN	RIGHT TURN	
Veh Type:	PASSENGER CAR	PASSENGER CAR	
Age:	42	50	
Gender:	M	M	
Cond:	NORMAL	NORMAL	
Cont Fact 1	IMPROPERLY PARKED	FOLLOWING TOO CLOSELY	
Cont Fact 2	NO IMPROPER DRIVING	NO IMPROPER DRIVING	

Crash ID: 123450082 **Date:** 12/10/2012 **Time:** 0747
County: BLUE EARTH **City:** MANKATO

Sys: 05-MSAS
Route: 24200140 000+00.374

Severity: PROPERTY DAMAGE
Road Type: 4_6 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/SIGN POLE
Surf Cond: ICE/PACKED SNOW
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED

First Event: OFF ROADWAY ON SHOULDER
To Junction: 4-LEGGED INTERSECTION
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 30
Diagram: OTHER
Officer:
Reliability: CONFIDENT
# of Vehicles: 1.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	S		
Veh Act:	STRAIGHT AHEAD		
Veh Type:	PASSENGER CAR		
Age:	46		
Gender:	F		
Cond:	NORMAL		
Cont Fact 1	WEATHER		
Cont Fact 2	SKIDDING		

Crash ID: 132680037 **Date:** 08/23/2013 **Time:** 1500
County: BLUE EARTH **City:** MANKATO

Sys: 04-CSAH
Route: 07000060 001+00.650

Severity: POSSIBLE INJURY
Road Type: NOT SPECIFIED
Road Char: NOT SPECIFIED
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED

First Event: NOT SPECIFIED
To Junction: NOT SPECIFIED
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 40
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	EAST	E	
Veh Act:	STOPPED TRAFFIC	PARKED	
Veh Type:	PASSENGER CAR	SPORT UNTILITY VEHICLE	
Age:	19	18	
Gender:	M	M	
Cond:	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 1	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 132970051 **Date:** 09/22/2013 **Time:** 1740
County: BLUE EARTH **City:** MANKATO

Sys: 04-CSAH
Route: 07000060 001+00.656

Severity: PROPERTY DAMAGE
Road Type: NOT SPECIFIED
Road Char: NOT SPECIFIED
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED

First Event: NOT SPECIFIED
To Junction: NOT SPECIFIED
Traffic Device: STOP SIGN 4-WAY
Speed Limit:
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	W	SE	
Veh Act:	STRAIGHT AHEAD	RIGHT TURN	
Veh Type:	MOTORCYCLE	PASSENGER CAR	
Age:	57	24	
Gender:	M	F	
Cond:	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 1	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 133580083 **Date:** 11/21/2013 **Time:** 1633
County: BLUE EARTH **City:** MANKATO

Sys: 04-CSAH
Route: 07000060 001+00.649

Severity: PROPERTY DAMAGE
Road Type: NOT SPECIFIED
Road Char: NOT SPECIFIED
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: ICE/PACKED SNOW
Light Cond: DAYLIGHT
Weather 1: SNOW
Weather 2: NOT SPECIFIED

First Event: NOT SPECIFIED
To Junction: NOT SPECIFIED
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 40
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	EAST	E	
Veh Act:	STRAIGHT AHEAD	STOPPED TRAFFIC	
Veh Type:	PASSENGER CAR	PASSENGER CAR	
Age:	18	20	
Gender:	M	F	
Cond:	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 1	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 140990204 **Date:** 04/09/2014 **Time:** 2201
County: BLUE EARTH **City:** MANKATO

Sys: 04-CSAH
Route: 07000060 001+00.650

Severity: PROPERTY DAMAGE
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DARK - STREET LIGHTS ON
Weather 1: CLEAR
Weather 2: CLEAR

First Event: ON ROADWAY
To Junction: 4-LEGGED INTERSECTION
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 30
Diagram: RIGHT ANGLE
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	W	SE	
Veh Act:	START TRAFFIC	LEFT TURN	
Veh Type:	PICKUP TRUCK	PICKUP TRUCK	
Age:	30	20	
Gender:	M	M	
Cond:	NORMAL	UNDER THE INFLUENCE	
Cont Fact 1	NOT SPECIFIED	IMPROPER LANE	
Cont Fact 2	NOT SPECIFIED	FAIL TO YIELD ROW	

Crash ID: 141120069 **Date:** 03/20/2014 **Time:** 1613
County: BLUE EARTH **City:** MANKATO

Sys: 05-MSAS
Route: 24200140 000+00.364

Severity: PROPERTY DAMAGE
Road Type: NOT SPECIFIED
Road Char: NOT SPECIFIED
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED

First Event: NOT SPECIFIED
To Junction: NOT SPECIFIED
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 30
Diagram: SIDESWIPE PASSING
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	S	N	
Veh Act:	STRAIGHT AHEAD	LEFT TURN	
Veh Type:	PASSENGER CAR	PASSENGER CAR	
Age:	69	22	
Gender:	F	M	
Cond:	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 1	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 141130108 **Date:** 04/23/2014 **Time:** 1807
County: BLUE EARTH **City:** MANKATO

Sys: 04-CSAH
Route: 07000060 001+00.650

Severity: PROPERTY DAMAGE
Road Type: 2 LANES UNDIV 2_WAY
Road Char: UNKNOWN
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: UNKNOWN
Light Cond: 99
Weather 1: UNKNOWN
Weather 2: NOT SPECIFIED

First Event: ON ROADWAY
To Junction: 4-LEGGED INTERSECTION
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 40
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	W	W	
Veh Act:	STOPPED TRAFFIC	SLOWING TRAFFIC	
Veh Type:	PICKUP TRUCK	PASSENGER CAR	
Age:	26	21	
Gender:	M	M	
Cond:	NORMAL	NORMAL	
Cont Fact 1	NO IMPROPER DRIVING	DISTRACTION	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 152670051 **Date:** 08/25/2015 **Time:** 1602 **Sys:** 04-CSAH
County: BLUE EARTH **City:** MANKATO **Route:** 07000060 001+00.650

Severity: PROPERTY DAMAGE
Road Type: NOT SPECIFIED
Road Char: NOT SPECIFIED
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED
First Event: NOT SPECIFIED
To Junction: NOT SPECIFIED
Traffic Device: STOP SIGN 4-WAY
Speed Limit:
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	MC	MC	
Veh Act:	STOPPED TRAFFIC	PARKED	
Veh Type:	SPORT UNTILITY VEHICLE	PASSENGER CAR	
Age:	44	49	
Gender:	F	F	
Cond:	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 1	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 152710071 **Date:** 08/27/2015 **Time:** 1615 **Sys:** 04-CSAH
County: BLUE EARTH **City:** MANKATO **Route:** 07000060 001+00.649

Severity: PROPERTY DAMAGE
Road Type: NOT SPECIFIED
Road Char: NOT SPECIFIED
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: WET
Light Cond: DARK - STREET LIGHTS OFF
Weather 1: RAIN
Weather 2: NOT SPECIFIED
First Event: NOT SPECIFIED
To Junction: NOT SPECIFIED
Traffic Device: STOP SIGN 4-WAY
Speed Limit: 40
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	EAST	E	
Veh Act:	STOPPED TRAFFIC	STRAIGHT AHEAD	
Veh Type:	SPORT UNTILITY VEHICLE	PASSENGER CAR	
Age:	26	22	
Gender:	M	F	
Cond:	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 1	NOT SPECIFIED	NOT SPECIFIED	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 152740192	**Date:** 10/01/2015	**Time:** 1820	**Sys:** 04-CSAH		
County: BLUE EARTH	**City:** MANKATO		**Route:** 07000060	001+00.650	

Severity:	PROPERTY DAMAGE	**First Event:**	ON ROADWAY
Road Type:	4_6 LANES UNDIV 2_WAY	**To Junction:**	4-LEGGED INTERSECTION
Road Char:	STRAIGHT AND LEVEL	**Traffic Device:**	STOP SIGN 4-WAY
Crash Type:	COLL W/MV IN TRANSPORT	**Speed Limit:**	40
Surf Cond:	DRY	**Diagram:**	OTHER
Light Cond:	DAYLIGHT	**Officer:**	
Weather 1:	CLEAR	**Reliability:**	CONFIDENT
Weather 2:	NOT SPECIFIED	**# of Vehicles:**	3.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	W	N	S
Veh Act:	STRAIGHT AHEAD	STRAIGHT AHEAD	STOPPED TRAFFIC
Veh Type:	PASSENGER CAR	PASSENGER CAR	VAN OR MINIVAN
Age:	19	21	77
Gender:	M	F	M
Cond:	NORMAL	NORMAL	NORMAL
Cont Fact 1	DISREGARD TRAFFIC DEVICE	NO IMPROPER DRIVING	SKIDDING
Cont Fact 2	OTHER VEHICLE DEFECT	NOT SPECIFIED	NOT SPECIFIED

Selection Filter:

WORK AREA: Statewide - FILTER: CRASH_YEAR('2011','2012','2013','2014','2015'), TRAFFIC_CONTROL_DEVICE_CODE('03') - SPATIAL FILTER APPLIED

Analyst:

Luke James

Notes:

Existing Year 2016 Warrants Analysis

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Existing Year 2016

Stadium Road (CSAH 60) at Pohl Road
Intersection Control Evaluation Studies
MAPO

Background Information

		Speed (mph)	Lanes	Approach	
Location :	MAPO	40	2 or more	Major Approach 1:	Eastbound Stadium Road (CSAH 60)
Date:	9/28/2016	40	2 or more	Major Approach 3:	Westbound Stadium Road (CSAH 60)
Analysis Prepared By:	Luke James	30	2 or more	Minor Approach 2:	Northbound Pohl Road
Population Less than 10,000:	No	30	2 or more	Minor Approach 4:	Southbound Pohl Road
Seventy Percent Factor Used:	No				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 600	Warrant Met 900	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 200	Warrant Met 100	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 300	MWSA (C) 200
6 - 7 AM	176	154	330			71	55	71							X	
7 - 8 AM	343	335	678	X		201	164	201	X	X	X		X		X	X
8 - 9 AM	294	271	565			155	134	155		X					X	X
9 - 10 AM	218	308	526			126	106	126		X					X	X
10 - 11 AM	255	262	517			124	115	124		X					X	X
11 - 12 AM	324	319	643	X		163	146	163		X			X		X	X
12 - 1 PM	379	354	733	X		191	156	191		X			X	X	X	X
1 - 2 PM	410	376	786	X		168	151	168		X			X	X	X	X
2 - 3 PM	400	415	815	X		189	190	190		X			X	X	X	X
3 - 4 PM	439	469	908	X	X	177	186	186		X		X	X	X	X	X
4 - 5 PM	515	554	1069	X	X	213	215	215	X	X	X	X	X	X	X	X
5 - 6 PM	517	630	1147	X	X	194	250	250	X	X	X	X	X	X	X	X
6 - 7 PM	415	487	902	X	X	151	177	177		X		X	X	X	X	X
7 - 8 PM	419	400	819	X		122	143	143		X				X	X	X
8 - 9 PM	335	385	720	X		85	125	125		X				X	X	X
9 - 10 PM	228	305	533			69	116	116		X					X	
10 - 11 PM	141	170	311			39	61	61							X	
											3	4	9	9	14	

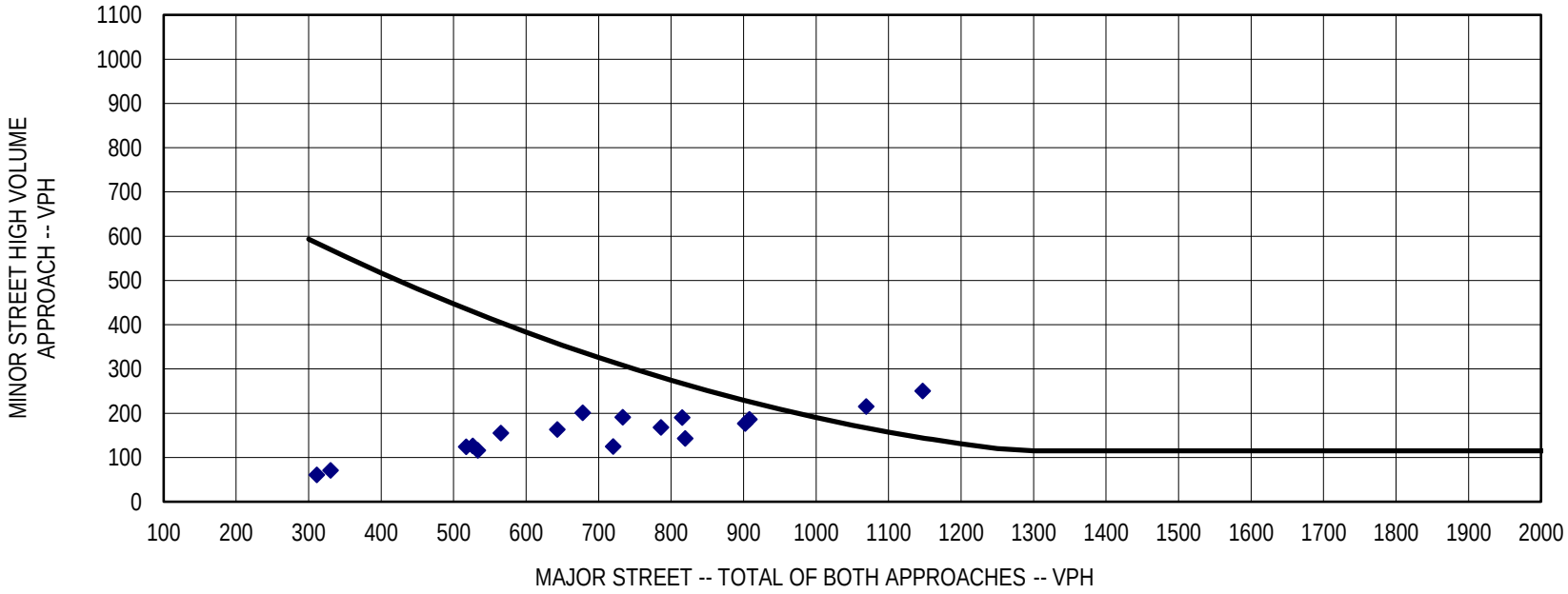
Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	3	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	4	8	Not Met
Warrant 1C:	Combination of Warrants	9	8	Met - Warrant 1C Satisfied
Warrant 2:	Four-Hour Vehicular Volume	2	4	Not Met
Warrant 3B:	Peak Hour	0	1	Not Met
MWSA (C):	Multiway Stop Applications Condition C	14	8	Met - Multiway Stop Applications

Stadium Road (CSAH 60) at Pohl Road
Intersection Control Evaluation Studies
MAPO

Warrants Analysis: Warrant 2

WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME



Number of Hours Satisfying Requirements:	2

Notes: 1. 115 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

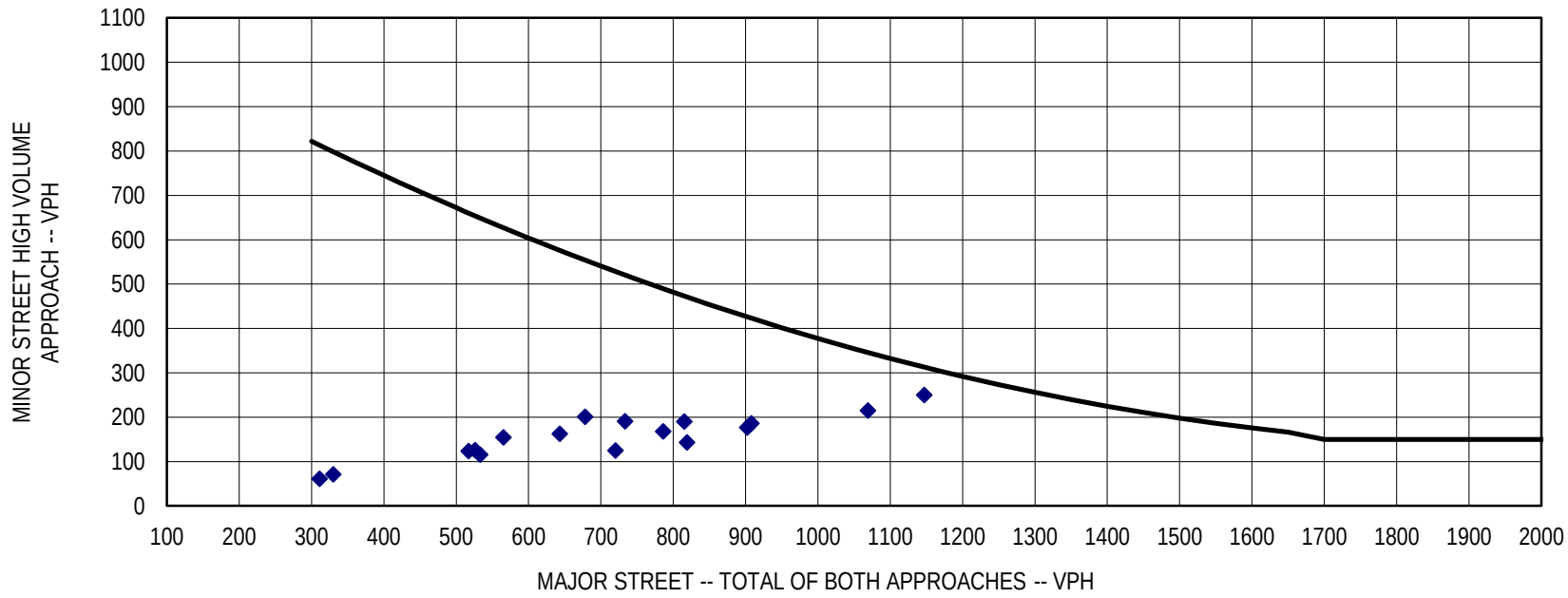
Consulting Group, Inc.

WARRANTS ANALYSIS

Existing Year 2016

Stadium Road (CSAH 60) at Pohl Road
Intersection Control Evaluation Studies
MAPO

Warrants Analysis: Warrant 3



Number of Hours Satisfying Requirements:	0

Notes: 1. 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 APPROACHING WITH ONE LANE.

Forecasted Year 2036 Warrants Analysis

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Forecasted Year 2036

Stadium Road (CSAH 60) at Pohl Road
Intersection Control Evaluation Studies
MAPO

Background Information

		Speed (mph)	Lanes	Approach	
Location :	MAPO	40	2 or more	Major Approach 1:	Eastbound Stadium Road (CSAH 60)
Date:	9/28/2016	40	2 or more	Major Approach 3:	Westbound Stadium Road (CSAH 60)
Analysis Prepared By:	Luke James	30	2 or more	Minor Approach 2:	Northbound Pohl Road
Population Less than 10,000:	No	30	2 or more	Minor Approach 4:	Southbound Pohl Road
Seventy Percent Factor Used:	No				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 600	Warrant Met 900	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 200	Warrant Met 100	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 300	MWSA (C) 200
6 - 7 AM	211	194	405			107	73	107		X					X	
7 - 8 AM	412	422	834	X		302	216	302	X	X	X		X	X	X	X
8 - 9 AM	353	341	694	X		233	177	233	X	X	X		X		X	X
9 - 10 AM	262	388	650	X		189	140	189		X			X		X	X
10 - 11 AM	306	330	636	X		186	152	186		X			X		X	X
11 - 12 AM	389	402	791	X		245	193	245	X	X	X		X	X	X	X
12 - 1 PM	455	446	901	X	X	287	206	287	X	X	X	X	X	X	X	X
1 - 2 PM	492	474	966	X	X	252	199	252	X	X	X	X	X	X	X	X
2 - 3 PM	480	523	1003	X	X	284	251	284	X	X	X	X	X	X	X	X
3 - 4 PM	527	591	1118	X	X	266	246	266	X	X	X	X	X	X	X	X
4 - 5 PM	618	698	1316	X	X	320	284	320	X	X	X	X	X	X	X	X
5 - 6 PM	620	794	1414	X	X	291	330	330	X	X	X	X	X	X	X	X
6 - 7 PM	498	614	1112	X	X	227	234	234	X	X	X	X	X	X	X	X
7 - 8 PM	503	504	1007	X	X	183	189	189		X		X	X	X	X	X
8 - 9 PM	402	485	887	X		128	165	165		X			X	X	X	X
9 - 10 PM	274	384	658	X		104	153	153		X					X	X
10 - 11 PM	169	214	383			59	81	81							X	
											10	8	14	11	15	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	10	8	Met - Warrant 1A Satisfied
Warrant 1B:	Interruption of Continuous Traffic	8	8	Met - Warrant 1B Satisfied
Warrant 1C:	Combination of Warrants	11	8	Met - Warrant 1C Satisfied
Warrant 2:	Four-Hour Vehicular Volume	9	4	Met - Warrant 2 Satisfied
Warrant 3B:	Peak Hour	2	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	15	8	Met - Multiway Stop Applications

Consulting Group, Inc.

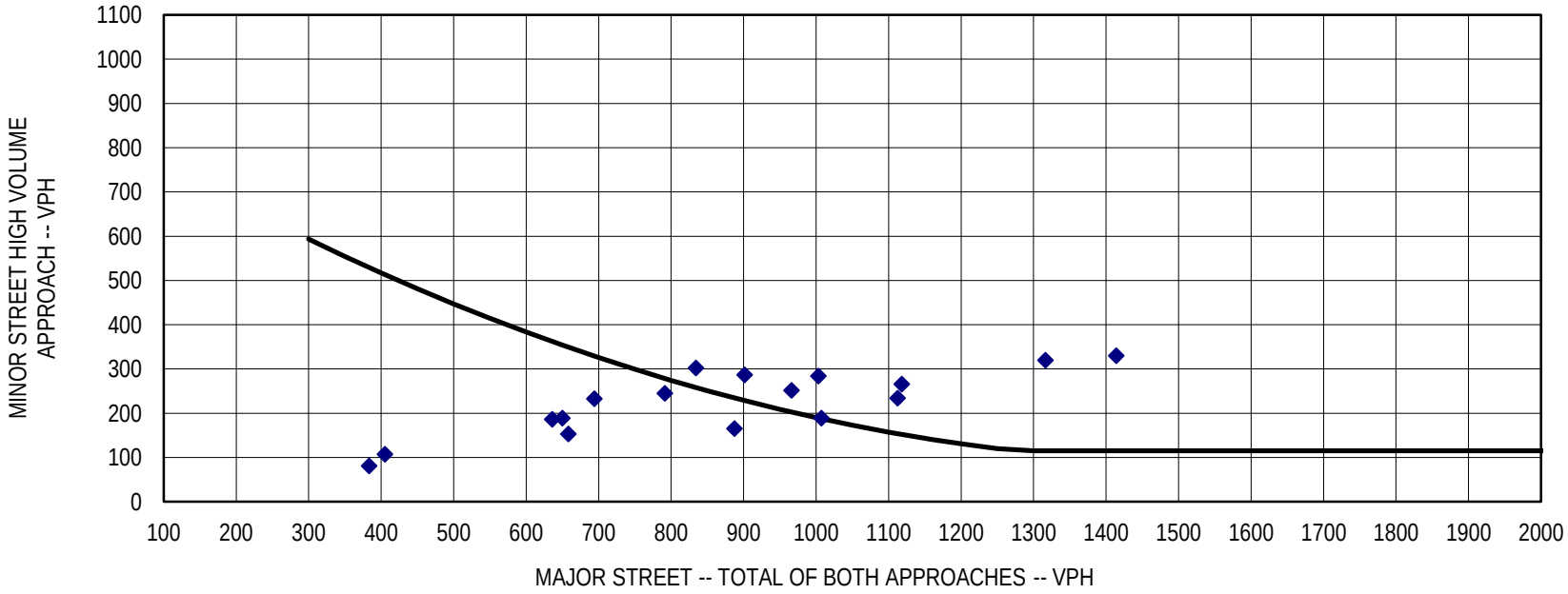
WARRANTS ANALYSIS

Forecasted Year 2036

Stadium Road (CSAH 60) at Pohl Road
Intersection Control Evaluation Studies
MAPO

Warrants Analysis: Warrant 2

WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME



Number of Hours Satisfying Requirements:	9

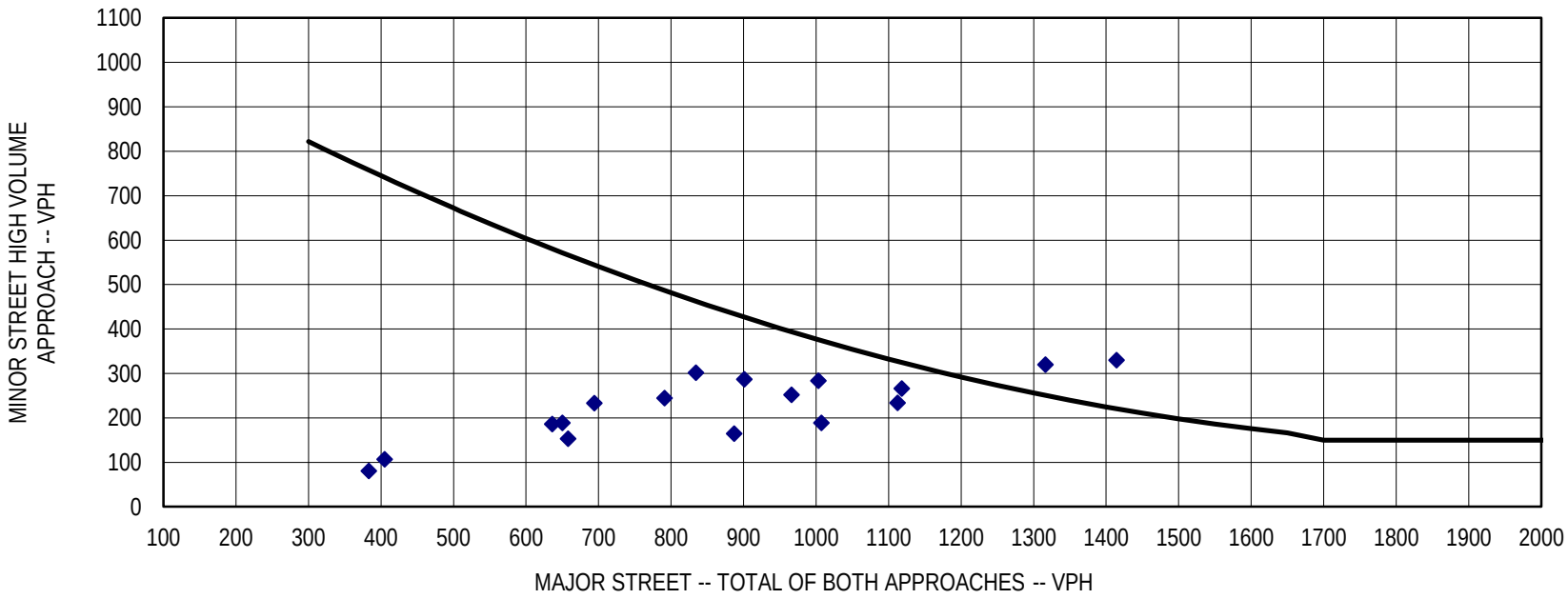
Notes: 1. 115 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

WARRANTS ANALYSIS

Forecasted Year 2036

Stadium Road (CSAH 60) at Pohl Road
Intersection Control Evaluation Studies
MAPO

Warrants Analysis: Warrant 3



Number of Hours Satisfying Requirements:	2

Notes: 1. 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 APPROACHING WITH ONE LANE.

Existing Year 2016 Detailed Operational Analysis

All-Way Stop Control

3: Pohl Road & Stadium Road Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.1	0.1	0.1	0.1	0.3
Denied Del/Veh (s)	0.8	1.1	0.9	1.2	1.0
Total Delay (hr)	1.4	1.0	0.5	0.3	3.2
Total Del/Veh (s)	13.3	10.0	7.2	6.9	10.0
Stop Delay (hr)	0.7	0.4	0.3	0.2	1.7
Stop Del/Veh (s)	6.9	4.5	4.9	4.5	5.4
Total Stops	382	357	236	172	1147
Stop/Veh	0.99	1.00	0.99	1.00	0.99

Intersection: 3: Pohl Road & Stadium Road

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	54	187	55	116	50	90	58	76
Average Queue (ft)	24	76	31	58	25	50	27	40
95th Queue (ft)	49	134	50	95	51	80	51	62
Link Distance (ft)		966		966		966		966
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	160		250		100		120	
Storage Blk Time (%)		1				0		0
Queuing Penalty (veh)		0				0		0

3: Pohl Road & Stadium Road Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.2	0.3	0.0	0.0	0.5
Denied Del/Veh (s)	1.2	1.4	0.8	0.6	1.1
Total Delay (hr)	2.8	3.9	0.5	0.6	7.9
Total Del/Veh (s)	18.2	21.4	8.9	9.5	17.0
Stop Delay (hr)	1.8	2.7	0.4	0.5	5.4
Stop Del/Veh (s)	11.6	14.9	6.7	7.3	11.7
Total Stops	555	650	206	238	1649
Stop/Veh	0.99	0.99	0.99	0.99	0.99

Intersection: 3: Pohl Road & Stadium Road

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	168	260	188	311	62	106	46	124
Average Queue (ft)	46	114	50	141	24	52	17	61
95th Queue (ft)	107	208	116	259	53	86	45	99
Link Distance (ft)		966		966		966		966
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	160		250		100		120	
Storage Blk Time (%)		5		3		0		0
Queuing Penalty (veh)		6		5		0		0

Existing Year 2016 Detailed Operational Analysis

Traffic Signal Control

3: Pohl Road & Stadium Road Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.1	0.1	0.1	0.1	0.3
Denied Del/Veh (s)	0.8	1.1	0.8	1.1	0.9
Total Delay (hr)	1.1	1.1	0.6	0.5	3.3
Total Del/Veh (s)	10.4	10.4	9.8	10.6	10.3
Stop Delay (hr)	0.6	0.7	0.5	0.4	2.2
Stop Del/Veh (s)	5.8	6.6	7.6	8.5	6.8
Total Stops	178	183	154	117	632
Stop/Veh	0.47	0.50	0.66	0.66	0.55

Intersection: 3: Pohl Road & Stadium Road

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	64	172	93	141	66	118	77	98
Average Queue (ft)	24	73	38	63	25	55	30	43
95th Queue (ft)	57	134	75	116	56	95	64	81
Link Distance (ft)		966		966		966		966
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	160		250		100		120	
Storage Blk Time (%)		0			0	1	0	0
Queuing Penalty (veh)		0			0	0	0	0

3: Pohl Road & Stadium Road Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.2	0.3	0.0	0.0	0.5
Denied Del/Veh (s)	1.2	1.4	0.8	0.6	1.2
Total Delay (hr)	3.0	3.2	0.9	1.1	8.3
Total Del/Veh (s)	19.0	17.5	15.7	16.1	17.6
Stop Delay (hr)	1.9	2.0	0.8	0.9	5.7
Stop Del/Veh (s)	12.2	10.9	13.3	13.4	12.0
Total Stops	370	413	156	184	1123
Stop/Veh	0.65	0.62	0.73	0.75	0.66

Intersection: 3: Pohl Road & Stadium Road

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	234	342	158	308	66	146	84	175
Average Queue (ft)	64	151	65	147	25	67	20	79
95th Queue (ft)	146	279	125	257	59	117	59	137
Link Distance (ft)		966		966		966		966
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	160		250		100		120	
Storage Blk Time (%)	0	7		1		3		2
Queuing Penalty (veh)	0	8		2		1		1

Existing Year 2016 Detailed Operational Analysis

Roundabout Control (HCS)

ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Luke James*	Intersection	*Stadium Road at Pohl Road*
Agency or Co.	*SRF Consulting Group, Inc.*	E/W Street Name	*Stadium Road*
Date Performed	*8/5/2016*	N/S Street Name	*Pohl Road*
Time Period	*A.M. Peak*	Analysis Year	*2016*
Peak Hour Factor	*1.00*	Project ID	*9243*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*1*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*				*LTR*				*LTR*				*LTR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*40*	*350*	*30*	*0*	*75*	*240*	*45*	*0*	*40*	*70*	*125*	*0*	*45*	*60*	*60*	*0*
Heavy Veh. Adj. (f_{HV}), %	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*3.1858*		*3.1858*	*3.1858*		*3.1858*	*3.1858*		*3.1858*	*3.1858*	

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*183*			*153*			*444*			*362*		
Exiting Flow (V_{ex}), pc/h	*530*			*347*			*158*			*168*		
Entry Flow (V_e), pc/h		*428*			*367*			*240*			*168*	
Entry Volume veh/h		*420*			*360*			*235*			*165*	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*940*			*970*			*725*			*787*	
Capacity (*c*), veh/h		*922*			*951*			*711*			*771*	
v/c Ratio (X)		*0.46*			*0.38*			*0.33*			*0.21*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*9.4*			*8.0*			*9.2*			*7.0*	
Lane LOS		*A*			*A*			*A*			*A*	
Lane 95% Queue		*2.4*			*1.8*			*1.4*			*0.8*	
Approach Delay, s/veh	*9.40*			*7.96*			*9.20*			*7.00*		
Approach LOS, s/veh	*A*			*A*			*A*			*A*		
Intersection Delay, s/veh	*8.59*											
Intersection LOS	*A*											

ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Luke James*	Intersection	*Stadium Road at Pohl Road*
Agency or Co.	*SRF Consulting Group, Inc.*	E/W Street Name	*Stadium Road*
Date Performed	*8/5/2016*	N/S Street Name	*Pohl Road*
Time Period	*P.M. Peak*	Analysis Year	*2016*
Peak Hour Factor	*1.00*	Project ID	*9243*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*1*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*				*LTR*				*LTR*				*LTR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*120*	*395*	*45*	*0*	*160*	*435*	*45*	*0*	*35*	*60*	*110*	*0*	*25*	*75*	*140*	*0*
Heavy Veh. Adj. (f_{HV}), %	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*3.1858*		*3.1858*	*3.1858*		*3.1858*	*3.1858*		*3.1858*	*3.1858*	

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*265*			*219*			*551*			*643*		
Exiting Flow (V_{ex}), pc/h	*541*			*622*			*230*			*286*		
Entry Flow (V_e), pc/h		*571*			*653*			*209*			*245*	
Entry Volume veh/h		*560*			*640*			*205*			*240*	

Capacity and v/c Ratios

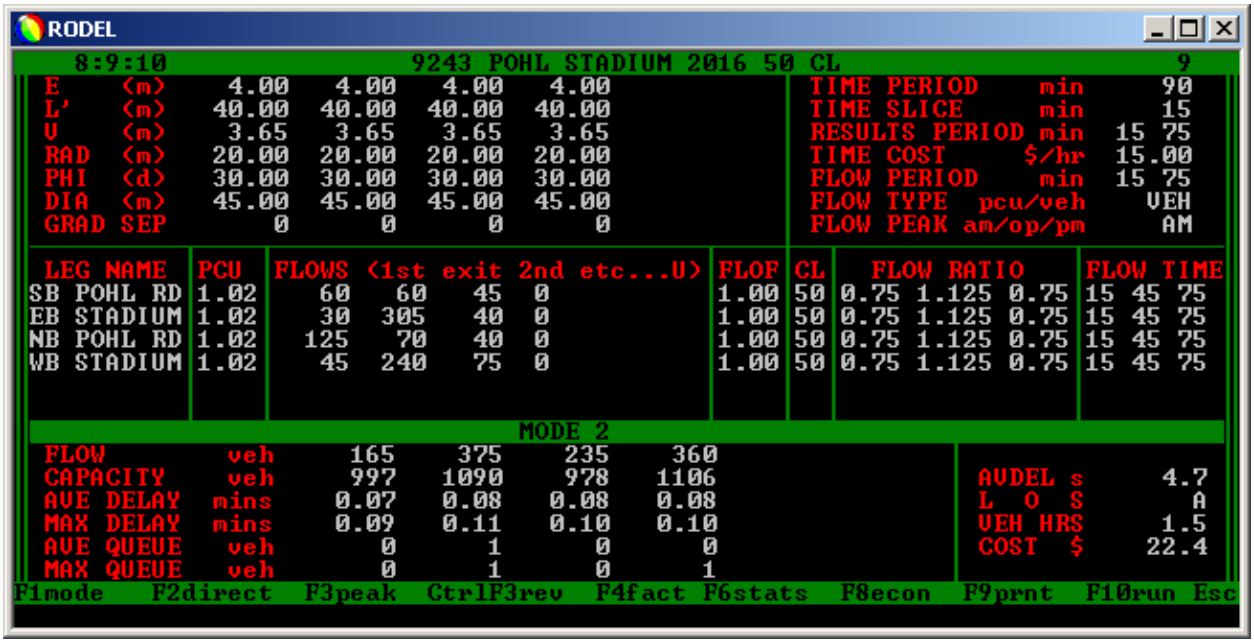
	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*867*			*907*			*651*			*594*	
Capacity (*c*), veh/h		*850*			*890*			*639*			*583*	
v/c Ratio (X)		*0.66*			*0.72*			*0.32*			*0.41*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*15.3*			*17.3*			*9.9*			*12.5*	
Lane LOS		*C*			*C*			*A*			*B*	
Lane 95% Queue		*5.1*			*6.4*			*1.4*			*2.0*	
Approach Delay, s/veh	*15.30*			*17.27*			*9.87*			*12.49*		
Approach LOS, s/veh	*C*			*C*			*A*			*B*		
Intersection Delay, s/veh	*14.98*											
Intersection LOS	*B*											

Existing Year 2016 Detailed Operational Analysis

Roundabout Control (RODEL)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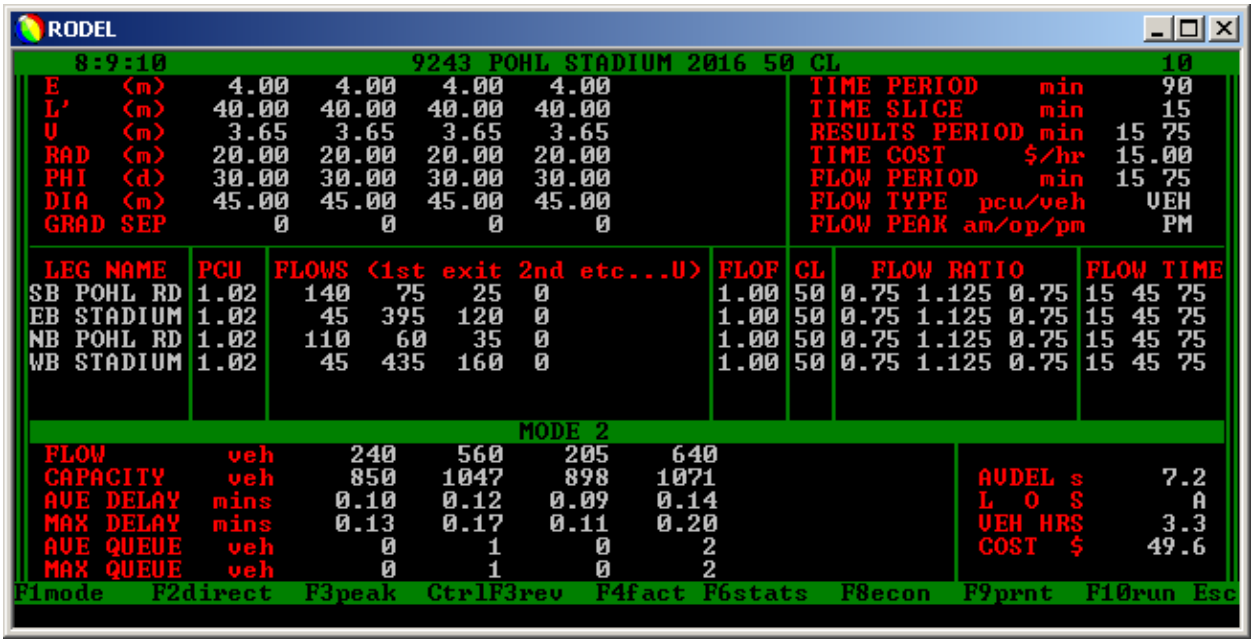
E (m) 4.00 4.00 4.00 4.00
L' (m) 40.00 40.00 40.00 40.00
V (m) 3.65 3.65 3.65 3.65
RAD (m) 20.00 20.00 20.00 20.00
PHI (d) 30.00 30.00 30.00 30.00
DIA (m) 45.00 45.00 45.00 45.00
GRAD SEP 0 0 0 0
TIME PERIOD min 90
TIME SLICE min 15
RESULTS PERIOD min 15 75
TIME COST $/hr 15.00
FLOW PERIOD min 15 75
FLOW TYPE pcu/veh VEH
FLOW PEAK am/op/pm AM
LEG NAME PCU FLOWS (1st exit 2nd etc...U) FLOF CL FLOW RATIO FLOW TIME
SB POHL RD 1.02 60 60 45 0 1.00 50 0.75 1.125 0.75 15 45 75
EB STADIUM 1.02 30 305 40 0 1.00 50 0.75 1.125 0.75 15 45 75
NB POHL RD 1.02 125 70 40 0 1.00 50 0.75 1.125 0.75 15 45 75
WB STADIUM 1.02 45 240 75 0 1.00 50 0.75 1.125 0.75 15 45 75
MODE 2
FLOW veh 165 375 235 360
CAPACITY veh 997 1090 978 1106
AVE DELAY mins 0.07 0.08 0.08 0.08
MAX DELAY mins 0.09 0.11 0.10 0.10
AVE QUEUE veh 0 1 0 0
MAX QUEUE veh 0 1 0 1
AVDEL s 4.7
L O S A
VEH HRS 1.5
COST $ 22.4
F1mode F2direct F3peak CtrlF3rev F4fact F6stats F8econ F9prnt F10run Esc


RODEL
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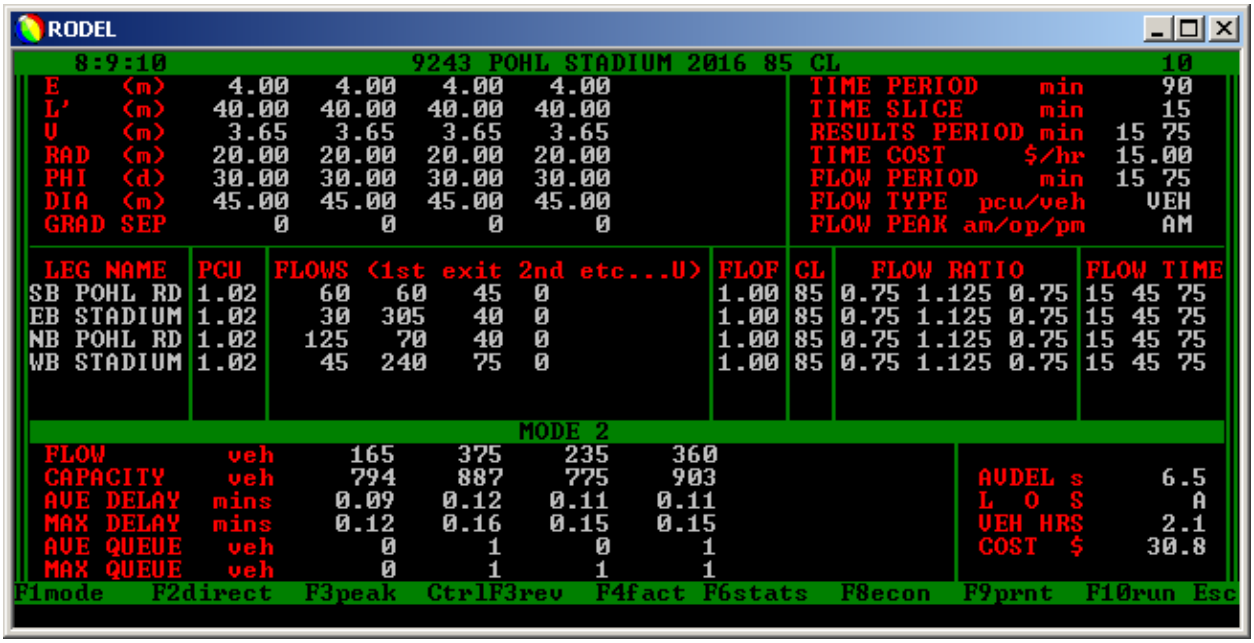
E (m) 4.00 4.00 4.00 4.00
L' (m) 40.00 40.00 40.00 40.00
V (m) 3.65 3.65 3.65 3.65
RAD (m) 20.00 20.00 20.00 20.00
PHI (d) 30.00 30.00 30.00 30.00
DIA (m) 45.00 45.00 45.00 45.00
GRAD SEP 0 0 0 0
TIME PERIOD min 90
TIME SLICE min 15
RESULTS PERIOD min 15 75
TIME COST $/hr 15.00
FLOW PERIOD min 15 75
FLOW TYPE pcu/veh VEH
FLOW PEAK am/op/pm PM
LEG NAME PCU FLOWS (1st exit 2nd etc...U) FLOF CL FLOW RATIO FLOW TIME
SB POHL RD 1.02 140 75 25 0 1.00 50 0.75 1.125 0.75 15 45 75
EB STADIUM 1.02 45 395 120 0 1.00 50 0.75 1.125 0.75 15 45 75
NB POHL RD 1.02 110 60 35 0 1.00 50 0.75 1.125 0.75 15 45 75
WB STADIUM 1.02 45 435 160 0 1.00 50 0.75 1.125 0.75 15 45 75
MODE 2
FLOW veh 240 560 205 640
CAPACITY veh 850 1047 898 1071
AVE DELAY mins 0.10 0.12 0.09 0.14
MAX DELAY mins 0.13 0.17 0.11 0.20
AVE QUEUE veh 0 1 0 2
MAX QUEUE veh 0 1 0 2
AVDEL s 7.2
L O S A
VEH HRS 3.3
COST $ 49.6
F1mode F2direct F3peak CtrlF3rev F4fact F6stats F8econ F9prnt F10run Esc


RODEL
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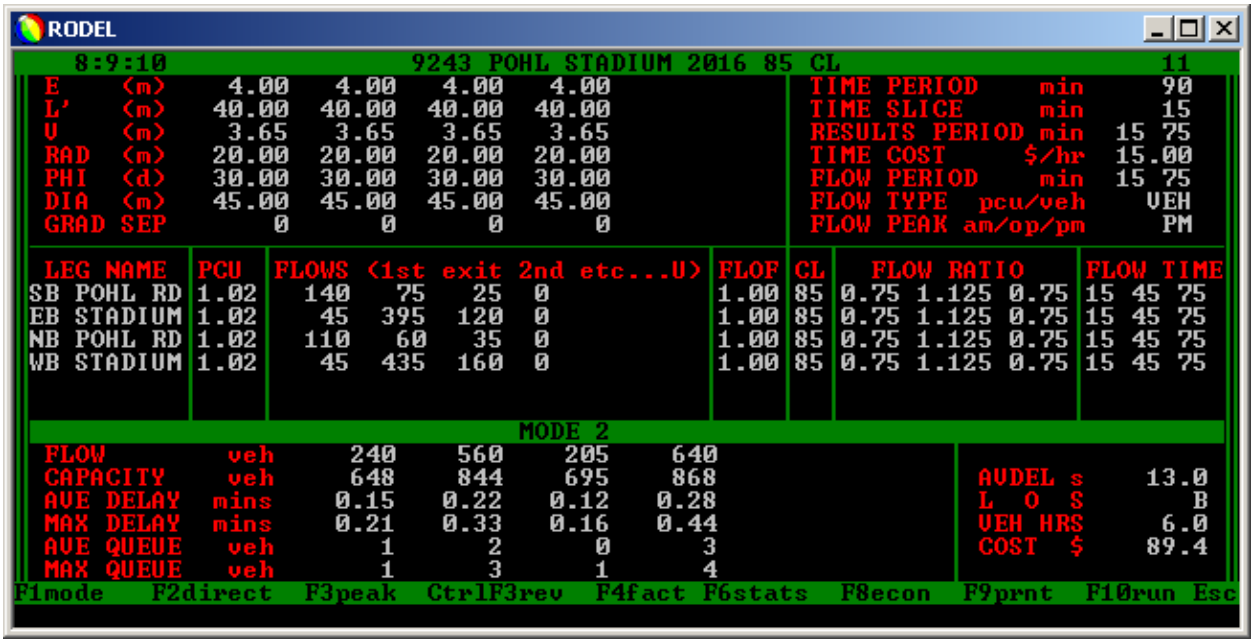
E (m) 4.00 4.00 4.00 4.00
L' (m) 40.00 40.00 40.00 40.00
V (m) 3.65 3.65 3.65 3.65
RAD (m) 20.00 20.00 20.00 20.00
PHI (d) 30.00 30.00 30.00 30.00
DIA (m) 45.00 45.00 45.00 45.00
GRAD SEP 0 0 0 0
TIME PERIOD min 90
TIME SLICE min 15
RESULTS PERIOD min 15 75
TIME COST $/hr 15.00
FLOW PERIOD min 15 75
FLOW TYPE pcu/veh VEH
FLOW PEAK am/op/pm AM
LEG NAME PCU FLOWS (1st exit 2nd etc...U) FLOF CL FLOW RATIO FLOW TIME
SB POHL RD 1.02 60 60 45 0 1.00 85 0.75 1.125 0.75 15 45 75
EB STADIUM 1.02 30 305 40 0 1.00 85 0.75 1.125 0.75 15 45 75
NB POHL RD 1.02 125 70 40 0 1.00 85 0.75 1.125 0.75 15 45 75
WB STADIUM 1.02 45 240 75 0 1.00 85 0.75 1.125 0.75 15 45 75
MODE 2
FLOW veh 165 375 235 360
CAPACITY veh 794 887 775 903
AVE DELAY mins 0.09 0.12 0.11 0.11
MAX DELAY mins 0.12 0.16 0.15 0.15
AVE QUEUE veh 0 1 0 1
MAX QUEUE veh 0 1 1 1
AVDEL s 6.5
L O S A
VEH HRS 2.1
COST $ 30.8
F1mode F2direct F3peak CtrlF3rev F4fact F6stats F8econ F9prnt F10run Esc


RODEL
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E (m) 4.00 4.00 4.00 4.00
L' (m) 40.00 40.00 40.00 40.00
V (m) 3.65 3.65 3.65 3.65
RAD (m) 20.00 20.00 20.00 20.00
PHI (d) 30.00 30.00 30.00 30.00
DIA (m) 45.00 45.00 45.00 45.00
GRAD SEP 0 0 0 0
TIME PERIOD min 90
TIME SLICE min 15
RESULTS PERIOD min 15 75
TIME COST $/hr 15.00
FLOW PERIOD min 15 75
FLOW TYPE pcu/veh VEH
FLOW PEAK am/op/pm PM
LEG NAME PCU FLOWS (1st exit 2nd etc...U) FLOF CL FLOW RATIO FLOW TIME
SB POHL RD 1.02 140 75 25 0 1.00 85 0.75 1.125 0.75 15 45 75
EB STADIUM 1.02 45 395 120 0 1.00 85 0.75 1.125 0.75 15 45 75
NB POHL RD 1.02 110 60 35 0 1.00 85 0.75 1.125 0.75 15 45 75
WB STADIUM 1.02 45 435 160 0 1.00 85 0.75 1.125 0.75 15 45 75
MODE 2
FLOW veh 240 560 205 640
CAPACITY veh 648 844 695 868
AVE DELAY mins 0.15 0.22 0.12 0.28
MAX DELAY mins 0.21 0.33 0.16 0.44
AVE QUEUE veh 1 2 0 3
MAX QUEUE veh 1 3 1 4
AVDEL s 13.0
L O S B
VEH HRS 6.0
COST $ 89.4
F1mode F2direct F3peak CtrlF3rev F4fact F6stats F8econ F9prnt F10run Esc

Forecasted Year 2036 Detailed Operational Analysis

All-Way Stop Control

3: Pohl Road & Stadium Road Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.1	0.1	0.1	0.1	0.4
Denied Del/Veh (s)	0.9	1.2	0.9	1.1	1.0
Total Delay (hr)	4.1	1.8	1.2	0.6	7.7
Total Del/Veh (s)	32.1	14.5	12.0	9.0	18.5
Stop Delay (hr)	3.3	1.1	1.0	0.4	5.8
Stop Del/Veh (s)	26.1	8.6	9.6	6.5	13.9
Total Stops	458	450	354	222	1484
Stop/Veh	1.00	0.99	0.99	1.00	1.00

Intersection: 3: Pohl Road & Stadium Road

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	200	424	67	200	105	185	68	97
Average Queue (ft)	49	150	35	83	33	77	31	50
95th Queue (ft)	165	360	55	153	67	137	57	81
Link Distance (ft)		966		966		966		966
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	160		250		100		120	
Storage Blk Time (%)		18		0	0	5		0
Queuing Penalty (veh)		10		0	0	3		0

3: Pohl Road & Stadium Road Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	12.5	57.8	0.1	0.1	70.4
Denied Del/Veh (s)	67.9	261.5	0.9	0.6	121.7
Total Delay (hr)	28.7	36.5	1.1	1.4	67.7
Total Del/Veh (s)	156.7	188.3	12.7	15.8	122.5
Stop Delay (hr)	29.6	38.3	0.9	1.2	70.0
Stop Del/Veh (s)	161.6	197.5	10.3	13.5	126.6
Total Stops	471	284	308	316	1379
Stop/Veh	0.71	0.41	0.99	0.99	0.69

Intersection: 3: Pohl Road & Stadium Road

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	260	983	350	1025	72	162	56	174
Average Queue (ft)	236	769	343	961	31	73	22	87
95th Queue (ft)	348	1227	416	1138	60	124	51	149
Link Distance (ft)		966		966		966		966
Upstream Blk Time (%)		45		85				
Queuing Penalty (veh)		0		0				
Storage Bay Dist (ft)	160		250		100		120	
Storage Blk Time (%)	0	93		100	0	4		5
Queuing Penalty (veh)	0	130		199	0	2		2

Forecasted Year 2036 Detailed Operational Analysis

Traffic Signal Control

3: Pohl Road & Stadium Road Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.1	0.2	0.1	0.1	0.4
Denied Del/Veh (s)	0.8	1.2	0.9	1.1	1.0
Total Delay (hr)	1.8	1.9	1.2	0.8	5.7
Total Del/Veh (s)	14.2	14.9	12.0	12.3	13.6
Stop Delay (hr)	1.1	1.3	0.9	0.6	3.9
Stop Del/Veh (s)	8.5	10.1	9.1	10.0	9.4
Total Stops	238	264	236	150	888
Stop/Veh	0.53	0.57	0.65	0.66	0.59

Intersection: 3: Pohl Road & Stadium Road

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	103	218	135	204	75	196	76	112
Average Queue (ft)	32	103	56	89	32	84	36	52
95th Queue (ft)	73	178	109	161	67	151	68	97
Link Distance (ft)		966		966		966		966
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	160		250		100		120	
Storage Blk Time (%)	0	1		0	0	4		0
Queuing Penalty (veh)	0	1		0	0	3		0

3: Pohl Road & Stadium Road Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.2	0.3	0.1	0.1	0.7
Denied Del/Veh (s)	1.4	1.6	0.9	0.7	1.3
Total Delay (hr)	5.9	7.2	1.7	1.7	16.5
Total Del/Veh (s)	31.7	31.8	19.3	19.4	28.1
Stop Delay (hr)	4.1	4.9	1.4	1.4	11.9
Stop Del/Veh (s)	21.9	21.7	16.2	16.3	20.2
Total Stops	551	667	228	224	1670
Stop/Veh	0.82	0.82	0.72	0.72	0.79

Intersection: 3: Pohl Road & Stadium Road

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	260	478	334	470	91	204	80	207
Average Queue (ft)	89	235	116	256	38	98	28	103
95th Queue (ft)	207	460	260	437	75	171	66	175
Link Distance (ft)		966		966		966		966
Upstream Blk Time (%)		0						
Queuing Penalty (veh)		0						
Storage Bay Dist (ft)	160		250		100		120	
Storage Blk Time (%)	0	20	0	11	0	8	0	7
Queuing Penalty (veh)	0	28	1	23	0	5	0	2

Forecasted Year 2036 Detailed Operational Analysis

Roundabout Control (HCS)

ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Luke James*	Intersection	*Stadium Road at Pohl Road*
Agency or Co.	*SRF Consulting Group, Inc.*	E/W Street Name	*Stadium Road*
Date Performed	*8/5/2016*	N/S Street Name	*Pohl Road*
Time Period	*A.M. Peak*	Analysis Year	*2036*
Peak Hour Factor	*1.00*	Project ID	*9243*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*1*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*				*LTR*				*LTR*				*LTR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*50*	*370*	*35*	*0*	*95*	*300*	*55*	*0*	*60*	*105*	*190*	*0*	*60*	*80*	*80*	*0*
Heavy Veh. Adj. (f_{HV}), %	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*3.1858*		*3.1858*	*3.1858*		*3.1858*	*3.1858*		*3.1858*	*3.1858*	

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*240*			*219*			*489*			*464*		
Exiting Flow (V_{ex}), pc/h	*632*			*449*			*214*			*214*		
Entry Flow (V_e), pc/h		*464*			*459*			*362*			*224*	
Entry Volume veh/h		*455*			*450*			*355*			*220*	

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*889*			*907*			*693*			*710*	
Capacity (*c*), veh/h		*872*			*890*			*679*			*697*	
v/c Ratio (X)		*0.52*			*0.51*			*0.52*			*0.32*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*11.1*			*10.6*			*13.6*			*9.1*	
Lane LOS		*B*			*B*			*B*			*A*	
Lane 95% Queue		*3.1*			*2.9*			*3.1*			*1.3*	
Approach Delay, s/veh	*11.15*			*10.64*			*13.57*			*9.10*		
Approach LOS, s/veh	*B*			*B*			*B*			*A*		
Intersection Delay, s/veh	*11.27*											
Intersection LOS	*B*											

ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*Luke James*	Intersection	*Stadium Road at Pohl Road*
Agency or Co.	*SRF Consulting Group, Inc.*	E/W Street Name	*Stadium Road*
Date Performed	*8/5/2016*	N/S Street Name	*Pohl Road*
Time Period	*P.M. Peak*	Analysis Year	*2036*
Peak Hour Factor	*1.00*	Project ID	*9243*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes (N)	*0*	*1*	*0*		*0*	*1*	*0*		*0*	*1*	*0*		*0*	*1*	*0*	
Lane Assignment			*LTR*				*LTR*				*LTR*				*LTR*	
Right-Turn Bypass	*None*				None				None				None			
Conflicting Lanes	*1*				1				1				1			
Volume (V), veh/h	*140*	*475*	*50*	*0*	*200*	*545*	*55*	*0*	*55*	*90*	*165*	*0*	*35*	*100*	*185*	*0*
Heavy Veh. Adj. (f_{HV}), %	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
Pedestrians Crossing	*0*				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*	*5.1929*
Follow-Up Headway (sec)	*3.1858*	*3.1858*		*3.1858*	*3.1858*		*3.1858*	*3.1858*		*3.1858*	*3.1858*	

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	*342*			*291*			*663*			*816*		
Exiting Flow (V_{ex}), pc/h	*689*			*801*			*291*			*357*		
Entry Flow (V_e), pc/h		*678*			*816*			*316*			*326*	
Entry Volume veh/h		*665*			*800*			*310*			*320*	

Capacity and v/c Ratios

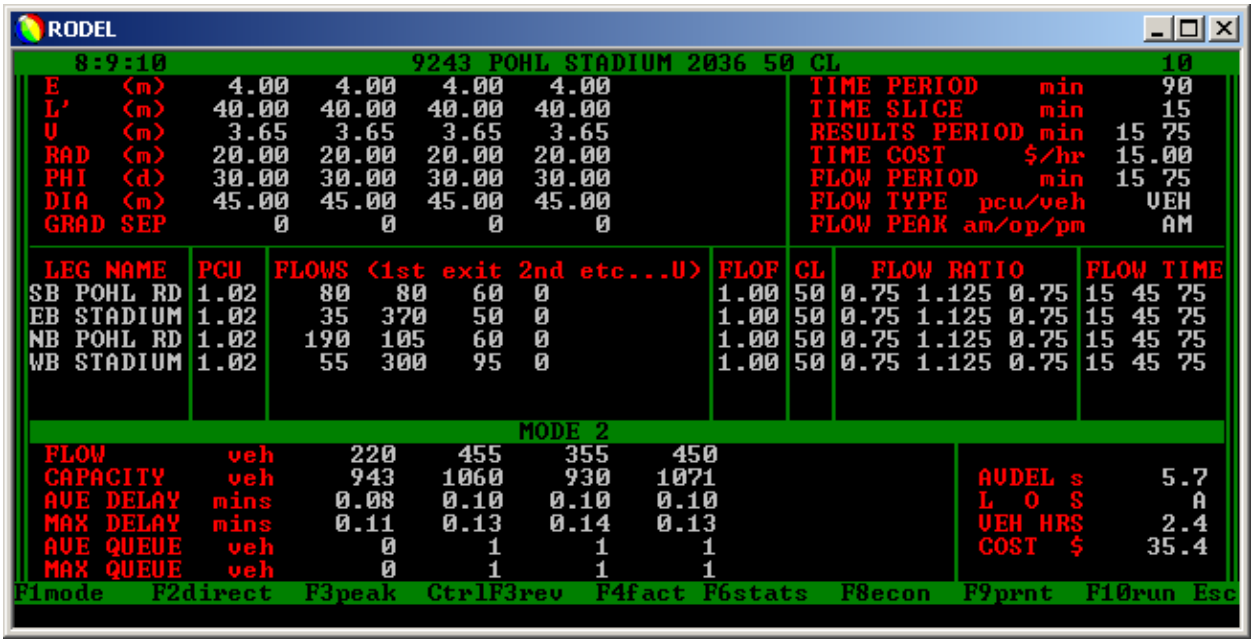
	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		*803*			*845*			*582*			*500*	
Capacity (*c*), veh/h		*787*			*828*			*571*			*490*	
v/c Ratio (X)		*0.84*			*0.97*			*0.54*			*0.65*	

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		*28.2*			*45.7*			*16.2*			*23.4*	
Lane LOS		*D*			*E*			*C*			*C*	
Lane 95% Queue		*9.9*			*15.7*			*3.2*			*4.6*	
Approach Delay, s/veh	*28.25*			*45.71*			*16.24*			*23.35*		
Approach LOS, s/veh	*D*			*E*			*C*			*C*		
Intersection Delay, s/veh	*32.39*											
Intersection LOS	*D*											

Forecasted Year 2036 Detailed Operational Analysis

Roundabout Control (RODEL)


RODEL
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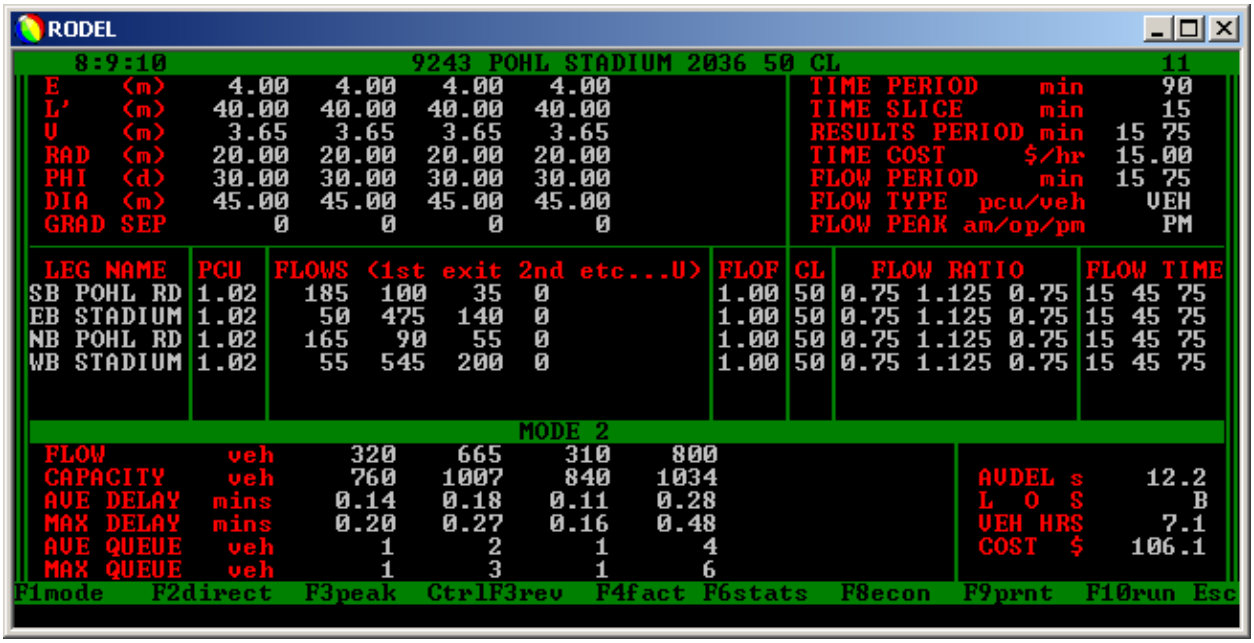
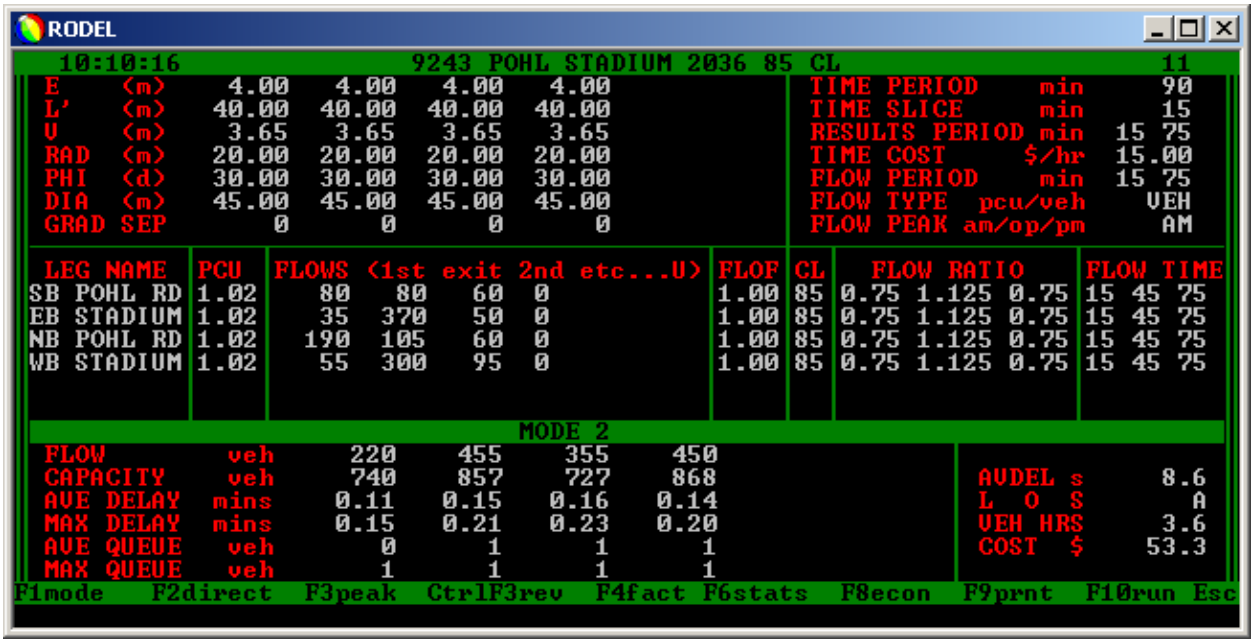
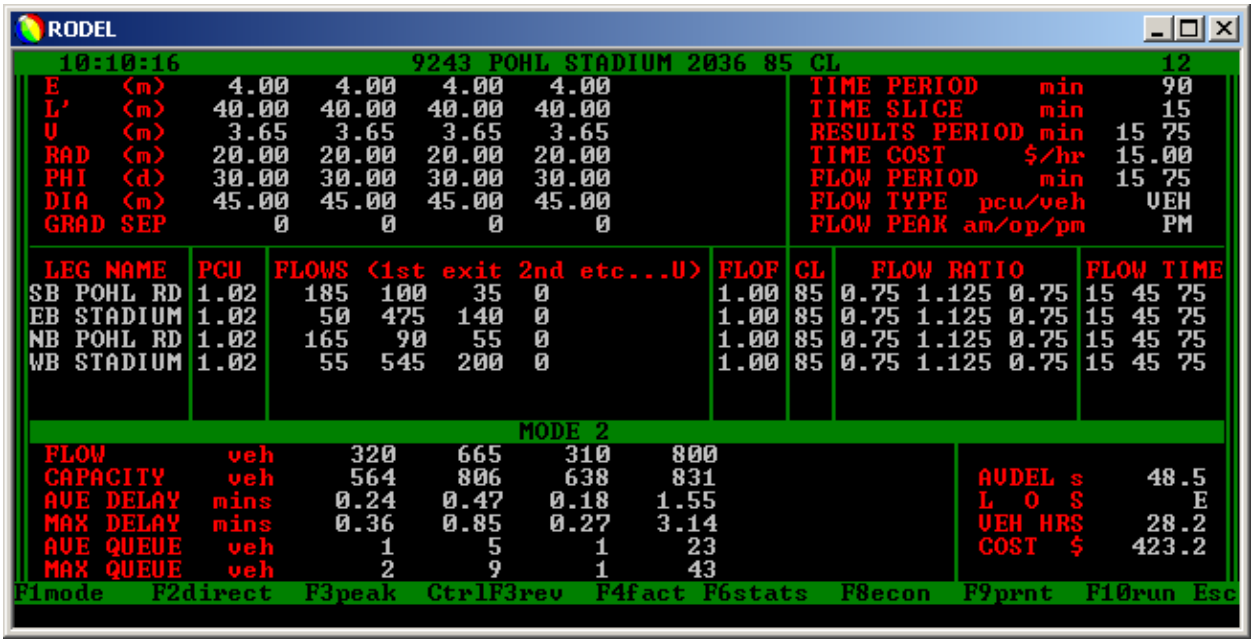
E (m) 4.00 4.00 4.00 4.00
L' (m) 40.00 40.00 40.00 40.00
V (m) 3.65 3.65 3.65 3.65
RAD (m) 20.00 20.00 20.00 20.00
PHI (d) 30.00 30.00 30.00 30.00
DIA (m) 45.00 45.00 45.00 45.00
GRAD SEP 0 0 0 0
TIME PERIOD min 90
TIME SLICE min 15
RESULTS PERIOD min 15 75
TIME COST $/hr 15.00
FLOW PERIOD min 15 75
FLOW TYPE pcu/veh VEH
FLOW PEAK am/op/pm AM
LEG NAME PCU FLOWS (1st exit 2nd etc...U) FLOF CL FLOW RATIO FLOW TIME
SB POHL RD 1.02 80 80 60 0 1.00 50 0.75 1.125 0.75 15 45 75
EB STADIUM 1.02 35 370 50 0 1.00 50 0.75 1.125 0.75 15 45 75
NB POHL RD 1.02 190 105 60 0 1.00 50 0.75 1.125 0.75 15 45 75
WB STADIUM 1.02 55 300 95 0 1.00 50 0.75 1.125 0.75 15 45 75
MODE 2
FLOW veh 220 455 355 450
CAPACITY veh 943 1060 930 1071
AVE DELAY mins 0.08 0.10 0.10 0.10
MAX DELAY mins 0.11 0.13 0.14 0.13
AVE QUEUE veh 0 1 1 1
MAX QUEUE veh 0 1 1 1
AVDEL s 5.7
L O S A
VEH HRS 2.4
COST $ 35.4
F1mode F2direct F3peak CtrlF3rev F4fact F6stats F8econ F9prnt F10run Esc


RODEL
8:9:10 9243 POHL STADIUM 2036 50 CL 11
E (m) 4.00 4.00 4.00 4.00
L' (m) 40.00 40.00 40.00 40.00
V (m) 3.65 3.65 3.65 3.65
RAD (m) 20.00 20.00 20.00 20.00
PHI (d) 30.00 30.00 30.00 30.00
DIA (m) 45.00 45.00 45.00 45.00
GRAD SEP 0 0 0 0
TIME PERIOD min 90
TIME SLICE min 15
RESULTS PERIOD min 15 75
TIME COST $/hr 15.00
FLOW PERIOD min 15 75
FLOW TYPE pcu/veh VEH
FLOW PEAK am/op/pm PM
LEG NAME PCU FLOWS (1st exit 2nd etc...U) FLOF CL FLOW RATIO FLOW TIME
SB POHL RD 1.02 185 100 35 0 1.00 50 0.75 1.125 0.75 15 45 75
EB STADIUM 1.02 50 475 140 0 1.00 50 0.75 1.125 0.75 15 45 75
NB POHL RD 1.02 165 90 55 0 1.00 50 0.75 1.125 0.75 15 45 75
WB STADIUM 1.02 55 545 200 0 1.00 50 0.75 1.125 0.75 15 45 75
MODE 2
FLOW veh 320 665 310 800
CAPACITY veh 760 1007 840 1034
AVE DELAY mins 0.14 0.18 0.11 0.28
MAX DELAY mins 0.20 0.27 0.16 0.48
AVE QUEUE veh 1 2 1 4
MAX QUEUE veh 1 3 1 6
AVDEL s 12.2
L O S B
VEH HRS 7.1
COST $ 106.1
F1mode F2direct F3peak CtrlF3rev F4fact F6stats F8econ F9prnt F10run Esc


RODEL
10:10:16 9243 POHL STADIUM 2036 85 CL 11
E (m) 4.00 4.00 4.00 4.00
L' (m) 40.00 40.00 40.00 40.00
V (m) 3.65 3.65 3.65 3.65
RAD (m) 20.00 20.00 20.00 20.00
PHI (d) 30.00 30.00 30.00 30.00
DIA (m) 45.00 45.00 45.00 45.00
GRAD SEP 0 0 0 0
TIME PERIOD min 90
TIME SLICE min 15
RESULTS PERIOD min 15 75
TIME COST $/hr 15.00
FLOW PERIOD min 15 75
FLOW TYPE pcu/veh VEH
FLOW PEAK am/op/pm AM
LEG NAME PCU FLOWS (1st exit 2nd etc...U) FLOF CL FLOW RATIO FLOW TIME
SB POHL RD 1.02 80 80 60 0 1.00 85 0.75 1.125 0.75 15 45 75
EB STADIUM 1.02 35 370 50 0 1.00 85 0.75 1.125 0.75 15 45 75
NB POHL RD 1.02 190 105 60 0 1.00 85 0.75 1.125 0.75 15 45 75
WB STADIUM 1.02 55 300 95 0 1.00 85 0.75 1.125 0.75 15 45 75
MODE 2
FLOW veh 220 455 355 450
CAPACITY veh 740 857 727 868
AVE DELAY mins 0.11 0.15 0.16 0.14
MAX DELAY mins 0.15 0.21 0.23 0.20
AVE QUEUE veh 0 1 1 1
MAX QUEUE veh 1 1 1 1
AVDEL s 8.6
L O S A
VEH HRS 3.6
COST $ 53.3
F1mode F2direct F3peak CtrlF3rev F4fact F6stats F8econ F9prnt F10run Esc


RODEL
10:10:16 9243 POHL STADIUM 2036 85 CL 12
E (m) 4.00 4.00 4.00 4.00
L' (m) 40.00 40.00 40.00 40.00
V (m) 3.65 3.65 3.65 3.65
RAD (m) 20.00 20.00 20.00 20.00
PHI (d) 30.00 30.00 30.00 30.00
DIA (m) 45.00 45.00 45.00 45.00
GRAD SEP 0 0 0 0
TIME PERIOD min 90
TIME SLICE min 15
RESULTS PERIOD min 15 75
TIME COST $/hr 15.00
FLOW PERIOD min 15 75
FLOW TYPE pcu/veh VEH
FLOW PEAK am/op/pm PM
LEG NAME PCU FLOWS (1st exit 2nd etc...U) FLOF CL FLOW RATIO FLOW TIME
SB POHL RD 1.02 185 100 35 0 1.00 85 0.75 1.125 0.75 15 45 75
EB STADIUM 1.02 50 475 140 0 1.00 85 0.75 1.125 0.75 15 45 75
NB POHL RD 1.02 165 90 55 0 1.00 85 0.75 1.125 0.75 15 45 75
WB STADIUM 1.02 55 545 200 0 1.00 85 0.75 1.125 0.75 15 45 75
MODE 2
FLOW veh 320 665 310 800
CAPACITY veh 564 806 638 831
AVE DELAY mins 0.24 0.47 0.18 1.55
MAX DELAY mins 0.36 0.85 0.27 3.14
AVE QUEUE veh 1 5 1 23
MAX QUEUE veh 2 9 1 43
AVDEL s 48.5
L O S E
VEH HRS 28.2
COST $ 423.2
F1mode F2direct F3peak CtrlF3rev F4fact F6stats F8econ F9prnt F10run Esc

Detailed Cost Analysis

SRF Consulting Group, Inc. | Engineers Planners Designers

Concept Cost Estimate (based upon 2016 bid price information)

Prepared By: SRF Consulting Group, Inc., Date 10/2016

						Stadium Road at Pohl Road	
	ITEM DESCRIPTION		UNIT	UNIT PRICE	EST. QUANTITY	EST. AMOUNT
PAVING AND GRADING COSTS							
GrP 1	Excavation - common & subgrade		cu. yd.	$7.00	4,900	$34,300
GrP 2	Granular Subgrade (CV)		cu. yd.	$14.00	2,900	$40,600
GrP 3	County Road Pavement	(1)	sq. yd.	$32.00	5,870	$187,840
GrP 4	Concrete Median	(1)	sq. yd.	$40.00	600	$24,000
GrP 5	Walk / Trail	(1)	sq. yd.	$25.00	1,820	$45,500
GrP 6	ADA Pedestrian Curb Ramp		each	$800.00	20	$16,000
GrP 7	Concrete Curb and Gutter		lin. ft.	$12.00	4,120	$49,440
GrP 8	Removals - Pavement		sq. yd.	$2.50	8,380	$20,950
	SUBTOTAL PAVING AND GRADING COSTS:					**$418,630**
DRAINAGE, UTILITIES AND EROSION CONTROL						
Dr 1	Local Utilities - Sanitary Sewers		lin. ft.			
Dr 2	Local Utilities - Watermains		lin. ft.			
Dr 3	Water Quality Ponds		l.s.			
Dr 5	Drainage - urban (10-30%)		30%			$126,000
Dr 6	Turf Establishment & Erosion Control		10%			$42,000
Dr 7	Landscaping					
	SUBTOTAL DRAINAGE, UTILITIES AND EROSION CONTROL					**$168,000**
SIGNAL AND LIGHTING COSTS						
SGL 1	Signals (permanent)		each	$200,000		
SGL 2	At Grade Intersection Lighting (permanent - non signa		each	$10,000	12	$120,000
	SUBTOTAL SIGNAL AND LIGHTING COSTS:					**$120,000**
SIGNING & STRIPING COSTS						
SGN 1	Mainline Signing (C&D)		mile	$20,000	0.3	$6,000
SGN 2	Mainline Striping		mile	$10,000	0.3	$3,000
	SUBTOTAL SIGNING & STRIPING COSTS:					**$9,000**
	SUBTOTAL CONSTRUCTION COSTS:					**$715,630**
MISCELLANEOUS COSTS						
M 1	Mobilization		6%			$43,000
M 2	Non Quantified Minor Items (10% to 30%)		20%			$143,000
M 3	Temporary Pavement & Drainage		2%			$14,000
M 4	Traffic Control		4%			$29,000
	SUBTOTAL MISCELLANEOUS COSTS:					**$229,000**
ESTIMATED TOTAL CONSTRUCTION COSTS without Contingency:						**$944,630**
1	Contingency or "risk" (10% to 30%)		20%			$189,000
ESTIMATED TOTAL CONSTRUCTION COSTS PLUS CONTINGENCY:						**$1,133,630**

OTHER PROJECT COSTS:					
R/W ACQUISITIONS	Lump Sum				
DESIGN ENG. & CONSTRUCTION ADMIN.	Lump Sum				
SUBTOTAL OTHER PROJECT COSTS					
TOTAL PROJECT COST (based upon 2016 bid price information)					**$1,133,630**

INFLATION COST (CURRENT YR. TO YR. OF OPE	Years	3%			
TOTAL PROJECT COST (OPENING YEAR DOLLARS)					**$1,133,630**

NOTE: (1) Includes aggregate base class 5.

MAJOR ITEMS NOT INCLUDED:
- Local utilities (sanitary sewer or watermain)
- Water quality ponds or other BMPs
- R/W acquisitions
- Engineering design fees
- Inflation