

LOR-82-2.57 Safety Study

Intersection of SR 82 & SR 83 in Lorain County, OH



#98 – 2021 Rural Intersections
#124 – 2020 Rural Intersections
#99 – 2018 Rural Intersections
#83 – 2017 Rural Intersections
#25 – 2016 Rural Intersections
#35 – 2015 Rural Intersections

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Table of Contents

1.0	Executive Summary.....	1
2.0	Purpose & Location.....	2
3.0	Previous Studies	2
4.0	Existing Conditions.....	4
5.0	Existing Capacity Analysis.....	6
6.0	Existing Safety Analysis	8
7.0	Countermeasures for Consideration.....	11
8.0	Countermeasure Evaluation.....	13
9.0	Conclusions & Recommendations.....	18

List of Figures

Figure 1: Study Area.....	2
Figure 2: Intersection Lane Configuration.....	4
Figure 3: Crash Summary by Year.....	9
Figure 4: Crash Summary by Type	9

List of Photos

Photo 1: Circle K Driveway, North of Study Intersection	3
Photo 2: Signage and Pavement Marking Conditions, SR 83 Looking South.....	5
Photo 3: Intersection Span Wire	5
Photo 4: Radar Detection System.....	5

List of Tables

Table 1: Roadway Data.....	4
Table 2: Peak Hour Volumes	6
Table 3: LOS Categories, Signalized Intersections	7
Table 4: Existing and No Build Capacity Results.....	7
Table 5: Storage Length Evaluation.....	8
Table 6: Existing Safety Analysis Results	11
Table 7: Proposed Capacity Analysis, Left Turn Phasing - 2043	13
Table 8: Proposed Capacity Analysis, Right Turn Lanes - 2043	14
Table 9: Proposed Capacity Analysis, 2x1 Roundabout - 2043	15
Table 10: Proposed Capacity Analysis, Single Lane Roundabout - 2033.....	15
Table 11: Proposed ECAT Summary, Short Term - 2023.....	16
Table 12: Proposed ECAT Summary, Medium Term - 2023	17
Table 13: Proposed ECAT Summary, Long Term - 2023.....	17
Table 14: Benefit-Cost Analysis	17

Appendices

Appendix A – *2017 Safety Study*

Appendix B – *2021 Signal Evaluation*

Appendix C – Existing Capacity Analysis (HCS)

Appendix D – Existing Crash Analysis (Diagram and CAM)

Appendix E – Existing Safety Analysis (ECAT)

Appendix F – Proposed Capacity Analysis (HCS)

Appendix G – Proposed Concept Designs

Appendix H – Proposed Safety Analysis (ECAT)

Appendix I – Cost Estimates and Benefit-Cost Analysis

1.0 Executive Summary

The purpose of this study is to analyze the existing safety and capacity conditions to determine potential countermeasures to decrease crash frequency at the SR 82 and SR 83 intersection in Eaton Township, Ohio. The study area has had the following priority intersection rankings, according to ODOT's HSIP list for rural intersections:

- #98 in 2021
- #124 in 2020
- #99 in 2018
- #83 in 2017
- #25 in 2016
- #35 in 2015

Land use surrounding the study intersection is a mix of commercial, residential, and municipal properties. Eaton Township's fire department and township hall are in the southeast corner of the intersection, and a Circle K gas station is in the northwest corner. East of the intersection features a private high school and residential subdivision.

Crash data from January 1, 2018 through December 31, 2022 was obtained for the study area from ODOT's *GIS Crash Analysis Tool* (GCAT). In the five-year period, 28 crashes occurred in the study area with 43 percent resulting in injury. There were no fatalities during the study period and one serious injury. The most prevalent crash type was rear end, which made up 64 percent of all crashes. This was followed by Angle crashes, which made up 14 percent of all crashes, and Left Turn crashes which made up 11 percent of all crashes. Compared to the statewide average crash rates for rural signalized intersections, rear end was the only type that exceeded the statewide average – by nearly 33 percent.

According to Highway Safety Manual principles, the intersection experiences approximately 0.47 fewer crashes per year than predicted based on the intersection roadway characteristics and traffic volumes. However, there are slightly more fatal and injury crashes than would be predicted.

Based on the crash patterns and traffic operations at the SR 82 and SR 83 intersection, the following alternatives are proposed:

Short Term:

- Install supplemental traffic signal heads on new support poles at all approaches.
- Upgrade existing advance warning signage with dual Signal Ahead (W3-3) signs with street name plaques (W16-8P) at all approaches.
- Install emergency vehicle preemption.
- Consider driveway consolidation at the northeast corner of the intersection.

Medium Term:

- Construct right turn lanes on the eastbound and westbound approaches.
- Convert the signal head span wire layout to a mast arm design.
 - Estimated Cost: \$2,705,800 (2024 dollars)
 - Estimated Benefit/Cost Ratio = 0.09

Long Term:

- Construct a multilane roundabout with bypass lanes.
 - Estimated Cost: \$4,130,100 (2024 dollars)
 - Estimated Benefit/Cost Ratio = 0.43

Implementation of short term countermeasures is predicted to reduce total crash frequency by approximately 0.26 crashes per year. Implementation of medium term countermeasures is predicted to reduce total crash frequency by approximately 0.63 crashes per year. Implementation of long term countermeasures is predicted to reduce fatal and injury crash frequency by approximately 1.22 crashes per year.

2.0 Purpose & Location

The intersection of State Route 82 and State Route 83 is a signalized rural intersection located in Eaton Township. The intersection has been consistently ranked on the Ohio Department of Transportation (ODOT) Highway Safety Improvement Program (HSIP) Rural Intersection list. Historical rankings are as follows:

- #98 in 2021
- #124 in 2020
- #99 in 2018
- #83 in 2017
- #25 in 2016
- #35 in 2015

The ranking improved between 2015 and 2018 but has remained relatively stagnant since 2018. The purpose of this study is to analyze the existing safety and capacity conditions to determine potential countermeasures to improve safety at the intersection. The study area is shown below in **Figure 1**.



Figure 1: Study Area

3.0 Previous Studies

The intersection at State Route 82 and State Route 83 has been studied nearly a dozen times, dating back as early as 1991. The most recent studies included a 2017 safety study and a 2021 signal evaluation report, both authored by ODOT. A copy of these reports is included in **Appendix A** and **Appendix B**, respectively. Findings and outcomes of these studies are summarized below.

2017 Safety Study Findings and Outcomes

- Crash highlights (2013-2015 data)
 - 23 total crashes
 - 35 percent injury rate (no serious injuries), 0 fatalities

- Most prevalent crash type was rear end (39 percent of all crashes), followed by angle (22 percent of all crashes)
- Traffic Capacity highlights (2016 data)
 - No concerns were noted with existing intersection capacity.
- Short Term Recommendations – (all completed)
 - Update clearance intervals and max green times for the signal.
 - Replace the existing loop detection system with radar detection.
 - Install “No Left Turn” and “Do Not Enter” signage and vertical lane separators to prevent left turns out of the Circle K driveway on SR 83. **Photo 1** shows the current Circle K right in/right out signing and center line delineators. The plastic delineators were initially installed in 2017 but extended in 2021 after illegal U-turns persisted. One such crash from 2019 is noted on the crash diagram in **Appendix D**.



Photo 1: Circle K Driveway, North of Study Intersection

- Medium Term Recommendations – (none completed)
 - Install protected left turn phases OR
 - Install a single lane roundabout.

2021 Signal Evaluation Report Findings and Outcomes

- Signal is warranted.
- Clearance intervals are appropriate.
- Crash highlights (2016-2020 data)
 - 19 total crashes
 - 37 percent injury rate, 0 fatalities
 - Most prevalent crash type was rear end (37 percent of all crashes), followed by angle (32 percent of all crashes)
- Traffic Capacity highlights (2021 data)
 - No concerns were noted with existing intersection capacity.
- Recommendations
 - Reduce signal passage time to 2 seconds. (completed in February 2022)
 - Install emergency vehicle preemption. (not completed)
 - Evaluate addition of left turn phases for northbound and southbound traffic (evaluation completed, and not recommended for implementation).

4.0 Existing Conditions

Land Use

Land use surrounding the study intersection is a mix of commercial, residential, and municipal properties. Eaton Township's fire department and township hall are southeast of the intersection, and a Circle K gas station is in the northwest corner. East of the intersection features a private high school and residential subdivision.

Roadway Conditions

SR 82 is classified as a rural minor arterial with a speed limit of 50 mph. SR 83 is classified as a rural major collector with a speed limit of 55 mph. Pertinent roadway data is summarized in **Table 1**.

Table 1: Roadway Data

	Volume (2023 AADT)*	Classification	Speed Limit
SR 82	9,123	Rural Minor Arterial	50 mph
SR 83	7,214	Rural Major Collector	55 mph

*AADT volumes according to ODOT MS2 data, and not directly at the intersection. SR 82 volume was from west of Durkee Road. SR 83 volume was north of SR 82.

Each roadway is constructed of asphalt material in good condition. They intersect at a 90-degree angle. At the intersection, ditches run along the northwest and southwest quadrants and drainage grates collect water in the northeast quadrant. Lane widths are 12 feet throughout, and shoulder widths vary between four and eight feet. Several driveways are present within 200 feet of the intersection area.

Intersection Conditions

The lane configuration at the SR 82/SR 83 intersection is shown in **Figure 2**. Each approach features a left turn and thru/right lane with lane control signs at the beginning of each left turn lane taper.

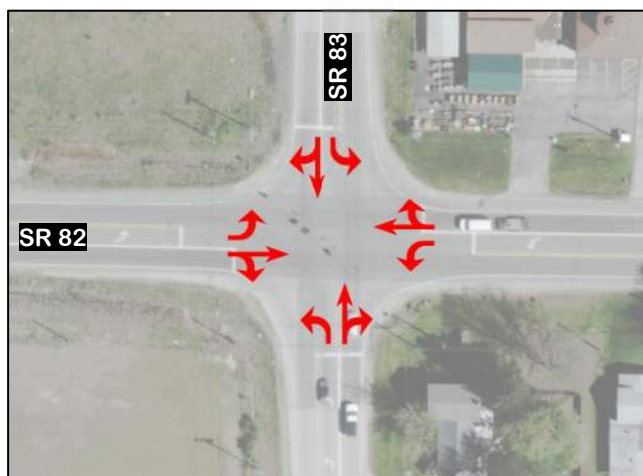


Figure 2: Intersection Lane Configuration

Advanced Signal Ahead (W3-3) signage is also present on three of the four approaches. The eastbound approach does not have an existing Advanced Signal Ahead sign. All signage and pavement markings are legible and in good condition (**Photo 2**). The intersection is lighted by one luminaire with additional supplemental lighting supplied by the surrounding businesses. No pedestrian amenities such as crosswalks or curb ramps are present.



Photo 2: Signage and Pavement Marking Conditions, SR 83 Looking South

The intersection is controlled by a diagonal span wire signal with two three-section signal heads per approach. The diagonal span is constructed with two strain poles – one in the northwest corner and another in the southeast corner. All signal heads are tethered and equipped with reflective backplates (Photo 3).

There are no pedestrian accommodations such as pedestrian signal heads or push buttons. The signal runs on a two-phase operation (permitted-only left turns), actuated by a radar system that includes stop bar detection and advanced dilemma zone detection on all approaches (Photo 4).



Photo 3: Intersection Span Wire



Photo 4: Radar Detection System

5.0 Existing Capacity Analysis

Traffic counts were collected at the intersection on September 14, 2021 from 6:00 AM and 6:00 PM. Based on this count data the peak hours were determined to be 7:15-8:15 AM and 4:00-5:00 PM. Current year (2023) and design year (2043) traffic volumes were calculated using growth rates and design hour volume (DHV) factors obtained from ODOT's Traffic Forecasting and Modeling Section. These rates and factors are as follows:

- East and West approaches = 0.6% annual growth rate
- North approach = 0.25% annual growth rate
- South approach = 0.4% annual growth rate
- SR 82 DHV = 1.17 (east and west approaches)
- SR 83 DHV = 1.12 (north and south approaches)

Traffic counts from 2021 can be found within the 2021 *Signal Evaluation* report in **Appendix B**. AM and PM peak period volumes for 2021, 2023 and 2043 are also summarized in **Table 2**, calculated based on the criteria above.

Table 2: Peak Hour Volumes

Year	Peak Period	Eastbound			Westbound			Northbound			Southbound		
		LT	Thru	RT	LT	Thru	RT	LT	Thru	RT	LT	Thru	RT
2021	7:15 AM	68	396	124	43	377	103	195	294	74	117	171	40
2021	4:00 PM	55	395	161	94	450	73	157	205	43	148	329	53
2023	7:15 AM	69	401	125	44	382	104	197	296	75	118	172	40
2023	4:00 PM	56	400	163	95	455	74	158	207	43	149	331	53
2043	7:15 AM	77	448	140	49	427	117	212	320	81	123	180	42
2043	4:00 PM	62	447	182	106	509	83	171	223	47	156	347	56

Existing and future intersection capacity analysis was performed using HCS 2023 capacity analysis software. HCS output is presented in the form of four measures of effectiveness:

Control Delay: defined as the additional travel time experienced per vehicle because of the presence of traffic control devices.

Level of Service (LOS): a qualitative measure used to define how well vehicles travel through an intersection. LOS classifications range from A through F, as defined in **Table 3**. Generally, intersections ranked LOS D or better are considered acceptable.

Table 3: LOS Categories, Signalized Intersections

LOS Classification	Control Delay (sec/veh)	Description
A	Less than or equal to 10	Free flow conditions
B	Greater than 10 and less than 20	Reasonably free flow conditions
C	Greater than 20 and less than 35	Stable flow conditions
D	Greater than 35 and less than 55	Approaching unstable flow conditions
E	Greater than 55 and less than 80	Unstable flow conditions, operating at capacity
F	Greater than 80	Breakdown or failing conditions

V/C Ratio: defined as the volume to capacity ratio, used to measure an intersection's ability to accommodate the vehicular demand. Ratios greater than 1.0 indicate that demand is exceeding capacity. Generally, ratios of 0.85 or less are deemed acceptable and vehicles are not expected to experience significant delay.

95th Percentile Queue: defined as the queue length with a 5% probability of being exceeded during the peak hour period.

Results are summarized in **Table 4**. Detailed reports are provided in **Appendix C**

Table 4: Existing and No Build Capacity Results

Peak	Movement	2023				2043			
		LOS	Delay (sec)	V/C	95 th % Queue (feet)	LOS	Delay (sec)	V/C	95 th % Queue (feet)
AM Peak	EB LT	C	32.7	0.31	65	D	42.1	0.41	94
	EB THRU/RT	C	23.1	0.75	364	C	30.0	0.81	504
	WB LT	C	32.9	0.22	43	D	42.3	0.30	61
	WB THRU/RT	C	22.0	0.71	341	C	28.0	0.77	469
	NB LT	C	27.4	0.51	171	C	32.7	0.56	223
	NB THRU/RT	C	21.6	0.59	259	C	25.4	0.62	330
	SB LT	C	32.6	0.45	115	D	40.1	0.52	151
	SB THRU/RT	B	18.5	0.34	141	C	21.3	0.35	181
	Overall	C	23.6			C	29.3		
PM Peak	EB LT	C	34.0	0.23	56	D	42.3	0.32	74
	EB THRU/RT	C	25.8	0.74	422	C	33.3	0.83	555
	WB LT	D	40.5	0.45	107	E	60.2	0.68	162
	WB THRU/RT	C	23.6	0.67	381	C	29.0	0.76	491
	NB LT	D	38.6	0.57	175	D	43.5	0.63	211
	NB THRU/RT	C	21.3	0.36	186	C	22.4	0.38	215
	SB LT	C	29.5	0.39	140	C	32.0	0.42	162
	SB THRU/RT	C	24.1	0.57	293	C	25.5	0.58	328
	Overall	C	26.5			C	31.8		

Results show that overall, the intersection is currently operating acceptably with most movements performing at LOS C during both the AM and PM peak hours. With no improvements the intersection will operate with a slight increase in delay during the design year, 2043. Several left turn lanes are expected to operate at LOS D during the peak hours, and the WB left turn lane is expected to operate at capacity in the PM peak hour. The v/c ratios are acceptable in both 2023 and 2043.

Storage Length Calculations

Existing left turn lane lengths were calculated and compared to the existing condition using the methodology as defined in ODOT's Location and Design Manual, Volume 2, Section 400. Findings are summarized in **Table 5**.

Table 5: Storage Length Evaluation

Approach (Hour)	Existing Turn Lane Length (Feet)	Calculated Left Turn Lane Storage Length, Condition C (Feet)	Calculated Thru Lane Storage Length (Feet)	Thru- Block? (Yes/No)	Recommended Turn Lane Length (Feet)
NB Left (AM)	340	440	450	Yes	340* (matches existing)
NB Left (PM)		415	350	No	
SB Left (AM)	320	340	275	No	320* (matches existing)
SB Left (PM)		365	475	Yes	
EB Left (AM)	265	295	625	Yes	555*
EB Left (PM)		245	675	Yes	
WB Left (AM)	240	245	550	Yes	500*
WB Left (PM)		320	625	Yes	

*Denotes recommendation is based on 95th queue lengths calculated by HCS.

Note – calculations are based on projected 2043 traffic volumes.

Storage length calculations show that the existing left turn lanes on all approaches experience thru-lane storage block. This means that the queues in the thru lane extend to a point beyond the left turn lane taper that prevents left turning vehicles from entering the turn lane. These calculations were compared against the 95th percentile queue lengths calculated by HCS. The 95th percentile queue lengths also show that thru-block is an issue on the eastbound and westbound approaches – the thru lane queues extend over 250 feet beyond where the left turn lane begins. According to HCS output, thru block is not an issue on the northbound and southbound approaches because the thru lane queues match the left turn lane lengths.

6.0 Existing Safety Analysis

Crash Trends Analysis

Crash data from January 1, 2018 through December 31, 2022 was obtained for the study area from ODOT's GIS Crash Analysis Tool (GCAT) and analyzed using ODOT's Crash Analysis Module (CAM) tool. In the five-year period, 28 crashes occurred in the study area with 43 percent resulting in injury. There were no fatalities reported during this period. One serious injury crash occurred on Tuesday, August 3, 2021 during the 8 AM hour when an eastbound vehicle was rear ended by another eastbound vehicle when stopped at a red light. The weather conditions were clear, and the pavement conditions were

dry. The primary contributing factor was noted as failure to assure clear stopping distance. Drug usage was also a suspected contributing factor.

Figure 3 shows the breakdown of crashes by severity per year. The years 2019 and 2021 experienced the highest frequency of crashes, both with eight total crashes. These same years experienced the highest frequency of injury crashes as well, with four injury crashes in 2019 and three injury crashes in 2021. Compared to the statewide average crash rates for rural signalized intersections, the overall injury rate at SR 82/SR 83 exceeds the statewide average by over 17 percent.

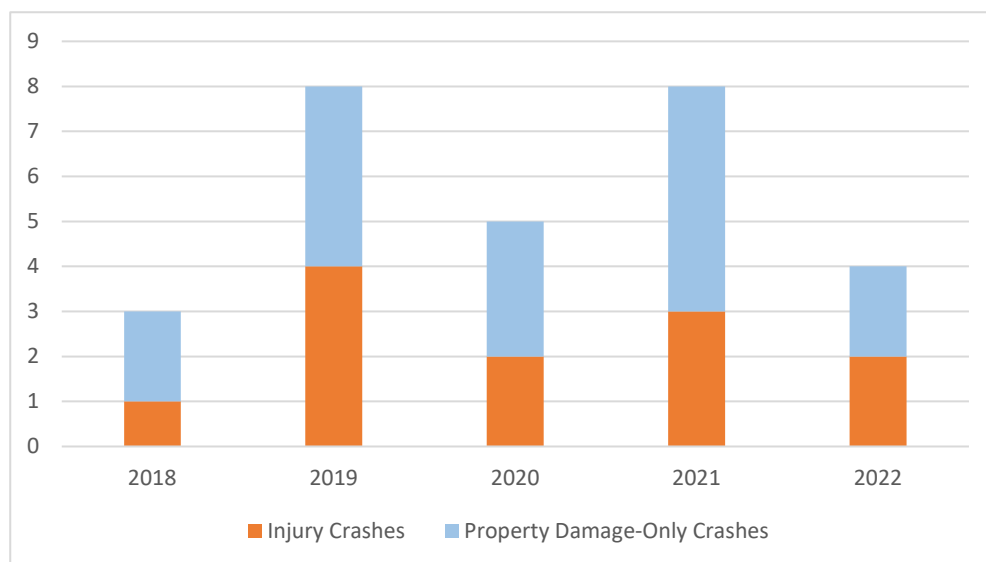


Figure 3: Crash Summary by Year

Figure 4 summarizes the crashes by type at the SR 82 and SR 83 intersection. The most prevalent crash type was rear end, which made up 64 percent of all crashes. This was followed by Angle crashes, which made up 14 percent of all crashes, and Left Turn crashes which made up 11 percent of all crashes. Compared to the statewide average crash rates for rural signalized intersections, rear end was the only type that exceeded the statewide average – by nearly 33 percent.

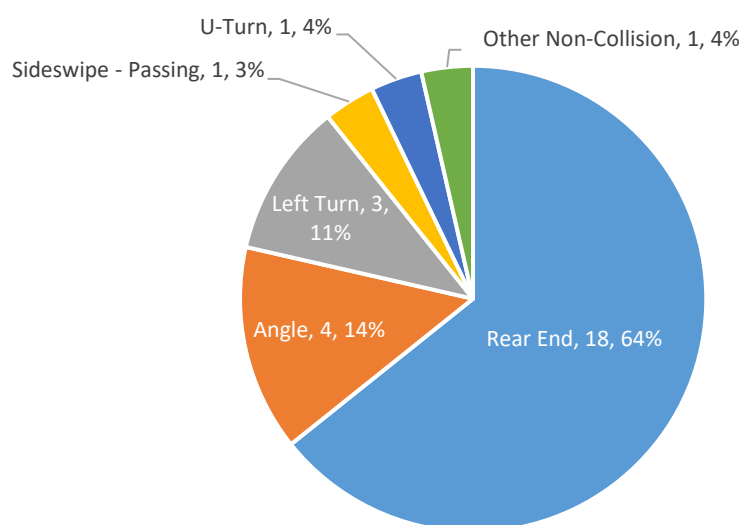


Figure 4: Crash Summary by Type

Rear end crashes were evenly distributed across all approaches, but most frequently occurred in the thru travel lanes. Out of the 18 total rear end crashes, seven resulted in injury. Most rear end crashes cited “failure to assure clear stopping distance” as the primary contributing factor. Two crashes reported unsafe speeds as the primary contributing factor.

Although not directly reported in the crash reports, the frequency of rear end crashes may also be related to emergency vehicles passing through the intersection. A fire department is in the southeast corner of the intersection, and when emergency personnel are dispatched from the station vehicles traveling in the area should slow or pull to the side of the road to allow the emergency vehicle to pass. If trailing vehicles don’t realize what is happening, it could be contributing to rear end crashes. Additionally, all approaches experience a high percentage of truck volumes (as high as 14% in the AM peak hour) which could restrict signal visibility.

Angle and left turn crashes were also evenly distributed across all approaches, and all noted “ran red light” or “failure to yield” as the primary contributing factor. Three of the four angle crashes occurred under wet or snowy conditions. Overall, the frequency of angle and left turn crashes has decreased in recent years. This is partially due to the elimination of left turns in and out of the east Circle K driveway by installing “No Left Turn” signage and plastic delineators. Per District 3 staff, the plastic delineators were initially installed in 2017 but extended in 2021 after illegal U-turns continued to persist. One such crash from 2019 is noted on the crash diagram in **Appendix D**.

Age, impaired driving, and distraction were factors reported in some crashes:

- For at-fault drivers, 29 percent were between the ages of 16-25. Due to inexperience, young drivers are more likely to make errors when driving such as hesitating and/or misjudging turning maneuvers. Young drivers are also more likely to drive too fast for the road conditions, run red lights, follow vehicles too closely and make riskier turning movements. Two of the four angle crashes reported were caused by drivers under the age of 25 running the red light. A left turn and a U-turn crash were also caused by young drivers misjudging the conditions of oncoming traffic. There were no observed trends between school arrival/dismissal hours and crashes involving young drivers.
- Four crashes (14 percent) were caused by drivers under the influence of drugs or alcohol. Impaired driving causes delayed response times and reduces the ability to control the vehicle. All impaired driving crashes in the study area resulted in rear end crashes. There were no trends noted between age and driving under the influence.
- Distracted driving was a reported factor in 11 percent of the study period’s crashes, though the total number may be much greater due to at-fault drivers’ reluctance on self-admission. Two angle crashes were caused by distracted drivers failing to stop at the red light.

A detailed crash diagram and CAM tool output is provided in **Appendix D**.

Safety Performance Analysis

Highway Safety Manual methodology was applied using ODOT’s Economic Crash Analysis Tool (ECAT). This process allows users to assess the existing safety performance of a location based on a combination of historical crash data, existing roadway characteristics, and traffic volumes. The analysis output is provided via three values, defined below.

Predicted Crash Frequency ($N_{PREDICTED}$) – defined as how a site would be expected to perform relative to 1,000 sites with comparable roadway characteristics and traffic volumes. This value is presented using units of crashes per year, and commonly broken down according to injury severity level.

Expected Crash Frequency ($N_{EXPECTED}$) – defined as the average performance of a site, normalized over an extended period based on actual crash history. This value is presented using units of crashes per year, and commonly broken down according to injury severity level.

Potential for Safety Improvement (N_{PSI}) – Difference between Expected Crash Frequency and Predicted Crash Frequency. A positive value indicates that the location is performing poorly compared to similar locations and safety improvements would likely have a significant impact on reducing crash frequency.

Injury Severity Levels are based on FHWA's KABCO rating scale where: K refers to fatal injury crash, A represents incapacitating injury crash, B refers to non-incapacitating injury crash, C represents possible injury, and O refers to no injury/property damage only.

Existing condition ECAT results are summarized in **Table 6**. The detailed output is included in **Appendix E**.

Table 6: Existing Safety Analysis Results

	KA	B	C	O	Total
$N_{PREDICTED}$ - Existing Conditions	0.15	0.63	0.79	4.72	6.28
$N_{EXPECTED}$ - Existing Conditions	0.16	0.67	0.85	4.13	5.82
N_{PSI} - Existing Conditions	0.01	0.05	0.06	-0.59	-0.47

Findings show the intersection is performing better than would be predicted based on the roadway characteristics and traffic volumes. The intersection experiences approximately 0.47 fewer crashes than predicted per year. However, there are slightly more fatal and injury crashes than would be predicted.

7.0 Countermeasures for Consideration

The following countermeasure were identified to mitigate crashes and improve safety within the study area:

Short Term:

- Install supplemental traffic signal heads on new support poles at all approaches.

The purpose of this countermeasure is to help improve signal head visibility. The intersection experiences heavy truck traffic (14 percent), which restricts signal head visibility and could be contributing to the frequency of rear end crashes at the intersection. Additionally, according to ODOT's Traffic Engineering Manual Section 420-4.12, approaches to traffic signals with high truck percentages (10 percent or greater) and/or high approach speeds (45 mph or greater) should include one or more supplemental signal heads.

- Upgrade existing advance warning signage with dual Signal Ahead (W3-3) signs with street name plaques (W16-8P) on all approaches.

Like the recommendation for supplemental signal heads, the purpose of this countermeasure is to bring increased awareness of the approaching signal. Due to the high speeds approaching the intersection – 50 mph posted speed limit on the eastbound and westbound approaches, and 55 mph posted speed limit on the northbound and southbound approaches, improved signage can bring increased awareness of the approaching decision point and notify drivers that they may experience slow or stopped traffic ahead. Dual signage can help with sign visibility restrictions that may be caused by truck traffic.

- Install emergency vehicle preemption.

Although no crashes explicitly noted conflicts with emergency vehicles in the area, this is not something that always shows up in the crash reports, especially if the crash did not directly involve an emergency vehicle. The fire department is located in the southeast corner of the intersection, so emergency vehicle presence is certain.

- Consider driveway consolidation in the northeast corner of the intersection.

Although not specifically identified as a concern based on the crash data, the commercial property in the northeast corner of the intersection currently has three driveways all within the functional intersection area. The number and location of the driveways can cause increased and unnecessary turbulence. Beginning discussions with the property owner can be a proactive approach to prevent future crashes.

Medium Term:

- Construct right turn lanes on the eastbound and westbound approaches.

Queue length analysis showed excessive queueing in the eastbound and westbound thru lanes that extends to a point that prevents full utilization of the existing left turn lanes. The purpose of right turn lanes at the intersection is to provide additional storage capacity. Additionally, 22 percent of thru lane volumes turn right.

The team also considered less invasive intersection improvements such as signal timing improvements but found that improvements such as lagging protected/permmissive left turn lanes degraded intersection LOS to an unacceptable level. Details are provided in the next section of this study.

- Convert the signal head span wire layout to a mast arm design.

Mast arm signal designs can improve signal head alignment and visibility compared to the existing diagonal span wire layout.

Long Term:

- Construct a multi-lane roundabout with bypass lanes.

Roundabouts have been proven to reduce crash severity at intersections, which was noted as a concern in the existing safety analysis. The team evaluated both single lane

and multi-lane roundabout configurations. Details are provided in the next section of this study.

8.0 Countermeasure Evaluation

Operational Evaluation

Operational analysis was conducted with *HCS* software for two medium term scenarios - proposed lagging protected-permitted left turn phasing, and addition of eastbound and westbound right turn lanes. *HCS* results for lagging protected-permitted left turn phasing is shown in **Table 7**, and results for the addition of right turn lanes is shown in **Table 8**. All analysis was performed using design year (2043) volumes. Detailed *HCS* reports are provided in **Appendix F**.

Table 7: Proposed Capacity Analysis, Left Turn Phasing - 2043

Peak	Movement	2043 No Build				2043 Build Lagging Protected/Permitted Left Turn Phasing			
		LOS	Delay (sec)	V/C	95 th % Queue	LOS	Delay (sec)	V/C	95 th % Queue
AM Peak	EB LT	D	42.1	0.41	94	D	50.9	0.41	107
	EB THRU/RT	C	30.0	0.81	504	D	53.7	0.94	714
	WB LT	D	42.3	0.30	61	D	53.0	0.33	71
	WB THRU/RT	C	28.0	0.77	469	D	52.1	0.93	676
	NB LT	C	32.7	0.56	223	D	47.2	0.66	274
	NB THRU/RT	C	25.4	0.62	330	E	68.8	0.94	570
	SB LT	D	40.1	0.52	151	E	57.2	0.83	190
	SB THRU/RT	C	21.3	0.35	181	E	58.7	0.87	323
	Overall	C	29.3			E	56.0		
PM Peak	EB LT	D	42.3	0.32	74	D	53.9	0.29	89
	EB THRU/RT	C	33.3	0.83	555	E	62.0	0.96	816
	WB LT	E	60.2	0.68	162	E	61.8	0.75	166
	WB THRU/RT	C	29.0	0.76	491	E	65.7	0.96	790
	NB LT	D	43.5	0.63	211	E	67.7	0.87	266
	NB THRU/RT	C	22.4	0.38	215	E	66.6	0.89	392
	SB LT	C	32.0	0.42	162	D	46.7	0.47	211
	SB THRU/RT	C	25.5	0.58	328	E	69.6	0.93	580
	Overall	C	31.8			E	63.9		

Left turn phasing results show that any adjustments to left turn phasing will have unacceptable negative impacts to intersection capacity. All movements are at or approaching unstable flow conditions in 2043 and all thru lanes experience V/C ratios that indicate the lane is nearing maximum capacity.

With the addition of eastbound and westbound right turn lanes, results show that all movements are expected to operate acceptably.

See **Appendix G** for a concept design showing eastbound and westbound right turn lane additions.

Table 8: Proposed Capacity Analysis, Right Turn Lanes – 2043

Peak	Movement	2043 Build Eastbound/Westbound Right Turn Lanes			
		LOS	Delay (sec)	V/C	95 th % Queue
AM Peak	EB LT	B	18.6	0.26	35
	EB THRU	B	14.7	0.67	165
	EB RT	B	10.1	0.25	38
	WB LT	B	18.0	0.17	22
	WB THRU	B	14.2	0.66	156
	WB RT	A	9.9	0.21	32
	NB LT	C	23.2	0.61	114
	NB THRU/RT	C	23.2	0.79	207
	SB LT	C	27.9	0.58	78
	SB THRU/RT	B	14.1	0.45	79
	Overall	B	17.3		
PM Peak	EB LT	B	19.3	0.23	27
	EB THRU	B	13.7	0.63	147
	EB RT	B	10.3	0.30	47
	WB LT	B	18.7	0.34	46
	WB THRU	B	15.9	0.72	187
	WB RT	A	9.4	0.14	20
	NB LT	C	34.7	0.73	118
	NB THRU/RT	B	14.5	0.50	91
	SB LT	C	20.5	0.47	71
	SB THRU/RT	C	21.0	0.75	184
	Overall	B	17.4		

Operational analysis was also conducted to determine the smallest roundabout size that would operate acceptably from a traffic capacity perspective. This was determined to be a 2x1 roundabout - meaning two entering lanes on the eastbound and westbound approaches with one entering lane on the northbound and southbound approaches - with northbound and southbound right turn bypass lanes.

HCS results are summarized in **Table 9**, and detailed HCS reports are provided in **Appendix F**.

Results show that all movements operate acceptably, although the northbound left/thru lane begins to approach capacity in the AM peak hour and the southbound left/thru begins to approach capacity in the PM peak hour.

See **Appendix G** for the proposed roundabout concept design.

Table 9: Proposed Capacity Analysis, 2x1 Roundabout – 2043

Peak	Movement	2043 Build			
		LOS	Delay (sec)	V/C	95 th % Queue
AM Peak	EB LT/THRU	A	8.4	0.38	45
	EB RT/THRU	A	9.1	0.42	53
	WB LT/THRU	B	12.2	0.45	60
	WB RT/THRU	B	13.7	0.51	73
	NB LT/THRU	D	31.4	0.84	235
	NB RT	A	7.3	0.14	13
	SB LT/THRU	B	14.5	0.52	75
	SB RT	A	7.4	0.08	8
	Overall	C	16.0		
PM Peak	EB LT/THRU	B	11.5	0.47	63
	EB RT/THRU	B	12.9	0.52	78
	WB LT/THRU	A	9.0	0.40	48
	WB RT/THRU	A	9.9	0.45	60
	NB LT/THRU	B	14.3	0.57	93
	NB RT	A	6.3	0.07	5
	SB LT/THRU	D	31.5	0.83	220
	SB RT	A	7.2	0.10	8
	Overall	C	15.6		

At the request of ODOT District 3, a single lane roundabout with bypass lanes on all approaches was analyzed using 2033 volumes. HCS results are shown in **Table 10**.

Table 10: Proposed Capacity Analysis, Single Lane Roundabout – 2033

Peak	Movement	2033 Single Lane Roundabout			
		LOS	Delay (sec)	V/C	95 th % Queue
AM Peak	EB THRU/LT	B	14.9	0.64	118
	EB RT	A	5.1	0.15	13
	WB THRU/LT	D	28.8	0.79	193
	WB RT	A	6.2	0.15	13
	NB THRU/LT	E	45.6	0.92	290
	NB RT	A	7.0	0.13	10
	SB THRU/LT	C	18.2	0.58	93
	SB RT	A	7.1	0.08	5
	Overall	C	24.2		
PM Peak	EB THRU/LT	C	23.6	0.75	170
	EB RT	A	7.0	0.23	23
	WB THRU/LT	C	20.8	0.76	180
	WB RT	A	4.5	0.08	8
	NB THRU/LT	C	17.5	0.62	108
	NB RT	A	6.0	0.07	5
	SB THRU/LT	E	48.4	0.92	285
	SB RT	A	6.9	0.09	8
	Overall	C	24.5		

Safety Performance Analysis

Like the existing safety analysis, Highway Safety Manual methodology was applied using ODOT's ECAT to assess the predicted safety performance of the recommended countermeasures.

Short Term Safety Analysis

Short term recommendations include:

- Install supplemental traffic signal heads.
- Upgrade existing and install new dual advance "Signal Ahead" signage.
- Install emergency vehicle preemption.
- Consider driveway consolidation in the northeast corner of the intersection.

Based on these recommendations, the following Crash Modification Factor (CMF) was applied:

- Implement Systemic Signing and Visibility Improvements at Signalized Intersections
 - CMF = 0.955 for all crash types, severities, and area types
 - Study = *Safety Effects of Low-Cost Systemic Safety Improvements at Signalized and Stop-Controlled Intersections*, Le Et al., 2017

No published research was found regarding the safety effectiveness of emergency vehicle preemption, but this does not mean safety benefits will not be realized. Also, because the crash data did not identify an existing problem and to avoid overestimating safety benefits, no CMF was applied for driveway consolidation. Predicted safety performance of the short term recommendations are summarized in **Table 11**. Detailed ECAT output and CMF documentation is provided in **Appendix H**.

Table 11: Proposed ECAT Summary, Short Term – 2023

	KA	B	C	O	Total
N_{EXPECTED} - Existing Conditions (2023)	0.16	0.67	0.85	4.13	5.82
N_{EXPECTED} – Prop. Short-Term Conditions (2023)	0.15	0.64	0.81	3.95	5.56
Difference	-0.01	-0.03	-0.04	-0.18	-0.26

Results show that implementation of the short term countermeasures is predicted to reduce total crash frequency by approximately 0.26 crashes per year. This crash reduction should be realized across all crash severity levels, but the largest benefit is expected in PDO crashes.

Medium Term Safety Analysis

Medium term recommendations include:

- Install right turn lanes on the eastbound and westbound approaches.
- Install new signal with mast arm design.

Based on these recommendations, the following CMF was applied:

- Install Mast Arm Signals
 - CMF = 0.97 for all crash types, in all area types
 - Study = *Evaluating the Safety Effects of Span Wire to Mast Arm Signal Conversion*, Khattak and Fontaine, 2018

Predicted safety performance of the medium term recommendations are summarized in **Table 12**. Full ECAT output and CMF documentation is provided in **Appendix H**.

Table 12: Proposed ECAT Summary, Medium Term – 2023

	KA	B	C	O	Total
N_{EXPECTED} – Existing Conditions (2023)	0.16	0.67	0.85	4.13	5.82
N_{EXPECTED} – Prop. Medium Term Conditions (2023)	0.14	0.60	0.76	3.68	5.19
Difference	-0.02	-0.07	-0.09	-0.45	-0.63

Results show that implementation of medium term countermeasures is predicted to reduce total crash frequency by approximately 0.63 crashes per year. This crash reduction should be realized across all crash severity levels, but the largest benefit is expected in PDO crashes.

Long Term Safety Analysis

Long term recommendations include:

- Install 2x1 roundabout with northbound and southbound right turn bypass lanes.

The safety performance for the roundabout was performed as a function of the ECAT/safety performance functions without utilizing CMFs. The ECAT analysis is summarized in **Table 13**, and the full analysis can be found in **Appendix H**.

Table 13: Proposed ECAT Summary, Long Term – 2023

	KA	B	C	O	Total
N_{PREDICTED} – Existing Conditions (2023)	0.15	0.63	0.79	4.72	6.28
N_{PREDICTED} – Prop. Long Term Conditions (2023)	0.02	0.15	0.18	6.97	7.32
Difference	-0.13	-0.48	-0.61	2.25	1.04

Results show that implementation of the long term countermeasure is predicted to reduce fatal and injury crashes by approximately 1.22 crashes per year, but increase PDO crashes by roughly 2.25 crashes per year.

Benefit-Cost Analysis

Detailed cost estimates were developed for the addition of right turn lanes as well as the 2x1 roundabout. These costs were used in conjunction with the analysis results from ECAT to evaluate the benefit-cost ratio of each alternative. The benefit-cost analysis results are summarized in **Table 14**. Detailed cost estimates and benefit-cost reports are provided in **Appendix I**.

Table 14: Benefit-Cost Analysis

	Net Present Cost	Net Present Benefit	Benefit-Cost Ratio
Medium Term (add right turn lanes with signal upgrade)	\$2,705,800	\$252,911	0.09
Long Term (new 2x1 Roundabout)	\$4,130,100	\$1,784,110	0.43

In both alternatives, the benefit-cost ratio is below 1.0 which indicates there is more cost than safety benefit. The roundabout alternative would provide a better value since its benefit-cost ratio is higher than the right turn lane alternative.

9.0 Conclusions & Recommendations

Based on the crash patterns and traffic operations in the SR 82 and SR 83 intersection, the following alternatives are proposed:

Short Term:

- Install supplemental traffic signal heads on new support poles at all approaches.
- Upgrade existing advance warning signage with dual Signal Ahead (W3-3) signs with street name plaques (W16-8P) at all approaches.
- Install emergency vehicle preemption.
- Consider driveway consolidation in the northeast corner of the intersection.

Medium Term:

- Construct right turn lanes on the eastbound and westbound approaches.
- Convert the signal head span wire layout to a mast arm layout with four new poles.
 - Estimated Cost: \$2,705,800 (2024 dollars)

Long Term:

- Construct a multilane roundabout with bypass lanes.
 - Estimated Cost: \$4,130,100 (2024 dollars)

Medium term and long term alternatives cannot be chosen together, only one or the other as appropriate.

Appendix A – *2017 Safety Study*



SAFETY STUDY LORAIN CO. SR 82 SLM 2.57 SR 83 INTERSECTION

2015 HSIP RURAL INTERSECTION
NO. 35

*Jared D. Feller, P.E.
April 2017*



TABLE OF CONTENTS

Table of Contents

Executive Summary	1
Project Background	1
Purpose and Need	1
Crash History and Probable Causes	1
Recommended Countermeasures	2
Existing Conditions	3
Background	3
Physical Conditions	4
Crash Analysis	7
Crash Data	7
Crash Analysis	7
Probable Causes	9
Summary of Supplemental Traffic Studies	10
Safety Countermeasures	12
HSM Methodology	12
Proposed Countermeasures	13
Implementation Plan	16

Appendices

Crash Diagram	A
Existing Sign Diagram & Signal Plan	B
Turning Movement Count	C
HCM Analysis	D
HSM Outputs	E
Roundabout Concept Plan	F
ECAT Analysis	G

EXECUTIVE SUMMARY

Executive Summary

PROJECT BACKGROUND

The study intersection of State Route (SR) 82 and SR 83 in Lorain County is a four-leg signalized intersection in Eaton Township. SR 82 is an east-west road that begins at SR 57 between Grafton and Elyria and ends at US Route 62 near the Ohio/Pennsylvania state line. SR 83 is a north-south road that intersects SR 82 around 2.5 miles east of SR 57. **Figure 1** below shows a map of the study intersection.



FIGURE 1: STUDY INTERSECTION MAP

PURPOSE AND NEED

This safety study analyzes the crash patterns and proposes countermeasures at the intersection of SR 82 and SR 83 in Lorain County. This intersection was ranked number 35 on ODOT's 2015 HSIP list of rural intersections.

CRASH HISTORY AND PROBABLE CAUSES

Crashes at the SR 82 and SR 83 intersection from 2013-2015, taken from the Ohio Department of Public Safety's database, were analyzed for this study. There were a total of 23 crashes during that three-year period, these crashes are shown on the **Crash Diagram** in **Appendix A**. The following crash types are the most prevalent:

EXECUTIVE SUMMARY

• 8 Injury Crashes	35 percent
• 9 Rear End	39 percent
• 5 Angle (2 at Circle K Right-in/Right-out Drive)	22 percent
• 5 Crashes were associated with the Circle K right-in/right-out drive	22 percent
• 3 Left Turn (Southbound vehicle at-fault in all crashes)	13 percent
• 8 Crashes occurred between 4 – 6 PM	26 percent
• 12 Crashes occurred from June through August	52 percent
• 18 Crashes occurred on Dry Pavement	78 percent
• 8 Drivers at Fault 25 Years Old or Younger	26 percent
• 3 Drivers at fault were Distracted	13 percent

RECOMMENDED COUNTERMEASURES

- **Short-Term:** The yellow and all-red clearance intervals were updated in 2016 using the current equations from the ODOT Office of Traffic Operations. Also, the maximum green time on SR 83 was increased in 2017 from 30 to 50 seconds.

Additional signing should be installed at the Circle K right-in/right out drive. A 'No Left Turn' sign should be added for traffic exiting the drive and an additional 'Do Not Enter Sign' could be installed in the concrete island. This signing had been installed in the past, however, the signs were frequently knocked down. To physically prevent left turns from the right-in/right-out drive, a lane separator could be installed along the center line of SR 83.

The existing loop detection could be replaced with radar detection on all approaches. The SR 82 approaches have dilemma zone detection and the SR 83 approaches have stop bar and dilemma zone detection.

- **Medium-Term:** Add protected left turn phases at the SR 82 and SR 83 intersection, no protected left turn phases currently exist. By adding protected left turn phases, the operation of the intersection would be negatively affected due to an increase in the average delay.

A roundabout would reduce the number of angle and left turn crashes at the SR 82 and SR 83 intersection. By eliminating all crossing path vehicle conflicts and slowing intersection traffic down, a roundabout would significantly increase safety at this intersection. The roundabout would improve the operation of the intersection when comparing the average intersection delay to the existing signal.

EXISTING CONDITIONS

Existing Conditions

BACKGROUND

In the study area, SR 82 is a two lane rural minor arterial roadway and SR 83 is a two lane rural major collector. All approaches have dedicated left turn lanes and shared through/right turn lanes at the intersection. Existing traffic information for SR 82 and SR 83 can be found below in **Tables 1 and 2**, respectively. Aside from a decrease in 2008, the Average Annual Daily Traffic (AADT) on SR 82 and SR 83 has been fairly constant since the early 2000's. In 2014, the AADT on SR 82 was around 9,000 and was around 7,400 on SR 83.

TABLE 1 - ROADWAY TRAFFIC DATA: SR 82¹

YEAR	AADT	PERCENT TRUCKS
2014	9,037	9%
2011	9,160	6%
2008	7,900	6%
2004	9,280	6%

TABLE 2 - ROADWAY TRAFFIC DATA: SR 83¹

YEAR	AADT	PERCENT TRUCKS
2014	7,376	12%
2011	7,110	8%
2008	8,020	7%
2006	6,540	12%
2002	7,400	8%

¹ Ohio Department of Transportation, Office of Technical Services. (2017, February 6). MS2. Retrieved from Transportation Data Management System: <http://odot.ms2soft.com/tcds/tsearch.asp?loc=OdottOhio>

EXISTING CONDITIONS

This intersection has been studied for operational and safety improvements many times in the past. The list below shows times the SR 82 and SR 83 intersection was studied and the results of those studies.

- **1991** Safety Study: Left turn lanes installed on SR 82 in 1994.
- **1995** Safety Study: Left turn lanes installed on SR 83 in 2000/2001.
- **2001** Traffic signal installed at intersection.
- **2003** Signal Evaluation: No record of changes made.
- **2007** Operational and Speed Study: No changes made to intersection. Speed limit on SR 82 reduced from 55 to 45 MPH.
- **2016** Speed Zone Study: Speed limit on SR 82 increased from 45 to 50 MPH.
- **2016** Signal Evaluation: Increase the maximum green time on SR 83 from 30 seconds to 50 seconds. Yellow and all-red clearance intervals were updated in 2016.

PHYSICAL CONDITIONS

Both SR 82 and SR 83 are relatively straight, flat, two-lane rural roadways. There are many roadway and traffic control features in the vicinity of the intersection. These features are further explained below and the existing signs installed near the intersection can be found on the **Existing Sign Diagram** in **Appendix B**.

ROADWAY AND INTERSECTION

SR 82 is asphalt pavement with twelve foot lanes and four foot paved shoulders and SR 83 is asphalt pavement with twelve foot lanes and two foot paved shoulders. Both roadways are flat and straight, with land use being a mix of residential, commercial, and agricultural at the study intersection. The SR 82 and SR 83 intersection has a mixture of enclosed drainage and shallow ditches. These roads intersect at a 90 degree angle. There are multiple residential or commercial access points within 600 feet of the intersection on all approaches.

TRAFFIC CONTROL

All approaches to the SR 82 and SR 83 intersection have striped white edge lines and double yellow centerlines. At the intersection, all approaches include a left turn only lane and a shared through/right turn lane. All approaches have a stop bar in advance of the traffic signal, as well as channelizing lines and lane arrows for the left turn lanes. The posted speed limit on SR 82 is 50 mph and is 55 mph on SR 83. The intersection is lighted at night by a luminaire at the northwest corner of the intersection, as shown in **Photo 1**. Signal ahead warning signs and lane use signs are present on all approaches to the intersection.

EXISTING CONDITIONS



PHOTO 1- SOUTHBOUND INTERSECTION APPROACH

TRAFFIC SIGNAL

The traffic signal is a 175 foot long simple span with Design 11 strain poles at the northwest and southeast corners of the intersection. All signal heads are black, three-section heads with 12 inch LED bulbs and reflective backplates, hung on messenger wire and supported by tether wire. Each approach has two signal heads controlling the approach. Loop detectors are present on all approaches, SR 82 has advance dilemma zone detection and SR 83 has stop bar detection and advance dilemma zone detection. Additional signal information for each approach is shown in **Table 3** below:

TABLE 3 - SIGNAL APPROACH INFORMATION

ROADWAY	APPROACH	LEFT TURN LANES		STOP BAR TO SIGNAL HEAD	
		PRESENT	LENGTH (FT)	NEAR (FT)	FAR (FT)
SR 82	West (EB)	Yes	270	43	63
	East (WB)	Yes	245	42	62
SR 83	South (NB)	Yes	340	47	60
	North (SB)	Yes	325	43	60

The traffic signal is controlled by an eight-phase controller with a solid state digital microprocessor located in a cabinet in the southeast corner of the intersection. The signal runs on a two-phase operation. **Table 4** shows the signal timing settings for each phase and the existing signal plan can be found in **Appendix B**.

EXISTING CONDITIONS

TABLE 4 - SIGNAL TIMING SETTINGS

ROADWAY	APPROACH	PHASE	GREEN TIME(S)		CLEARANCE(S)		MIN RECALL
			MIN	MAX	YELLOW	ALL-RED	
SR 82	West (EB)	2	20	50	5.5	1.0	Yes
	East (WB)	6	20	50	5.5	1.0	Yes
SR 83	South (NB)	4	12	50	6.0	1.0	No
	North (SB)	8	12	50	6.0	1.0	No

CRASH ANALYSIS

Crash Analysis

CRASH DATA

Crashes near the SR 82 and SR 83 intersection from 2013-2015, taken from the Ohio Department of Public Safety's database, were analyzed for this study. There were a total of 23 crashes during that three-year period, as shown on the **Crash Diagram** in **Appendix A**. The most prevalent crash patterns from 2013-2015 are shown in **Table 5** below.

TABLE 5 - CRASH DATA 2013 – 2015

YEAR		SEVERITY		TYPE		ROAD CONDITION	
2013	4 (17%)	Fatal	0 (0%)	Rear End	9 (39%)	Dry	18 (78%)
2014	9 (39%)	Injury	8 (35%)	Angle	5 (22%)	Wet	3 (13%)
2015	10 (44%)	PDO	15 (65%)	Left Turn	3 (13%)	Snow	1 (4%)
				SS - Meeting	2 (9%)	Ice	1 (4%)
				Backing	2 (9%)		
				Right Turn	1 (4%)		
				SS - Passing	1 (4%)		
TOTAL	23 (100%)						

CRASH ANALYSIS

There were 16 crashes that occurred at the intersection of SR 82 and SR 83 from 2013-2015. The remaining 7 crashes occurred at drives near the intersection. A further review of the crash history at this intersection is provided below.

CRASH SEVERITY

Injury Crashes: There were eight injury crashes that occurred at or near the intersection from 2013-2015, the crash reports did not indicate any incapacitating/serious injuries. All injuries were recorded as possible or non-incapacitating.

CRASH TYPE

Rear End: There were a total of nine rear end crashes in the study area, which made up the majority of crashes. At the intersection, there were no more than two rear end crashes on a single approach and a total of six rear end crashes at the intersection. The at-fault driver was distracted in two of the rear end crashes. One rear end crash occurred on wet pavement and one occurred on icy pavement.

Angle: There were five angle crashes that occurred near the study intersection, three occurred at the intersection and two occurred at the Circle K right-in/right-out drive. One angle crash at the intersection involved a northbound driver who had a green light, but failed to yield to an eastbound police vehicle with

CRASH ANALYSIS

its lights and sirens activated. Another angle crash involved an eastbound driver who likely traveled through a red light shortly after the light changed to red. This assumption is due to the southbound vehicle's speed being 5 mph and there being no westbound vehicles queued at the intersection. The crash report for the third angle crash at the intersection did not indicate which driver was at fault, however, based on the statements from the drivers it is likely the eastbound driver was at-fault. Sun glare would not have been an issue due to the time of day that the angle crashes occurred.

Left Turn: There were three left turn crashes at the intersection, all three crashes involved southbound drivers that failed to yield to northbound traffic. Two of the left turn crashes involved southbound drivers who turned left in front of northbound traffic once the traffic signal changed from green to yellow. Both of these crashes occurred during the 7:00 am hour and involved drivers heading to the Christian Community School located to the east of the SR 82 and SR 83 intersection. The third left turn crash involved a teenage driver who turned in front of a northbound vehicle that they thought was slowing to allow them to turn left.

Backing: There were two backing crashes that occurred in the northbound left turn lane at the intersection. One of the crashes involved a box truck that was backing due to a semi-truck that turned too tight and the other was a passenger vehicle that was partially in the intersection waiting to turn left and backed up after the light turned red.

CONTRIBUTING FACTOR

The contributing factor in 65% (15/23) of the crashes was either failure to yield or following too closely/assured clear distance. These factors relate directly to the three types of crashes that occurred the most (rear end, angle, and left turn). Only one crash was attributed to unsafe speed.

OTHER CRASH PATTERNS

Driver Age: In six of the study area crashes the driver at-fault was 22 years old or younger. The types of crashes included three rear ends, one angle, one left turn, and one backing.

Access near the Intersection: There were a total of seven crashes that occurred at private drives near the intersection of SR 82 and SR 83. Six of the crashes involved vehicles making left turns into or out of a private drive, four of these crashes occurred at the Circle K right-in/right-out drive. Of the seven crashes that occurred at private drives, five occurred at the Circle K right-in/right-out drive.

2016 CRASHES

In 2016, there were seven crashes reported at the intersection. There were three angle crashes, one involved a distracted driver and one occurred at the Circle K right-in/right-out drive. There were two left turn crashes, a southbound 18 year old who was distracted was at-fault in one and a westbound 88 year old was at-fault in the other. The remaining two crashes were rear ends, one caused by a 16 year old and the other by a 19 year old.

CRASH ANALYSIS

PROBABLE CAUSES

The majority of the crashes that occurred in the area of the SR 82 and SR 83 intersection from 2013 – 2015 were rear end, angle, and left turn crashes. The rear end and angle crashes occurred at multiple locations near the study intersection, while the three left turn crashes were all caused by southbound drivers. There were also four crashes due to drivers turning left into or out of the Circle K right-in/right-out drive. These crash patterns require a deeper look to identify the root causes of crashes in the study area, and are further explored below.

Left-Turning Vehicles: Nine of the crashes (39%) involved left turning traffic. Three of the left turn crashes occurred when southbound drivers failed to yield to northbound traffic at the SR 82 and SR 83 intersection. The six remaining crashes due to left turning traffic occurred at private drives near the intersection. These six crashes were classified as either angle or rear end crashes. While reviewing the intersection on 2/15/2017 during the PM peak hour, there were 12 vehicles that turned left out of the Circle K right-in/right-out drive and one vehicle that turned left into this drive.

Driver Inexperience: Since young drivers (25 years old or younger) were at-fault in 26% of the study area crashes, driver inexperience likely played a significant role in the crash patterns at the intersection. Less experienced drivers often do not leave adequate gaps between their vehicle and the vehicle in front of them, leading to rear end crashes. Younger drivers also tend to be more aggressive, which could lead to an overall increased frequency of crashes. This is evident in one of the left turn crashes, as a 19 year old southbound driver thought a northbound driver was slowing to allow them to turn left in front of the northbound vehicle. Young drivers have a difficult time judging speed and distance (i.e. how fast a vehicle is approaching).

Driver Inattention: While only three of the crash reports indicated that the at-fault driver was distracted, it is likely driver inattention was a factor in most of the crashes. Driver inattention could have contributed to at least half of the crashes that occurred near the SR 82 and SR 83 intersection.

SUMMARY OF SUPPLEMENTAL TRAFFIC STUDIES

Summary of Supplemental Traffic Studies

TURNING MOVEMENT COUNT

A Turning Movement Count (TMC) is an intersection traffic count that records all vehicle turning movements. A TMC was completed for the SR 82 & SR 83 intersection to obtain updated traffic volumes. The traffic count was performed on February 16, 2016 between the hours of 7:00 AM and 7:00 PM. The AM and PM peak hour volumes are shown below in **Figure 2** and the full results of the Turning Movement Count can be found in **Appendix C**.

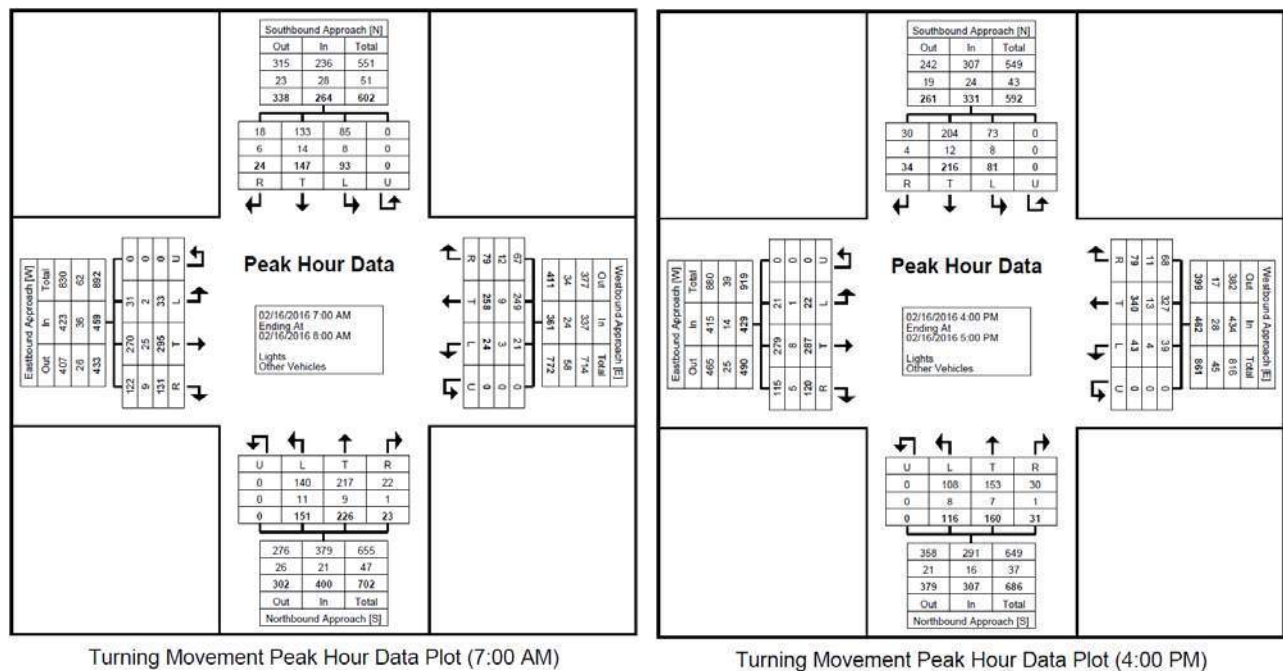


FIGURE 2: PEAK HOUR TURNING MOVEMENT COUNTS

CLEARANCE INTERVAL CALCULATION

Having appropriate yellow and all-red clearance intervals is important to the safe operation of a signal. In 2016, the ODOT Office of Traffic Operations revised the recommended equations for calculating yellow and all-red clearance intervals. Using the revised equations, the new recommended yellow time is 5.5 seconds on SR 82 and 6.0 seconds on SR 83. The all-red time is 1.0 seconds for all approaches. The previous yellow time was 5.0 seconds for SR 82 and SR 83; the all-red time was 2.0 seconds for all approaches.

SUMMARY OF SUPPLEMENTAL TRAFFIC STUDIES

HCS 2010 ANALYSIS

Highway Capacity Software 2010 (HCS) was used to create a model of the SR 82 and SR 83 traffic signal in order to calculate intersection capacity and delay. Using methodology from the Highway Capacity Manual (HCM), HCS was used to calculate the delay and Level of Service (LOS) for the traffic signal utilizing existing signal timing as well as with protected left turn phases and a roundabout, shown in **Table 6** below. The **HCM Analysis** results are further detailed in **Appendix D**.

TABLE 6 - HCS CAPACITY ANALYSIS

INTERSECTION TRAFFIC CONTROL	AM PEAK DELAY (SEC/VEH)					PM PEAK DELAY (SEC/VEH)				
	EB	WB	NB	SB	TOTAL	EB	WB	NB	SB	TOTAL
Existing Signal Timing	14.3 (B)	12.8 (B)	16.0 (B)	15.5 (B)	14.6 (B)	14.1 (B)	14.5 (B)	16.1 (B)	15.4 (B)	14.9 (B)
Protected Left Turns (SR 83 Only)	19.1 (B)	17.1 (B)	27.9 (C)	27.7 (C)	22.5 (C)	18.2 (B)	18.8 (B)	26.6 (C)	28.4 (C)	22.3 (C)
Protected Left Turns (All Approaches)	27.1 (C)	24.1 (C)	34.5 (C)	35.7 (D)	29.9 (C)	28.1 (C)	27.0 (C)	32.9 (C)	36.2 (D)	30.5 (C)
Roundabout	11.0 (B)	11.1 (B)	12.6 (B)	9.6 (A)	11.2 (B)	10.9 (B)	11.3 (B)	9.1 (A)	12.5 (B)	11.0 (B)

The HCM delay calculations show the increase in delay at the SR 82 and SR 83 intersection if protected left turn phases are added. As shown in **Table 6**, the average delay doubles with protected left turn phases on all approaches when compared to the existing conditions. The HCM delay calculations also show that the average intersection delay is about the same when comparing a single-lane roundabout to the existing signal.

SAFETY COUNTERMEASURES

Safety Countermeasures

HSM METHODOLOGY

The Highway Safety Manual (HSM), published by the American Association of State Highway and Transportation Officials (AASHTO), is a document that quantifies the safety of roadway segments and intersections using crash data and statistical analysis to compare and correlate roadway characteristics with crash patterns and frequency. The HSM compiles crash data and physical attributes from many locations so that roadway features that result in safe or unsafe roadways can be recognized and quantified. The HSM not only informs which roadway features are safer, but also quantifies how much safer by predicting the number of crashes.

The HSM contains formulas and factors to predict crashes for different roadway segments and intersections: urban, rural, freeway, two-lane, signalized and unsignalized. The first step in analysis is to determine the **predicted crashes** for the particular roadway or intersection. The predicted crashes are the average number of crashes that can be expected based on the physical characteristics of the site. The predicted crashes are then compared to the **expected crashes** at a site. Expected crashes are the average number of crashes that can be experienced over time based on actual crash data. If there are **excess crashes** at a site, or the number of expected crashes are greater than the number of predicted crashes, then there is a statistical potential for safety improvements. In order to analyze expected crashes for a proposed countermeasure, Crash Modification Factors (CMFs) have been calculated based on statistical research for historical crash patterns at different site conditions. These CMFs have a numerical value, with values greater than one meaning crashes would increase for a given site condition and values less than one would result in a decrease in crashes.

Table 7 below shows the predicted, expected and excess crashes for different crash severities at the intersection of SR 82 and SR 83. Although the fatal, serious injury, and property damage only crashes are less than the overall predicted crashes, there is a statistical potential for improvement for minor injury crashes. The full **HSM Outputs** for this intersection can be found in **Appendix E**.

TABLE 7 - SUMMARY OF ANTICIPATED SAFETY PERFORMANCE (AVERAGE CRASHES/YEAR)

CRASH TYPE	KA (FATAL/ DISABLING)	B (EVIDENT)	C (POSSIBLE)	O (PDO)	TOTAL
Predicted	0.1483	0.6307	0.7973	4.7645	6.3408
Expected	0.1479	0.6418	0.8040	4.5467	6.1404
Excess	-0.0004	0.0111	0.0067	-0.2178	-0.2004

SAFETY COUNTERMEASURES

PROPOSED COUNTERMEASURES

Potential safety countermeasures for crash patterns can be analyzed for different time frames and cost categories. Short-term, low-cost countermeasures are minor actions that can be implemented in less than one year and in some cases immediately. Examples are installing signs and pavement markings and updating signal timing and operation. Medium-term, medium-cost countermeasures involve larger projects that take one to five years to complete like minor lane additions, signal installations and intersection reconfigurations. The most complex and costly countermeasures like grade separation and creating bypass roadways are considered long-term, high-cost countermeasures. Long-term countermeasures generally take more than five years to complete.

SHORT-TERM

Countermeasures that can be pursued immediately in the study segment are mostly traffic control related.

- The signal timing was reviewed in 2016 as part of the signal evaluation for the SR 82 and SR 83 intersection, all ODOT maintained signals are to be evaluated every five years. Since the clearance intervals were updated in August of 2016, the only recommendation from the signal evaluation was to increase the maximum green time on SR 83 from 30 to 50 seconds. This signal timing change was made on March 10, 2017 and should help clear the high left turn volumes on SR 83 during peak times. The existing signing and striping are in good condition and appropriate for the intersection.
- Additional 'No Left Turn' and 'Do Not Enter' signs should be installed at the Circle K right-in/right-out drive due to the number of crashes involving left turns at this drive. There is a concrete island in the center of the drive, but there is currently no sign prohibiting left turns for traffic exiting the drive. There used to be a 'No Left Turn' sign and 'Do Not Enter' sign installed in the concrete island. However, these signs were frequently knocked down.
- To physically prevent left turns in and out of the Circle K right-in/right-out drive, a lane separator could be installed along the center line on the north approach of SR 83. This would also prevent left turns from Amish Swings & Things located in the northeast corner of the intersection, however, Amish Swings & Things has additional access points along SR 82.
- The detection at the intersection could be improved by installing radar detection to replace the existing loop detection on all approaches. Radar detection would be expected to result in a reduced number of rear end crashes since all approaches of the SR 82 and SR 83 intersection are high speed approaches.

MEDIUM-TERM

An improvement that could improve safety in the study area is adding protected left turn phases at the intersection. However, this would have a negative effect on the operation of the intersection due to the increase in average delay. This countermeasure would be expected to reduce the occurrence of left turn crashes at the intersection.

SAFETY COUNTERMEASURES

The Economic Crash Analysis Tool (ECAT) developed by ODOT, shows that the number of expected crashes per year would decrease from 6.14 to 4.79 (1.35 crashes or 22%) if protected left turn phases were added on all approaches of the SR 82 and SR 83 intersection; **Table 8** further details these results. The HSM Outputs for the protected left turn phases can be found in **Appendix E**.

TABLE 8 - EXPECTED ANNUAL CRASHES: EXISTING VS. PROTECTED LEFT TURN PHASES

SITE CONDITION	KA	B	C	O	TOTAL
Existing Conditions	0.1479	0.6418	0.8040	4.5467	6.1404
Prot. Left Turn Phases	0.1154	0.5006	0.6271	3.5464	4.7895
Difference	0.0325	0.1412	0.1769	1.0003	1.3509

A single-lane roundabout should also be considered since all crashes that occurred at or near the intersection could be mitigated by a roundabout. Based on the HSM analysis, the average delay is very similar when comparing a single-lane roundabout to the existing signal. Roundabouts improve safety primarily by reducing conflict points and lowering vehicle speeds², **Figure 3** shows that the number of conflict points for single lane, four-leg approaches at a signalized intersection is 32 versus only 8 at a roundabout. Also, while a signalized intersection has 16 crossing conflict points, a roundabout does not have any crossing conflict points. So not only do roundabouts typically have fewer crashes than signalized intersections, the crashes that do occur are less severe, since angle and left turn crashes are significantly reduced.

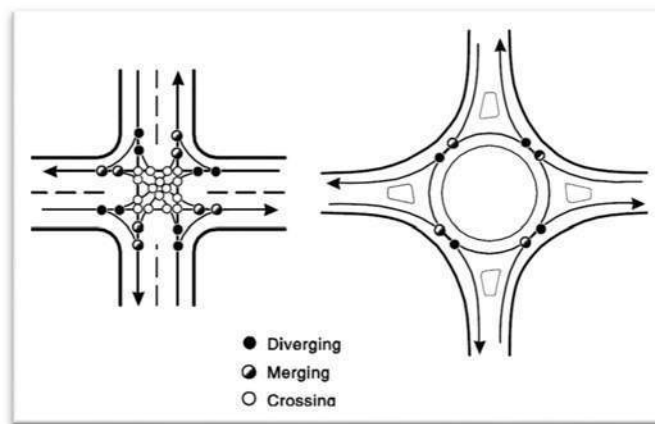


FIGURE 3- FOUR-LEG INTERSECTION CONFLICT POINT DIAGRAM³

² Rodegerts, L., Bansen, J., Tiesler, C., Knudsen, J., Myers, E., Johnson, M., . . . O'Brien, A. (2010). *Roundabouts: An Informational Guide (Second ed.)*. Retrieved from http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf

³ Rodegerts, et. al. (2010). *Roundabouts: An Informational Guide (Second ed.)*.

SAFETY COUNTERMEASURES

Using ECAT, the number of expected crashes per year would decrease from 6.14 to 2.71 (3.43 crashes or 56%) if a roundabout was installed at the SR 82 and SR 83 intersection. **Table 9** below further details these results. A conceptual plan of the proposed roundabout at this intersection is shown on the **Roundabout Concept Plan** in **Appendix F**. The HSM Outputs for the roundabout can be found in **Appendix E**.

TABLE 9 - EXPECTED ANNUAL CRASHES: EXISTING VS. ROUNDABOUT

SITE CONDITION	KA	B	C	O	TOTAL
Existing Conditions	0.1479	0.6418	0.8040	4.5467	6.1404
Roundabout	0.0325	0.1412	0.1769	2.3643	2.7149
Difference	0.1154	0.5006	0.6271	2.1824	3.4255

The ECAT software can also be used to calculate a safety benefit based on the decrease in crashes resulting from the proposed countermeasures. The safety benefit calculated in ECAT for adding protected left turn phases is **\$277,813** (10 year design life) and for the proposed roundabout is **\$1,494,726** (20 year design life). These amounts are the expected savings that would be generated for the traveling public over the design life of the project.

The next step is to calculate the cost of the proposed countermeasures to generate a Benefit/Cost (B/C) Ratio. Generally a safety-related project will not be funded if the B/C Ratio is less than one. If the District 3 Safety Review Team decides to pursue either countermeasure, a detailed cost estimate will be created after a multi-disciplinary field review.

The estimated cost to replace the existing signal and install a new signal using mast arms would be **\$175,000**, resulting in a B/C Ratio of **1.59**.

Based on the cost of previous roundabouts constructed in District 3, the average construction cost has been around **\$3,000,000**. The total cost of the proposed roundabout at the SR 82 and SR 83 intersection is expected to be less than previous District 3 roundabouts since there is more existing pavement and less right-of-way would likely be required when compared to the other roundabouts. Using the average cost of around \$3,000,000 the B/C Ratio for the roundabout is **0.50**. In order to reach a B/C Ratio of 1.00, an additional \$1.50 million in funds would be required. With a B/C Ratio less than one, it is unlikely this project would receive funding using only safety funds.

The full analysis for these countermeasures can be found in the **ECAT Analysis** in **Appendix H**.

LONG-TERM

There are no feasible high-cost countermeasures that would take longer than five years to complete that could improve safety at this intersection.

IMPLEMENTATION PLAN

Implementation Plan

The final step to improve safety at the intersection of SR 82 and SR 83 is to formulate an implementation plan for the proposed countermeasures. The following steps should be taken to improve safety at the intersection if recommended by the District 3 Safety Review Team:

- *Install Additional Signs and Lane Separator at Circle K Right-in/Right-out Drive:* Install a 'No Left Turn' sign for vehicles exiting the right-in/right-out drive. Install an additional 'Do Not Enter' sign in the concrete island for northbound SR 83 traffic. Left turns in and out of the Circle K right-in/right-out drive could also be prevented by installing a lane separator (Qwick Kurb) along the center line of SR 83.
- *Install Radar Detection:* Install radar detection on all approaches to the intersection.
- *Add Protected Left Turn Phases:* Install new signal in order to implement protected left turn phases. Submit an abbreviated safety application for the new signal.
- *Construct Roundabout:* Apply for safety funds to install a roundabout at the SR 82 and SR 83 intersection.

APPENDIX A

CRASH DIAGRAM

Crashes By Year

2013: 4
2014: 9
2015: 10
Total: 23

Crashes By Severity

Fatal: 0
Injury: 8
PDO: 15

NOTES

- 9 (39%) were Rear End crashes
- 5 (22%) were Angle crashes
- 3 (13%) were Left Turn crashes
- 2 (9%) were Sideswipe - Meeting crashes
- 2 (9%) were Backing crashes
- 1 (4%) was a Right Turn crash
- 1 (4%) was a Sideswipe - Passing crash

5 of the crashes were associated with the RI/RO drive north of the intersection.

CRASH DIAGRAM

Lorain Co. SR 82 & SR 83 (slm 9.05)
Signalized Intersection
Date: 1/1/2013 - 12/31/2015

Both drivers were cited, one for making an illegal left turn and the other for hitting the vehicle who turned left illegally.

Hit vehicle waiting to turn left into RI/RO drive.

Based on statements from drivers, it is likely the EB driver ran the red light.

NB vehicle had green light, but struck EB police vehicle with lights and sirens activated.

Hit vehicle waiting to turn left.

Legend:

Symbols

- Other
- Backing Vehicle
- Pedestrian
- Parked Vehicle
- Fixed Object
- Fatal Crash
- Injury Crash
- Signal
- Street
- Street Name
- Stop Sign
- Animal

Types of Collisions

- Rear End
- Head On
- Side-Swipe Passing
- Side-Swipe Meeting
- Out-of-Control
- Angle
- Angle
- Left Turn
- Right Turn
- Right Turn

Diagram Label Key

Date/Hour/Road Condition

D = Dry W = Wet S = Snow I = Ice
(R) = Ran Red Light (D) = Distracted

By: JDF

SR 83

SR 82

09-04-15/15/D (D)
09-23-15/17/D

06-13-14/14/D (R) - EB
08-10-15/14/D (R) - ??

02-20-13/9/S

11-20-14/9/D
07-20-15/12/D

07-15-13/16/D
12-19-14/12/W

07-17-15/11/D
08-23-14/12/D
11-16-15/15/D
07-19-15/11/D

07-23-13/16/D

06-20-15/16/D (D)

11-14-14/17/D

09-12-13/7/W
04-30-14/7/W
07-30-15/18/D

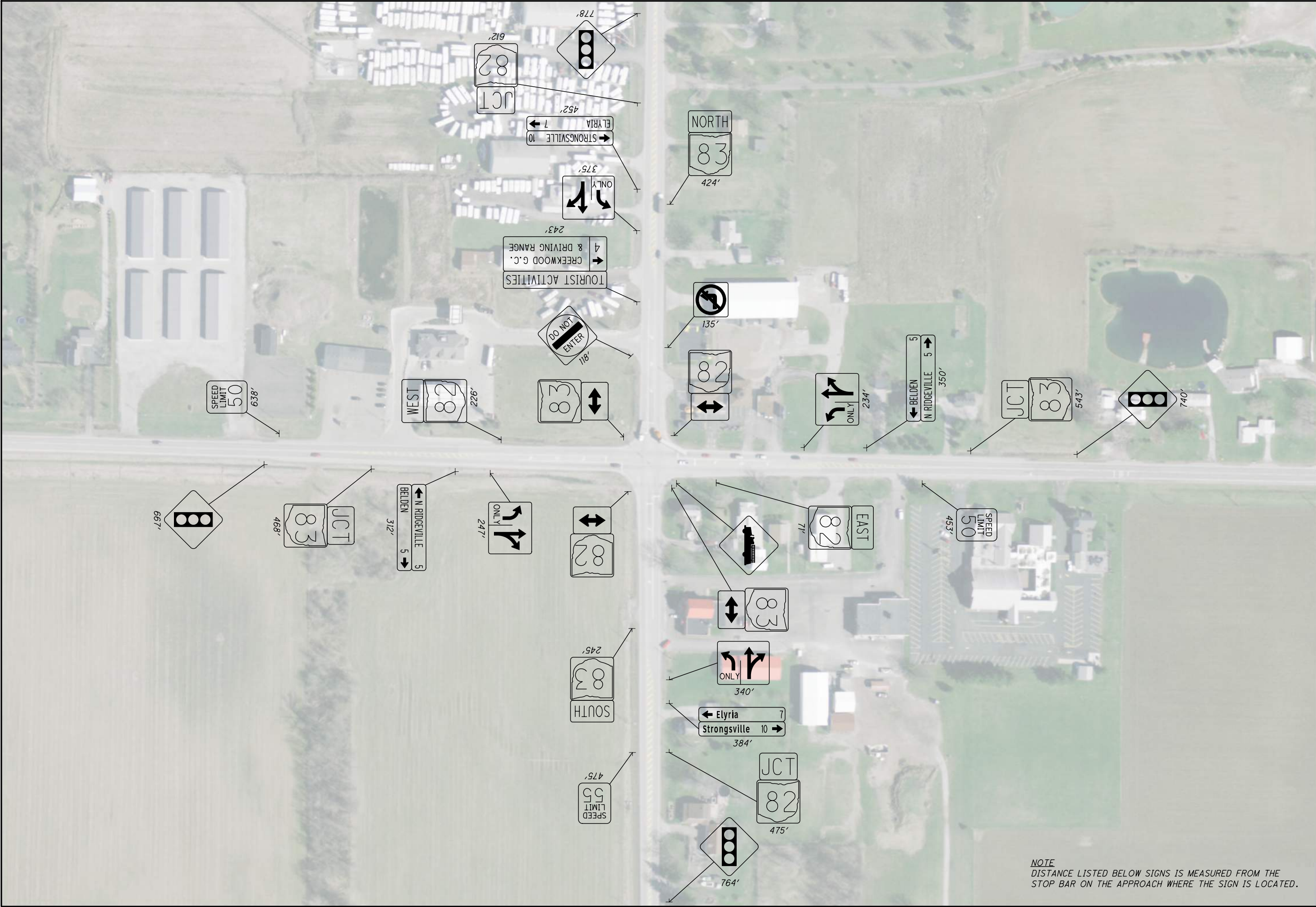
01-06-14/17/I

11-07-15/21/D (D)

06-28-14/13/D

APPENDIX B

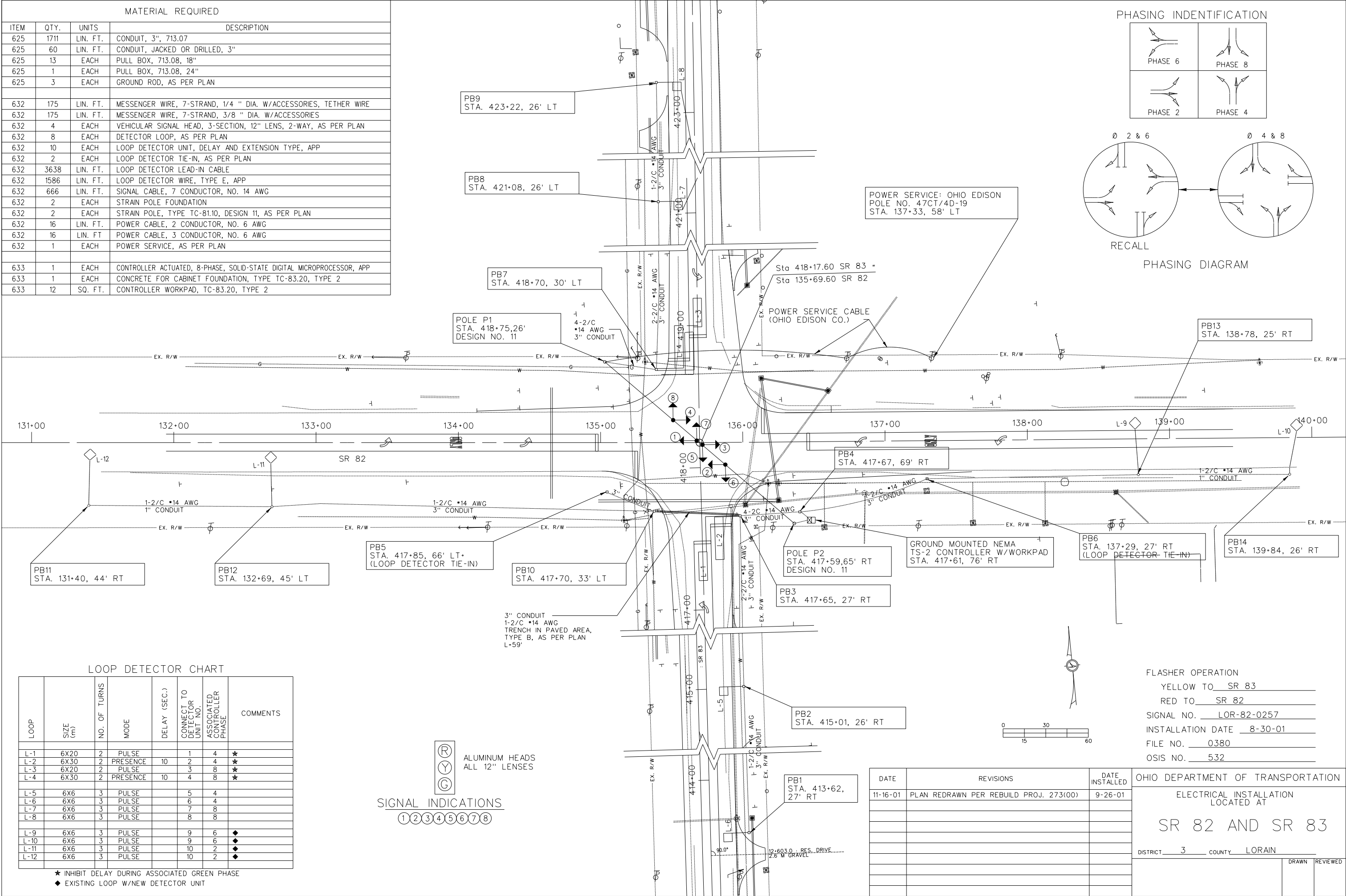
EXISTING SIGN DIAGRAM & SIGNAL PLAN



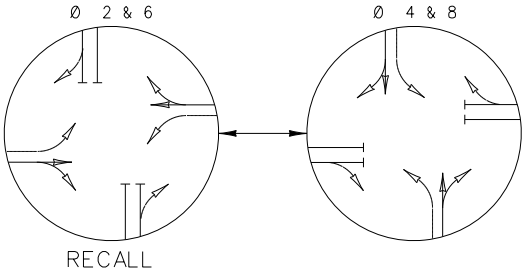
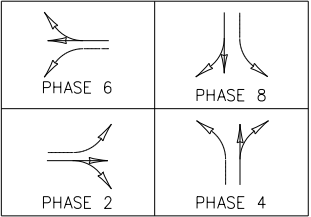
NOTE
DISTANCE LISTED BELOW SIGNS IS MEASURED FROM THE
STOP BAR ON THE APPROACH WHERE THE SIGN IS LOCATED.



MATERIAL REQUIRED			
ITEM	QTY.	UNITS	DESCRIPTION
625	1711	LIN. FT.	CONDUIT, 3", 713.07
625	60	LIN. FT.	CONDUIT, JACKED OR DRILLED, 3"
625	13	EACH	PULL BOX, 713.08, 18"
625	1	EACH	PULL BOX, 713.08, 24"
625	3	EACH	GROUND ROD, AS PER PLAN
632	175	LIN. FT.	MESSENGER WIRE, 7-STRAND, 1/4 " DIA. W/ACCESSORIES, TETHER WIRE
632	175	LIN. FT.	MESSENGER WIRE, 7-STRAND, 3/8 " DIA. W/ACCESSORIES
632	4	EACH	VEHICULAR SIGNAL HEAD, 3-SECTION, 12" LENS, 2-WAY, AS PER PLAN
632	8	EACH	DETECTOR LOOP, AS PER PLAN
632	10	EACH	LOOP DETECTOR UNIT, DELAY AND EXTENSION TYPE, APP
632	2	EACH	LOOP DETECTOR TIE-IN, AS PER PLAN
632	3638	LIN. FT.	LOOP DETECTOR LEAD-IN CABLE
632	1586	LIN. FT.	LOOP DETECTOR WIRE, TYPE E, APP
632	666	LIN. FT.	SIGNAL CABLE, 7 CONDUCTOR, NO. 14 AWG
632	2	EACH	STRAIN POLE FOUNDATION
632	2	EACH	STRAIN POLE, TYPE TC-81.10, DESIGN 11, AS PER PLAN
632	16	LIN. FT.	POWER CABLE, 2 CONDUCTOR, NO. 6 AWG
632	16	LIN. FT.	POWER CABLE, 3 CONDUCTOR, NO. 6 AWG
632	1	EACH	POWER SERVICE, AS PER PLAN
633	1	EACH	CONTROLLER ACTUATED, 8-PHASE, SOLID-STATE DIGITAL MICROPROCESSOR, APP
633	1	EACH	CONCRETE FOR CABINET FOUNDATION, TYPE TC-83.20, TYPE 2
633	12	SQ. FT.	CONTROLLER WORKPAD, TC-83.20, TYPE 2



PHASING IDENTIFICATION



PHASING DIAGRAM

LOOP DETECTOR CHART

LOOP	SIZE (m)	NO. OF TURNS	MODE	DELAY (SEC.)	CONNECT TO DETECTOR UNIT NO.	ASSOCIATED CONTROLLER PHASE	COMMENTS
L-1	6X20	2	PULSE		1	4	★
L-2	6X30	2	PRESENCE	10	2	4	★
L-3	6X20	2	PULSE		3	8	★
L-4	6X30	2	PRESENCE	10	4	8	★
L-5	6X6	3	PULSE		5	4	
L-6	6X6	3	PULSE		6	4	
L-7	6X6	3	PULSE		7	8	
L-8	6X6	3	PULSE		8	8	
L-9	6X6	3	PULSE		9	6	◆
L-10	6X6	3	PULSE		9	6	◆
L-11	6X6	3	PULSE		10	2	◆
L-12	6X6	3	PULSE		10	2	◆

★ INHIBIT DELAY DURING ASSOCIATED GREEN PHASE
◆ EXISTING LOOP W/NEW DETECTOR UNIT



ALUMINUM HEADS
ALL 12" LENSES

SIGNAL INDICATIONS

①②③④⑤⑥⑦⑧

FLASHER OPERATION

YELLOW TO SR 83
RED TO SR 82
SIGNAL NO. LOR-82-0257
INSTALLATION DATE 8-30-01
FILE NO. 0380
OSIS NO. 532

DATE	REVISIONS	DATE INSTALLED
11-16-01	PLAN REDRAWN PER REBUILD PROJ. 273(00)	9-26-01

OHIO DEPARTMENT OF TRANSPORTATION

ELECTRICAL INSTALLATION LOCATED AT	
SR 82 AND SR 83	
DISTRICT 3	COUNTY LORAIN
DRAWN	REVIEWED

APPENDIX C

TURNING MOVEMENT COUNT



Ohio Department of Transportation
1980 West Broad Street
Mail Stop 5160
Columbus, Ohio, United States 43223
+16147528099 scott.ockunzzi@dot.ohio.gov
Office of Traffic Engineering

Count Name: LOR-82 @ SR-83 TMC
Site Code:
Start Date: 02/16/2016
Page No: 1

Turning Movement Data

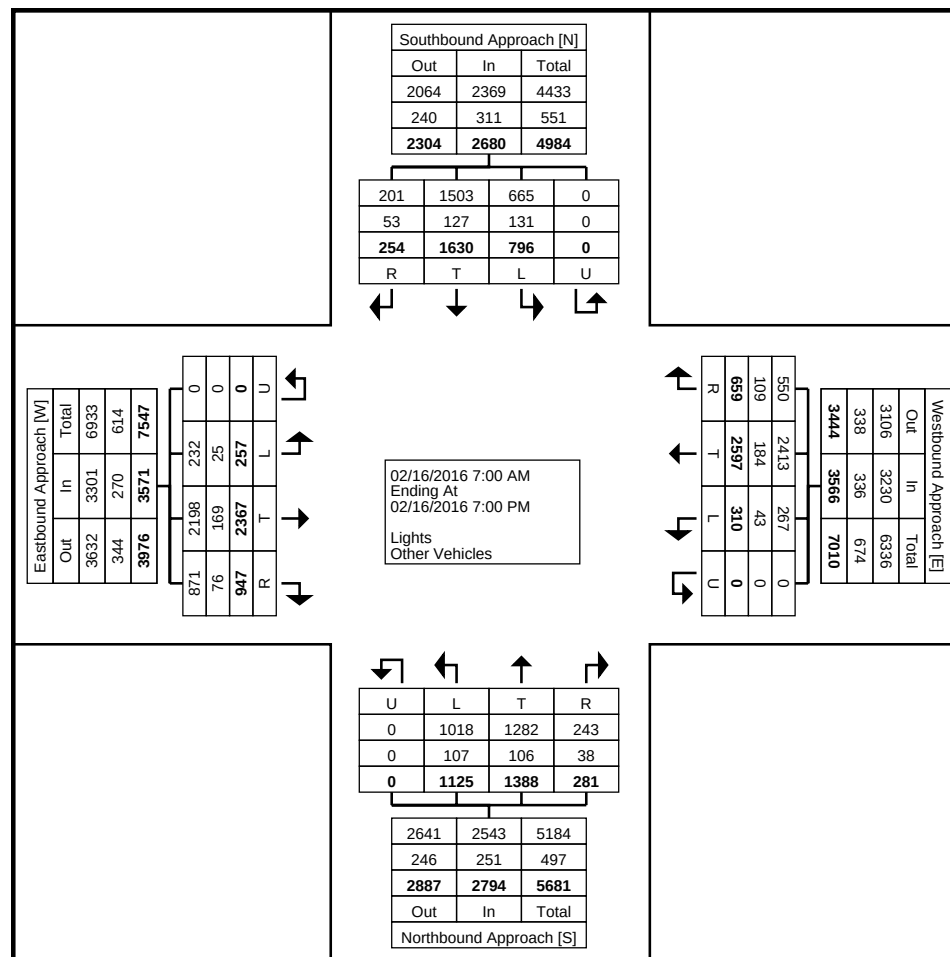
Start Time	Southbound Approach					Westbound Approach					Northbound Approach					Eastbound Approach					Int. Total
	Southbound					Westbound					Northbound					Eastbound					
	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	
7:00 AM	11	37	19	0	67	12	57	7	0	76	5	68	32	0	105	31	75	7	0	113	361
7:15 AM	8	36	19	0	63	15	60	6	0	81	3	42	28	0	73	39	73	10	0	122	339
7:30 AM	3	43	29	0	75	26	72	5	0	103	9	66	59	0	134	34	72	10	0	116	428
7:45 AM	2	31	26	0	59	26	69	6	0	101	6	50	32	0	88	27	75	6	0	108	356
Hourly Total	24	147	93	0	264	79	258	24	0	361	23	226	151	0	400	131	295	33	0	459	1484
8:00 AM	3	35	17	0	55	12	58	6	0	76	4	30	30	0	64	18	44	8	0	70	265
8:15 AM	7	23	10	0	40	13	51	5	0	69	9	47	23	0	79	15	39	5	0	59	247
8:30 AM	3	31	17	0	51	9	41	7	0	57	5	36	33	0	74	31	52	6	0	89	271
8:45 AM	8	25	14	0	47	21	44	7	0	72	5	33	22	0	60	12	46	8	0	66	245
Hourly Total	21	114	58	0	193	55	194	25	0	274	23	146	108	0	277	76	181	27	0	284	1028
9:00 AM	2	19	15	0	36	14	25	4	0	43	4	33	15	0	52	17	27	3	0	47	178
9:15 AM	5	14	8	0	27	11	39	4	0	54	7	23	24	0	54	11	29	6	0	46	181
9:30 AM	2	20	11	0	33	12	35	7	0	54	6	25	17	0	48	4	42	4	0	50	185
9:45 AM	4	10	14	0	28	10	30	5	0	45	4	18	14	0	36	11	25	3	0	39	148
Hourly Total	13	63	48	0	124	47	129	20	0	196	21	99	70	0	190	43	123	16	0	182	692
10:00 AM	5	24	19	0	48	8	33	3	0	44	4	17	13	0	34	9	34	3	0	46	172
10:15 AM	4	10	11	0	25	13	45	4	0	62	3	22	16	0	41	11	28	6	0	45	173
10:30 AM	3	16	11	0	30	10	39	4	0	53	4	20	16	0	40	7	37	1	0	45	168
10:45 AM	3	23	21	0	47	15	34	0	0	49	5	19	19	0	43	9	41	4	0	54	193
Hourly Total	15	73	62	0	150	46	151	11	0	208	16	78	64	0	158	36	140	14	0	190	706
11:00 AM	3	23	10	0	36	9	34	4	0	47	6	20	16	0	42	8	43	5	0	56	181
11:15 AM	8	21	13	0	42	7	56	1	0	64	4	21	24	0	49	16	31	5	0	52	207
11:30 AM	7	30	15	0	52	6	22	3	0	31	9	12	12	0	33	17	29	5	0	51	167
11:45 AM	7	25	20	0	52	9	46	6	0	61	2	14	9	0	25	16	24	4	0	44	182
Hourly Total	25	99	58	0	182	31	158	14	0	203	21	67	61	0	149	57	127	19	0	203	737
12:00 PM	2	17	7	0	26	12	35	3	0	50	4	19	17	0	40	17	47	2	0	66	182
12:15 PM	10	18	9	0	37	6	42	7	0	55	3	20	15	0	38	7	41	2	0	50	180
12:30 PM	2	21	22	0	45	13	37	4	0	54	6	18	18	0	42	19	35	4	0	58	199
12:45 PM	4	23	15	0	42	3	31	3	0	37	6	11	12	0	29	9	50	7	0	66	174
Hourly Total	18	79	53	0	150	34	145	17	0	196	19	68	62	0	149	52	173	15	0	240	735
1:00 PM	3	22	14	0	39	10	54	9	0	73	8	22	17	0	47	22	33	4	0	59	218
1:15 PM	5	34	11	0	50	10	46	7	0	63	3	11	18	0	32	36	36	3	0	75	220
1:30 PM	6	25	19	0	50	12	46	6	0	64	4	20	20	0	44	30	41	2	0	73	231
1:45 PM	8	22	8	0	38	12	50	6	0	68	4	21	17	0	42	10	32	7	0	49	197
Hourly Total	22	103	52	0	177	44	196	28	0	268	19	74	72	0	165	98	142	16	0	256	866
2:00 PM	4	34	16	0	54	11	45	6	0	62	10	36	58	0	104	18	47	5	0	70	290
2:15 PM	4	25	14	0	43	13	72	14	0	99	11	30	43	0	84	17	54	6	0	77	303

2:30 PM	7	32	22	0	61	17	75	9	0	101	8	24	23	0	55	13	88	7	0	108	325
2:45 PM	7	39	24	0	70	28	69	11	0	108	10	34	25	0	69	15	83	12	0	110	357
Hourly Total	22	130	76	0	228	69	261	40	0	370	39	124	149	0	312	63	272	30	0	365	1275
3:00 PM	2	47	23	0	72	14	58	11	0	83	9	35	19	0	63	13	59	9	0	81	299
3:15 PM	8	28	24	0	60	12	53	11	0	76	4	20	23	0	47	19	57	7	0	83	266
3:30 PM	4	40	18	0	62	22	79	10	0	111	11	33	51	0	95	24	61	7	0	92	360
3:45 PM	11	50	21	0	82	26	96	5	0	127	6	39	37	0	82	18	59	8	0	85	376
Hourly Total	25	165	86	0	276	74	286	37	0	397	30	127	130	0	287	74	236	31	0	341	1301
4:00 PM	11	63	19	0	93	23	86	17	0	126	6	36	33	0	75	20	71	7	0	98	392
4:15 PM	7	66	23	0	96	11	72	10	0	93	7	43	35	0	85	33	67	4	0	104	378
4:30 PM	9	45	22	0	76	21	65	9	0	95	9	31	24	0	64	33	61	8	0	102	337
4:45 PM	7	42	17	0	66	24	117	7	0	148	9	50	24	0	83	34	88	3	0	125	422
Hourly Total	34	216	81	0	331	79	340	43	0	462	31	160	116	0	307	120	287	22	0	429	1529
5:00 PM	8	87	29	0	124	13	78	6	0	97	5	34	25	0	64	29	58	5	0	92	377
5:15 PM	6	74	19	0	99	20	80	7	0	107	6	38	23	0	67	37	69	4	0	110	383
5:30 PM	0	72	14	0	86	15	76	9	0	100	7	29	23	0	59	29	70	1	0	100	345
5:45 PM	4	59	23	0	86	16	46	8	0	70	7	14	19	0	40	29	53	4	0	86	282
Hourly Total	18	292	85	0	395	64	280	30	0	374	25	115	90	0	230	124	250	14	0	388	1387
6:00 PM	0	50	14	0	64	16	67	8	0	91	6	37	7	0	50	9	40	3	0	52	257
6:15 PM	8	43	13	0	64	10	45	4	0	59	2	22	15	0	39	24	30	9	0	63	225
6:30 PM	6	25	6	0	37	8	37	6	0	51	3	26	19	0	48	24	34	6	0	64	200
6:45 PM	3	31	11	0	45	3	50	3	0	56	3	19	11	0	33	16	37	2	0	55	189
Hourly Total	17	149	44	0	210	37	199	21	0	257	14	104	52	0	170	73	141	20	0	234	871
Grand Total	254	1630	796	0	2680	659	2597	310	0	3566	281	1388	1125	0	2794	947	2367	257	0	3571	12611
Approach %	9.5	60.8	29.7	0.0	-	18.5	72.8	8.7	0.0	-	10.1	49.7	40.3	0.0	-	26.5	66.3	7.2	0.0	-	-
Total %	2.0	12.9	6.3	0.0	21.3	5.2	20.6	2.5	0.0	28.3	2.2	11.0	8.9	0.0	22.2	7.5	18.8	2.0	0.0	28.3	-
Lights	201	1503	665	0	2369	550	2413	267	0	3230	243	1282	1018	0	2543	871	2198	232	0	3301	11443
% Lights	79.1	92.2	83.5	-	88.4	83.5	92.9	86.1	-	90.6	86.5	92.4	90.5	-	91.0	92.0	92.9	90.3	-	92.4	90.7
Other Vehicles	53	127	131	0	311	109	184	43	0	336	38	106	107	0	251	76	169	25	0	270	1168
% Other Vehicles	20.9	7.8	16.5	-	11.6	16.5	7.1	13.9	-	9.4	13.5	7.6	9.5	-	9.0	8.0	7.1	9.7	-	7.6	9.3



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Count Name: LOR-82 @ SR-83 TMC
Site Code:
Start Date: 02/16/2016
Page No: 3





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Site Code:
Start Date: 02/16/2016
Page No: 4

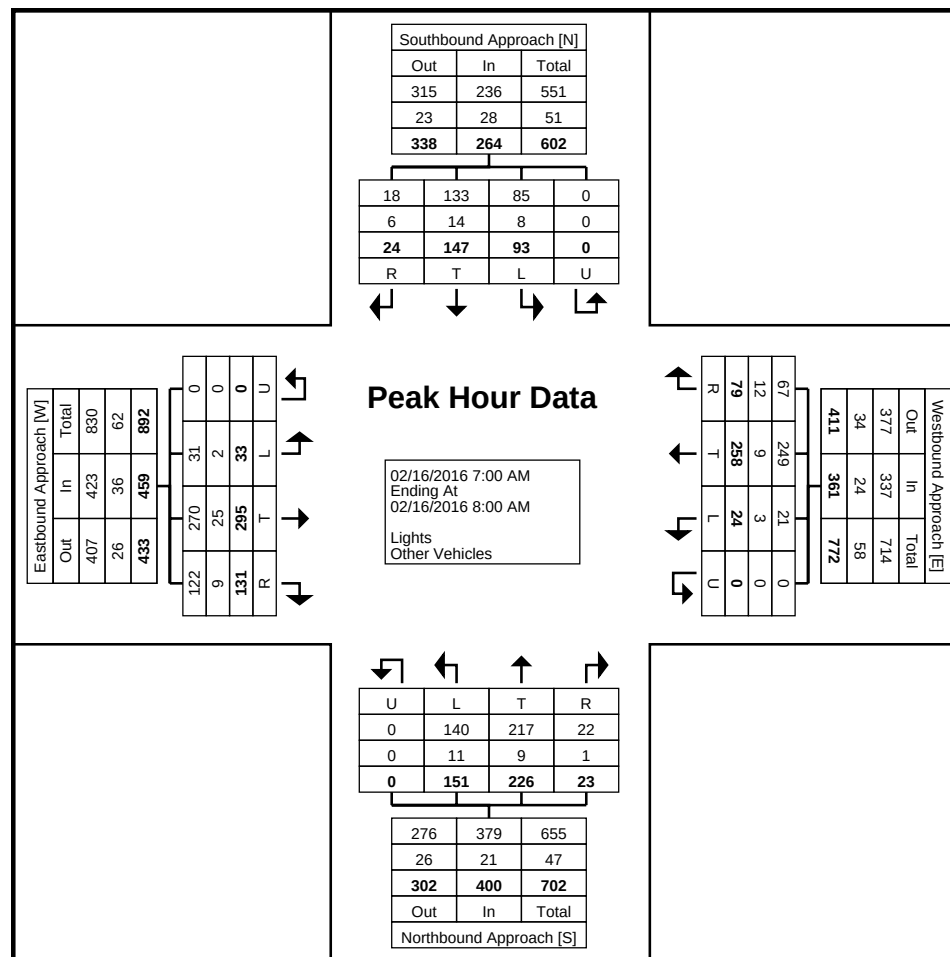
Turning Movement Peak Hour Data (7:00 AM)

Start Time	Southbound Approach					Westbound Approach					Northbound Approach					Eastbound Approach					Int. Total
	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	
7:00 AM	11	37	19	0	67	12	57	7	0	76	5	68	32	0	105	31	75	7	0	113	361
7:15 AM	8	36	19	0	63	15	60	6	0	81	3	42	28	0	73	39	73	10	0	122	339
7:30 AM	3	43	29	0	75	26	72	5	0	103	9	66	59	0	134	34	72	10	0	116	428
7:45 AM	2	31	26	0	59	26	69	6	0	101	6	50	32	0	88	27	75	6	0	108	356
Total	24	147	93	0	264	79	258	24	0	361	23	226	151	0	400	131	295	33	0	459	1484
Approach %	9.1	55.7	35.2	0.0	-	21.9	71.5	6.6	0.0	-	5.8	56.5	37.8	0.0	-	28.5	64.3	7.2	0.0	-	-
Total %	1.6	9.9	6.3	0.0	17.8	5.3	17.4	1.6	0.0	24.3	1.5	15.2	10.2	0.0	27.0	8.8	19.9	2.2	0.0	30.9	-
PHF	0.545	0.855	0.802	0.000	0.880	0.760	0.896	0.857	0.000	0.876	0.639	0.831	0.640	0.000	0.746	0.840	0.983	0.825	0.000	0.941	0.867
Lights	18	133	85	0	236	67	249	21	0	337	22	217	140	0	379	122	270	31	0	423	1375
% Lights	75.0	90.5	91.4	-	89.4	84.8	96.5	87.5	-	93.4	95.7	96.0	92.7	-	94.8	93.1	91.5	93.9	-	92.2	92.7
Other Vehicles	6	14	8	0	28	12	9	3	0	24	1	9	11	0	21	9	25	2	0	36	109
% Other Vehicles	25.0	9.5	8.6	-	10.6	15.2	3.5	12.5	-	6.6	4.3	4.0	7.3	-	5.3	6.9	8.5	6.1	-	7.8	7.3



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Start Date: 02/16/2016
Page No: 5



Turning Movement Peak Hour Data Plot (7:00 AM)



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 Site Code:
 Start Date: 02/16/2016
 Page No: 6

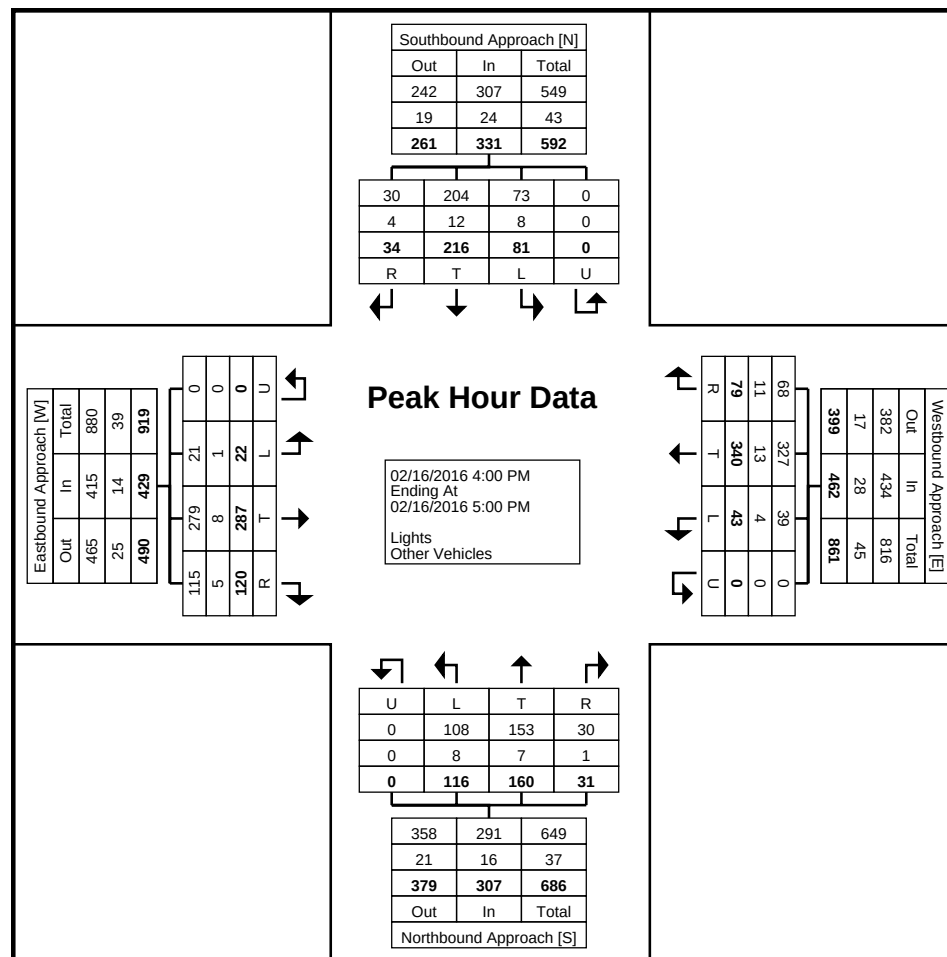
Turning Movement Peak Hour Data (4:00 PM)

Start Time	Southbound Approach					Westbound Approach					Northbound Approach					Eastbound Approach					Int. Total
	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	
4:00 PM	11	63	19	0	93	23	86	17	0	126	6	36	33	0	75	20	71	7	0	98	392
4:15 PM	7	66	23	0	96	11	72	10	0	93	7	43	35	0	85	33	67	4	0	104	378
4:30 PM	9	45	22	0	76	21	65	9	0	95	9	31	24	0	64	33	61	8	0	102	337
4:45 PM	7	42	17	0	66	24	117	7	0	148	9	50	24	0	83	34	88	3	0	125	422
Total	34	216	81	0	331	79	340	43	0	462	31	160	116	0	307	120	287	22	0	429	1529
Approach %	10.3	65.3	24.5	0.0	-	17.1	73.6	9.3	0.0	-	10.1	52.1	37.8	0.0	-	28.0	66.9	5.1	0.0	-	-
Total %	2.2	14.1	5.3	0.0	21.6	5.2	22.2	2.8	0.0	30.2	2.0	10.5	7.6	0.0	20.1	7.8	18.8	1.4	0.0	28.1	-
PHF	0.773	0.818	0.880	0.000	0.862	0.823	0.726	0.632	0.000	0.780	0.861	0.800	0.829	0.000	0.903	0.882	0.815	0.688	0.000	0.858	0.906
Lights	30	204	73	0	307	68	327	39	0	434	30	153	108	0	291	115	279	21	0	415	1447
% Lights	88.2	94.4	90.1	-	92.7	86.1	96.2	90.7	-	93.9	96.8	95.6	93.1	-	94.8	95.8	97.2	95.5	-	96.7	94.6
Other Vehicles	4	12	8	0	24	11	13	4	0	28	1	7	8	0	16	5	8	1	0	14	82
% Other Vehicles	11.8	5.6	9.9	-	7.3	13.9	3.8	9.3	-	6.1	3.2	4.4	6.9	-	5.2	4.2	2.8	4.5	-	3.3	5.4



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Site Code:
Start Date: 02/16/2016
Page No: 7



Turning Movement Peak Hour Data Plot (4:00 PM)

APPENDIX D

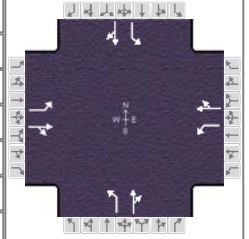
HCM ANALYSIS

HCS7 Signalized Intersection Results Summary

General Information

Agency		Analysis Date	1/17/2017	Duration, h	0.25
Analyst		Area Type	Other	PHF	0.92
Jurisdiction		Analysis Year	2017	Analysis Period	1> 7:00
Urban Street	SR 82	File Name	LOR SR 82_SR 83 AM Peak.xus		
Intersection	SR 83				
Project Description	AM Peak				

Intersection Information



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	33	295	131	24	258	79	151	226	23	93	147	24

Signal Information

Cycle, s	51.5	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	21.4	16.7	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	6.0	0.0	0.0	0.0	0.0		
				Red	1.0	1.0	0.0	0.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		6.0		6.0		6.0
Phase Duration, s		27.9		27.9		23.7		23.7
Change Period, (Y+R _c), s		7.0		7.0		7.0		7.0
Max Allow Headway (MAH), s		5.1		5.1		5.1		5.1
Queue Clearance Time (g _s), s		13.6		14.9		12.8		12.6
Green Extension Time (g _e), s		6.1		6.0		3.9		3.9
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.01		0.01		0.11		0.10

Movement Group Results

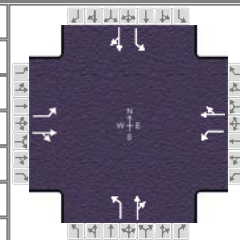
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	36	463		26	366		164	271		101	186	
Adjusted Saturation Flow Rate (s), veh/h/ln	983	1688		848	1738		1150	1811		1047	1709	
Queue Service Time (g _s), s	1.5	11.6		1.3	8.2		6.5	6.1		4.4	4.2	
Cycle Queue Clearance Time (g _c), s	9.7	11.6		12.9	8.2		10.8	6.1		10.6	4.2	
Green Ratio (g/C)	0.41	0.41		0.41	0.41		0.32	0.32		0.32	0.32	
Capacity (c), veh/h	381	683		292	703		415	585		353	552	
Volume-to-Capacity Ratio (X)	0.094	0.678		0.089	0.521		0.395	0.462		0.287	0.337	
Back of Queue (Q), ft/ln (50 th percentile)	7.2	88.6		6.3	61.7		37.3	50		23.7	34	
Back of Queue (Q), veh/ln (50 th percentile)	0.3	3.3		0.2	2.4		1.4	1.9		0.9	1.3	
Queue Storage Ratio (RQ) (50 th percentile)	0.04	0.00		0.03	0.00		0.13	0.00		0.08	0.00	
Uniform Delay (d ₁), s/veh	15.2	12.6		17.9	11.6		17.4	13.9		18.1	13.2	
Incremental Delay (d ₂), s/veh	0.2	1.7		0.2	0.9		0.9	0.8		0.6	0.5	
Initial Queue Delay (d ₃), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	15.4	14.3		18.0	12.4		18.2	14.7		18.7	13.7	
Level of Service (LOS)	B	B		B	B		B	B		B	B	
Approach Delay, s/veh / LOS	14.3	B		12.8	B		16.0	B		15.5	B	
Intersection Delay, s/veh / LOS	14.6						B					

Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	2.2	B		2.2	B		2.3	B		2.3	B	
Bicycle LOS Score / LOS	1.3	A		1.1	A		1.2	A		1.0	A	

HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	1/17/2017	Area Type	Other
Jurisdiction		Time Period		PHF	0.92
Urban Street	SR 82	Analysis Year	2017	Analysis Period	1> 7:00
Intersection	SR 83	File Name	LOR SR 82_SR 83 PM Peak.xus		
Project Description	PM Peak				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	22	287	120	43	340	79	116	160	31	81	216	34

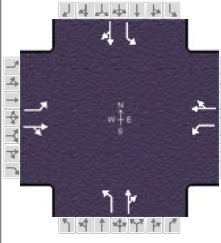
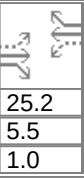
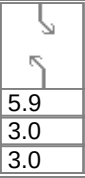
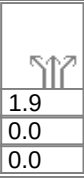
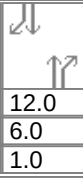
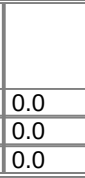
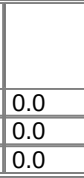
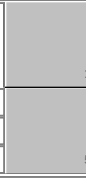
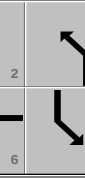
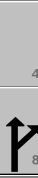
Signal Information											
Cycle, s	53.3	Reference Phase	2								
Offset, s	0	Reference Point	End								
Uncoordinated	Yes	Simult. Gap E/W	On	Green	22.1	17.7	0.0	0.0	0.0	0.0	
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	6.0	0.0	0.0	0.0	0.0	
				Red	1.0	1.0	0.0	0.0	0.0	0.0	

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		6.0		6.0		6.0
Phase Duration, s		28.6		28.6		24.7		24.7
Change Period, (Y+R _c), s		7.0		7.0		7.0		7.0
Max Allow Headway (MAH), s		5.1		5.1		5.1		5.1
Queue Clearance Time (g _s), s		14.3		14.9		14.2		10.2
Green Extension Time (g _e), s		6.7		6.7		3.6		3.9
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.02		0.02		0.12		0.06

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	24	442		47	455		126	208		88	272	
Adjusted Saturation Flow Rate (s), veh/h/ln	914	1762		895	1752		1064	1788		1100	1768	
Queue Service Time (g _s), s	1.2	10.6		2.3	11.1		5.7	4.7		3.5	6.5	
Cycle Queue Clearance Time (g _c), s	12.3	10.6		12.9	11.1		12.2	4.7		8.2	6.5	
Green Ratio (g/C)	0.41	0.41		0.41	0.41		0.33	0.33		0.33	0.33	
Capacity (c), veh/h	314	713		319	709		358	595		403	588	
Volume-to-Capacity Ratio (X)	0.076	0.620		0.146	0.642		0.352	0.349		0.219	0.462	
Back of Queue (Q), ft/ln (50 th percentile)	5.5	82.5		11.2	88.1		31.1	37.5		19.7	52.7	
Back of Queue (Q), veh/ln (50 th percentile)	0.2	3.2		0.4	3.4		1.2	1.5		0.7	2.0	
Queue Storage Ratio (RQ) (50 th percentile)	0.03	0.00		0.06	0.00		0.11	0.00		0.07	0.00	
Uniform Delay (d ₁), s/veh	17.7	12.6		17.7	12.8		18.9	13.4		16.6	14.0	
Incremental Delay (d ₂), s/veh	0.1	1.3		0.3	1.4		0.8	0.5		0.4	0.8	
Initial Queue Delay (d ₃), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	17.8	13.9		18.0	14.1		19.7	13.9		17.0	14.8	
Level of Service (LOS)	B	B		B	B		B	B		B	B	
Approach Delay, s/veh / LOS	14.1	B		14.5	B		16.1	B		15.4	B	
Intersection Delay, s/veh / LOS	14.9						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.2	B	2.2	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	1.3	A	1.3	A	1.0	A	1.1	A

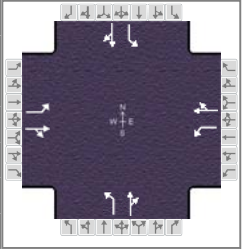
HCS7 Signalized Intersection Results Summary

General Information						Intersection Information											
Agency						Duration, h		0.25									
Analyst				Analysis Date		1/17/2017		Area Type		Other							
Jurisdiction				Time Period				PHF		0.92							
Urban Street		SR 82		Analysis Year		2017		Analysis Period		1> 7:00							
Intersection		SR 83		File Name		LOR SR 82_SR 83 AM Peak_Protected Left Turn...											
Project Description		AM Peak															
Demand Information						EB			WB			NB			SB		
Approach Movement						L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h						33	295	131	24	258	79	151	226	23	93	147	24
Signal Information																	
Cycle, s	64.5	Reference Phase	2														
Offset, s	0	Reference Point	End														
Uncoordinated	Yes	Simult. Gap E/W	On														
Force Mode	Fixed	Simult. Gap N/S	On														
						Green	25.2	5.9	1.9	12.0	0.0	0.0					
						Yellow	5.5	3.0	0.0	6.0	0.0	0.0					
						Red	1.0	3.0	0.0	1.0	0.0	0.0					
Timer Results						EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Assigned Phase							2		6	3	8	7	4				
Case Number							6.0		6.0	2.0	4.0	2.0	4.0				
Phase Duration, s							31.7		31.7	13.8	20.9	11.9	19.0				
Change Period, (Y+R c), s							7.0		7.0	6.0	7.0	6.0	7.0				
Max Allow Headway (MAH), s							5.1		5.1	2.9	4.9	2.9	4.9				
Queue Clearance Time (g s), s							17.0		18.8	8.0	10.9	5.7	8.4				
Green Extension Time (g e), s							6.0		5.9	0.2	2.2	0.1	2.3				
Phase Call Probability							1.00		1.00	0.95	1.00	0.84	1.00				
Max Out Probability							0.02		0.02	0.00	0.01	0.00	0.01				
Movement Group Results						EB			WB			NB			SB		
Approach Movement						L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement						5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h						36	463		26	366		164	271		101	186	
Adjusted Saturation Flow Rate (s), veh/h/ln						983	1688		848	1738		1711	1811		1682	1709	
Queue Service Time (g s), s						1.9	15.0		1.7	10.6		6.0	8.9		3.7	6.4	
Cycle Queue Clearance Time (g c), s						12.5	15.0		16.8	10.6		6.0	8.9		3.7	6.4	
Green Ratio (g/C)						0.38	0.38		0.38	0.38		0.12	0.22		0.09	0.19	
Capacity (c), veh/h						326	647		239	666		206	391		153	318	
Volume-to-Capacity Ratio (X)						0.110	0.716		0.109	0.550		0.795	0.693		0.661	0.584	
Back of Queue (Q), ft/ln (50 th percentile)						10.5	133.6		9	93.1		60.2	91		37.4	65.2	
Back of Queue (Q), veh/ln (50 th percentile)						0.4	5.0		0.3	3.6		2.3	3.5		1.4	2.4	
Queue Storage Ratio (RQ) (50 th percentile)						0.05	0.00		0.05	0.00		0.21	0.00		0.13	0.00	
Uniform Delay (d 1), s/veh						20.4	16.9		24.0	15.5		27.6	23.3		28.4	24.0	
Incremental Delay (d 2), s/veh						0.2	2.1		0.3	1.0		2.6	3.1		1.8	2.4	
Initial Queue Delay (d 3), s/veh						0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh						20.7	19.0		24.3	16.6		30.2	26.4		30.2	26.4	
Level of Service (LOS)						C	B		C	B		C	C		C	C	
Approach Delay, s/veh / LOS						19.1	B		17.1	B		27.9	C		27.7	C	
Intersection Delay, s/veh / LOS						22.5						C					
Multimodal Results						EB			WB			NB			SB		
Pedestrian LOS Score / LOS						2.3	B		2.3	B		2.3	B		2.3	B	
Bicycle LOS Score / LOS						1.3	A		1.1	A		1.2	A		1.0	A	

HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	1/17/2017	Area Type	Other
Jurisdiction		Time Period		PHF	0.92
Urban Street	SR 82	Analysis Year	2017	Analysis Period	1> 7:00
Intersection	SR 83	File Name	LOR SR 82_SR 83 PM Peak_Protected Left Turn...		
Project Description	PM Peak				





Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	22	287	120	43	340	79	116	160	31	81	216	34

Signal Information				</					
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Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6	3	8	7	4
Case Number		6.0		6.0	2.0	4.0	2.0	4.0
Phase Duration, s		32.0		32.0	12.3	21.4	11.6	20.7
Change Period, (Y+R _c), s		7.0		7.0	6.0	7.0	6.0	7.0
Max Allow Headway (MAH), s		5.1		5.1	2.9	4.9	2.9	4.9
Queue Clearance Time (g _s), s		17.5		18.3	6.7	8.6	5.3	11.3
Green Extension Time (g _e), s		6.6		6.6	0.1	2.4	0.1	2.3
Phase Call Probability		1.00		1.00	0.90	1.00	0.80	1.00
Max Out Probability		0.03		0.03	0.00	0.01	0.00	0.02

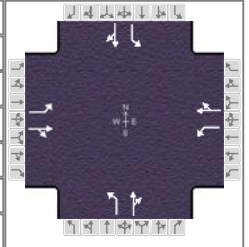
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	24	442		47	455		126	208		88	272	
Adjusted Saturation Flow Rate (s), veh/h/ln	914	1762		895	1752		1711	1788		1668	1768	
Queue Service Time (g _s), s	1.5	13.4		2.9	14.1		4.7	6.6		3.3	9.3	
Cycle Queue Clearance Time (g _c), s	15.5	13.4		16.3	14.1		4.7	6.6		3.3	9.3	
Green Ratio (g/C)	0.38	0.38		0.38	0.38		0.10	0.22		0.09	0.21	
Capacity (c), veh/h	265	677		270	673		166	397		143	373	
Volume-to-Capacity Ratio (X)	0.090	0.653		0.173	0.676		0.761	0.523		0.614	0.729	
Back of Queue (Q), ft/ln (50 th percentile)	7.5	117.8		15.4	126		47.4	65		33	96.5	
Back of Queue (Q), veh/ln (50 th percentile)	0.3	4.6		0.6	4.8		1.8	2.5		1.2	3.7	
Queue Storage Ratio (RQ) (50 th percentile)	0.04	0.00		0.09	0.00		0.16	0.00		0.12	0.00	
Uniform Delay (d ₁), s/veh	23.1	16.4		23.1	16.6		28.6	22.3		28.7	23.9	
Incremental Delay (d ₂), s/veh	0.2	1.5		0.4	1.7		2.7	1.5		1.6	3.9	
Initial Queue Delay (d ₃), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	23.3	18.0		23.6	18.3		31.3	23.8		30.2	27.8	
Level of Service (LOS)	C	B		C	B		C	C		C	C	
Approach Delay, s/veh / LOS	18.2	B		18.8	B		26.6	C		28.4	C	
Intersection Delay, s/veh / LOS	22.3						C					

Multimodal Results	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	2.3	B		2.3	B		2.3	B		2.3	B	
Bicycle LOS Score / LOS	1.3	A		1.3	A		1.0	A		1.1	A	

HCS7 Signalized Intersection Results Summary

General Information

Agency		Analysis Date	1/17/2017	Duration, h	0.25
Analyst		Area Type	Other	PHF	0.92
Jurisdiction		Analysis Year	2017	Analysis Period	1 > 7:00
Urban Street	SR 82	File Name	LOR SR 82_SR 83 AM Peak_Protected Left Turn...		
Intersection	SR 83				
Project Description	AM Peak				



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	33	295	131	24	258	79	151	226	23	93	147	24

Signal Information

Cycle, s	76.6	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On									
Force Mode	Fixed	Simult. Gap N/S	On									

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0
Phase Duration, s	9.8	33.3	9.0	32.6	15.1	22.1	12.2	19.2
Change Period, (Y+R _c), s	6.0	7.0	6.0	7.0	6.0	7.0	6.0	7.0
Max Allow Headway (MAH), s	3.0	5.0	3.0	5.0	2.9	4.9	2.9	4.9
Queue Clearance Time (g _s), s	3.6	21.0	3.2	15.7	9.2	12.8	6.5	9.9
Green Extension Time (g _e), s	0.0	5.2	0.0	5.4	0.2	2.2	0.1	2.3
Phase Call Probability	0.53	1.00	0.43	1.00	0.97	1.00	0.88	1.00
Max Out Probability	0.00	0.02	0.00	0.01	0.00	0.02	0.00	0.01

Movement Group Results

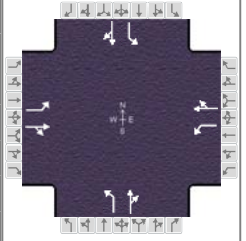
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	36	463		26	366		164	271		101	186	
Adjusted Saturation Flow Rate (s), veh/h/ln	1725	1688		1626	1738		1711	1811		1682	1709	
Queue Service Time (g _s), s	1.6	19.0		1.2	13.7		7.2	10.8		4.5	7.9	
Cycle Queue Clearance Time (g _c), s	1.6	19.0		1.2	13.7		7.2	10.8		4.5	7.9	
Green Ratio (g/C)	0.05	0.34		0.04	0.33		0.12	0.20		0.08	0.16	
Capacity (c), veh/h	85	581		64	581		204	357		136	272	
Volume-to-Capacity Ratio (X)	0.424	0.797		0.409	0.631		0.806	0.758		0.743	0.684	
Back of Queue (Q), ft/ln (50 th percentile)	16.6	188.6		13	133.5		75	119.6		47.9	87.1	
Back of Queue (Q), veh/ln (50 th percentile)	0.6	7.1		0.5	5.1		2.8	4.6		1.8	3.2	
Queue Storage Ratio (RQ) (50 th percentile)	0.08	0.00		0.07	0.00		0.26	0.00		0.17	0.00	
Uniform Delay (d ₁), s/veh	35.4	22.8		36.0	21.6		33.0	29.1		34.5	30.5	
Incremental Delay (d ₂), s/veh	1.2	3.6		1.6	1.6		2.9	4.7		3.0	4.3	
Initial Queue Delay (d ₃), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	36.7	26.4		37.6	23.2		35.8	33.7		37.5	34.7	
Level of Service (LOS)	D	C		D	C		D	C		D	C	
Approach Delay, s/veh / LOS	27.1	C		24.1	C		34.5	C		35.7	D	
Intersection Delay, s/veh / LOS	29.9						C					

Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	2.3	B		2.3	B		2.3	B		2.3	B	
Bicycle LOS Score / LOS	1.3	A		1.1	A		1.2	A		1.0	A	

HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	1/17/2017	Area Type	Other
Jurisdiction		Time Period		PHF	0.92
Urban Street	SR 82	Analysis Year	2017	Analysis Period	1> 7:00
Intersection	SR 83	File Name	LOR SR 82_SR 83 PM Peak_Protected Left Turn...		
Project Description	PM Peak				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	22	287	120	43	340	79	116	160	31	81	216	34

Signal Information												
Cycle, s	79.9	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	2.9	1.6	26.5	6.0	1.4	15.9		
				Yellow	3.0	0.0	5.5	3.0	0.0	6.0		
Force Mode	Fixed	Simult. Gap N/S	On	Red	3.0	0.0	1.0	3.0	0.0	1.0		

													
1	2	3	4	5	6	7	8	9	10	11	12	13	14

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0
Phase Duration, s	8.9	33.0	10.5	34.6	13.5	24.4	12.0	22.9
Change Period, ($Y+R_c$), s	6.0	7.0	6.0	7.0	6.0	7.0	6.0	7.0
Max Allow Headway (MAH), s	3.0	5.0	3.0	5.0	2.9	4.9	2.9	4.9
Queue Clearance Time (g_s), s	3.1	20.1	4.2	20.4	7.8	10.2	6.1	13.6
Green Extension Time (g_e), s	0.0	5.8	0.0	5.8	0.1	2.4	0.1	2.2
Phase Call Probability	0.41	1.00	0.65	1.00	0.94	1.00	0.86	1.00
Max Out Probability	0.00	0.03	0.00	0.03	0.00	0.01	0.00	0.03

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	24	442		47	455		126	208		88	272	
Adjusted Saturation Flow Rate (s), veh/h/ln	1739	1762		1682	1752		1711	1788		1668	1768	
Queue Service Time (g_s), s	1.1	18.1		2.2	18.4		5.8	8.2		4.1	11.6	
Cycle Queue Clearance Time (g_c), s	1.1	18.1		2.2	18.4		5.8	8.2		4.1	11.6	
Green Ratio (g/C)	0.04	0.33		0.06	0.35		0.09	0.22		0.08	0.20	
Capacity (c), veh/h	63	573		96	606		160	389		126	353	
Volume-to-Capacity Ratio (X)	0.379	0.772		0.489	0.752		0.789	0.533		0.700	0.770	
Back of Queue (Q), ft/ln (50 th percentile)	11.7	182.2		23.1	185.3		61.8	85.6		44	128.8	
Back of Queue (Q), veh/ln (50 th percentile)	0.5	7.1		0.9	7.1		2.3	3.3		1.6	4.9	
Queue Storage Ratio (RQ) (50 th percentile)	0.06	0.00		0.13	0.00		0.21	0.00		0.16	0.00	
Uniform Delay (d_1), s/veh	37.7	24.3		36.6	23.1		35.5	27.7		36.1	30.3	
Incremental Delay (d_2), s/veh	1.4	3.2		1.4	2.7		3.3	1.6		2.6	5.0	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	39.1	27.5		38.0	25.9		38.8	29.3		38.7	35.3	
Level of Service (LOS)	D	C		D	C		D	C		D	D	
Approach Delay, s/veh / LOS	28.1	C		27.0	C		32.9	C		36.2	D	
Intersection Delay, s/veh / LOS	30.5						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.3	B	2.3	B	2.3	B	2.3	B
Bicycle LOS Score / LOS	1.3	A	1.3	A	1.0	A	1.1	A

HCS7 Roundabouts Report

General Information

Analyst	JDF
Agency or Co.	ODOT D3
Date Performed	3/22/2017
Analysis Year	2017
Time Analyzed	
Project Description	AM Peak

Site Information

Intersection	SR 82 & SR 83
E/W Street Name	SR 82
N/S Street Name	SR 83
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment	LTR				LTR				LTR				LTR			
Volume (V), veh/h	0	33	295	131	0	24	258	79	0	151	226	23	0	93	147	24
Percent Heavy Vehicles, %	3	6	8	8	3	13	6	6	3	7	4	4	3	9	10	10
Flow Rate (v_{pce}), pc/h	0	38	346	154	0	29	297	91	0	176	255	26	0	110	176	29
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		538			417			457			315	
Entry Volume veh/h		499			392			435			287	
Circulating Flow (v_c), pc/h	315			469			494			502		
Exiting Flow (v_{ex}), pc/h	482			502			384			359		
Capacity (C_{pce}), pc/h		1001			855			834			827	
Capacity (c), veh/h		928			803			793			754	
v/c Ratio (x)		0.54			0.49			0.55			0.38	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		11.0			11.1			12.6			9.6	
Lane LOS		B			B			B			A	
95% Queue, veh		3.3			2.7			3.4			1.8	
Approach Delay, s/veh	11.0			11.1			12.6			9.6		
Approach LOS	B			B			B			A		
Intersection Delay, s/veh LOS	11.2						B					

HCS7 Roundabouts Report

General Information

Analyst	JDF
Agency or Co.	ODOT D3
Date Performed	3/22/2017
Analysis Year	2017
Time Analyzed	
Project Description	PM Peak

Site Information

Intersection	SR 82 & SR 83
E/W Street Name	SR 82
N/S Street Name	SR 83
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment	LTR				LTR				LTR				LTR			
Volume (V), veh/h	0	22	287	120	0	43	340	79	0	116	160	31	0	81	216	34
Percent Heavy Vehicles, %	3	5	3	3	3	9	6	6	3	7	4	4	3	10	6	6
Flow Rate (v_{pce}), pc/h	0	25	321	134	0	51	392	91	0	135	181	35	0	97	249	39
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		480			534			351			385	
Entry Volume veh/h		466			502			334			360	
Circulating Flow (v_c), pc/h	397			341			443			578		
Exiting Flow (v_{ex}), pc/h	453			566			297			434		
Capacity (C_{pce}), pc/h		920			975			878			765	
Capacity (c), veh/h		893			917			835			715	
v/c Ratio (x)		0.52			0.55			0.40			0.50	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		10.9			11.3			9.1			12.5	
Lane LOS		B			B			A			B	
95% Queue, veh		3.1			3.4			1.9			2.9	
Approach Delay, s/veh	10.9			11.3			9.1			12.5		
Approach LOS	B			B			A			B		
Intersection Delay, s/veh LOS	11.0						B					

APPENDIX E

HSM OUTPUTS

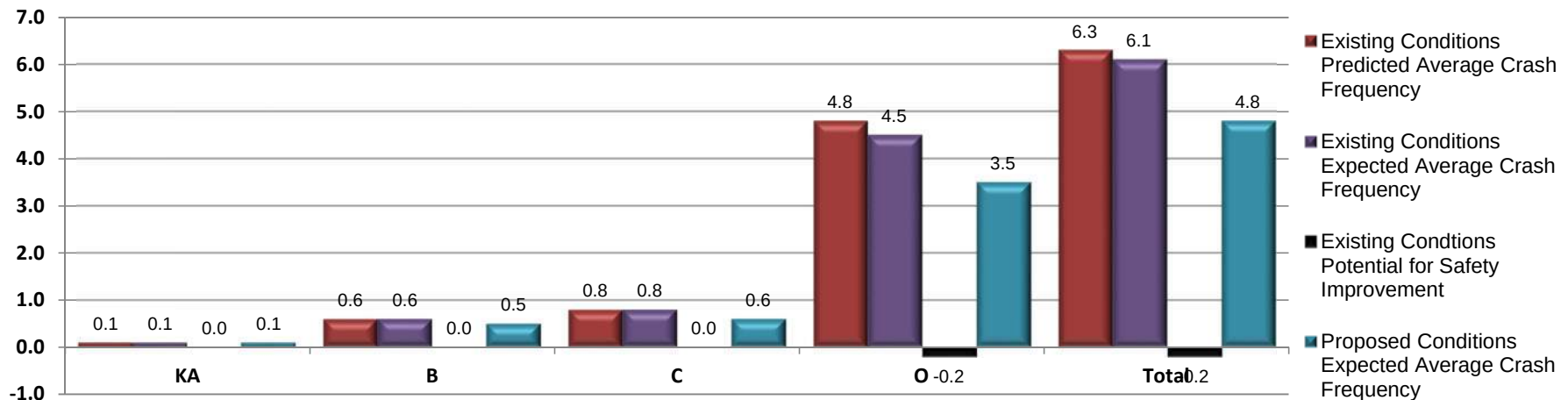


Project Safety Performance Report

General Information

Project Name	LOR-82-2.57 Safety Study	Contact Email	Jared.Feller@dot.ohio.gov
Project Description	SR 82 & SR 83 Intersection Protected Left Turn Phases	Contact Phone	419-207-7058
Reference Number	N/A	Date Performed	4/20/2017
Analyst	Jared Feller	Analysis Year	2017
Agency/Company	ODOT District 3		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{\text{predicted}}$ - Existing Conditions	0.1483	0.6307	0.7973	4.7645	6.3408
N_{expected} - Existing Conditions	0.1479	0.6418	0.8040	4.5467	6.1404
$N_{\text{potential for improvement}}$ - Existing Conditions	-0.0004	0.0111	0.0067	-0.2178	-0.2004
N_{expected} - Proposed Conditions	0.1154	0.5006	0.6271	3.5464	4.7895

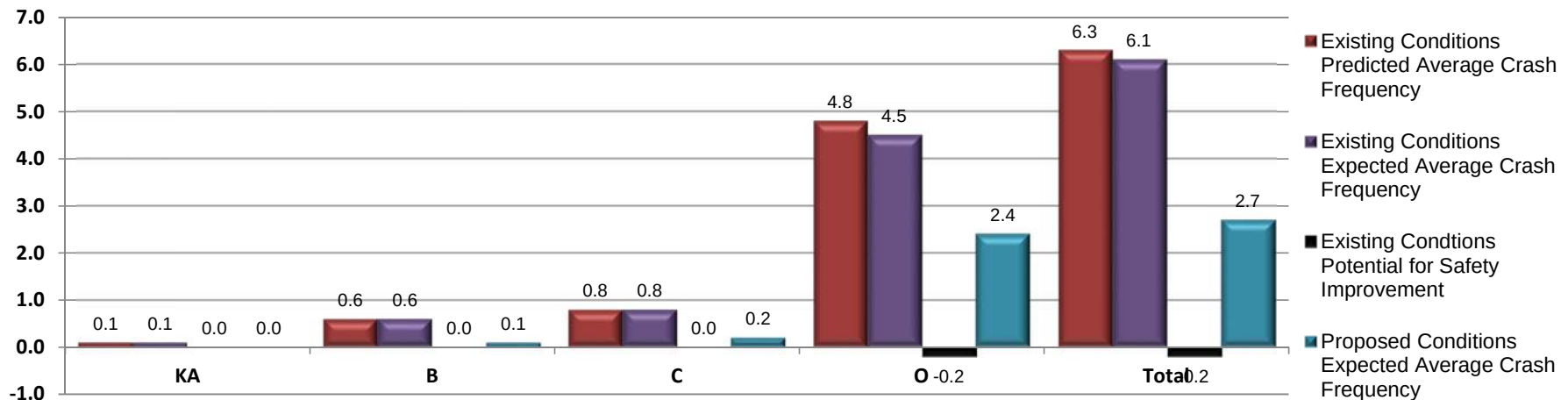


Project Safety Performance Report

General Information

Project Name	LOR-82-2.57 Safety Study	Contact Email	Jared.Feller@dot.ohio.gov
Project Description	SR 82 & SR 83 Intersection Roundabout	Contact Phone	419-207-7058
Reference Number	N/A	Date Performed	4/20/2017
Analyst	Jared Feller	Analysis Year	2017
Agency/Company	ODOT District 3		

Summary of Anticipated Safety Performance of the Project (average crashes/year)

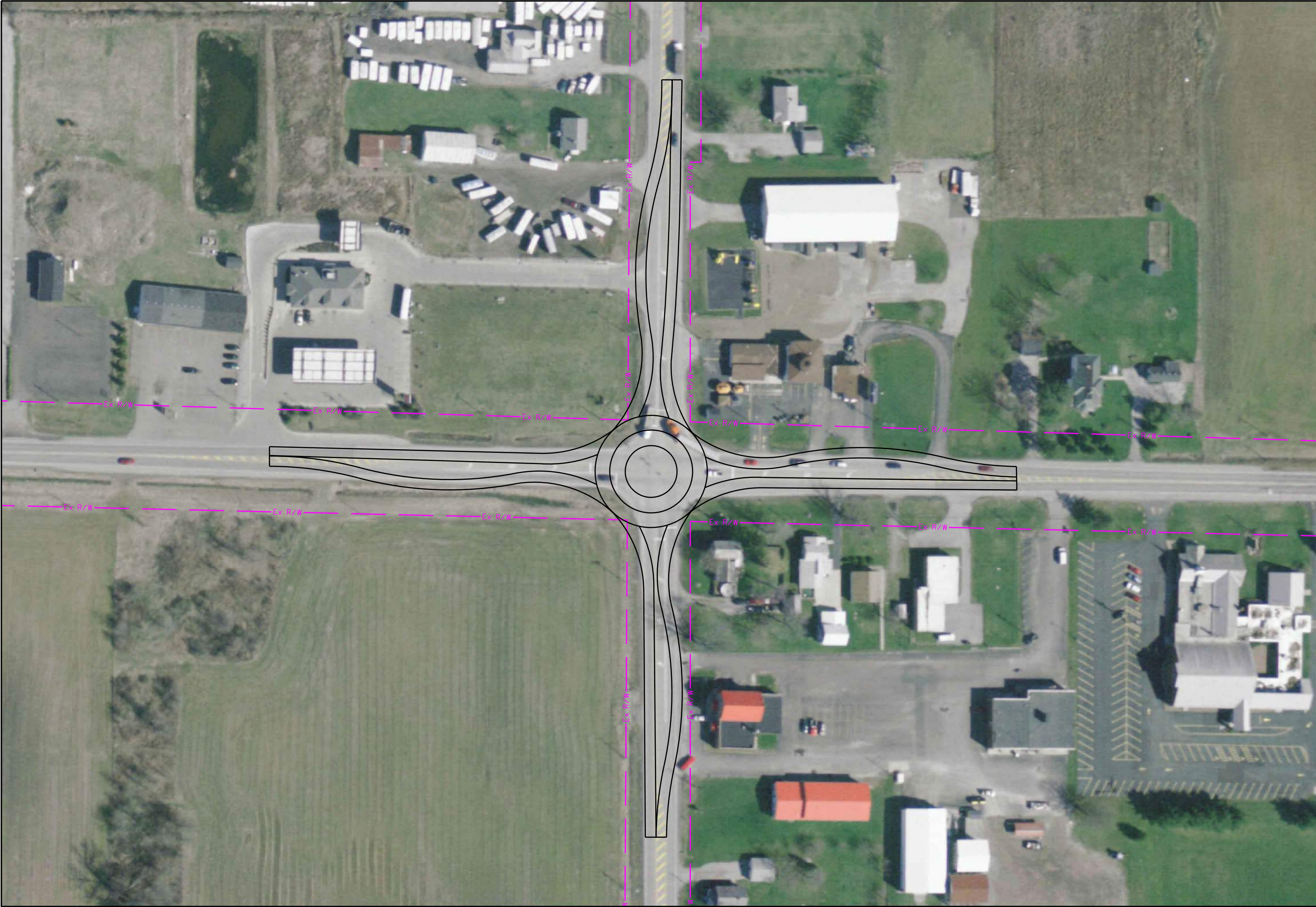


Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{\text{predicted}}$ - Existing Conditions	0.1483	0.6307	0.7973	4.7645	6.3408
N_{expected} - Existing Conditions	0.1479	0.6418	0.8040	4.5467	6.1404
$N_{\text{potential for improvement}}$ - Existing Conditions	-0.0004	0.0111	0.0067	-0.2178	-0.2004
N_{expected} - Proposed Conditions	0.0325	0.1412	0.1769	2.3643	2.7149

APPENDIX F

ROUNDBOUT CONCEPT PLAN



APPENDIX G

ECAT ANALYSIS



Safety Benefit - Cost Analysis

General Information

Project Name	LOR-82-2.57 Safety Study	Contact Email	Jared.Feller@dot.ohio.gov
Project Description	SR 82 & SR 83 Intersection Protected Left Turn Phases	Contact Phone	419-207-7058
Reference Number	N/A	Date Performed	4/20/2017
Analyst	Jared Feller	Analysis Year	2017
Agency/Company	ODOT District 3		

Select Site Types to be used in Benefit-Cost Analysis:

All Sites

Comments:

Countermeasure Service Lives, Costs, and Safety Benefits

Countermeasures	Service Life (Years)	Initial Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value	Net Present Cost of Countermeasure	Total Cost of Countermeasures	Summary of Annual Crash Modifications	Net Present Value of Safety Benefits
Site Characteristic Improvements (Please add description about improvements i.e. Lane widening)					\$0.00	\$0.00	0.000	\$0
Site Characteristic Improvements (Please add description about improvements i.e. Lighting)					\$0.00	\$0.00		
Site Characteristic Improvements (Please add description about improvements i.e. Signal Phasing)					\$0.00	\$0.00		
Site Characteristic Improvements (Please add description about improvements i.e. Added Right Turn Lane)					\$0.00	\$0.00		
CMF 1 - Change from permitted or permitted-protected to protected left-turn phase	10	\$175,000.00			\$175,000.00	\$175,000.00	-1.351	\$277,813
					\$0.00	\$0.00	0.000	\$0
					\$0.00	\$0.00	0.000	\$0
					\$0.00	\$0.00	0.000	\$0
					\$0.00	\$0.00	0.000	\$0
					\$0.00	\$0.00	0.000	\$0
					\$0.00	\$0.00	0.000	\$0
					\$0.00	\$0.00	0.000	\$0
					\$0.00	\$0.00	0.000	\$0
					\$0.00	\$0.00	0.000	\$0
					\$0.00	\$0.00	0.000	\$0
Totals		\$175,000.00	\$0.00	\$0.00	\$175,000.00	\$175,000.00	-1.351	\$277,813



Safety Benefit - Cost Analysis

General Information

Project Name	LOR-82-2.57 Safety Study	Contact Email	Jared.Feller@dot.ohio.gov
Project Description	SR 82 & SR 83 Intersection Protected Left Turn Phases	Contact Phone	419-207-7058
Reference Number	N/A	Date Performed	4/20/2017
Analyst	Jared Feller	Analysis Year	2017
Agency/Company	ODOT District 3		

Benefit - Cost Calculator

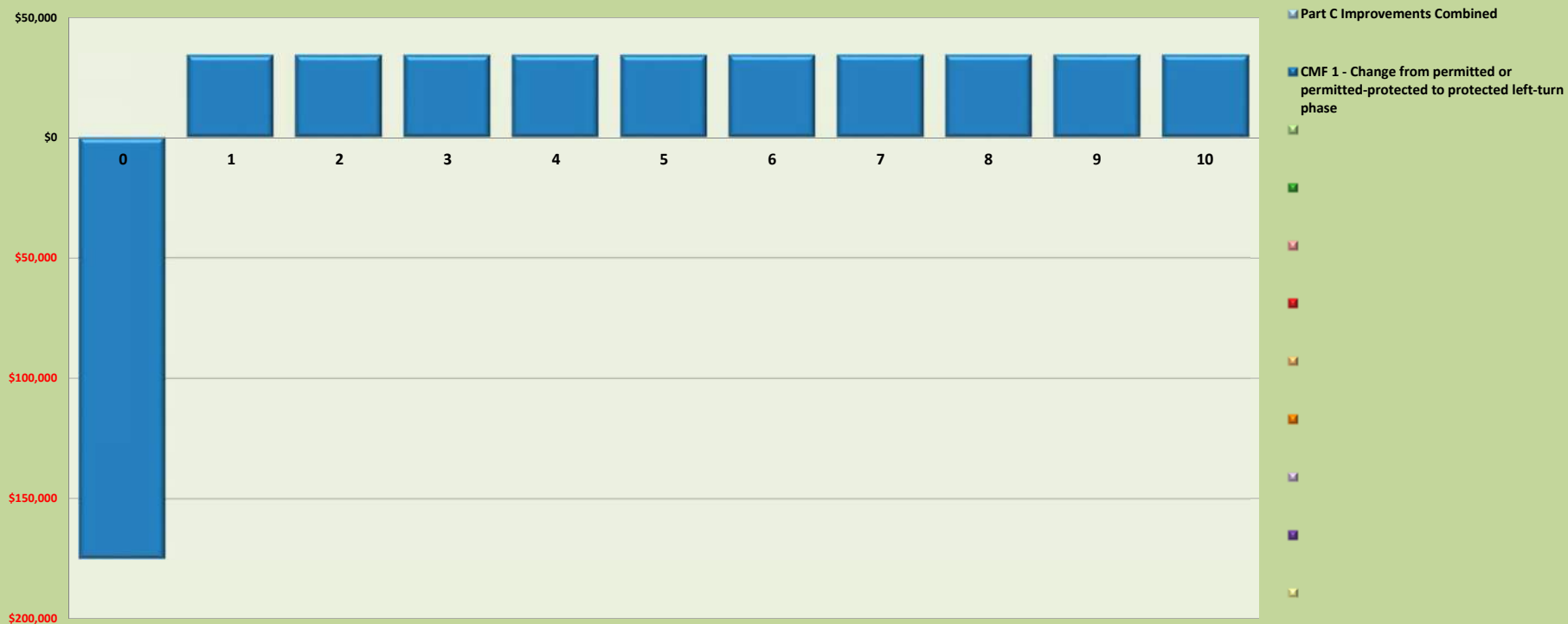
Net Present Value of Project	\$175,000.00
Net Present Value of Safety Benefits	\$277,812.54
Net Benefit	\$102,812.54
Benefit / Cost Ratio	1.59

Expected Annual Crash Adjustment

Number of Fatal & Incapacitating Injury Crashes	-0.033
Number of Injury Crashes	-0.351
Number of Total Crashes	-1.351

Comments:

Safety Benefits and Project Costs Combined Cash Flows By Countermeasure Per Year



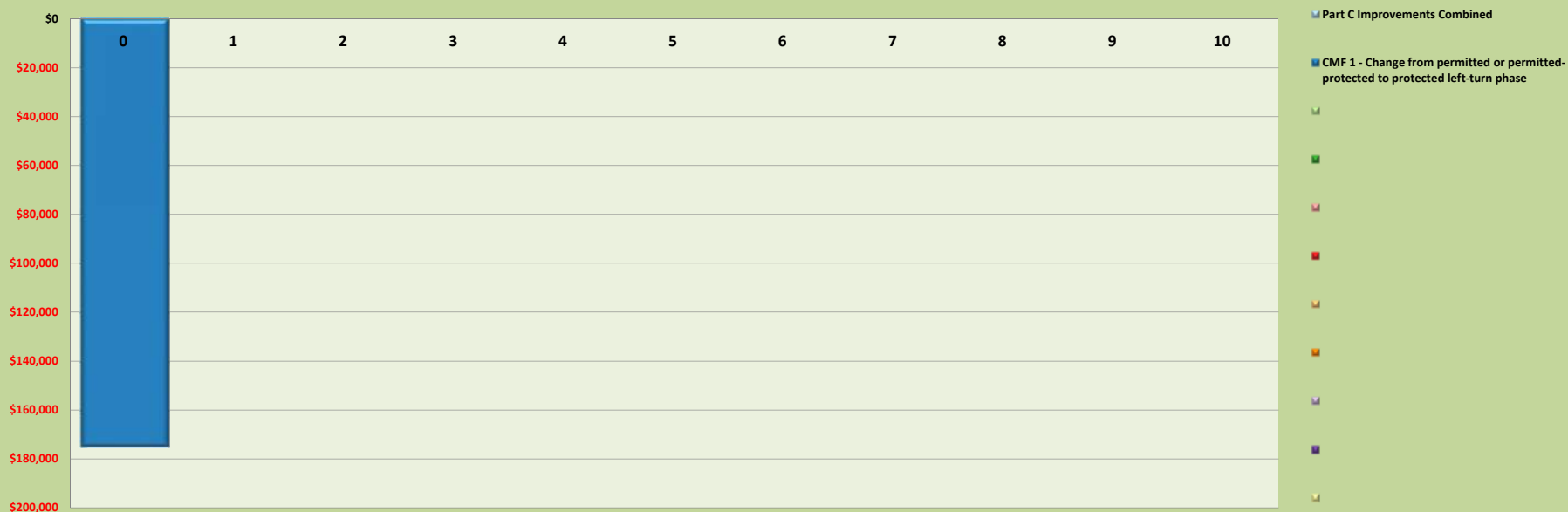


Safety Benefit - Cost Analysis

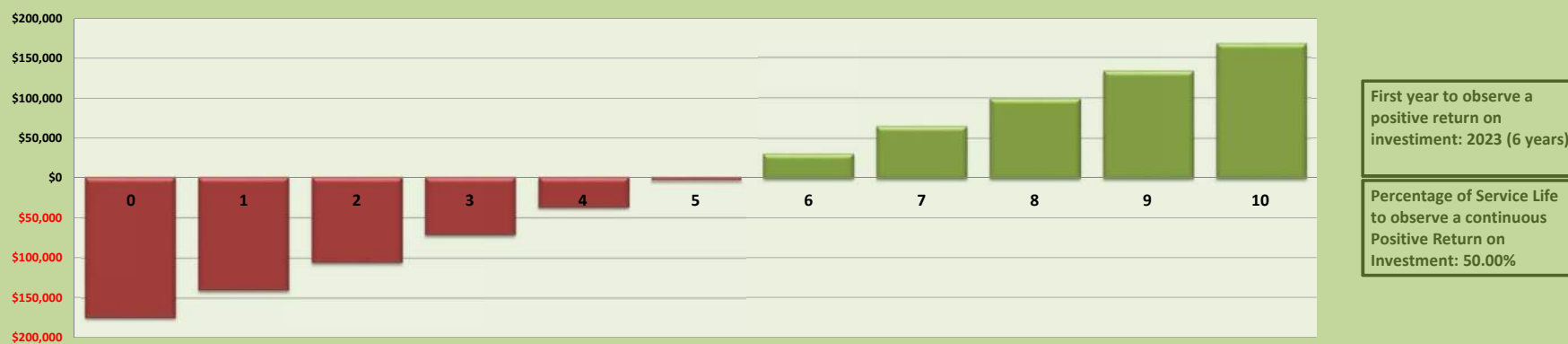
General Information

Project Name	LOR-82-2.57 Safety Study	Contact Email	Jared.Feller@dot.ohio.gov
Project Description	SR 82 & SR 83 Intersection Protected Left Turn Phases	Contact Phone	419-207-7058
Reference Number	N/A	Date Performed	4/20/2017
Analyst	Jared Feller	Analysis Year	2017
Agency/Company	ODOT District 3		

Project Costs Only Cash Flows By Countermeasure Per Year



Return on Investment (Safety Benefits and Project Investments)





Project Name	LOR-82-2.57 Safety Study	Contact Email	Jared.Feller@dot.ohio.gov
Project Description	SR 82 & SR 83 Intersection Roundabout	Contact Phone	419-207-7058
Reference Number	N/A	Date Performed	4/20/2017
Analyst	Jared Feller	Analysis Year	2017
Agency/Company	ODOT District 3		

Comments:

Countermeasure Service Lives, Costs, and Safety Benefits

Created by the Office of Systems Planning and Program Management



Safety Benefit - Cost Analysis

General Information

Project Name	LOR-82-2.57 Safety Study	Contact Email	Jared.Feller@dot.ohio.gov
Project Description	SR 82 & SR 83 Intersection Roundabout	Contact Phone	419-207-7058
Reference Number	N/A	Date Performed	4/20/2017
Analyst	Jared Feller	Analysis Year	2017
Agency/Company	ODOT District 3		

Benefit - Cost Calculator

Net Present Value of Project **\$3,000,000.00**

Net Present Value of Safety Benefits **\$1,494,726.37**

Net Benefit **(\$1,505,273.63)**

Benefit / Cost Ratio **0.50**

Expected Annual Crash Adjustment

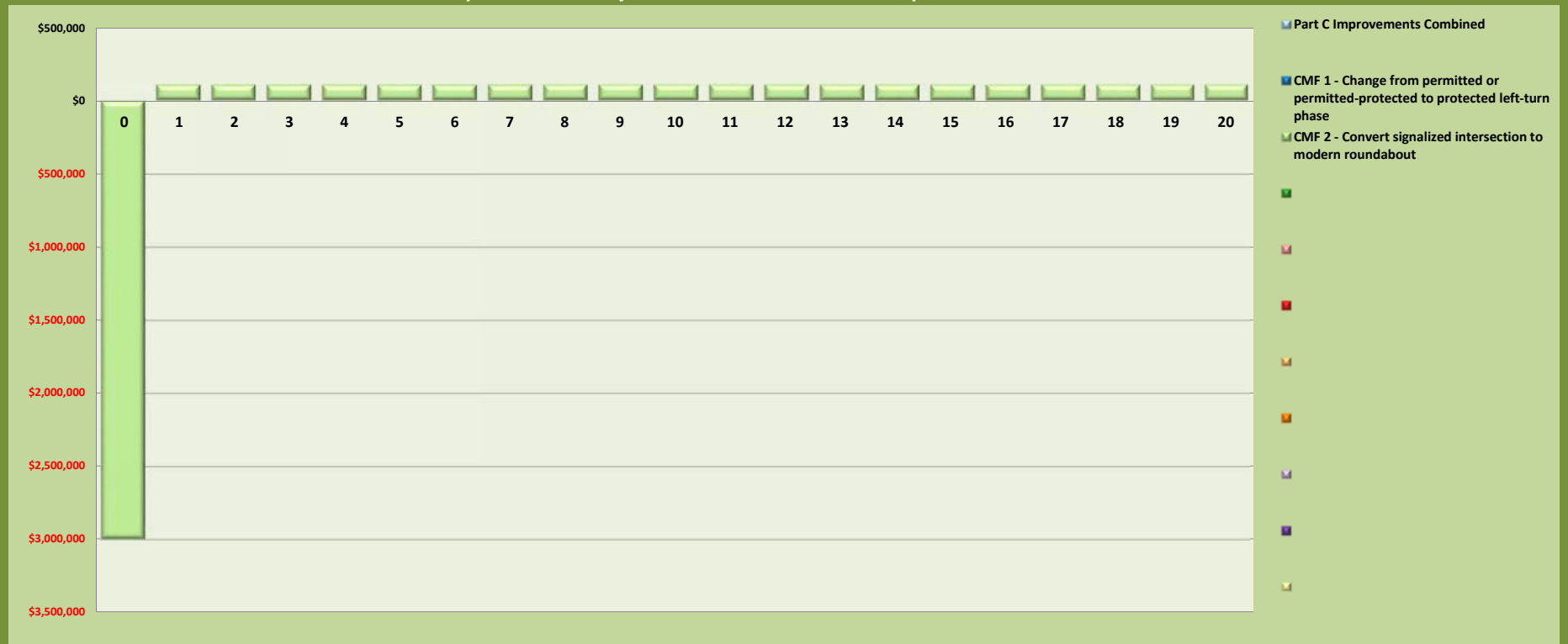
Number of Fatal & Incapacitating Injury Crashes **-0.115**

Number of Injury Crashes **-1.243**

Number of Total Crashes **-3.426**

Comments:

Safety Benefits and Project Costs Combined Cash Flows By Countermeasure Per Year



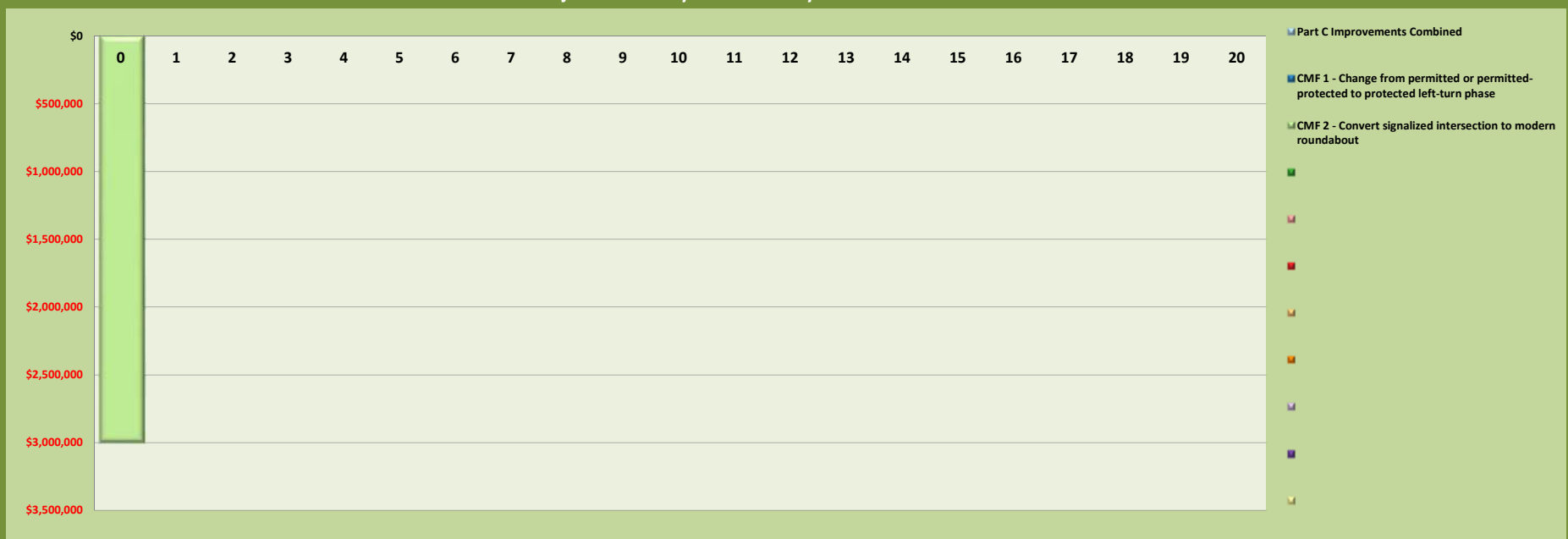


Safety Benefit - Cost Analysis

General Information

Project Name	LOR-82-2.57 Safety Study	Contact Email	Jared.Feller@dot.ohio.gov
Project Description	SR 82 & SR 83 Intersection Roundabout	Contact Phone	419-207-7058
Reference Number	N/A	Date Performed	4/20/2017
Analyst	Jared Feller	Analysis Year	2017
Agency/Company	ODOT District 3		

Project Costs Only Cash Flows By Countermeasure Per Year



Return on Investment (Safety Benefits and Project Investments)



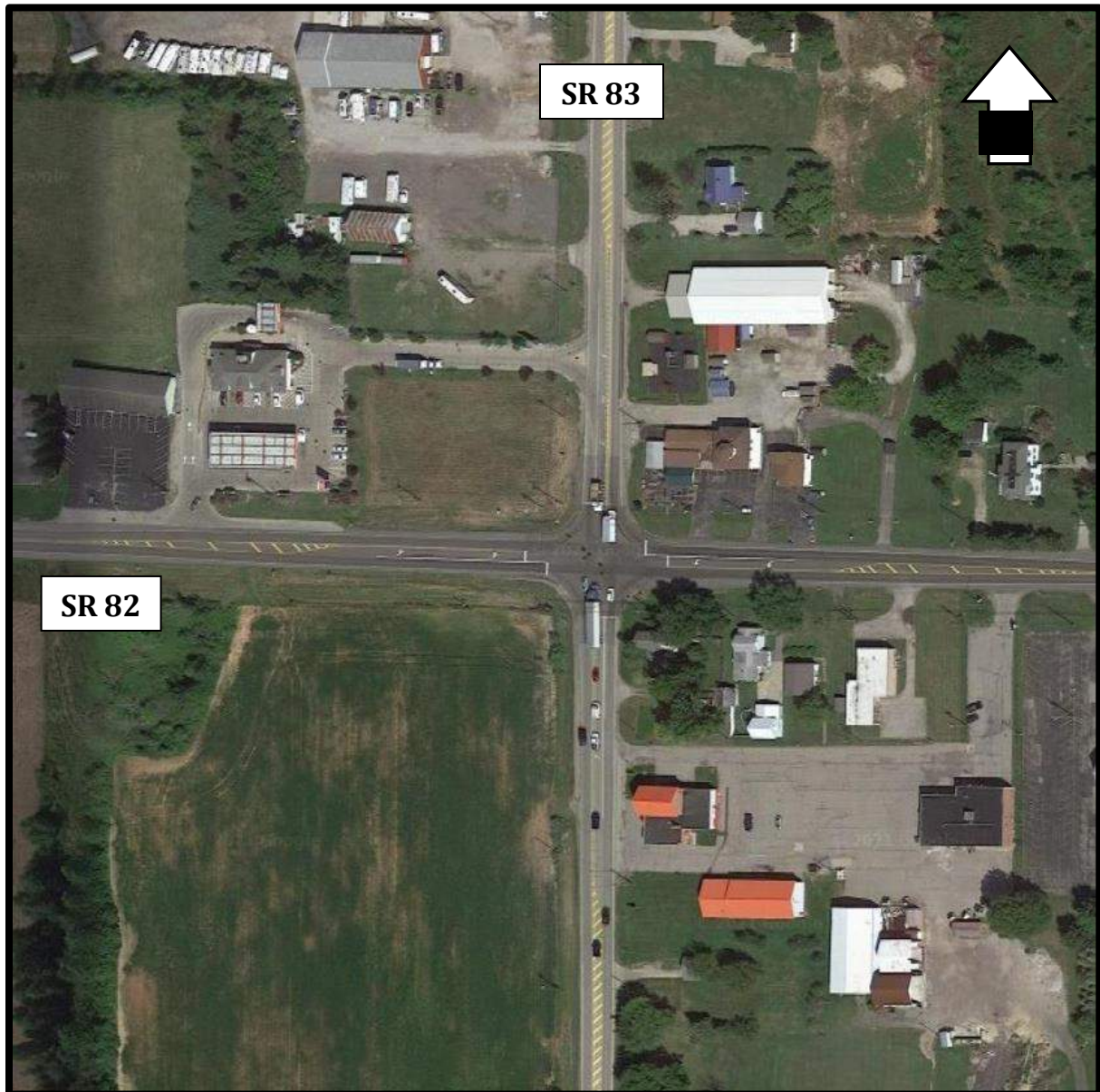
Appendix B – *2021 Signal Evaluation*



Ohio Department of Transportation, District 3
2021 Signal Evaluation
Lorain County SR 82, SLM 2.57
SR 83 Intersection

By: Jared Feller

Date: February 2022



Signal Evaluation Background

The Ohio Manual of Uniform Traffic Control Devices (OMUTCD) requires that the operation of existing traffic signals to be analyzed every five years. The following report considers whether an existing signal is still warranted per OMUTCD signal warrants, and if any operational changes are required to ensure the signal is performing well.

Existing Signal

The following features are present at the existing signal constructed in 2006:

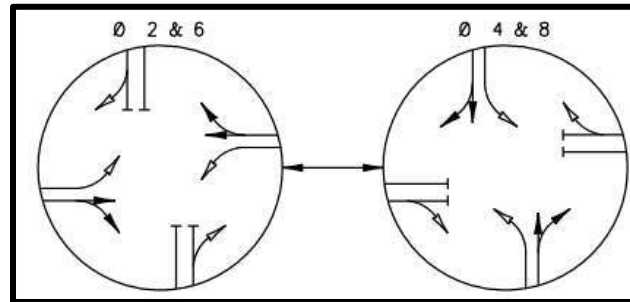
- Signal Type: Simple Span
- Signal Heads: Black Polycarbonate, 12-inch LEDs with Reflective Backplates
- Controller: Ground Mounted with Battery Backup
- Turn Lanes: Left Turn Lanes (storage lengths listed below)
 - EB Approach = 210', WB Approach = 185'
 - NB Approach = 300', SB Approach = 280'
- Detection: Stop Bar (SR 82, SR 83) – Radar
Dilemma Zone (SR 82, SR 83) – Radar
- Timing: See **Table 1** below.

Table 1 – Traffic Signal Timing

DATE: 9/28/2017		OVERLAP				A	B	C	D
FLASH MODE: ALL RED		PHASES							
INTERVAL OR FEATURE		CONTROLLER MOVEMENT No.							
		1	2	3	4	5	6	7	8
INTERSECTION MOVEMENT			EB		SB		WB		NB
MINIMUM GREEN (INITIAL)	(SEC)		20		12		20		12
PASSAGE TIME (GAP)	(SEC)		4		4		4		4
MAXIMUM GREEN	(SEC)		50		50		50		50
YELLOW CHANGE	(SEC)		5.5		6		5.5		6
ALL RED CLEARANCE	(SEC)		1		1		1		1
WALK	(SEC)								
PEDESTRIAN CLEARANCE	(SEC)								
RECALL	MINIMUM (ON/OFF)	OFF	ON	OFF	OFF	OFF	ON	OFF	OFF
	MAXIMUM (ON/OFF)	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	PEDESTRIAN (ON/OFF)	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
NON-LOCK	(ON/OFF)	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON
ADDED INITIAL	(SEC)		1.5				1.5		
MAXIMUM INITIAL	(SEC)		30				30		
TIME TO REDUCE	(SEC)		15				15		
TIME BEFORE REDUCTION	(SEC)		15				15		
MINIMUM GAP	(SEC)		3				3		

- Phasing: See **Figure 1** below.

Figure 1 – Phasing Diagram



- Photo: See **Image 1** below for a photograph of the intersection.



Image 1 – SR 82 & SR 83 Signal from the southeast corner (January 2022)

- Speeds: SR 82 = 50 MPH, SR 83 = 55 MPH
- Traffic: Moderate traffic volumes on SR 82 and light to moderate traffic volumes on SR 83 were observed on field visit. (mid-afternoon on 1/5/2022)
- Other Issues: No signal operation or queueing issues were observed.

Crash Data

Crashes were analyzed at the SR 82 & SR 83 intersection from January 1, 2016 through December 31, 2020. The reported crashes are summarized in **Table 2**.

Table 2 – Crash Data

YEAR		SEVERITY		TYPE		ROAD CONDITION	
2016	4 (21%)	Fatal	0 (0%)	Rear End	7 (37%)	Dry	11 (58%)
2017	4 (21%)	Injury	7 (37%)	Angle	6 (32%)	Wet	5 (26%)
2018	3 (16%)	PDO	12 (63%)	Left Turn	4 (21%)	Snow/Ice	3 (16%)
2019	6 (32%)			SS – Passing	2 (10%)		
2020	2 (10%)						
TOTAL	19 (100%)						

- There were seven rear end crashes reported at the intersection from 2016 – 2020. This is a reduction in the frequency of rear end crashes compared to the time frame reviewed with the previous signal evaluation (seven rear end crashes from 2013 – 2015). Three of the rear end crashes occurred in the southbound direction.
- There were six angle crashes reported at the intersection from 2016 – 2020. This is a slight increase in frequency compared to the time frame reviewed with the previous signal evaluation (three angle crashes from 2013 – 2015). Two of the angle crashes were a result of distracted driving, one was OVI, and one was due to a vehicle sliding into the intersection on snowy pavement.
- There were four left turn crashes at the intersection from 2016 – 2020. This is a slight decrease in frequency compared to the time frame reviewed with the previous signal evaluation (three left turn crashes from 2013 – 2015). All approach directions, except westbound, had a left turn crash and one left turn crash was a result of distracted driving.
- The lower number of crashes in 2020 may be a result of reduced traffic volumes due to the COVID-19 pandemic.

Supplemental Evaluations

The following additional studies were performed to ensure safe and efficient operation of the signal:

- 1. Turning Movements:** A traffic count was requested to obtain updated traffic volumes for the intersection. The traffic count was performed on September 14, 2021 between the hours of 6:00 AM – 6:00 PM. The count information can be found in **Table 3** below:

Table 3 – Turning Movement Count

Peak Hour (Start Time)	SR 83 Southbound				SR 82 Westbound				SR 83 Northbound				SR 82 Eastbound				Total
	R	T	L	Tot	R	T	L	Tot	R	T	L	Tot	R	T	L	Tot	
Total Count	369	1,985	1,117	3,471	857	3,102	497	4,456	443	1,979	1,449	3,871	1,196	3,046	474	4,716	16,514
AM Peak (7:15)	36	153	105	294	88	322	37	447	66	263	174	503	106	338	58	502	1,746
PM Peak (4:00)	47	294	132	473	62	384	80	526	38	183	140	361	137	337	47	521	1,881

- 2. Signal Warrant:** The signal warrant was analyzed at this intersection to verify if the existing signal should be retained. The OMUTCD Section 4C lists nine warrants for the installation of a signal. Warrants 1–3 (8-Hour Volume, 4-Hour Volume, Peak Hour Volume) were all analyzed based on the Turning Movement Count data. The intersection met the following signal warrants using the 70 percent volumes for signal retention as shown in **Table 4**:

Table 4 – Signal Warrant

Warrant	Hours Needed	Hours Met	Warrant Met
1A - Eight Hour Vehicular Volumes	8	12	Yes
1B - Interruption of Continuous Traffic	8	12	Yes
1 A&B - Combination of Warrants	1A 8	12	Yes
	1B 8	12	
2 - Four Hour Volumes	4	12	Yes
3 - Peak Hour Volumes	-	-	Yes

- 3. Clearance Interval Calculation:** Appropriate yellow and all-red clearance intervals are important to safe operation of a signal. Yellow and all red clearance intervals were calculated based on current ODOT Traffic Engineering Manual (TEM) guidelines, with the exception that all calculated values were rounded up to the nearest half second. Clearance intervals were previously updated in 2017 and the current intervals are appropriate. The calculated clearance intervals are shown in **Table 5**:

Table 5 – Clearance Intervals

INTERVAL OR FEATURE	CONTROLLER MOVEMENT No.							
	1	2	3	4	5	6	7	8
INTERSECTION MOVEMENT		EB		SB		WB		NB
YELLOW CHANGE (SEC)		5.2		5.6		5.2		5.6
ALL RED CLEARANCE (SEC)		0.2		0.1		0.1		0.2
PEDESTRIAN CLEARANCE** (SEC)		13.7		13.4		14.6		14.0

**Pedestrian signals and crosswalks are not provided at the intersection. Pedestrian Clearance intervals are less than the Minimum Green + Yellow Change for all movements. No timing changes are required to accommodate the pedestrian clearance.

- 4. Capacity Analysis:** Highway Capacity Software (HCS 7) was used to analyze the Level of Service (LOS) of each approach for existing timing at the intersection. The LOS is based on the calculated seconds of delay for each approach at an intersection using the Highway Capacity Manual (HCM) methodology. The results are summarized in **Table 6** below:

Table 6 – Existing Intersection Level of Service by Approach

Existing Delay s/veh and (LOS)	Intersection Approach				Intersection Combined Delay
	SR 82		SR 83		
	EB	WB	NB	SB	
AM Peak	20.2 (C)	19.4 (B)	19.6 (B)	19.4 (B)	19.7 (B)
PM Peak	21.1 (C)	21.1 (C)	23.1 (C)	21.6 (C)	21.6 (C)

Signal Evaluation Recommendations

- Reduce Passage Time to 2 seconds since radar detection has been installed
- Add Emergency Vehicle Preemption (three emergency vehicle crashes reported since 2013)
- Review adding Left Turn Phases for northbound/southbound traffic

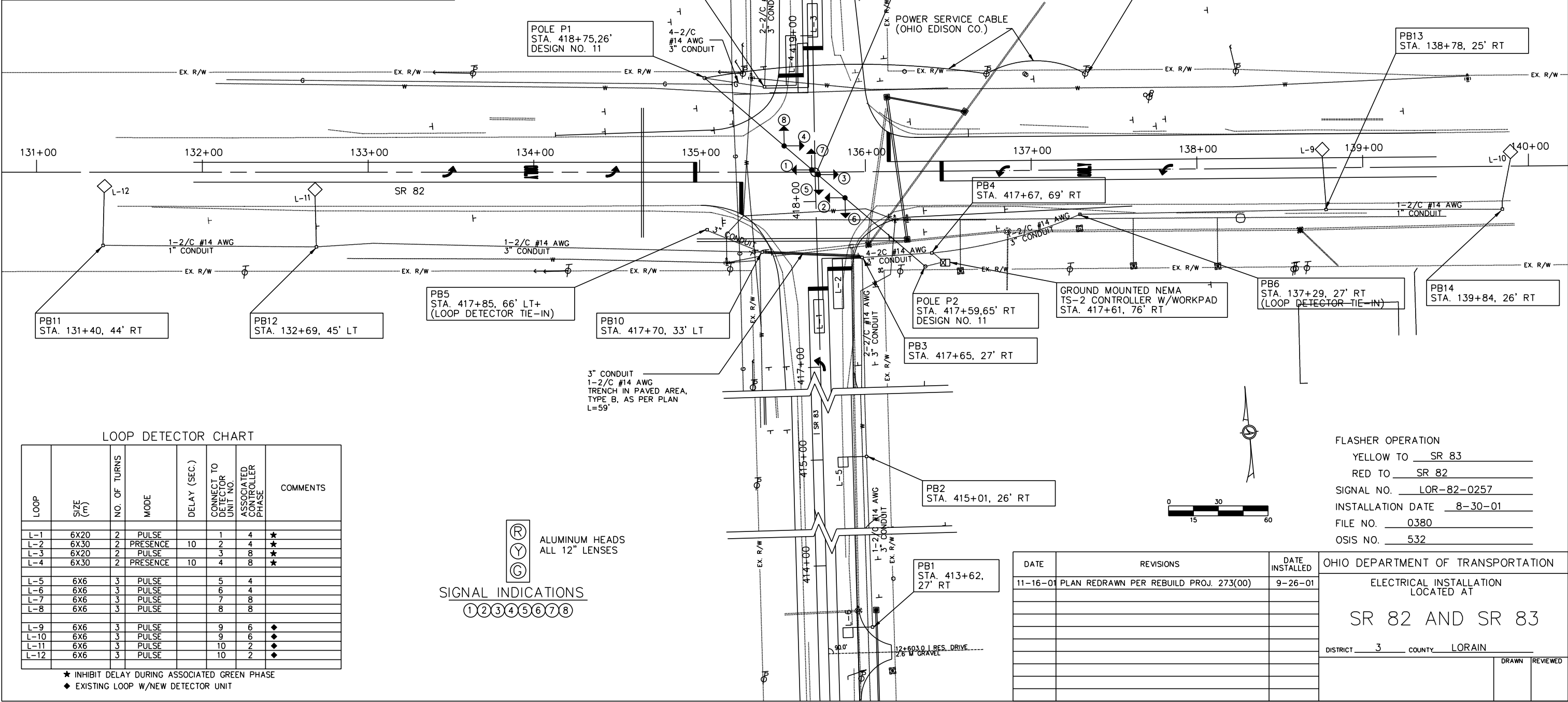
The signal is operating well based on the capacity analysis and operations observed during the field review. Peak hour intersection operations are near the border between LOS B and C. Approach LOS is similar during the peak hours due to since the traffic volume on at least one SR 83 approach is similar to the SR 82 approach traffic volumes during the peak hours.

The addition of Left Turn Phases for northbound and southbound traffic was reviewed in HCS 7 since these left turn volumes are considerably higher than the left turn volumes for eastbound and westbound traffic during the peak hours. Based on the increase in average intersection delay, left turn phase are not recommended. The results are summarized in **Table 7** below:

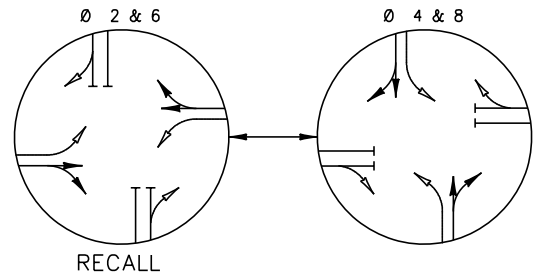
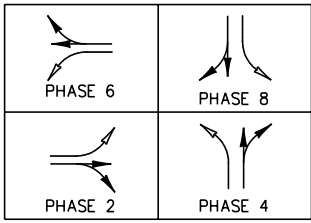
Table 7 – Intersection Level of Service with NB/SB Left Turn Phases

	Existing	Protected/ Permissive Left Turns	Protected Only Left Turns
	Delay s/veh and (LOS)		
AM Peak	19.7 (B)	25.3 (C)	29.6 (C)
PM Peak	21.6 (C)	26.7 (C)	32.2 (C)

MATERIAL REQUIRED			
ITEM	QTY.	UNITS	DESCRIPTION
625	1711	LIN. FT.	CONDUIT, 3", 713.07
625	60	LIN. FT.	CONDUIT, JACKED OR DRILLED, 3"
625	13	EACH	PULL BOX, 713.08, 18"
625	1	EACH	PULL BOX, 713.08, 24"
625	3	EACH	GROUND ROD, AS PER PLAN
632	175	LIN. FT.	MESSENGER WIRE, 7-STRAND, 1/4" DIA. W/ACCESSORIES, TETHER WIRE
632	175	LIN. FT.	MESSENGER WIRE, 7-STRAND, 3/8" DIA. W/ACCESSORIES
632	4	EACH	VEHICULAR SIGNAL HEAD, 3-SECTION, 12" LENS, 2-WAY, AS PER PLAN
632	8	EACH	DETECTOR LOOP, AS PER PLAN
632	10	EACH	LOOP DETECTOR UNIT, DELAY AND EXTENSION TYPE, APP
632	2	EACH	LOOP DETECTOR TIE-IN, AS PER PLAN
632	3638	LIN. FT.	LOOP DETECTOR LEAD-IN CABLE
632	1586	LIN. FT.	LOOP DETECTOR WIRE, TYPE E, APP
632	666	LIN. FT.	SIGNAL CABLE, 7 CONDUCTOR, NO. 14 AWG
632	2	EACH	STRAIN POLE FOUNDATION
632	2	EACH	STRAIN POLE, TYPE TC-81.10, DESIGN 11, AS PER PLAN
632	16	LIN. FT.	POWER CABLE, 2 CONDUCTOR, NO. 6 AWG
632	16	LIN. FT.	POWER CABLE, 3 CONDUCTOR, NO. 6 AWG
632	1	EACH	POWER SERVICE, AS PER PLAN
633	1	EACH	CONTROLLER ACTUATED, 8-PHASE, SOLID-STATE DIGITAL MICROPROCESSOR, APP
633	1	EACH	CONCRETE FOR CABINET FOUNDATION, TYPE TC-83.20, TYPE 2
633	12	SQ. FT.	CONTROLLER WORKPAD, TC-83.20, TYPE 2



PHASING IDENTIFICATION



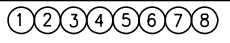
PHASING DIAGRAM

LOOP DETECTOR CHART

LOOP	SIZE (m)	NO. OF TURNS	MODE	DELAY (SEC.)	CONNECT TO DETECTOR UNIT NO.	ASSOCIATED CONTROLLER PHASE	COMMENTS
L-1	6X20	2	PULSE		1	4	★
L-2	6X30	2	PRESENCE	10	2	4	★
L-3	6X20	2	PULSE		3	8	★
L-4	6X30	2	PRESENCE	10	4	8	★
L-5	6X6	3	PULSE		5	4	
L-6	6X6	3	PULSE		6	4	
L-7	6X6	3	PULSE		7	8	
L-8	6X6	3	PULSE		8	8	
L-9	6X6	3	PULSE		9	6	◆
L-10	6X6	3	PULSE		9	6	◆
L-11	6X6	3	PULSE		10	2	◆
L-12	6X6	3	PULSE		10	2	◆

- ★ INHIBIT DELAY DURING ASSOCIATED GREEN PHASE
- ◆ EXISTING LOOP W/NEW DETECTOR UNIT

SIGNAL INDICATIONS



ALUMINUM HEADS
ALL 12" LENSES

FLASHER OPERATION

YELLOW TO SR 83
RED TO SR 82
SIGNAL NO. LOR-82-0257
INSTALLATION DATE 8-30-01
FILE NO. 0380
OSIS NO. 532

OHIO DEPARTMENT OF TRANSPORTATION

ELECTRICAL INSTALLATION
LOCATED AT

SR 82 AND SR 83

DISTRICT 3 COUNTY LORAIN

DRAWN REVIEWED

DATE	REVISIONS	DATE INSTALLED
11-16-01	PLAN REDRAWN PER REBUILD PROJ. 273(00)	9-26-01

L82&83.DWG

TRAFFIC SIGNAL TIMING (In Seconds)								
LOCATION: SR 82 / SR 83								
DATE: 09/28/2017								
PERSONNEL: KC								
	PHASE NUMBER							
	1	2	3	4	5	6	7	8
INTERVAL	NOT USED	SR 82 EB	NOT USED	SR 83 NB	NOT USED	SR 82 WB	NOT USED	SR 83 SB
MINIMUM GREEN		20		12		20		12
PASSAGE TIME		4.0		4.0		4.0		4.0
YELLOW CLEARANCE		5.5		6.0		5.5		6.0
RED CLEARANCE		1.0		1.0		1.0		1.0
MAX GREEN 1		50		50		50		50
MAX GREEN 2		50		50		50		50
MAX GREEN 3		0		0		0		0
WALK		0		0		0		0
DON'T WALK		0		0		0		0
MINIMUM RECALL		+		-		+		-
MAXIMUM RECALL		-		-		-		-
NON-LOCK		-		+		-		+
ADDED INITIAL (Sec./act.)		1.5		0		1.5		0
MAXIMUM INITIAL		30		0		30		0
TIME TO REDUCE		15		0		15		0
TIME BEFORE REDUCTION		15		0		15		0
MINIMUM GAP		3.0		0		3.0		0
NOTES:								
BLANK or N/A = Not Applicable or Not Used. (+) = Yes or On. (-) = No or Off								

CRASH DIAGRAM

Lorain Co. SR-82, SLM 2.57
SR-83 Intersection
Date: 1/1/2016 - 12/31/2020

Crashes By Year

2016: 4
2017: 4
2018: 3
2019: 6
2020: 2

Total: 19

Crashes By Severity

Fatal: 0
Injury: 7
PDO: 12

NOTES

-7 rear end
-6 angle
-4 left turn
-2 sideswipe-passing



SR-83

12-13-17/8/Dry
01-10-19/11/Wet
08-05-19/21/Dry

12-16-16/18/Dry(D)
10-29-19/18/Dry

05-13-16/16/Dry

05-19-20/9/Wet

09-13-17/22/Wet

An EB ambulance caused a car to stop abruptly just before the intersection. This caused a boom truck to rear end the car.

09-09-19/15/Dry

01-03-18/17/OtherSnow
10-15-18/8/Wet

02-26-17/20/Dry(I)
03-21-18/3/Snow

09-02-16/7/Dry (D)
11-13-16/21/Dry
07-06-19/19/Dry (D)
12-12-20/16/Wet

WB ran red

SB ran red

WB ran red

SB ran red

02-09-17/12/Snow
10-21-19/7/Dry

NB ran red

EB driver stopped for emergency vehicle and was sideswiped by another EB driver.

EB driver said the light turned yellow and tried to stop but continued to slide through the intersection due to the snowy conditions.

SR-82

Legend

Symbols	Types of Collisions
Other	Rear End
Backing Vehicle	Head On
Pedestrian	Side-Swipe Passing
Parked Vehicle	Side-Swipe Meeting
Fixed Object	Out-of-Control
Fatal Crash	Angle
Injury Crash	Angle
Signal	Left Turn
Street	Right Turn
Stop Sign	Right Turn
Animal	

Diagram Label Key

Date/Hour/Road Condition
(I) = Alcohol, Drugs (D) = Distracted
Jacob Molnar



Ohio DOT - Traffic Operations
1606 West Broad Street

Columbus, Ohio, United States 43223
+16144667170 D03trafficcunts@dot.ohio.gov

Count Name: LOR-82-2.57
Site Code:
Start Date: 09/14/2021
Page No: 1

Turning Movement Data

Start Time	Southbound Approach Southbound					Westbound Approach Westbound					Northbound Approach Northbound					Eastbound Approach Eastbound					Int. Total
	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	
6:00 AM	2	14	8	0	24	12	16	1	0	29	5	68	36	0	109	19	32	9	0	60	222
6:15 AM	5	25	15	0	45	13	40	3	0	56	9	74	35	0	118	30	40	10	0	80	299
6:30 AM	11	39	12	0	62	22	52	8	0	82	9	59	42	0	110	47	76	10	0	133	387
6:45 AM	6	42	28	0	76	16	57	2	0	75	10	52	32	0	94	41	73	15	0	129	374
Hourly Total	24	120	63	0	207	63	165	14	0	242	33	253	145	0	431	137	221	44	0	402	1282
7:00 AM	9	26	21	0	56	15	59	4	0	78	9	55	24	0	88	31	64	19	0	114	336
7:15 AM	9	52	25	0	86	16	79	12	0	107	15	83	32	0	130	28	81	16	0	125	448
7:30 AM	10	37	31	0	78	21	76	8	0	105	20	58	59	0	137	31	98	18	0	147	467
7:45 AM	9	27	29	0	65	29	99	11	0	139	18	60	54	0	132	25	89	12	0	126	462
Hourly Total	37	142	106	0	285	81	313	35	0	429	62	256	169	0	487	115	332	65	0	512	1713
8:00 AM	8	37	20	0	65	22	68	6	0	96	13	62	29	0	104	22	70	12	0	104	369
8:15 AM	7	39	26	0	72	15	65	11	0	91	6	47	37	0	90	17	49	6	0	72	325
8:30 AM	2	27	18	0	47	19	52	6	0	77	9	46	25	0	80	24	66	12	0	102	306
8:45 AM	4	19	18	0	41	12	34	4	0	50	9	30	29	0	68	20	41	10	0	71	230
Hourly Total	21	122	82	0	225	68	219	27	0	314	37	185	120	0	342	83	226	40	0	349	1230
9:00 AM	3	38	21	0	62	22	49	9	0	80	7	32	22	0	61	25	45	5	0	75	278
9:15 AM	3	24	18	0	45	14	36	4	0	54	3	33	28	0	64	12	31	6	0	49	212
9:30 AM	14	34	17	0	65	9	60	6	0	75	9	34	27	0	70	9	45	8	0	62	272
9:45 AM	3	32	21	0	56	19	51	10	0	80	6	30	21	0	57	19	47	10	0	76	269
Hourly Total	23	128	77	0	228	64	196	29	0	289	25	129	98	0	252	65	168	29	0	262	1031
10:00 AM	5	26	13	0	44	24	30	6	0	60	5	41	29	0	75	10	52	8	0	70	249
10:15 AM	10	28	16	1	55	13	55	5	0	73	12	30	21	0	63	14	45	13	0	72	263
10:30 AM	11	38	24	2	75	13	55	12	0	80	6	34	13	0	53	17	52	5	0	74	282
10:45 AM	6	31	25	0	62	14	42	6	0	62	8	26	18	0	52	11	38	9	0	58	234
Hourly Total	32	123	78	3	236	64	182	29	0	275	31	131	81	0	243	52	187	35	0	274	1028
11:00 AM	2	28	27	0	57	20	48	13	0	81	11	26	19	0	56	27	49	3	0	79	273
11:15 AM	6	23	16	0	45	14	50	11	0	75	9	32	13	0	54	26	45	8	0	79	253
11:30 AM	7	33	28	0	68	22	52	11	0	85	6	35	13	0	54	16	61	7	0	84	291
11:45 AM	6	34	18	0	58	18	51	4	0	73	13	23	22	0	58	20	47	11	0	78	267
Hourly Total	21	118	89	0	228	74	201	39	0	314	39	116	67	0	222	89	202	29	0	320	1084
12:00 PM	7	35	24	0	66	16	64	4	0	84	1	17	18	0	36	22	61	10	0	93	279
12:15 PM	4	27	18	0	49	20	37	8	0	65	7	27	21	0	55	24	62	6	0	92	261
12:30 PM	7	28	22	0	57	26	56	10	0	92	6	40	16	0	62	20	45	13	0	78	289
12:45 PM	6	42	33	0	81	14	43	10	0	67	9	32	27	0	68	20	52	9	0	81	297
Hourly Total	24	132	97	0	253	76	200	32	0	308	23	116	82	0	221	86	220	38	0	344	1126
1:00 PM	12	36	23	0	71	12	59	8	0	79	9	29	26	0	64	23	55	5	0	83	297

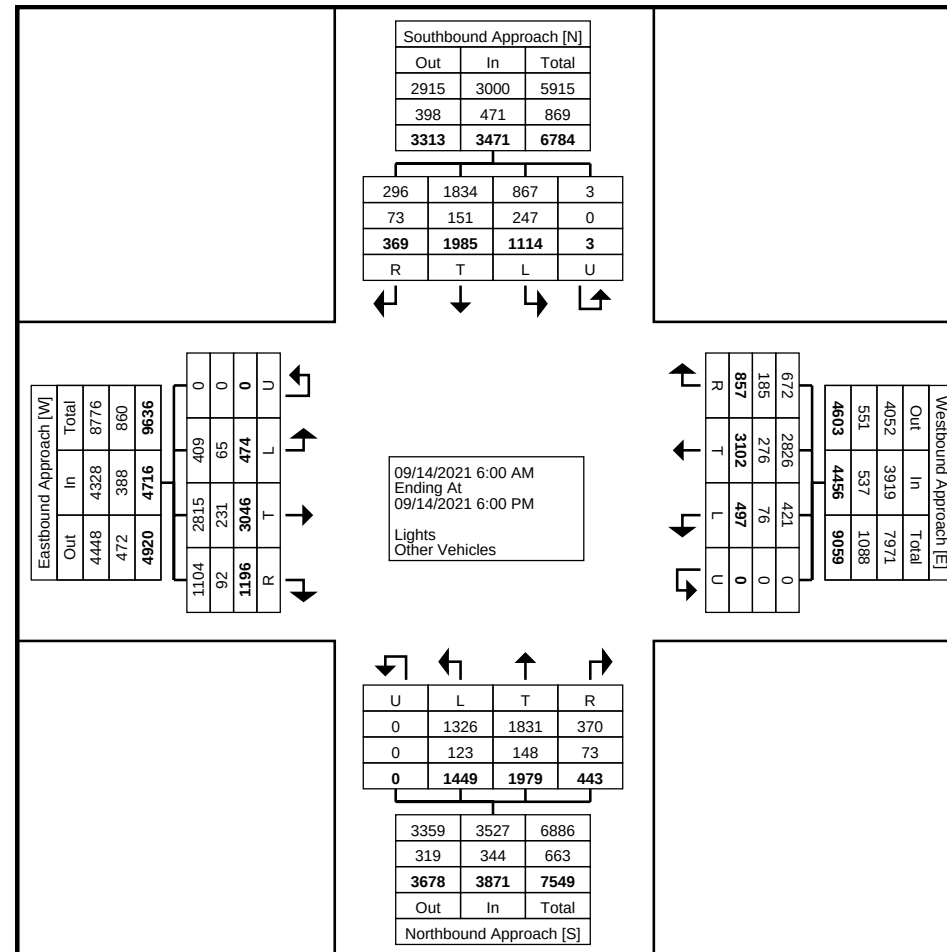
1:15 PM	6	45	26	0	77	16	48	13	0	77	4	26	17	0	47	31	62	7	0	100	301
1:30 PM	8	28	27	0	63	22	60	16	0	98	14	31	24	0	69	32	54	7	0	93	323
1:45 PM	11	33	14	0	58	14	66	10	0	90	11	27	30	0	68	10	68	9	0	87	303
Hourly Total	37	142	90	0	269	64	233	47	0	344	38	113	97	0	248	96	239	28	0	363	1224
2:00 PM	8	37	32	0	77	29	59	7	0	95	11	52	39	0	102	21	65	9	0	95	369
2:15 PM	18	33	25	0	76	10	61	11	0	82	8	52	42	0	102	26	61	6	0	93	353
2:30 PM	13	52	28	0	93	18	78	12	0	108	8	33	38	0	79	28	61	5	0	94	374
2:45 PM	10	50	20	0	80	32	86	16	0	134	11	36	38	0	85	23	69	17	0	109	408
Hourly Total	49	172	105	0	326	89	284	46	0	419	38	173	157	0	368	98	256	37	0	391	1504
3:00 PM	4	42	18	0	64	24	115	13	0	152	11	41	53	0	105	23	68	18	0	109	430
3:15 PM	10	57	33	0	100	15	76	17	0	108	7	46	23	0	76	29	89	11	0	129	413
3:30 PM	8	64	24	0	96	18	83	9	0	110	16	47	33	0	96	34	83	13	0	130	432
3:45 PM	9	54	28	0	91	27	105	13	0	145	11	42	36	0	89	32	92	8	0	132	457
Hourly Total	31	217	103	0	351	84	379	52	0	515	45	176	145	0	366	118	332	50	0	500	1732
4:00 PM	12	52	47	0	111	13	94	17	0	124	11	43	34	0	88	47	89	14	0	150	473
4:15 PM	14	68	20	0	102	13	92	12	0	117	8	48	37	0	93	32	83	12	0	127	439
4:30 PM	12	97	30	0	139	20	93	23	0	136	10	51	32	0	93	32	84	8	0	124	492
4:45 PM	9	77	35	0	121	16	105	28	0	149	9	41	37	0	87	26	81	13	0	120	477
Hourly Total	47	294	132	0	473	62	384	80	0	526	38	183	140	0	361	137	337	47	0	521	1881
5:00 PM	6	77	19	0	102	17	96	24	0	137	17	33	40	0	90	31	74	8	0	113	442
5:15 PM	7	69	25	0	101	19	84	8	0	111	6	36	40	0	82	36	94	9	0	139	433
5:30 PM	5	80	20	0	105	21	90	26	0	137	7	38	39	0	84	29	98	8	0	135	461
5:45 PM	5	49	28	0	82	11	76	9	0	96	4	41	29	0	74	24	60	7	0	91	343
Hourly Total	23	275	92	0	390	68	346	67	0	481	34	148	148	0	330	120	326	32	0	478	1679
Grand Total	369	1985	1114	3	3471	857	3102	497	0	4456	443	1979	1449	0	3871	1196	3046	474	0	4716	16514
Approach %	10.6	57.2	32.1	0.1	-	19.2	69.6	11.2	0.0	-	11.4	51.1	37.4	0.0	-	25.4	64.6	10.1	0.0	-	-
Total %	2.2	12.0	6.7	0.0	21.0	5.2	18.8	3.0	0.0	27.0	2.7	12.0	8.8	0.0	23.4	7.2	18.4	2.9	0.0	28.6	-
Lights	296	1834	867	3	3000	672	2826	421	0	3919	370	1831	1326	0	3527	1104	2815	409	0	4328	14774
% Lights	80.2	92.4	77.8	100.0	86.4	78.4	91.1	84.7	-	87.9	83.5	92.5	91.5	-	91.1	92.3	92.4	86.3	-	91.8	89.5
Other Vehicles	73	151	247	0	471	185	276	76	0	537	73	148	123	0	344	92	231	65	0	388	1740
% Other Vehicles	19.8	7.6	22.2	0.0	13.6	21.6	8.9	15.3	-	12.1	16.5	7.5	8.5	-	8.9	7.7	7.6	13.7	-	8.2	10.5



Ohio DOT - Traffic Operations
1606 West Broad Street

Columbus, Ohio, United States 43223
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Count Name: LOR-82-2.57
Site Code:
Start Date: 09/14/2021
Page No: 3



Turning Movement Data Plot



Ohio DOT - Traffic Operations
1606 West Broad Street

Columbus, Ohio, United States 43223
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Count Name: LOR-82-2.57
Site Code:
Start Date: 09/14/2021
Page No: 4

Turning Movement Peak Hour Data (7:15 AM)

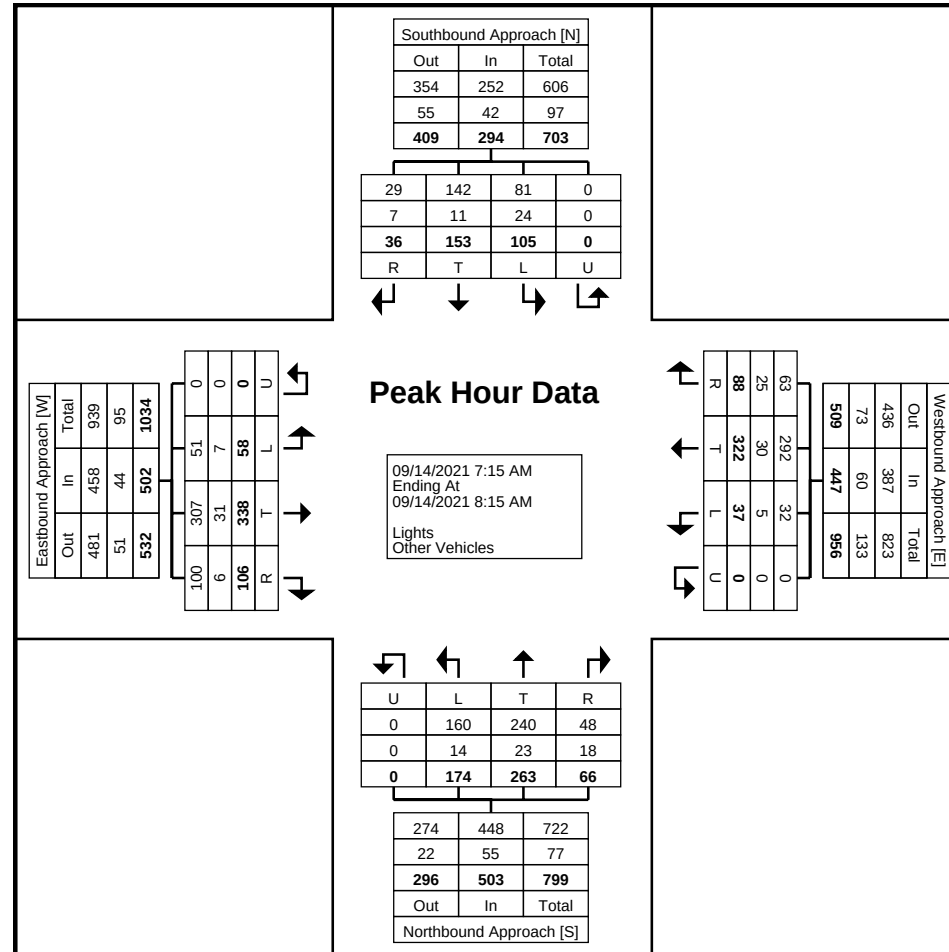
Start Time	Southbound Approach Southbound					Westbound Approach Westbound					Northbound Approach Northbound					Eastbound Approach Eastbound					Int. Total
	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	
7:15 AM	9	52	25	0	86	16	79	12	0	107	15	83	32	0	130	28	81	16	0	125	448
7:30 AM	10	37	31	0	78	21	76	8	0	105	20	58	59	0	137	31	98	18	0	147	467
7:45 AM	9	27	29	0	65	29	99	11	0	139	18	60	54	0	132	25	89	12	0	126	462
8:00 AM	8	37	20	0	65	22	68	6	0	96	13	62	29	0	104	22	70	12	0	104	369
Total	36	153	105	0	294	88	322	37	0	447	66	263	174	0	503	106	338	58	0	502	1746
Approach %	12.2	52.0	35.7	0.0	-	19.7	72.0	8.3	0.0	-	13.1	52.3	34.6	0.0	-	21.1	67.3	11.6	0.0	-	-
Total %	2.1	8.8	6.0	0.0	16.8	5.0	18.4	2.1	0.0	25.6	3.8	15.1	10.0	0.0	28.8	6.1	19.4	3.3	0.0	28.8	-
PHF	0.900	0.736	0.847	0.000	0.855	0.759	0.813	0.771	0.000	0.804	0.825	0.792	0.737	0.000	0.918	0.855	0.862	0.806	0.000	0.854	0.935
Lights	29	142	81	0	252	63	292	32	0	387	48	240	160	0	448	100	307	51	0	458	1545
% Lights	80.6	92.8	77.1	-	85.7	71.6	90.7	86.5	-	86.6	72.7	91.3	92.0	-	89.1	94.3	90.8	87.9	-	91.2	88.5
Other Vehicles	7	11	24	0	42	25	30	5	0	60	18	23	14	0	55	6	31	7	0	44	201
% Other Vehicles	19.4	7.2	22.9	-	14.3	28.4	9.3	13.5	-	13.4	27.3	8.7	8.0	-	10.9	5.7	9.2	12.1	-	8.8	11.5



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Count Name: LOR-82-2.57
Site Code:
Start Date: 09/14/2021
Page No: 5



Turning Movement Peak Hour Data Plot (7:15 AM)



Ohio DOT - Traffic Operations
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Count Name: LOR-82-2.57
Site Code:
Start Date: 09/14/2021
Page No: 6

Turning Movement Peak Hour Data (4:00 PM)

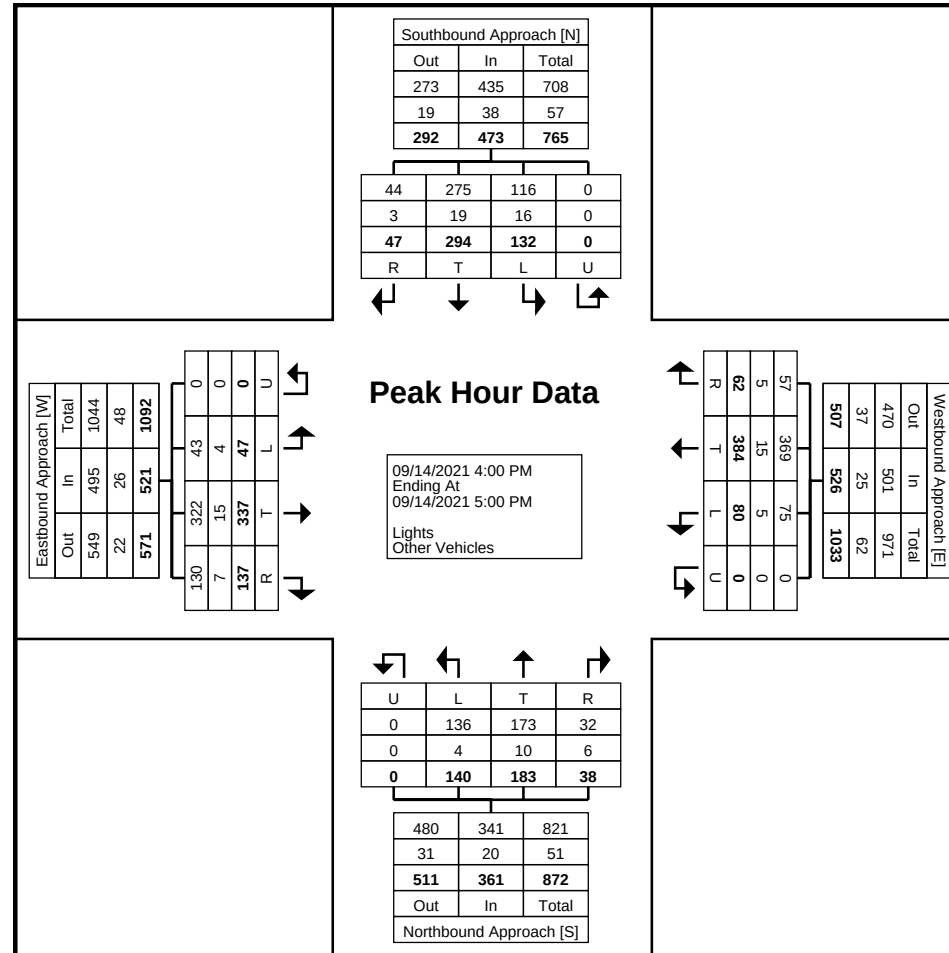
Start Time	Southbound Approach Southbound					Westbound Approach Westbound					Northbound Approach Northbound					Eastbound Approach Eastbound					Int. Total
	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	Right	Thru	Left	U-Turn	App. Total	
4:00 PM	12	52	47	0	111	13	94	17	0	124	11	43	34	0	88	47	89	14	0	150	473
4:15 PM	14	68	20	0	102	13	92	12	0	117	8	48	37	0	93	32	83	12	0	127	439
4:30 PM	12	97	30	0	139	20	93	23	0	136	10	51	32	0	93	32	84	8	0	124	492
4:45 PM	9	77	35	0	121	16	105	28	0	149	9	41	37	0	87	26	81	13	0	120	477
Total	47	294	132	0	473	62	384	80	0	526	38	183	140	0	361	137	337	47	0	521	1881
Approach %	9.9	62.2	27.9	0.0	-	11.8	73.0	15.2	0.0	-	10.5	50.7	38.8	0.0	-	26.3	64.7	9.0	0.0	-	-
Total %	2.5	15.6	7.0	0.0	25.1	3.3	20.4	4.3	0.0	28.0	2.0	9.7	7.4	0.0	19.2	7.3	17.9	2.5	0.0	27.7	-
PHF	0.839	0.758	0.702	0.000	0.851	0.775	0.914	0.714	0.000	0.883	0.864	0.897	0.946	0.000	0.970	0.729	0.947	0.839	0.000	0.868	0.956
Lights	44	275	116	0	435	57	369	75	0	501	32	173	136	0	341	130	322	43	0	495	1772
% Lights	93.6	93.5	87.9	-	92.0	91.9	96.1	93.8	-	95.2	84.2	94.5	97.1	-	94.5	94.9	95.5	91.5	-	95.0	94.2
Other Vehicles	3	19	16	0	38	5	15	5	0	25	6	10	4	0	20	7	15	4	0	26	109
% Other Vehicles	6.4	6.5	12.1	-	8.0	8.1	3.9	6.3	-	4.8	15.8	5.5	2.9	-	5.5	5.1	4.5	8.5	-	5.0	5.8



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Count Name: LOR-82-2.57
Site Code:
Start Date: 09/14/2021
Page No: 7



Turning Movement Peak Hour Data Plot (4:00 PM)

Report Title 1

Report Title 2

Report Title 3

Study Name: LOR-82 & 83

Study Date : 10/13/2021

Signal Warrants - Summary

Major Street Approaches

Eastbound: SR 82

Number of Lanes : 1

Total Approach Volume: 4,716

Westbound: SR 82

Number of Lanes :1

Total Approach Volume: 4,456

Minor Street Approaches

Northbound: SR 83

Number of Lanes :1

Total Approach Volume: 3,871

Southbound: SR 83

Number of Lanes :1

Total Approach Volume: 3,468

Warrant Summary (Rural Values Apply)

Warrant 1 - Eight Hour Vehicular Volumes.....Satisfied

Warrant 1A - Minimum Vehicular Volume.....Satisfied

Required volumes reached for 12 hours, 8 are needed

Warrant 1B - Interruption of Continuous Traffic.....Satisfied

Required volumes reached for 12 hours, 8 are needed

Warrant 1C - Combination of Warrants.....Satisfied

Required 1A volumes reached for 12 hours, 8 are needed

Required 1B volumes reached for 12 hours, 8 are needed

Warrant 2 - Four Hour Volumes.....Satisfied

Number of hours (12) volumes exceed minimum >= minimum required (4).

Warrant 3 - Peak Hour.....Satisfied

Warrant 3A - Peak Hour Delay.....Satisfied

Number of one hour periods (48) volumes exceed minimum >= required (1). Delay data not evaluated.

Warrant 3B - Peak Hour Volumes.....Satisfied

Volumes exceed minimums for at least one hour period.

Warrant 4 - Pedestrian Volumes.....Not Evaluated

Warrant 5 - School Crossing.....Not Evaluated

Warrant 6 - Coordinated Signal System.....Not Evaluated

Warrant 7 - Crash Experience.....Not Evaluated

Warrant 8 - Roadway Network.....Not Evaluated

Warrant 9 - Intersection Near a Grade Crossing.....Not Evaluated

Report Title 1

Report Title 2

Report Title 3

Study Name: LOR-82 & 83

Study Date : 10/13/2021

Warrant 1A - Minimum Volumes

Description

Intended for sites where the volume of intersecting traffic is the principal reason for consideration of a signal installation.

Summary

12 one hour periods meet minimums.
Warrant IS met.

Site Data Required

Rural Settings Apply = **True**
Number of Major Lanes = **1**
Number of Minor Lanes = **1**

Volume Requirements

Rural Factor of 70 % applied
Veh/Hr Major = **350**

Veh/Hr Minor = **105**

Major Road SR 82						Minor Road SR 83		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
15:45 - 16:45	533	+	522	=	1055	363	443	Yes
16:45 - 17:45	507	+	534	=	1041	343	429	Yes
14:45 - 15:45	477	+	504	=	981	362	340	Yes
06:45 - 07:45	515	+	365	=	880	449	296	Yes
07:45 - 08:45	404	+	403	=	807	406	249	Yes
13:45 - 14:45	369	+	375	=	744	351	304	Yes
12:45 - 13:45	357	+	321	=	678	248	292	Yes
11:45 - 12:45	341	+	314	=	655	211	230	Yes
10:45 - 11:45	300	+	303	=	603	216	232	Yes
09:45 - 10:45	292	+	293	=	585	248	227	Yes
08:45 - 09:45	257	+	259	=	516	263	213	Yes
05:45 - 06:45	273	+	167	=	440	337	131	Yes
05:30 - 06:30	140	+	85	=	225	227	69	No
17:45 - 18:45	91	+	96	=	187	74	82	No
05:15 - 06:15	60	+	29	=	89	109	24	No
22:15 - 23:15	0	+	0	=	0	0	0	No
18:00 - 19:00	0	+	0	=	0	0	0	No
22:00 - 23:00	0	+	0	=	0	0	0	No
22:30 - 23:30	0	+	0	=	0	0	0	No
00:00 - 01:00	0	+	0	=	0	0	0	No
23:45 - 00:45	0	+	0	=	0	0	0	No
19:15 - 20:15	0	+	0	=	0	0	0	No
23:30 - 00:30	0	+	0	=	0	0	0	No
22:45 - 23:45	0	+	0	=	0	0	0	No
23:00 - 00:00	0		0		0	0	0	No

Report Title 1

Report Title 2

Report Title 3

Study Name: LOR-82 & 83

Study Date : 10/13/2021

Warrant 1B - Interruption of Continuous Traffic

Description

Intended for sites where the volume of the major street is so heavy that traffic on the minor street suffers excessive delay or hazard.

Summary

12 one hour periods meet minimums.
Warrant IS met.

Site Data Required

Rural Settings Apply = **True**
Number of Major Lanes = **1**
Number of Minor Lanes = **1**

Volume Requirements

Rural Factor of 70 % applied
Veh/Hr Major = **525**

Veh/Hr Minor = **52**

Major Road SR 82						Minor Road SR 83		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
16:00 - 17:00	521	+	526	=	1047	361	473	Yes
15:00 - 16:00	500	+	515	=	1015	366	351	Yes
17:00 - 18:00	478	+	481	=	959	330	390	Yes
07:00 - 08:00	512	+	429	=	941	487	285	Yes
14:00 - 15:00	391	+	419	=	810	368	326	Yes
13:00 - 14:00	363	+	344	=	707	248	269	Yes
08:00 - 09:00	349	+	314	=	663	342	225	Yes
12:00 - 13:00	344	+	308	=	652	221	253	Yes
06:00 - 07:00	402	+	242	=	644	431	207	Yes
11:00 - 12:00	320	+	314	=	634	222	228	Yes
09:00 - 10:00	262	+	289	=	551	252	228	Yes
10:00 - 11:00	274	+	275	=	549	243	233	Yes
05:45 - 06:45	273	+	167	=	440	337	131	No
05:30 - 06:30	140	+	85	=	225	227	69	No
05:15 - 06:15	60	+	29	=	89	109	24	No
18:30 - 19:30	0	+	0	=	0	0	0	No
18:00 - 19:00	0	+	0	=	0	0	0	No
23:45 - 00:45	0	+	0	=	0	0	0	No
23:30 - 00:30	0	+	0	=	0	0	0	No
18:15 - 19:15	0	+	0	=	0	0	0	No
21:45 - 22:45	0	+	0	=	0	0	0	No
22:00 - 23:00	0	+	0	=	0	0	0	No
21:15 - 22:15	0	+	0	=	0	0	0	No
21:30 - 22:30	0	+	0	=	0	0	0	No
22:15 - 23:15	0		0		0	0	0	No

Report Title 1

Report Title 2

Report Title 3

Study Name: LOR-82 & 83

Study Date : 10/13/2021

Warrant 1C Combination of Warrants

Description

Intended for sites where the traffic volumes don't meet individual warrants but where Warrants 1A and 1B are both met to 80% of their stated values.

Summary

12 hours meet 1A minimums.
12 hours meet 1B minimums.
Warrant IS met.

Site Data Required

Rural Settings Apply = **True**
Number of Major Lanes = **1**
Number of Minor Lanes = **1**

Volume Requirements

Rural Factor of 70% applied
Warrant 1A 1B
Veh/Hr Major = **280 420**

Veh/Hr Minor = **84 42**

Major Road						Minor Road			
SR 82						SR 83			
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met1A?	
15:45 - 16:45	533	+	522	=	1055	363	443	Yes	
16:45 - 17:45	507	+	534	=	1041	343	429	Yes	
14:45 - 15:45	477	+	504	=	981	362	340	Yes	
06:45 - 07:45	515	+	365	=	880	449	296	Yes	
07:45 - 08:45	404	+	403	=	807	406	249	Yes	
13:45 - 14:45	369	+	375	=	744	351	304	Yes	
12:45 - 13:45	357	+	321	=	678	248	292	Yes	
11:45 - 12:45	341	+	314	=	655	211	230	Yes	
10:45 - 11:45	300	+	303	=	603	216	232	Yes	
09:45 - 10:45	292	+	293	=	585	248	227	Yes	
08:45 - 09:45	257	+	259	=	516	263	213	Yes	
05:45 - 06:45	273		167		440	337	131	Yes	

Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met1B?	
15:45 - 16:45	533	+	522	=	1055	363	443	Yes	
16:45 - 17:45	507	+	534	=	1041	343	429	Yes	
14:45 - 15:45	477	+	504	=	981	362	340	Yes	
06:45 - 07:45	515	+	365	=	880	449	296	Yes	
07:45 - 08:45	404	+	403	=	807	406	249	Yes	
13:45 - 14:45	369	+	375	=	744	351	304	Yes	
12:45 - 13:45	357	+	321	=	678	248	292	Yes	
11:45 - 12:45	341	+	314	=	655	211	230	Yes	
10:45 - 11:45	300	+	303	=	603	216	232	Yes	
09:45 - 10:45	292	+	293	=	585	248	227	Yes	
08:45 - 09:45	257	+	259	=	516	263	213	Yes	
05:45 - 06:45	273		167		440	337	131	Yes	

Report Title 1

Report Title 2

Report Title 3

Study Name: LOR-82 & 83

Study Date : 10/13/2021

Warrant 2 - Four Hour Volumes

Description

Intended for sites where the volume of intersecting traffic during any four hours of the day is the principal reason for consideration of a signal installation.

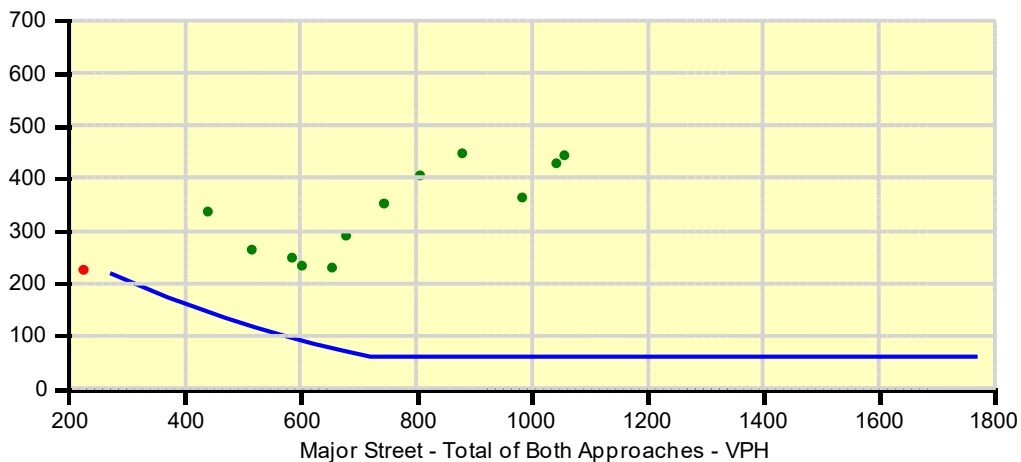
Summary

12 one hour periods meet minimums.
Warrant IS met.

Site Data Required

Rural Settings Apply = **True**
Number of Major Lanes = **1**
Number of Minor Lanes = **1**

Major Road SR 82						Minor Road SR 83		Met?
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	
15:45 - 16:45	533	+	522	=	1055	363	443	Yes
16:45 - 17:45	507	+	534	=	1041	343	429	Yes
14:45 - 15:45	477	+	504	=	981	362	340	Yes
06:45 - 07:45	515	+	365	=	880	449	296	Yes
07:45 - 08:45	404	+	403	=	807	406	249	Yes
13:45 - 14:45	369	+	375	=	744	351	304	Yes
12:45 - 13:45	357	+	321	=	678	248	292	Yes
11:45 - 12:45	341	+	314	=	655	211	230	Yes
10:45 - 11:45	300	+	303	=	603	216	232	Yes
09:45 - 10:45	292	+	293	=	585	248	227	Yes
08:45 - 09:45	257	+	259	=	516	263	213	Yes
							131	Yes



Report Title 1

Report Title 2

Report Title 3

Study Name: LOR-82 & 83

Study Date : 10/13/2021

Warrant 3A - Peak Hour Delay

Description

Intended for sites where for one hour of the day minor street traffic suffers undue traffic delay entering or crossing the major street.

Summary

48 one hour periods meet minimums.
Warrant IS met.

Site Data Required

Number of Minor Lanes = 1

Volume and Delay Requirements

Veh/Hr All Approaches = 800

Veh/Hr Minor = 100

Total Delay (Veh-Hrs) = 4

Major Road			Minor Road						
SR 82			SR 83						
Time	Total of All Approaches	Met?	Minor NB	Delay NB	Met?	Minor SB	Delay SB	Met?	Warrant Met?
16:00 - 17:00	1881	Yes	361	-	---	473	-	Yes	Yes
15:45 - 16:45	1861	Yes	363	-	---	443	-	Yes	Yes
16:15 - 17:15	1850	Yes	363	-	---	464	-	Yes	Yes
16:30 - 17:30	1844	Yes	352	-	---	463	-	Yes	Yes
16:45 - 17:45	1813	Yes	343	-	---	429	-	Yes	Yes
15:30 - 16:30	1801	Yes	366	-	---	400	-	Yes	Yes
15:15 - 16:15	1775	Yes	349	-	---	398	-	Yes	Yes
07:15 - 08:15	1746	Yes	503	-	Yes	294	-	---	Yes
15:00 - 16:00	1732	Yes	366	-	Yes	351	-	---	Yes
07:00 - 08:00	1713	Yes	487	-	Yes	285	-	---	Yes
14:45 - 15:45	1683	Yes	362	-	Yes	340	-	---	Yes
17:00 - 18:00	1679	Yes	330	-	---	390	-	Yes	Yes
06:45 - 07:45	1625	Yes	449	-	Yes	296	-	---	Yes
14:30 - 15:30	1625	Yes	345	-	Yes	337	-	---	Yes
07:30 - 08:30	1623	Yes	463	-	Yes	280	-	---	Yes
14:15 - 15:15	1565	Yes	371	-	Yes	313	-	---	Yes
06:30 - 07:30	1545	Yes	422	-	Yes	280	-	---	Yes
14:00 - 15:00	1504	Yes	368	-	Yes	326	-	---	Yes
07:45 - 08:45	1462	Yes	406	-	Yes	249	-	---	Yes
13:45 - 14:45	1399	Yes	351	-	Yes	304	-	---	Yes
06:15 - 07:15	1396	Yes	410	-	Yes	239	-	---	Yes
13:30 - 14:30	1348	Yes	341	-	Yes	274	-	---	Yes
13:15 - 14:15	1296	Yes	286	-	Yes	275	-	---	Yes
06:00 - 07:00	1282	Yes	431	-	Yes	207	-	---	Yes
17:15 - 18:15	1237	Yes	240	-	---	288	-	Yes	Yes

Report Title 1

Report Title 2

Report Title 3

Study Name: LOR-82 & 83

Study Date : 10/13/2021

Warrant 3B - Peak Hour Volumes

Description

Intended for sites where the volume of intersecting traffic during one hour of the day is the principal reason for consideration of a signal installation.

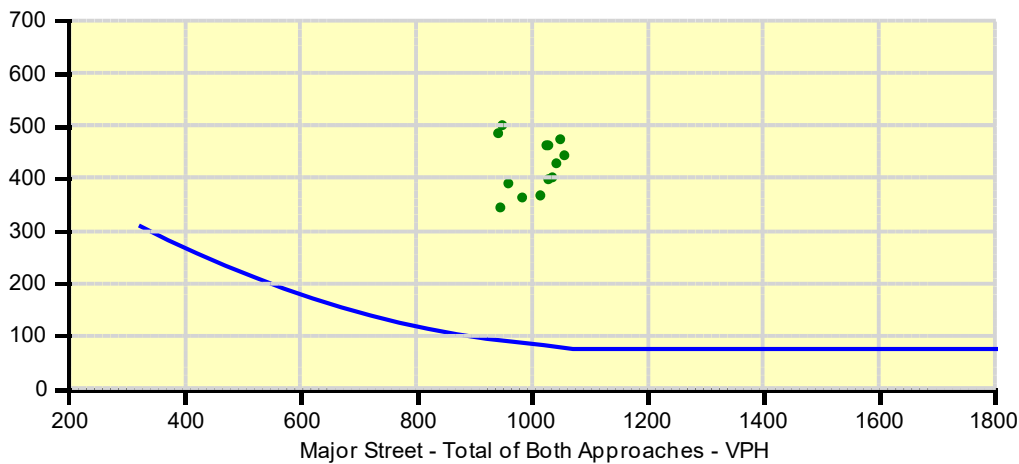
Summary

47 one hour periods meet minimums.
Warrant IS met.

Site Data Required

Rural Settings Apply = **True**
Number of Major Lanes = **1**
Number of Minor Lanes = **1**

Major Road SR 82						Minor Road SR 83		Met?
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	
15:45 - 16:45	533	+	522	=	1055	363	443	Yes
16:00 - 17:00	521	+	526	=	1047	361	473	Yes
16:45 - 17:45	507	+	534	=	1041	343	429	Yes
15:30 - 16:30	539	+	496	=	1035	366	400	Yes
16:30 - 17:30	496	+	533	=	1029	352	463	Yes
15:15 - 16:15	541	+	487	=	1028	349	398	Yes
16:15 - 17:15	484	+	539	=	1023	363	464	Yes
15:00 - 16:00	500	+	515	=	1015	366	351	Yes
14:45 - 15:45	477	+	504	=	981	362	340	Yes
17:00 - 18:00	478	+	481	=	959	330	390	Yes
07:15 - 08:15	502	+	447	=	949	503	294	Yes
							337	Yes



Associated Phase	Direction	Movement	Traffic Signal													Pedestrian														
			Factors *(TEM 403-2)								Calculated (TEM 403-2)			Final Clearance		Ped Movement	Associated Phase	Crosswalk Length	Pushbutton Provided	Distance to Pushbutton from Curb (furthest of the two corners)	OMUTCD 4E.06-12 Walk Interval (4-7s TYP)	OMUTCD 4E.06-07 Calculated Ped Clearance	Ped Change Interval (FDW)	3 fps Checks (OMUTCD 4E.06, 01-14)				Final Ped Timing		
			Posted Speed Limit	Perception/Reactio n Time (1s TYP)	Yellow Change Approach Speed*	Red Approach Speed*	Deceleration Rate (10 fps TYP)	Width of Intersection*	Length of Vehicle (20 ft TYP)	Approach Grade	Yellow	Red	Y + R	Yellow	Red									Y + R	(L+P)/(3 fps) (NOTE: P=6 if NO Pushbutton)	Walk + Ped Change Intervals + Yellow	IS Y>=X?	Additional Walk Interval Required	Final Walk Interval	Final Ped Change Interval (FDW)
				t	V _Y	V _R	a	W	L	g	Y	R	TOTAL	Y (3-6s TYP)	R (1-6s TYP)									TOTAL	X	Y				
MPH	SEC	MPH	MPH	FPS	FT	FT	%	SEC	SEC	SEC	SEC	SEC	SEC	SEC	FT	FT	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC	SEC			
1	-	-	-	1	-	-	10	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
2	EB	THROUGH/RT	50	1	57	57	10	82	20	0	5.2	0.2	5.4	-	-	-	EB	-	48	NO	-	-	13.7	#VALUE!	18.0	-	-	#VALUE!		
3	-	-	-	1	-	-	10	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
4	SB	THROUGH/RT	55	1	62	62	10	83	20	0	5.6	0.1	5.7	-	-	-	SB	-	47	NO	-	-	13.4	#VALUE!	17.7	-	-	#VALUE!		
5	-	-	-	1	-	-	10	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
6	WB	THROUGH/RT	50	1	57	57	10	75	20	0	5.2	0.1	5.3	-	-	-	WB	-	51	NO	-	-	14.6	#VALUE!	19.0	-	-	#VALUE!		
7	-	-	-	1	-	-	10	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
8	NB	THROUGH/RT	55	1	62	62	10	86	20	0	5.6	0.2	5.8	-	-	-	NB	-	49	NO	-	-	14.0	#VALUE!	18.3	-	-	#VALUE!		

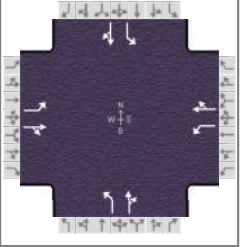
HCS7 Signalized Intersection Results Summary

General Information

Agency		Analysis Date	10/14/2021	Duration, h	0.250
Analyst		Area Type	Other	PHF	0.94
Jurisdiction		Analysis Year	2021	Analysis Period	1 > 7:00
Urban Street	SR 82	File Name	LOR-82_83 AM Peak.xus		
Intersection	SR 83				
Project Description	AM Peak				

Intersection Information

Duration, h	0.250
Area Type	Other
PHF	0.94
Analysis Period	1 > 7:00
File Name	LOR-82_83 AM Peak.xus



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	58	338	106	37	322	88	174	263	66	105	153	36

Signal Information

Cycle, s	71.4	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	29.9	28.0	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	6.0	0.0	0.0	0.0	0.0		
				Red	1.0	1.0	0.0	0.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		6.0		6.0		6.0
Phase Duration, s		36.4		36.4		35.0		35.0
Change Period, (Y+R _c), s		6.5		6.5		7.0		7.0
Max Allow Headway (MAH), s		5.1		5.1		5.3		5.3
Queue Clearance Time (g _s), s		23.1		23.0		18.8		22.3
Green Extension Time (g _e), s		6.8		6.8		5.8		5.7
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.08		0.08		0.02		0.04

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	62	472		39	436		185	350		112	201	
Adjusted Saturation Flow Rate (s), veh/h/ln	900	1560		841	1514		1097	1544		933	1507	
Queue Service Time (g _s), s	4.3	18.0		2.9	16.8		10.2	12.7		7.6	6.7	
Cycle Queue Clearance Time (g _c), s	21.1	18.0		21.0	16.8		16.8	12.7		20.3	6.7	
Green Ratio (g/C)	0.42	0.42		0.42	0.42		0.39	0.39		0.39	0.39	
Capacity (c), veh/h	266	654		241	635		428	605		300	590	
Volume-to-Capacity Ratio (X)	0.232	0.722		0.163	0.687		0.432	0.579		0.372	0.341	
Back of Queue (Q), ft/ln (95 th percentile)	41.8	255.1		27.6	241.4		116	193.5		79.2	100.1	
Back of Queue (Q), veh/ln (95 th percentile)	1.6	9.5		1.0	8.7		4.3	7.1		2.8	3.6	
Queue Storage Ratio (RQ) (95 th percentile)	0.20	0.00		0.14	0.00		0.39	0.00		0.28	0.00	
Uniform Delay (d ₁), s/veh	25.5	17.3		26.0	16.9		21.1	17.1		25.0	15.2	
Incremental Delay (d ₂), s/veh	0.6	2.2		0.4	1.9		1.0	1.3		1.1	0.5	
Initial Queue Delay (d ₃), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	26.2	19.4		26.5	18.8		22.1	18.3		26.1	15.7	
Level of Service (LOS)	C	B		C	B		C	B		C	B	
Approach Delay, s/veh / LOS	20.2	C		19.4	B		19.6	B		19.4	B	
Intersection Delay, s/veh / LOS	19.7						B					

Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	1.90	B		1.90	B		1.90	B		1.90	B	
Bicycle LOS Score / LOS	1.37	A		1.27	A		1.37	A		1.00	A	

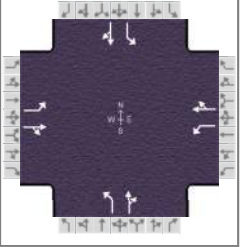
HCS7 Signalized Intersection Results Summary

General Information

Agency		Analysis Date	10/14/2021	Duration, h	0.250
Analyst		Time Period		Area Type	Other
Jurisdiction		Analysis Year	2021	PHF	0.96
Urban Street	SR 82	File Name	LOR-82_83 PM Peak.xus	Analysis Period	1> 7:00
Intersection	SR 83				
Project Description	PM Peak				

Intersection Information

Duration, h	0.250
Area Type	Other
PHF	0.96
Analysis Period	1> 7:00



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	47	337	137	80	384	62	140	183	38	132	294	47

Signal Information

Cycle, s	82.7	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	36.5	32.7	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	6.0	0.0	0.0	0.0	0.0		
				Red	1.0	1.0	0.0	0.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		4
Case Number		6.0		6.0		6.0		6.0
Phase Duration, s		43.0		43.0		39.7		39.7
Change Period, (Y+R _c), s		6.5		6.5		7.0		7.0
Max Allow Headway (MAH), s		5.1		5.1		5.2		5.2
Queue Clearance Time (g _s), s		24.0		29.7		27.3		18.6
Green Extension Time (g _e), s		7.5		6.9		5.4		5.9
Phase Call Probability		1.00		1.00		1.00		1.00
Max Out Probability		0.12		0.21		0.08		0.02

Movement Group Results

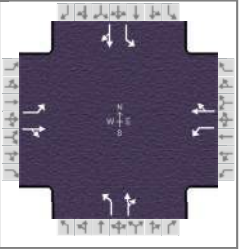
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	49	494		83	465		146	230		138	355	
Adjusted Saturation Flow Rate (s), veh/h/ln	906	1599		882	1641		994	1618		1096	1601	
Queue Service Time (g _s), s	3.7	20.6		7.0	18.2		11.1	8.3		8.4	14.3	
Cycle Queue Clearance Time (g _c), s	22.0	20.6		27.7	18.2		25.3	8.3		16.6	14.3	
Green Ratio (g/C)	0.44	0.44		0.44	0.44		0.40	0.40		0.40	0.40	
Capacity (c), veh/h	287	706		256	725		309	639		411	633	
Volume-to-Capacity Ratio (X)	0.171	0.699		0.326	0.641		0.472	0.360		0.335	0.562	
Back of Queue (Q), ft/ln (95 th percentile)	35.7	288.6		67.1	264.6		119.7	131.9		97	223.8	
Back of Queue (Q), veh/ln (95 th percentile)	1.4	11.1		2.6	10.2		4.6	5.0		3.6	8.4	
Queue Storage Ratio (RQ) (95 th percentile)	0.17	0.00		0.34	0.00		0.40	0.00		0.34	0.00	
Uniform Delay (d ₁), s/veh	26.6	18.7		29.9	18.0		29.3	17.6		23.5	19.5	
Incremental Delay (d ₂), s/veh	0.4	1.9		1.0	1.4		1.6	0.5		0.7	1.1	
Initial Queue Delay (d ₃), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	27.0	20.5		30.9	19.3		30.8	18.1		24.2	20.6	
Level of Service (LOS)	C	C		C	B		C	B		C	C	
Approach Delay, s/veh / LOS	21.1	C		21.1	C		23.1	C		21.6	C	
Intersection Delay, s/veh / LOS	21.6						C					

Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	1.90	B		1.90	B		1.91	B		1.91	B	
Bicycle LOS Score / LOS	1.38	A		1.39	A		1.11	A		1.30	A	

HCS7 Signalized Intersection Results Summary

General Information				Intersection Information		
Agency				Duration, h	0.250	
Analyst		Analysis Date	10/14/2021	Area Type	Other	
Jurisdiction		Time Period		PHF	0.94	
Urban Street	SR 82	Analysis Year	2021	Analysis Period	1> 7:00	
Intersection	SR 83	File Name	LOR-82_83 AM Peak.xus			
Project Description	AM Peak					



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	58	338	106	37	322	88	174	263	66	105	153	36

Signal Information														
Cycle, s	80.8	Reference Phase	2											
Offset, s	0	Reference Point	End											
Uncoordinated	Yes	Simult. Gap E/W	On	Green	32.9	6.4	2.8	19.5	0.0	0.0				
				Yellow	5.5	3.5	0.0	6.0	0.0	0.0				
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	2.0	0.0	1.0	0.0	0.0				

1		2		3		4	
5		6		7		8	

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6	3	8	7	4
Case Number		6.0		6.0	1.1	4.0	1.1	4.0
Phase Duration, s		39.4		39.4	14.8	29.4	11.9	26.5
Change Period, ($Y+R_c$), s		6.5		6.5	5.5	7.0	5.5	7.0
Max Allow Headway (MAH), s		5.1		5.1	3.0	5.0	3.0	5.0
Queue Clearance Time (g_s), s		26.3		26.2	9.2	19.1	6.5	11.4
Green Extension Time (g_e), s		6.6		6.6	0.2	3.2	0.1	3.3
Phase Call Probability		1.00		1.00	0.98	1.00	0.92	1.00
Max Out Probability		0.11		0.11	0.00	0.00	0.00	0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	62	472		39	436		185	350		112	201	
Adjusted Saturation Flow Rate (s), veh/h/ln	900	1560		841	1514		1524	1544		1485	1507	
Queue Service Time (g_s), s	5.0	20.8		3.4	19.4		7.2	17.1		4.5	9.4	
Cycle Queue Clearance Time (g_c), s	24.3	20.8		24.2	19.4		7.2	17.1		4.5	9.4	
Green Ratio (g/C)	0.41	0.41		0.41	0.41		0.36	0.28		0.32	0.24	
Capacity (c), veh/h	241	636		216	618		403	428		246	365	
Volume-to-Capacity Ratio (X)	0.256	0.742		0.182	0.706		0.460	0.817		0.454	0.551	
Back of Queue (Q), ft/ln (95 th percentile)	50.1	299.1		33	283.1		111.2	282.4		70.8	162.8	
Back of Queue (Q), veh/ln (95 th percentile)	1.9	11.2		1.2	10.3		4.1	10.4		2.5	5.9	
Queue Storage Ratio (RQ) (95 th percentile)	0.24	0.00		0.17	0.00		0.37	0.00		0.25	0.00	
Uniform Delay (d_1), s/veh	30.0	20.3		30.6	19.9		19.7	27.3		22.0	26.8	
Incremental Delay (d_2), s/veh	0.8	2.5		0.6	2.1		0.3	5.4		0.5	1.8	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	30.8	22.8		31.2	22.0		20.0	32.7		22.4	28.7	
Level of Service (LOS)	C	C		C	C		B	C		C	C	
Approach Delay, s/veh / LOS	23.7	C		22.8	C		28.3	C		26.4	C	
Intersection Delay, s/veh / LOS	25.3						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.90	B	1.90	B	1.92	B	1.92	B
Bicycle LOS Score / LOS	1.37	A	1.27	A	1.37	A	1.00	A

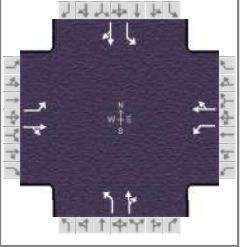
HCS7 Signalized Intersection Results Summary

General Information

Agency		Analysis Date	10/14/2021	Duration, h	0.250
Analyst		Time Period		Area Type	Other
Jurisdiction		Analysis Year	2021	PHF	0.96
Urban Street	SR 82	File Name	LOR-82_83 PM Peak.xus	Analysis Period	1> 7:00
Intersection	SR 83				
Project Description	PM Peak				

Intersection Information

Duration, h	0.250
Area Type	Other
PHF	0.96
Analysis Period	1> 7:00



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	47	337	137	80	384	62	140	183	38	132	294	47

Signal Information

Cycle, s	90.3	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	39.1	7.6	0.3	24.3	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	3.5	0.0	6.0	0.0	0.0		
				Red	1.0	2.0	0.0	1.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6	7	4	3	8
Case Number		6.0		6.0	1.1	4.0	1.1	4.0
Phase Duration, s		45.6		45.6	13.4	31.6	13.1	31.3
Change Period, (Y+R _c), s		6.5		6.5	5.5	7.0	5.5	7.0
Max Allow Headway (MAH), s		5.1		5.1	3.0	4.9	3.0	4.9
Queue Clearance Time (g _s), s		26.3		32.6	7.9	12.9	7.6	20.9
Green Extension Time (g _e), s		7.3		6.4	0.2	3.5	0.2	3.4
Phase Call Probability		1.00		1.00	0.97	1.00	0.97	1.00
Max Out Probability		0.15		0.28	0.00	0.00	0.00	0.00

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (v), veh/h	49	494		83	465		146	230		138	355	
Adjusted Saturation Flow Rate (s), veh/h/ln	906	1599		882	1641		1589	1618		1563	1601	
Queue Service Time (g _s), s	4.1	22.9		7.7	20.2		5.9	10.9		5.6	18.9	
Cycle Queue Clearance Time (g _c), s	24.3	22.9		30.6	20.2		5.9	10.9		5.6	18.9	
Green Ratio (g/C)	0.43	0.43		0.43	0.43		0.36	0.27		0.35	0.27	
Capacity (c), veh/h	270	693		239	711		279	441		354	431	
Volume-to-Capacity Ratio (X)	0.181	0.712		0.349	0.653		0.523	0.522		0.388	0.824	
Back of Queue (Q), ft/ln (95 th percentile)	40.5	326.4		76.2	297		95.5	191.2		91	312.8	
Back of Queue (Q), veh/ln (95 th percentile)	1.6	12.6		2.9	11.4		3.6	7.3		3.4	11.8	
Queue Storage Ratio (RQ) (95 th percentile)	0.20	0.00		0.39	0.00		0.32	0.00		0.32	0.00	
Uniform Delay (d ₁), s/veh	29.8	21.0		33.6	20.3		22.9	27.9		21.7	31.0	
Incremental Delay (d ₂), s/veh	0.5	2.5		1.2	1.5		0.6	1.4		0.3	5.6	
Initial Queue Delay (d ₃), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	30.3	23.5		34.8	21.8		23.5	29.3		22.0	36.7	
Level of Service (LOS)	C	C		C	C		C	C		C	D	
Approach Delay, s/veh / LOS	24.1	C		23.8	C		27.0	C		32.6	C	
Intersection Delay, s/veh / LOS	26.7						C					

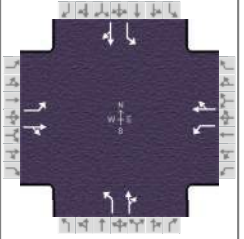
Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	1.90	B		1.90	B		1.92	B		1.93	B	
Bicycle LOS Score / LOS	1.38	A		1.39	A		1.11	A		1.30	A	

HCS7 Signalized Intersection Results Summary

General Information

Agency				Duration, h	0.250
Analyst		Analysis Date	10/14/2021	Area Type	Other
Jurisdiction		Time Period		PHF	0.94
Urban Street	SR 82	Analysis Year	2021	Analysis Period	1> 7:00
Intersection	SR 83	File Name	LOR-82_83 AM Peak_NB SB LT Phase PO.xus		
Project Description	AM Peak				



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	58	338	106	37	322	88	174	263	66	105	153	36

Signal Information

Cycle, s	83.9	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	34.0	7.8	4.3	18.8	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	3.5	0.0	6.0	0.0	0.0		
				Red	1.0	2.0	0.0	1.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6	3	8	7	4
Case Number		6.0		6.0	2.0	4.0	2.0	4.0
Phase Duration, s		40.5		40.5	17.5	30.1	13.3	25.8
Change Period, ($Y+R_c$), s		6.5		6.5	5.5	7.0	5.5	7.0
Max Allow Headway (MAH), s		5.1		5.1	3.0	5.0	3.0	5.0
Queue Clearance Time (g_s), s		27.4		27.3	12.0	19.9	8.2	12.0
Green Extension Time (g_e), s		6.5		6.5	0.2	3.2	0.1	3.3
Phase Call Probability		1.00		1.00	0.99	1.00	0.93	1.00
Max Out Probability		0.13		0.13	0.00	0.00	0.00	0.00

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	62	472		39	436		185	350		112	201	
Adjusted Saturation Flow Rate (s), veh/h/ln	900	1560		841	1514		1524	1544		1485	1507	
Queue Service Time (g_s), s	5.2	21.7		3.5	20.2		10.0	17.9		6.2	10.0	
Cycle Queue Clearance Time (g_c), s	25.4	21.7		25.3	20.2		10.0	17.9		6.2	10.0	
Green Ratio (g/C)	0.41	0.41		0.41	0.41		0.74	0.28		0.69	0.22	
Capacity (c), veh/h	234	633		209	614		219	426		138	339	
Volume-to-Capacity Ratio (X)	0.264	0.747		0.188	0.710		0.845	0.821		0.812	0.593	
Back of Queue (Q), ft/ln (95 th percentile)	52.8	314.8		34.8	297.1		179.8	294.2		113.5	177.4	
Back of Queue (Q), veh/ln (95 th percentile)	2.0	11.7		1.3	10.8		6.6	10.8		4.1	6.4	
Queue Storage Ratio (RQ) (95 th percentile)	0.26	0.00		0.18	0.00		0.60	0.00		0.40	0.00	
Uniform Delay (d_1), s/veh	31.5	21.3		32.1	20.9		35.1	28.5		37.5	29.2	
Incremental Delay (d_2), s/veh	0.8	2.6		0.6	2.2		4.2	5.6		4.3	2.4	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	32.4	24.0		32.7	23.1		39.4	34.1		41.8	31.5	
Level of Service (LOS)	C	C		C	C		D	C		D	C	
Approach Delay, s/veh / LOS	24.9	C		23.9	C		35.9	D		35.2	D	
Intersection Delay, s/veh / LOS	29.6						C					

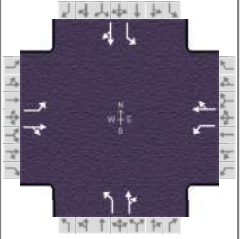
Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	1.91	B		1.91	B		1.92	B		1.93	B	
Bicycle LOS Score / LOS	1.37	A		1.27	A		1.37	A		1.00	A	

HCS7 Signalized Intersection Results Summary

General Information

Agency		Analysis Date	10/14/2021	Duration, h	0.250
Analyst		Time Period		Area Type	Other
Jurisdiction		Analysis Year	2021	PHF	0.96
Urban Street	SR 82	File Name	LOR-82_83 PM Peak_NB SB LT Phase PO.xus	Analysis Period	1> 7:00
Intersection	SR 83				
Project Description	PM Peak				



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	47	337	137	80	384	62	140	183	38	132	294	47

Signal Information

Cycle, s	96.5	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	41.2	10.3	0.4	25.7	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	3.5	0.0	6.0	0.0	0.0		
				Red	1.0	2.0	0.0	1.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6	7	4	3	8
Case Number		6.0		6.0	2.0	4.0	2.0	4.0
Phase Duration, s		47.7		47.7	16.2	33.1	15.8	32.7
Change Period, ($Y+R_c$), s		6.5		6.5	5.5	7.0	5.5	7.0
Max Allow Headway (MAH), s		5.1		5.1	3.0	4.9	3.0	4.9
Queue Clearance Time (g_s), s		28.3		35.2	10.7	13.7	10.3	22.2
Green Extension Time (g_e), s		7.0		5.9	0.1	3.4	0.1	3.3
Phase Call Probability		1.00		1.00	0.98	1.00	0.98	1.00
Max Out Probability		0.18		0.37	0.00	0.00	0.00	0.00

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	7	4	14	3	8	18
Adjusted Flow Rate (v), veh/h	49	494		83	465		146	230		138	355	
Adjusted Saturation Flow Rate (s), veh/h/ln	906	1599		882	1641		1589	1618		1563	1601	
Queue Service Time (g_s), s	4.4	24.8		8.4	21.9		8.7	11.7		8.3	20.2	
Cycle Queue Clearance Time (g_c), s	26.3	24.8		33.2	21.9		8.7	11.7		8.3	20.2	
Green Ratio (g/C)	0.43	0.43		0.43	0.43		0.63	0.27		0.62	0.27	
Capacity (c), veh/h	256	682		225	700		176	437		166	426	
Volume-to-Capacity Ratio (X)	0.191	0.724		0.371	0.663		0.829	0.526		0.827	0.834	
Back of Queue (Q), ft/ln (95 th percentile)	44.5	357.4		83.8	324.8		161	206		154.7	335.7	
Back of Queue (Q), veh/ln (95 th percentile)	1.7	13.7		3.2	12.5		6.1	7.9		5.8	12.6	
Queue Storage Ratio (RQ) (95 th percentile)	0.22	0.00		0.43	0.00		0.54	0.00		0.54	0.00	
Uniform Delay (d_1), s/veh	32.7	23.0		36.8	22.2		42.1	30.0		42.4	33.5	
Incremental Delay (d_2), s/veh	0.5	3.0		1.4	1.9		3.8	1.4		3.9	6.0	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	33.2	26.0		38.2	24.0		45.9	31.4		46.3	39.5	
Level of Service (LOS)	C	C		D	C		D	C		D	D	
Approach Delay, s/veh / LOS	26.6	C		26.2	C		37.1	D		41.4	D	
Intersection Delay, s/veh / LOS	32.2						C					

Multimodal Results

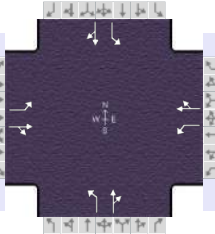
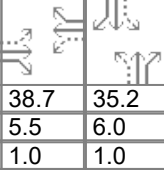
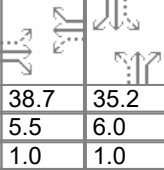
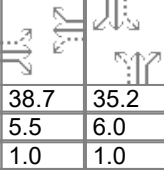
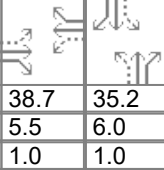
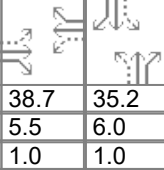
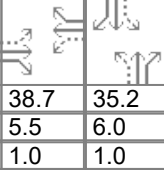
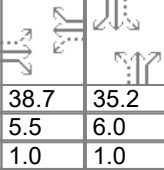
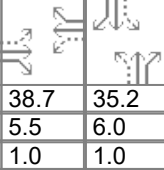
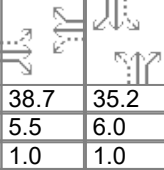
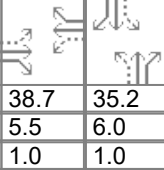
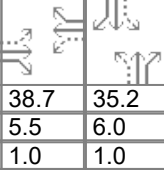
	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	1.91	B		1.91	B		1.93	B		1.93	B	
Bicycle LOS Score / LOS	1.38	A		1.39	A		1.11	A		1.30	A	

Appendix C – Existing Capacity Analysis (HCS)

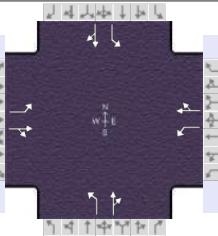
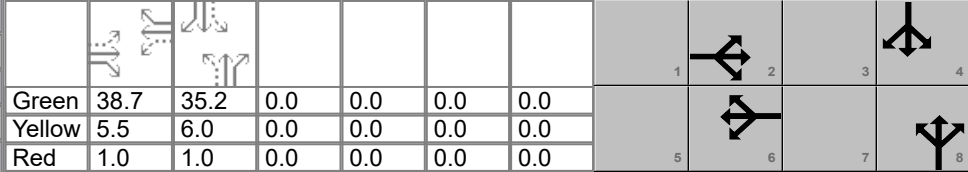
HCS Signalized Intersection Input Data

General Information						Intersection Information									
Agency	Lanham Engineering LLC					Duration, h	0.250								
Analyst	MJB	Analysis Date	11/21/2023			Area Type	Other								
Jurisdiction	ODOT D3	Time Period	AM Peak			PHF	0.94								
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2023			Analysis Period	1> 7:15								
Intersection	SR-82 at SR-83	File Name	2023 Existing AM Peak.xus												
Project Description	2023 Existing AM Peak Hour														
Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				69	401	125	44	382	104	197	296	75	118	172	40
Signal Information															
Cycle, s	87.4	Reference Phase	2												
Offset, s	0	Reference Point	End												
Uncoordinated	Yes	Simult. Gap E/W	On	Green	38.7	35.2	0.0	0.0	0.0	0.0					
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	6.0	0.0	0.0	0.0	0.0					
				Red	1.0	1.0	0.0	0.0	0.0	0.0					
Traffic Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				69	401	125	44	382	104	197	296	75	118	172	40
Initial Queue (Q_0), veh/h				0	0	0	0	0	0	0	0	0	0	0	0
Base Saturation Flow Rate (s_0), veh/h				1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Parking (N_m), man/h				None			None			None			None		
Heavy Vehicles (P_{HV}), %				9	9		13	13		11	11		14	14	
Ped / Bike / RTOR, /h				0	0	0	0	0	0	0	0	0	0	0	0
Buses (N_b), buses/h				0	0	0	0	0	0	0	0	0	0	0	0
Arrival Type (AT)				3	3	3	3	3	3	3	3	3	3	3	3
Upstream Filtering (I)				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lane Width (W), ft				11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Turn Bay Length, ft				170	1650		145	4300		225	1800		240	4950	
Grade (P_g), %					0			0			0			0	
Speed Limit, mi/h				50	50	50	50	50	50	55	55	55	55	55	55
Phase Information				EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Maximum Green (G_{max}) or Phase Split, s					50.0		50.0		50.0		50.0				
Yellow Change Interval (Y), s					5.5		5.5		6.0		6.0				
Red Clearance Interval (R_c), s					1.0		1.0		1.0		1.0				
Minimum Green (G_{min}), s					20		20		12		12				
Start-Up Lost Time (l_t), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Extension of Effective Green (e), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Passage (PT), s					4.0		4.0		4.0		4.0				
Recall Mode					Min		Min		Ped		Off				
Dual Entry					Yes		Yes		Yes		Yes				
Walk ($Walk$), s					0.0		0.0		0.0		0.0				
Pedestrian Clearance Time (PC), s					0.0		0.0		0.0		0.0				
Multimodal Information				EB			WB			NB			SB		
85th % Speed / Rest in Walk / Corner Radius				0.0	No	25.0	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0
Walkway / Crosswalk Width / Length, ft				9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0
Street Width / Island / Curb, ft				0.0	0	No	0.0	0	No	0.0	0	No	0.0	0	No
Width Outside / Bike Lane / Shoulder, ft				12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0
Pedestrian Signal / Occupied Parking				No	0.50		No	0.50		No	0.50		No	0.50	

HCS Signalized Intersection Results Summary

General Information						Intersection Information													
Agency	Lanham Engineering LLC					Duration, h	0.250												
Analyst	MJB		Analysis Date	11/21/2023		Area Type	Other												
Jurisdiction	ODOT D3		Time Period	AM Peak		PHF	0.94												
Urban Street	SR-82 (Royalton Rd)		Analysis Year	2023		Analysis Period	1> 7:15												
Intersection	SR-82 at SR-83		File Name	2023 Existing AM Peak.xus															
Project Description	2023 Existing AM Peak Hour																		
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand (ν), veh/h				69	401	125	44	382	104	197	296	75	118	172	40				
Signal Information																			
Cycle, s	87.4	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	Yes	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2				6				8				4	
Case Number						6.0				6.0				6.0				6.0	
Phase Duration, s						45.2				45.2				42.2				42.2	
Change Period, ($Y+R_c$), s						6.5				6.5				7.0				7.0	
Max Allow Headway (MAH), s						5.1				5.1				5.3				5.3	
Queue Clearance Time (g_s), s						31.2				30.7				25.0				29.2	
Green Extension Time (g_e), s						7.5				7.6				6.4				6.0	
Phase Call Probability						1.00				1.00				1.00				1.00	
Max Out Probability						0.30				0.29				0.09				0.15	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate (ν), veh/h				73	560		47	517		210	395		126	226					
Adjusted Saturation Flow Rate (s), veh/h/ln				835	1694		776	1644		1073	1676		895	1637					
Queue Service Time (g_s), s				6.8	24.0		4.7	22.3		14.7	16.1		11.1	8.3					
Cycle Queue Clearance Time (g_c), s				29.2	24.0		28.7	22.3		23.0	16.1		27.2	8.3					
Green Ratio (g/C)				0.44	0.44		0.44	0.44		0.40	0.40		0.40	0.40					
Capacity (c), veh/h				239	751		213	728		412	674		278	659					
Volume-to-Capacity Ratio (X)				0.307	0.745		0.220	0.710		0.509	0.585		0.451	0.342					
Back of Queue (Q), ft/ln (95 th percentile)				65.2	363.5		42.7	341.4		171.1	259		115.3	141.3					
Back of Queue (Q), veh/ln (95 th percentile)				2.4	13.6		1.5	12.4		6.3	9.5		4.1	5.1					
Queue Storage Ratio (RQ) (95 th percentile)				0.38	0.22		0.29	0.08		0.76	0.14		0.48	0.03					
Uniform Delay (d_1), s/veh				31.6	20.2		32.2	19.8		26.0	20.4		31.0	18.1					
Incremental Delay (d_2), s/veh				1.0	2.8		0.7	2.2		1.4	1.2		1.6	0.4					
Initial Queue Delay (d_3), s/veh				0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0					
Control Delay (d), s/veh				32.7	23.1		32.9	22.0		27.4	21.6		32.6	18.5					
Level of Service (LOS)				C	C		C	C		C	C		C	B					
Approach Delay, s/veh / LOS				24.2	C		22.9	C		23.6	C		23.6	C					
Intersection Delay, s/veh / LOS				23.6						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.90	B		1.90	B		1.91	B		1.91	B					
Bicycle LOS Score / LOS				1.53	B		1.42	A		1.48	A		1.07	A					

HCS Signalized Intersection Intermediate Values

General Information								Intersection Information													
Agency		Lanham Engineering LLC						Duration, h		0.250											
Analyst		MJB		Analysis Date		11/21/2023		Area Type		Other											
Jurisdiction		ODOT D3		Time Period		AM Peak		PHF		0.94											
Urban Street		SR-82 (Royaltown Rd)		Analysis Year		2023		Analysis Period		1 > 7:15											
Intersection		SR-82 at SR-83		File Name		2023 Existing AM Peak.xus															
Project Description		2023 Existing AM Peak Hour																			
Demand Information				EB			WB			NB			SB								
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R						
Demand (v), veh/h				69	401	125	44	382	104	197	296	75	118	172	40						
Signal Information																					
Cycle, s	87.4	Reference Phase	2																		
Offset, s	0	Reference Point	End																		
Uncoordinated	Yes	Simult. Gap E/W	On																		
Force Mode	Fixed	Simult. Gap N/S	On																		
				Green	38.7	35.2	0.0	0.0	0.0	0.0											
				Yellow	5.5	6.0	0.0	0.0	0.0	0.0											
				Red	1.0	1.0	0.0	0.0	0.0	0.0											
Saturation Flow / Delay				L	T	R	L	T	R	L	T	R	L	T	R						
Lane Width Adjustment Factor (f _w)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Heavy Vehicles and Grade Factor (f _{HVg})				0.930	0.930	1.000	0.899	0.899	1.000	0.914	0.914	1.000	0.891	0.891	1.000						
Parking Activity Adjustment Factor (f _p)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Bus Blockage Adjustment Factor (f _{bb})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Area Type Adjustment Factor (f _a)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Lane Utilization Adjustment Factor (f _{LU})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Left-Turn Adjustment Factor (f _{LT})				0.440	0.000		0.408	0.000		0.565	0.000		0.471	0.000							
Right-Turn Adjustment Factor (f _{RT})					0.959	0.959		0.963	0.963		0.965	0.965		0.967	0.967						
Left-Turn Pedestrian Adjustment Factor (f _{LPb})				1.000			1.000			1.000			1.000								
Right-Turn Ped-Bike Adjustment Factor (f _{RPb})						1.000			1.000			1.000			1.000						
Work Zone Adjustment Factor (f _{wz})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
DDI Factor (f _{DDI})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Left-Turn Prot. CAV Adj. Factor (f _{CAV,prot})																					
Left-Turn Perm. CAV Adj. Factor (f _{CAV,perm})				1.00			1.00			1.00			1.00								
Movement Saturation Flow Rate (s), veh/h				835	1292	403	776	1292	352	1073	1337	339	895	1328	309						
Proportion of Vehicles Arriving on Green (P)				0.44	0.44	0.44	0.44	0.44	0.44	0.40	0.40	0.40	0.40	0.40	0.40						
Incremental Delay Factor (k)				0.15	0.21		0.15	0.19		0.15	0.15		0.15	0.15							
Signal Timing / Movement Groups				EBL		EBT/R		WBL		WBT/R		NBL		NBT/R		SBL		SBT/R			
Lost Time (t _L)						6.5				6.5				7.0				7.0			
Green Ratio (g/C)						0.44				0.44				0.40				0.40			
Permitted Saturation Flow Rate (s _p), veh/h/ln						835				776				1073				895			
Shared Saturation Flow Rate (s _{sh}), veh/h/ln																					
Permitted Effective Green Time (g _p), s						38.7				38.7				35.1				35.1			
Permitted Service Time (g _u), s						16.4				14.7				26.8				19.1			
Permitted Queue Service Time (g _{ps}), s						6.8				4.7				14.7				11.1			
Time to First Blockage (g _t), s						0.0				0.0				0.0				0.0			
Queue Service Time Before Blockage (g _{ts}), s																					
Protected Right Saturation Flow (s _R), veh/h/ln																					
Protected Right Effective Green Time (g _R), s																					
Multimodal				EB			WB			NB			SB								
Pedestrian F _w / F _v				1.198			0.000			1.198			0.000			1.198			0.000		
Pedestrian F _s / F _{delay}				0.000			0.105			0.000			0.110			0.000			0.110		
Pedestrian M _{corner} / M _{cw}				0.00						0.00						0.00					
Bicycle c _b / d _b				885.89			13.55			885.89			13.55			805.03			15.59		
Bicycle F _w / F _v				-3.64			1.04			-3.64			0.93			-3.64			1.00		

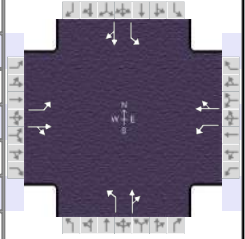
HCS Signalized Intersection Results Graphical Summary

General Information

Agency	Lanham Engineering LLC		
Analyst	MJB	Analysis Date	11/21/2023
Jurisdiction	ODOT D3	Time Period	AM Peak
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2023
Intersection	SR-82 at SR-83	File Name	2023 Existing AM Peak.xus
Project Description	2023 Existing AM Peak Hour		

Intersection Information

Duration, h	0.250
Area Type	Other
PHF	0.94
Analysis Period	1 > 7:15



Demand Information

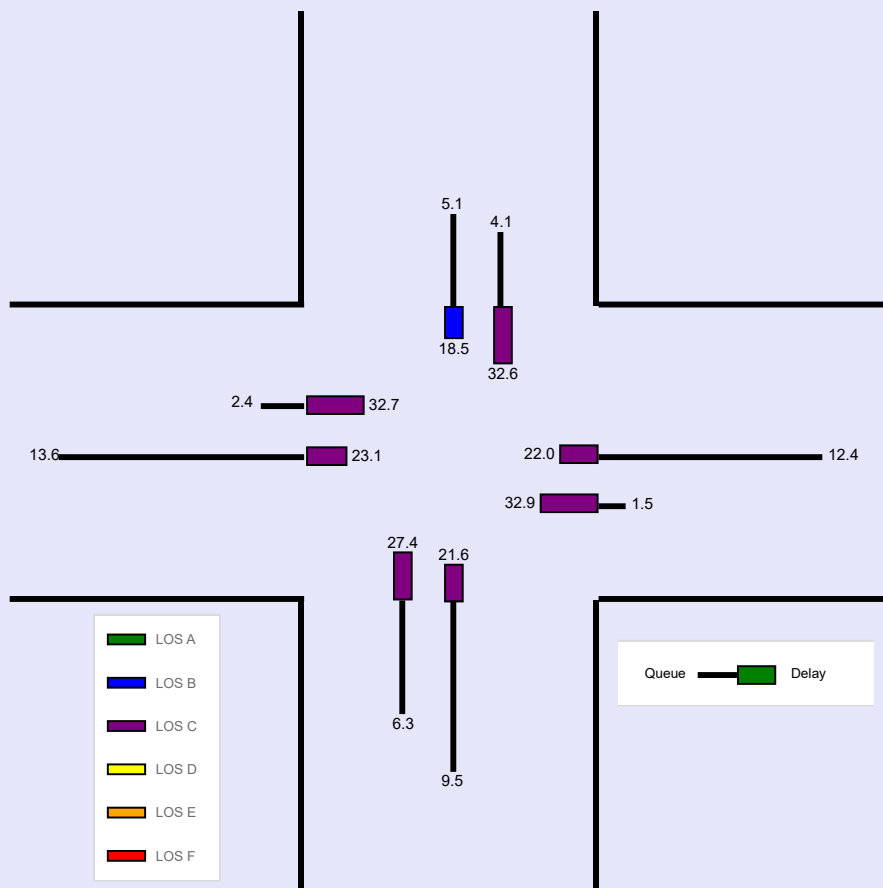
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	69	401	125	44	382	104	197	296	75	118	172	40

Signal Information

Cycle, s	87.4	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Back of Queue (Q), ft / In (95 th percentile)	65.2	363.5		42.7	341.4		171.1	259		115.3	141.3	
Back of Queue (Q), veh / In (95 th percentile)	2.4	13.6		1.5	12.4		6.3	9.5		4.1	5.1	
Queue Storage Ratio (RQ) (95 th percentile)	0.38	0.22		0.29	0.08		0.76	0.14		0.48	0.03	
Control Delay (d), s / veh	32.7	23.1		32.9	22.0		27.4	21.6		32.6	18.5	
Level of Service (LOS)	C	C		C	C		C	C		C	B	
Approach Delay, s / veh / LOS	24.2	C		22.9	C		23.6	C		23.6	C	
Intersection Delay, s / veh / LOS	23.6						C					



--- Messages ---

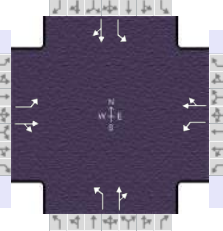
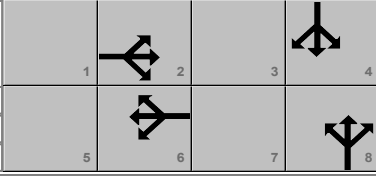
No errors or warnings exist.

--- Comments ---

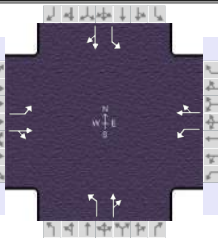
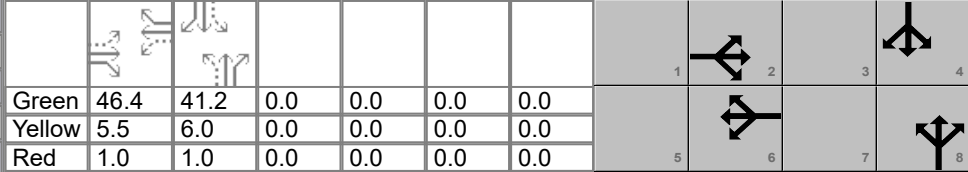
HCS Signalized Intersection Input Data

General Information						Intersection Information									
Agency	Lanham Engineering LLC					Duration, h	0.250								
Analyst	MJB	Analysis Date	11/21/2023			Area Type	Other								
Jurisdiction	ODOT D3	Time Period	PM Peak			PHF	0.96								
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2023			Analysis Period	1> 16:00								
Intersection	SR-82 at SR-83	File Name	2023 Existing PM Peak.xus												
Project Description	2023 Existing PM Peak Hour														
Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				56	400	163	95	455	74	158	207	43	149	331	53
Signal Information															
Cycle, s	101.1	Reference Phase	2												
Offset, s	0	Reference Point	End	Green	46.4	41.2	0.0	0.0	0.0	0.0					
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	5.5	6.0	0.0	0.0	0.0	0.0					
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	0.0	0.0	0.0	0.0					
Traffic Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				56	400	163	95	455	74	158	207	43	149	331	53
Initial Queue (Q_0), veh/h				0	0	0	0	0	0	0	0	0	0	0	0
Base Saturation Flow Rate (s_0), veh/h				1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Parking (N_m), man/h				None			None			None			None		
Heavy Vehicles (P_{HV}), %				5	5		5	5		6	6		8	8	
Ped / Bike / RTOR, /h				0	0	0	0	0	0	0	0	0	0	0	0
Buses (N_b), buses/h				0	0	0	0	0	0	0	0	0	0	0	0
Arrival Type (AT)				3	3	3	3	3	3	3	3	3	3	3	3
Upstream Filtering (I)				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lane Width (W), ft				11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Turn Bay Length, ft				170	1650		145	4300		225	1800		240	4950	
Grade (P_g), %					0			0			0			0	
Speed Limit, mi/h				50	50	50	50	50	50	55	55	55	55	55	55
Phase Information				EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Maximum Green (G_{max}) or Phase Split, s					50.0		50.0		50.0		50.0				
Yellow Change Interval (Y), s					5.5		5.5		6.0		6.0				
Red Clearance Interval (R_c), s					1.0		1.0		1.0		1.0				
Minimum Green (G_{min}), s					20		20		12		12				
Start-Up Lost Time (l_t), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Extension of Effective Green (e), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Passage (PT), s					4.0		4.0		4.0		4.0				
Recall Mode					Min		Min		Off		Off				
Dual Entry					Yes		Yes		Yes		Yes				
Walk ($Walk$), s					0.0		0.0		0.0		0.0				
Pedestrian Clearance Time (PC), s					0.0		0.0		0.0		0.0				
Multimodal Information				EB			WB			NB			SB		
85th % Speed / Rest in Walk / Corner Radius				0.0	No	25.0	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0
Walkway / Crosswalk Width / Length, ft				9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0
Street Width / Island / Curb, ft				0.0	0	No	0.0	0	No	0.0	0	No	0.0	0	No
Width Outside / Bike Lane / Shoulder, ft				12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0
Pedestrian Signal / Occupied Parking				No	0.50	No	0.50	No	0.50	No	0.50	No	0.50		

HCS Signalized Intersection Results Summary

General Information						Intersection Information													
Agency		Lanham Engineering LLC				Duration, h		0.250											
Analyst		MJB		Analysis Date	11/21/2023		Area Type		Other										
Jurisdiction		ODOT D3		Time Period	PM Peak		PHF		0.96										
Urban Street		SR-82 (Royalton Rd)		Analysis Year	2023		Analysis Period		1> 16:00										
Intersection		SR-82 at SR-83		File Name	2023 Existing PM Peak.xus														
Project Description		2023 Existing PM Peak Hour																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand (v), veh/h				56	400	163	95	455	74	158	207	43	149	331	53				
Signal Information				 															
Cycle, s		101.1	Reference Phase													2			
Offset, s		0	Reference Point													End			
Uncoordinated		Yes	Simult. Gap E/W													On			
Force Mode		Fixed	Simult. Gap N/S													On			
				Green	46.4	41.2	0.0	0.0	0.0	0.0									
				Yellow	5.5	6.0	0.0	0.0	0.0	0.0									
				Red	1.0	1.0	0.0	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2				6				8				4	
Case Number						6.0				6.0				6.0				6.0	
Phase Duration, s						52.9				52.9				48.2				48.2	
Change Period, (Y+R c), s						6.5				6.5				7.0				7.0	
Max Allow Headway (MAH), s						5.2				5.2				5.2				5.2	
Queue Clearance Time (g s), s						32.5				41.5				36.1				24.4	
Green Extension Time (g e), s						8.0				5.0				5.1				6.5	
Phase Call Probability						1.00				1.00				1.00				1.00	
Max Out Probability						0.40				0.78				0.35				0.08	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate (v), veh/h				58	586		99	551		165	260		155	400					
Adjusted Saturation Flow Rate (s), veh/h/ln				836	1735		809	1781		954	1757		1066	1738					
Queue Service Time (g s), s				5.9	27.9		11.5	24.5		16.2	10.4		12.0	17.9					
Cycle Queue Clearance Time (g c), s				30.5	27.9		39.5	24.5		34.1	10.4		22.4	17.9					
Green Ratio (g/C)				0.46	0.46		0.46	0.46		0.41	0.41		0.41	0.41					
Capacity (c), veh/h				252	797		219	818		291	716		396	708					
Volume-to-Capacity Ratio (X)				0.231	0.736		0.452	0.674		0.566	0.364		0.392	0.565					
Back of Queue (Q), ft/ln (95 th percentile)				55.6	422.4		107	381.1		174.5	186.3		139.7	293.4					
Back of Queue (Q), veh/ln (95 th percentile)				2.1	16.2		4.1	14.7		6.7	7.1		5.3	11.0					
Queue Storage Ratio (RQ) (95 th percentile)				0.33	0.26		0.74	0.09		0.78	0.10		0.58	0.06					
Uniform Delay (d 1), s/veh				33.4	22.3		38.5	21.4		36.2	20.9		28.6	23.1					
Incremental Delay (d 2), s/veh				0.7	3.4		2.1	2.2		2.5	0.4		0.9	1.0					
Initial Queue Delay (d 3), s/veh				0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0					
Control Delay (d), s/veh				34.0	25.8		40.5	23.6		38.6	21.3		29.5	24.1					
Level of Service (LOS)				C	C		D	C		D	C		C	C					
Approach Delay, s/veh / LOS				26.5		C	26.2		C	28.0		C	25.6		C				
Intersection Delay, s/veh / LOS				26.5									C						
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.91		B	1.91		B	1.91		B	1.91		B				
Bicycle LOS Score / LOS				1.55		B	1.56		B	1.19		A	1.40		A				

HCS Signalized Intersection Intermediate Values

General Information								Intersection Information													
Agency		Lanham Engineering LLC						Duration, h		0.250											
Analyst		MJB		Analysis Date		11/21/2023		Area Type		Other											
Jurisdiction		ODOT D3		Time Period		PM Peak		PHF		0.96											
Urban Street		SR-82 (Royaltown Rd)		Analysis Year		2023		Analysis Period		1> 16:00											
Intersection		SR-82 at SR-83		File Name		2023 Existing PM Peak.xus															
Project Description		2023 Existing PM Peak Hour																			
Demand Information				EB			WB			NB			SB								
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R						
Demand (v), veh/h				56	400	163	95	455	74	158	207	43	149	331	53						
Signal Information																					
Cycle, s	101.1	Reference Phase	2																		
Offset, s	0	Reference Point	End																		
Uncoordinated	Yes	Simult. Gap E/W	On																		
Force Mode	Fixed	Simult. Gap N/S	On																		
				Green	46.4	41.2	0.0	0.0	0.0	0.0											
				Yellow	5.5	6.0	0.0	0.0	0.0	0.0											
				Red	1.0	1.0	0.0	0.0	0.0	0.0											
Saturation Flow / Delay				L	T	R	L	T	R	L	T	R	L	T	R						
Lane Width Adjustment Factor (f _w)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Heavy Vehicles and Grade Factor (f _{HVg})				0.961	0.961	1.000	0.961	0.961	1.000	0.953	0.953	1.000	0.938	0.938	1.000						
Parking Activity Adjustment Factor (f _p)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Bus Blockage Adjustment Factor (f _{bb})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Area Type Adjustment Factor (f _a)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Lane Utilization Adjustment Factor (f _{LU})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Left-Turn Adjustment Factor (f _{LT})				0.440	0.000		0.426	0.000		0.502	0.000		0.561	0.000							
Right-Turn Adjustment Factor (f _{RT})					0.950	0.950		0.975	0.975		0.970	0.970		0.976	0.976						
Left-Turn Pedestrian Adjustment Factor (f _{LPb})				1.000			1.000			1.000			1.000								
Right-Turn Ped-Bike Adjustment Factor (f _{RPb})						1.000			1.000			1.000			1.000						
Work Zone Adjustment Factor (f _{wz})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
DDI Factor (f _{DDI})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
Left-Turn Prot. CAV Adj. Factor (f _{CAV,prot})																					
Left-Turn Perm. CAV Adj. Factor (f _{CAV,perm})				1.00			1.00			1.00			1.00								
Movement Saturation Flow Rate (s), veh/h				836	1233	502	809	1532	249	954	1455	302	1066	1498	240						
Proportion of Vehicles Arriving on Green (P)				0.46	0.46	0.46	0.46	0.46	0.46	0.41	0.41	0.41	0.41	0.41	0.41						
Incremental Delay Factor (k)				0.15	0.28		0.15	0.24		0.15	0.15		0.15	0.15							
Signal Timing / Movement Groups				EBL		EBT/R		WBL		WBT/R		NBL		NBT/R		SBL		SBT/R			
Lost Time (t _L)						6.5				6.5				7.0				7.0			
Green Ratio (g/C)						0.46				0.46				0.41				0.41			
Permitted Saturation Flow Rate (s _p), veh/h/ln						836				809				954				1066			
Shared Saturation Flow Rate (s _{sh}), veh/h/ln																					
Permitted Effective Green Time (g _p), s						46.4				46.4				41.2				41.2			
Permitted Service Time (g _u), s						21.9				18.5				23.3				30.8			
Permitted Queue Service Time (g _{ps}), s						5.9				11.5				16.2				12.0			
Time to First Blockage (g _t), s						0.0				0.0				0.0				0.0			
Queue Service Time Before Blockage (g _{ts}), s																					
Protected Right Saturation Flow (s _R), veh/h/ln																					
Protected Right Effective Green Time (g _R), s																					
Multimodal				EB			WB			NB			SB								
Pedestrian F _w / F _v				1.198			0.000			1.198			0.000			1.198			0.000		
Pedestrian F _s / F _{delay}				0.000			0.108			0.000			0.108			0.000			0.115		
Pedestrian M _{corner} / M _{cw}				0.00						0.00						0.00					
Bicycle c _b / d _b				918.41			14.79			918.41			14.79			814.65			17.76		
Bicycle F _w / F _v				-3.64			1.06			-3.64			1.07			-3.64			0.70		

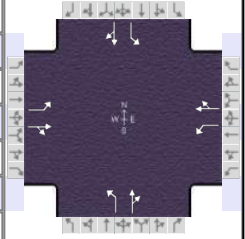
HCS Signalized Intersection Results Graphical Summary

General Information

Agency	Lanham Engineering LLC		
Analyst	MJB	Analysis Date	11/21/2023
Jurisdiction	ODOT D3	Time Period	PM Peak
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2023
Intersection	SR-82 at SR-83	File Name	2023 Existing PM Peak.xus
Project Description	2023 Existing PM Peak Hour		

Intersection Information

Duration, h	0.250
Area Type	Other
PHF	0.96
Analysis Period	1 > 16:00



Demand Information

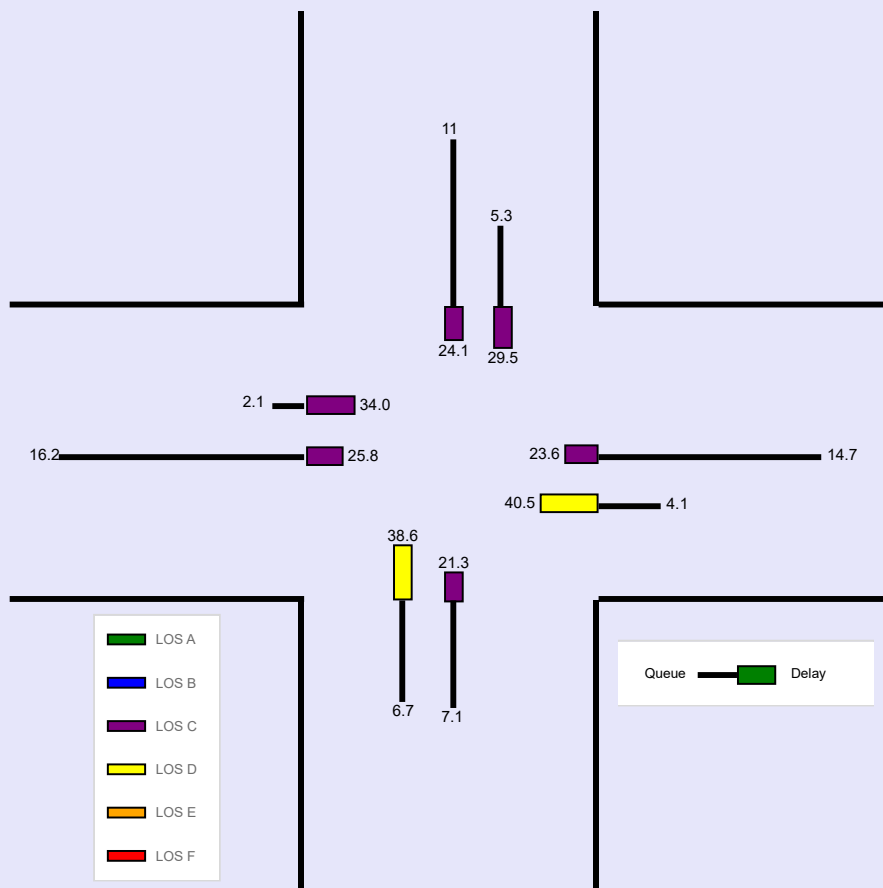
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	56	400	163	95	455	74	158	207	43	149	331	53

Signal Information

Cycle, s	101.1	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Back of Queue (Q), ft / In (95 th percentile)	55.6	422.4		107	381.1		174.5	186.3		139.7	293.4	
Back of Queue (Q), veh / In (95 th percentile)	2.1	16.2		4.1	14.7		6.7	7.1		5.3	11.0	
Queue Storage Ratio (RQ) (95 th percentile)	0.33	0.26		0.74	0.09		0.78	0.10		0.58	0.06	
Control Delay (d), s / veh	34.0	25.8		40.5	23.6		38.6	21.3		29.5	24.1	
Level of Service (LOS)	C	C		D	C		D	C		C	C	
Approach Delay, s / veh / LOS	26.5	C		26.2	C		28.0	C		25.6	C	
Intersection Delay, s / veh / LOS	26.5						C					

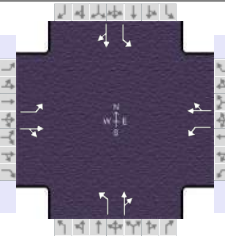


--- Messages ---

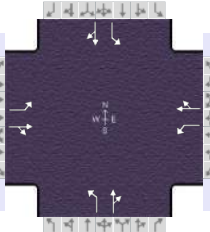
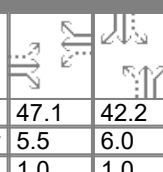
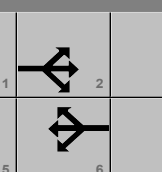
No errors or warnings exist.

--- Comments ---

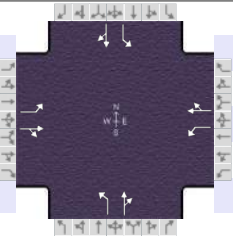
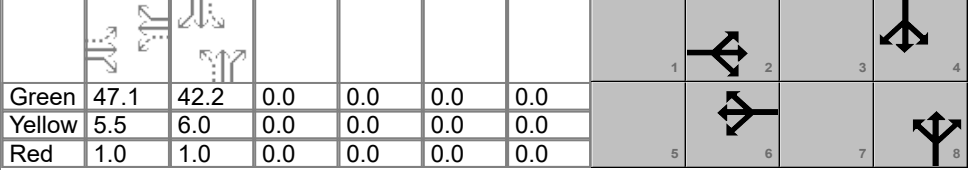
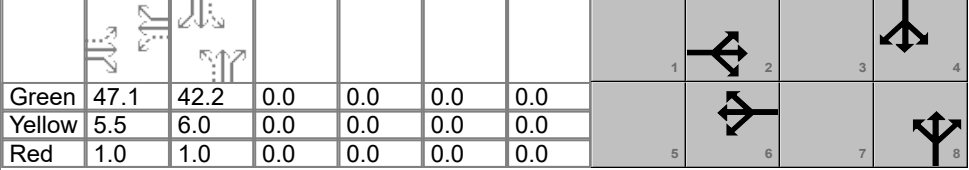
HCS Signalized Intersection Input Data

General Information						Intersection Information									
Agency	Lanham Engineering LLC					Duration, h	0.250								
Analyst	MJB	Analysis Date	11/21/2023			Area Type	Other								
Jurisdiction	ODOT D3	Time Period	AM Peak			PHF	0.94								
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043			Analysis Period	1> 7:15								
Intersection	SR-82 at SR-83	File Name	2043 No Build AM Peak.xus												
Project Description	2043 No Build AM Peak Hour														
Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				77	448	140	49	427	117	212	320	81	123	180	42
Signal Information															
Cycle, s	102.8	Reference Phase	2												
Offset, s	0	Reference Point	End	Green	47.1	42.2	0.0	0.0	0.0	0.0					
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	5.5	6.0	0.0	0.0	0.0	0.0					
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	0.0	0.0	0.0	0.0					
Traffic Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				77	448	140	49	427	117	212	320	81	123	180	42
Initial Queue (Q_0), veh/h				0	0	0	0	0	0	0	0	0	0	0	0
Base Saturation Flow Rate (s_0), veh/h				1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Parking (N_m), man/h				None			None			None			None		
Heavy Vehicles (P_{HV}), %				9	9		13	13		11	11		14	14	
Ped / Bike / RTOR, /h				0	0	0	0	0	0	0	0	0	0	0	0
Buses (N_b), buses/h				0	0	0	0	0	0	0	0	0	0	0	0
Arrival Type (AT)				3	3	3	3	3	3	3	3	3	3	3	3
Upstream Filtering (I)				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lane Width (W), ft				11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Turn Bay Length, ft				170	1650		145	4300		225	1800		240	4950	
Grade (P_g), %					0			0			0			0	
Speed Limit, mi/h				50	50	50	50	50	50	55	55	55	55	55	55
Phase Information				EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Maximum Green (G_{max}) or Phase Split, s					50.0		50.0		50.0		50.0				
Yellow Change Interval (Y), s					5.5		5.5		6.0		6.0				
Red Clearance Interval (R_c), s					1.0		1.0		1.0		1.0				
Minimum Green (G_{min}), s					20		20		12		12				
Start-Up Lost Time (l_t), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Extension of Effective Green (e), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Passage (PT), s					4.0		4.0		4.0		4.0				
Recall Mode					Min		Min		Off		Off				
Dual Entry					Yes		Yes		Yes		Yes				
Walk ($Walk$), s					0.0		0.0		0.0		0.0				
Pedestrian Clearance Time (PC), s					0.0		0.0		0.0		0.0				
Multimodal Information				EB			WB			NB			SB		
85th % Speed / Rest in Walk / Corner Radius				0.0	No	25.0	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0
Walkway / Crosswalk Width / Length, ft				9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0
Street Width / Island / Curb, ft				0.0	0	No	0.0	0	No	0.0	0	No	0.0	0	No
Width Outside / Bike Lane / Shoulder, ft				12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0
Pedestrian Signal / Occupied Parking				No	0.50		No	0.50		No	0.50		No	0.50	

HCS Signalized Intersection Results Summary

General Information						Intersection Information													
Agency		Lanham Engineering LLC				Duration, h		0.250											
Analyst		MJB		Analysis Date		11/21/2023		Area Type		Other									
Jurisdiction		ODOT D3		Time Period		AM Peak		PHF		0.94									
Urban Street		SR-82 (Royalton Rd)		Analysis Year		2043		Analysis Period		1> 7:15									
Intersection		SR-82 at SR-83		File Name		2043 No Build AM Peak.xus													
Project Description		2043 No Build AM Peak Hour																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand (v), veh/h				77	448	140	49	427	117	212	320	81	123	180	42				
Signal Information																			
Cycle, s	102.8	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	Yes	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	47.1	42.2	0.0	0.0	0.0	0.0									
				Yellow	5.5	6.0	0.0	0.0	0.0	0.0									
				Red	1.0	1.0	0.0	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2				6				8				4	
Case Number						6.0				6.0				6.0				6.0	
Phase Duration, s						53.6				53.6				49.2				49.2	
Change Period, (Y+R c), s						6.5				6.5				7.0				7.0	
Max Allow Headway (MAH), s						5.1				5.1				5.3				5.3	
Queue Clearance Time (g s), s						42.3				41.5				31.3				37.0	
Green Extension Time (g e), s						4.8				5.2				6.3				5.2	
Phase Call Probability						1.00				1.00				1.00				1.00	
Max Out Probability						0.84				0.79				0.22				0.43	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate (v), veh/h				82	626		52	579		226	427		131	236					
Adjusted Saturation Flow Rate (s), veh/h/ln				789	1694		730	1644		1062	1676		870	1637					
Queue Service Time (g s), s				10.0	32.6		6.8	30.3		19.1	20.7		14.4	10.2					
Cycle Queue Clearance Time (g c), s				40.3	32.6		39.5	30.3		29.3	20.7		35.0	10.2					
Green Ratio (g/C)				0.46	0.46		0.46	0.46		0.41	0.41		0.41	0.41					
Capacity (c), veh/h				199	776		172	753		401	689		253	672					
Volume-to-Capacity Ratio (X)				0.413	0.807		0.303	0.769		0.562	0.620		0.518	0.351					
Back of Queue (Q), ft/ln (95 th percentile)				94	504.3		61.2	469.1		223.4	329.6		151.2	180.8					
Back of Queue (Q), veh/ln (95 th percentile)				3.5	18.8		2.2	17.0		8.2	12.1		5.4	6.5					
Queue Storage Ratio (RQ) (95 th percentile)				0.55	0.31		0.42	0.11		0.99	0.18		0.63	0.04					
Uniform Delay (d 1), s/veh				40.2	24.0		40.9	23.3		30.9	23.9		37.8	20.8					
Incremental Delay (d 2), s/veh				1.9	6.0		1.4	4.7		1.8	1.4		2.3	0.4					
Initial Queue Delay (d 3), s/veh				0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0					
Control Delay (d), s/veh				42.1	30.0		42.3	28.0		32.7	25.4		40.1	21.3					
Level of Service (LOS)				D	C		D	C		C	C		D	C					
Approach Delay, s/veh / LOS				31.4		C	29.2		C	27.9		C	28.0		C				
Intersection Delay, s/veh / LOS				29.3						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.91		B	1.91		B	1.91		B	1.91		B				
Bicycle LOS Score / LOS				1.65		B	1.53		B	1.56		B	1.09		A				

HCS Signalized Intersection Intermediate Values

General Information													Intersection Information			
Agency	Lanham Engineering LLC						Duration, h	0.250								
Analyst	MJB		Analysis Date	11/21/2023		Area Type	Other									
Jurisdiction	ODOT D3		Time Period	AM Peak		PHF	0.94									
Urban Street	SR-82 (Royaltown Rd)		Analysis Year	2043		Analysis Period	1 > 7:15									
Intersection	SR-82 at SR-83		File Name	2043 No Build AM Peak.xus												
Project Description	2043 No Build AM Peak Hour															
Demand Information				EB			WB			NB			SB			
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R	
Demand (v), veh/h				77	448	140	49	427	117	212	320	81	123	180	42	
Signal Information																
Cycle, s	102.8	Reference Phase	2													
Offset, s	0	Reference Point	End													
Uncoordinated	Yes	Simult. Gap E/W	On													
Force Mode	Fixed	Simult. Gap N/S	On													
Green	47.1	42.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Yellow	5.5	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Red	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Saturation Flow / Delay				L	T	R	L	T	R	L	T	R	L	T	R	
Lane Width Adjustment Factor (f_w)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Heavy Vehicles and Grade Factor (f_{HVg})				0.930	0.930	1.000	0.899	0.899	1.000	0.914	0.914	1.000	0.891	0.891	1.000	
Parking Activity Adjustment Factor (f_p)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Bus Blockage Adjustment Factor (f_{bb})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Area Type Adjustment Factor (f_a)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Lane Utilization Adjustment Factor (f_{LU})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Left-Turn Adjustment Factor (f_{LT})				0.415	0.000		0.384	0.000		0.559	0.000		0.458	0.000		
Right-Turn Adjustment Factor (f_{RT})					0.959	0.959		0.963	0.963		0.965	0.965		0.967	0.967	
Left-Turn Pedestrian Adjustment Factor (f_{LPB})				1.000			1.000			1.000			1.000			
Right-Turn Ped-Bike Adjustment Factor (f_{RPB})						1.000			1.000			1.000			1.000	
Work Zone Adjustment Factor (f_{WZ})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
DDI Factor (f_{DDI})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Left-Turn Prot. CAV Adj. Factor ($f_{CAV,prot}$)																
Left-Turn Perm. CAV Adj. Factor ($f_{CAV,perm}$)				1.00			1.00			1.00			1.00			
Movement Saturation Flow Rate (s), veh/h				789	1291	403	730	1290	354	1062	1337	339	870	1327	310	
Proportion of Vehicles Arriving on Green (P)				0.46	0.46	0.46	0.46	0.46	0.46	0.41	0.41	0.41	0.41	0.41	0.41	
Incremental Delay Factor (k)				0.15	0.33		0.15	0.31		0.15	0.17		0.15	0.15		
Signal Timing / Movement Groups				EBL	EBT/R	WBL	WBT/R	NBL	NBT/R	SBL	SBT/R					
Lost Time (t_L)					6.5		6.5		7.0		7.0					
Green Ratio (g/C)					0.46		0.46		0.41		0.41					
Permitted Saturation Flow Rate (s_p), veh/h/ln					789		730		1062		870					
Shared Saturation Flow Rate (s_{sh}), veh/h/ln																
Permitted Effective Green Time (g_p), s					47.1		47.1		42.2		42.2					
Permitted Service Time (g_u), s					16.7		14.4		32.0		21.6					
Permitted Queue Service Time (g_{ps}), s					10.0		6.8		19.1		14.4					
Time to First Blockage (g_t), s					0.0		0.0		0.0		0.0					
Queue Service Time Before Blockage (g_{ts}), s																
Protected Right Saturation Flow (s_R), veh/h/ln																
Protected Right Effective Green Time (g_R), s																
Multimodal				EB		WB		NB		SB						
Pedestrian F_w / F_v				1.198	0.000	1.198	0.000	1.198	0.000	1.198	0.000					
Pedestrian F_s / F_{delay}				0.000	0.109	0.000	0.109	0.000	0.116	0.000	0.116					
Pedestrian M_{corner} / M_{cw}				0.00		0.00		0.00		0.00						
Bicycle c_b / d_b				915.54	15.11	915.54	15.11	821.79	17.84	821.79	17.84					
Bicycle F_w / F_v				-3.64	1.17	-3.64	1.04	-3.64	1.08	-3.64	0.61					

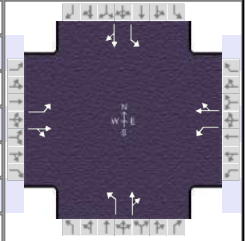
HCS Signalized Intersection Results Graphical Summary

General Information

Agency	Lanham Engineering LLC		
Analyst	MJB	Analysis Date	11/21/2023
Jurisdiction	ODOT D3	Time Period	AM Peak
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043
Intersection	SR-82 at SR-83	File Name	2043 No Build AM Peak.xus
Project Description	2043 No Build AM Peak Hour		

Intersection Information

Duration, h	0.250
Area Type	Other
PHF	0.94
Analysis Period	1 > 7:15



Demand Information

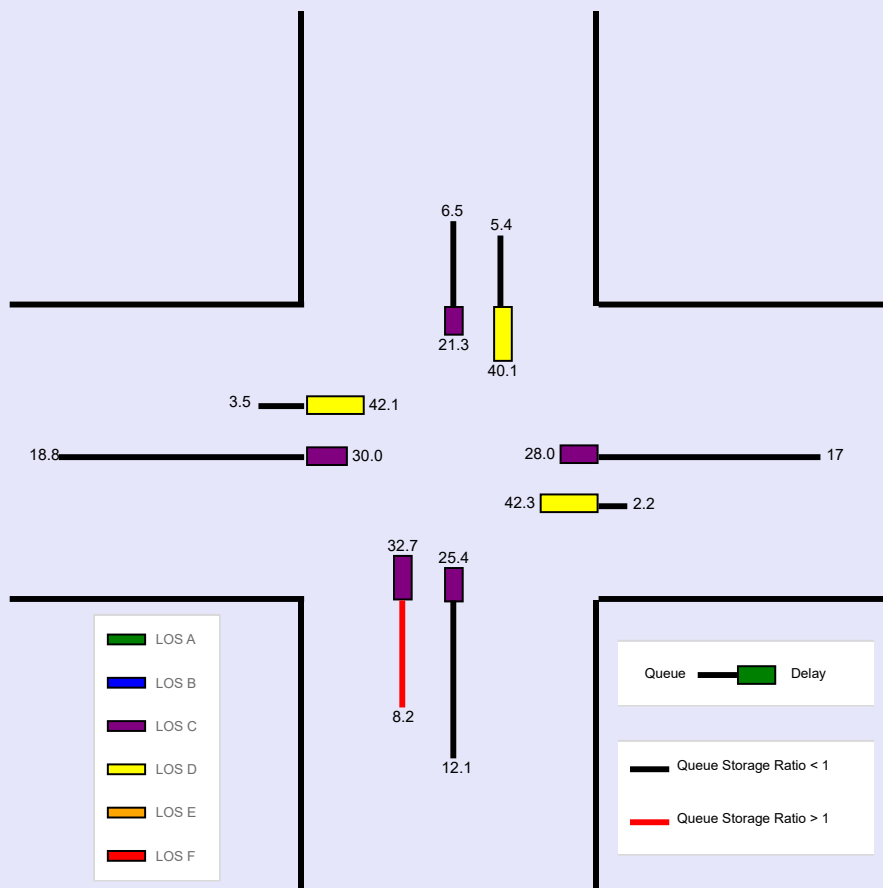
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	77	448	140	49	427	117	212	320	81	123	180	42

Signal Information

Cycle, s	102.8	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Back of Queue (Q), ft/ln (95 th percentile)	94	504.3		61.2	469.1		223.4	329.6		151.2	180.8	
Back of Queue (Q), veh/ln (95 th percentile)	3.5	18.8		2.2	17.0		8.2	12.1		5.4	6.5	
Queue Storage Ratio (RQ) (95 th percentile)	0.55	0.31		0.42	0.11		0.99	0.18		0.63	0.04	
Control Delay (d), s/veh	42.1	30.0		42.3	28.0		32.7	25.4		40.1	21.3	
Level of Service (LOS)	D	C		D	C		C	C		D	C	
Approach Delay, s/veh / LOS	31.4	C		29.2	C		27.9	C		28.0	C	
Intersection Delay, s/veh / LOS	29.3						C					



--- Messages ---

No errors or warnings exist.

--- Comments ---

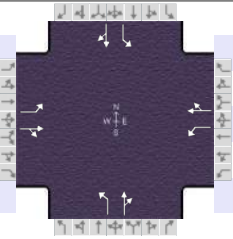
HCS Signalized Intersection Input Data

General Information						Intersection Information									
Agency	Lanham Engineering LLC					Duration, h	0.250								
Analyst	MJB	Analysis Date	11/21/2023			Area Type	Other								
Jurisdiction	ODOT D3	Time Period	PM Peak			PHF	0.96								
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043			Analysis Period	1> 16:00								
Intersection	SR-82 at SR-83	File Name	2043 No Build PM Peak.xus												
Project Description	2043 No Build PM Peak Hour														
Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				62	447	182	106	509	83	171	223	47	156	347	56
Signal Information															
Cycle, s	109.3	Reference Phase	2												
Offset, s	0	Reference Point	End												
Uncoordinated	Yes	Simult. Gap E/W	On												
Force Mode	Fixed	Simult. Gap N/S	On												
Green	50.0	45.8	0.0	0.0	0.0	0.0									
Yellow	5.5	6.0	0.0	0.0	0.0	0.0									
Red	1.0	1.0	0.0	0.0	0.0	0.0									
Traffic Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				62	447	182	106	509	83	171	223	47	156	347	56
Initial Queue (Q_0), veh/h				0	0	0	0	0	0	0	0	0	0	0	0
Base Saturation Flow Rate (s_0), veh/h				1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Parking (N_m), man/h				None			None			None			None		
Heavy Vehicles (P_{HV}), %				5	5		5	5		6	6		8	8	
Ped / Bike / RTOR, /h				0	0	0	0	0	0	0	0	0	0	0	0
Buses (N_b), buses/h				0	0	0	0	0	0	0	0	0	0	0	0
Arrival Type (AT)				3	3	3	3	3	3	3	3	3	3	3	3
Upstream Filtering (I)				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lane Width (W), ft				11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Turn Bay Length, ft				170	1650		145	4300		225	1800		240	4950	
Grade (P_g), %					0			0			0			0	
Speed Limit, mi/h				50	50	50	50	50	50	55	55	55	55	55	55
Phase Information				EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Maximum Green (G_{max}) or Phase Split, s					50.0		50.0		50.0		50.0				
Yellow Change Interval (Y), s					5.5		5.5		6.0		6.0				
Red Clearance Interval (R_c), s					1.0		1.0		1.0		1.0				
Minimum Green (G_{min}), s					20		20		12		12				
Start-Up Lost Time (l_t), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Extension of Effective Green (e), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Passage (PT), s					4.0		4.0		4.0		4.0				
Recall Mode					Min		Min		Off		Off				
Dual Entry					Yes		Yes		Yes		Yes				
Walk ($Walk$), s					0.0		0.0		0.0		0.0				
Pedestrian Clearance Time (PC), s					0.0		0.0		0.0		0.0				
Multimodal Information				EB			WB			NB			SB		
85th % Speed / Rest in Walk / Corner Radius				0.0	No	25.0	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0
Walkway / Crosswalk Width / Length, ft				9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0
Street Width / Island / Curb, ft				0.0	0	No	0.0	0	No	0.0	0	No	0.0	0	No
Width Outside / Bike Lane / Shoulder, ft				12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0
Pedestrian Signal / Occupied Parking				No		0.50	No		0.50	No		0.50	No		0.50

HCS Signalized Intersection Results Summary

General Information						Intersection Information									
Agency	Lanham Engineering LLC					Duration, h	0.250								
Analyst	MJB		Analysis Date	11/21/2023		Area Type	Other								
Jurisdiction	ODOT D3		Time Period	PM Peak		PHF	0.96								
Urban Street	SR-82 (Royalton Rd)		Analysis Year	2043		Analysis Period	1> 16:00								
Intersection	SR-82 at SR-83		File Name	2043 No Build PM Peak.xus											
Project Description	2043 No Build PM Peak Hour														
Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (ν), veh/h				62	447	182	106	509	83	171	223	47	156	347	56
Signal Information															
Cycle, s	109.3	Reference Phase	2												
Offset, s	0	Reference Point	End												
Uncoordinated	Yes	Simult. Gap E/W	On												
Force Mode	Fixed	Simult. Gap N/S	On												
				Green	50.0	45.8	0.0	0.0	0.0	0.0					
				Yellow	5.5	6.0	0.0	0.0	0.0	0.0					
				Red	1.0	1.0	0.0	0.0	0.0	0.0					
Timer Results				EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Assigned Phase					2		6		8		4				
Case Number					6.0		6.0		6.0		6.0				
Phase Duration, s					56.5		56.5		52.8		52.8				
Change Period, ($Y+R_c$), s					6.5		6.5		7.0		7.0				
Max Allow Headway (MAH), s					5.2		5.2		5.2		5.2				
Queue Clearance Time (g_s), s					41.5		52.0		41.9		28.0				
Green Extension Time (g_e), s					5.5		0.0		3.9		6.7				
Phase Call Probability					1.00		1.00		1.00		1.00				
Max Out Probability					0.83		1.00		0.73		0.16				
Movement Group Results				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (ν), veh/h				65	655		110	617		178	281		163	420	
Adjusted Saturation Flow Rate (s), veh/h/ln				787	1736		759	1781		936	1756		1046	1738	
Queue Service Time (g_s), s				8.1	36.0		14.0	31.4		19.7	12.1		13.9	20.2	
Cycle Queue Clearance Time (g_c), s				39.5	36.0		50.0	31.4		39.9	12.1		26.0	20.2	
Green Ratio (g/C)				0.46	0.46		0.46	0.46		0.42	0.42		0.42	0.42	
Capacity (c), veh/h				200	794		163	815		285	736		388	728	
Volume-to-Capacity Ratio (X)				0.323	0.825		0.676	0.757		0.625	0.382		0.419	0.576	
Back of Queue (Q), ft/ln (95 th percentile)				74	555		162	490.7		210.8	214.5		161.8	328.2	
Back of Queue (Q), veh/ln (95 th percentile)				2.8	21.3		6.2	18.9		8.0	8.2		6.1	12.3	
Queue Storage Ratio (RQ) (95 th percentile)				0.44	0.34		1.12	0.11		0.94	0.12		0.67	0.07	
Uniform Delay (d_1), s/veh				41.0	25.8		48.5	24.6		39.6	22.0		31.0	24.3	
Incremental Delay (d_2), s/veh				1.3	7.4		11.7	4.4		3.9	0.5		1.0	1.2	
Initial Queue Delay (d_3), s/veh				0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh				42.3	33.3		60.2	29.0		43.5	22.4		32.0	25.5	
Level of Service (LOS)				D	C		E	C		D	C		C	C	
Approach Delay, s/veh / LOS				34.1	C		33.7	C		30.6	C		27.3	C	
Intersection Delay, s/veh / LOS				31.8					C						
Multimodal Results				EB			WB			NB			SB		
Pedestrian LOS Score / LOS				1.91	B		1.91	B		1.91	B		1.91	B	
Bicycle LOS Score / LOS				1.68	B		1.69	B		1.25	A		1.45	A	

HCS Signalized Intersection Intermediate Values

General Information						Intersection Information									
Agency	Lanham Engineering LLC					Duration, h	0.250								
Analyst	MJB	Analysis Date	11/21/2023			Area Type	Other								
Jurisdiction	ODOT D3	Time Period	PM Peak			PHF	0.96								
Urban Street	SR-82 (Royaltan Rd)	Analysis Year	2043			Analysis Period	1 > 16:00								
Intersection	SR-82 at SR-83	File Name	2043 No Build PM Peak.xus												
Project Description	2043 No Build PM Peak Hour														
Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				62	447	182	106	509	83	171	223	47	156	347	56
Signal Information															
Cycle, s	109.3	Reference Phase	2												
Offset, s	0	Reference Point	End	Green	50.0	45.8	0.0	0.0	0.0	0.0					
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	5.5	6.0	0.0	0.0	0.0	0.0					
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	0.0	0.0	0.0	0.0					
Saturation Flow / Delay				L	T	R	L	T	R	L	T	R	L	T	R
Lane Width Adjustment Factor (f_w)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Heavy Vehicles and Grade Factor (f_{HVg})				0.961	0.961	1.000	0.961	0.961	1.000	0.953	0.953	1.000	0.938	0.938	1.000
Parking Activity Adjustment Factor (f_p)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Bus Blockage Adjustment Factor (f_{bb})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Area Type Adjustment Factor (f_a)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Lane Utilization Adjustment Factor (f_{LU})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Left-Turn Adjustment Factor (f_{LT})				0.414	0.000		0.400	0.000		0.493	0.000		0.550	0.000	
Right-Turn Adjustment Factor (f_{RT})					0.950	0.950		0.975	0.975		0.970	0.970		0.976	0.976
Left-Turn Pedestrian Adjustment Factor (f_{LPB})				1.000			1.000			1.000			1.000		
Right-Turn Ped-Bike Adjustment Factor (f_{RPB})						1.000			1.000			1.000			1.000
Work Zone Adjustment Factor (f_{WZ})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
DDI Factor (f_{DDI})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Left-Turn Prot. CAV Adj. Factor ($f_{CAV,prot}$)															
Left-Turn Perm. CAV Adj. Factor ($f_{CAV,perm}$)				1.00			1.00			1.00			1.00		
Movement Saturation Flow Rate (s), veh/h				787	1233	502	759	1531	250	936	1450	306	1046	1496	242
Proportion of Vehicles Arriving on Green (P)				0.46	0.46	0.46	0.46	0.46	0.46	0.42	0.42	0.42	0.42	0.42	0.42
Incremental Delay Factor (k)				0.15	0.38		0.28	0.33		0.19	0.15		0.15	0.17	
Signal Timing / Movement Groups				EBL	EBT/R		WBL	WBT/R		NBL	NBT/R		SBL	SBT/R	
Lost Time (t_L)					6.5			6.5			7.0			7.0	
Green Ratio (g/C)					0.46			0.46			0.42			0.42	
Permitted Saturation Flow Rate (s_p), veh/h/ln					787			759			936			1046	
Shared Saturation Flow Rate (s_{sh}), veh/h/ln															
Permitted Effective Green Time (g_p), s					50.0			50.0			45.8			45.8	
Permitted Service Time (g_u), s					18.6			14.0			25.6			33.7	
Permitted Queue Service Time (g_{ps}), s					8.1			14.0			19.7			13.9	
Time to First Blockage (g_r), s					0.0			0.0			0.0			0.0	
Queue Service Time Before Blockage (g_{fs}), s															
Protected Right Saturation Flow (s_R), veh/h/ln															
Protected Right Effective Green Time (g_R), s															
Multimodal				EB			WB			NB			SB		
Pedestrian F_w / F_v				1.198	0.000		1.198	0.000		1.198	0.000		1.198	0.000	
Pedestrian F_s / F_{delay}				0.000	0.111		0.000	0.111		0.000	0.117		0.000	0.117	
Pedestrian M_{corner} / M_{cw}				0.00			0.00			0.00			0.00		
Bicycle c_b / d_b				915.00	16.08		915.00	16.08		837.95	18.45		837.95	18.45	
Bicycle F_w / F_v				-3.64	1.19		-3.64	1.20		-3.64	0.76		-3.64	0.96	

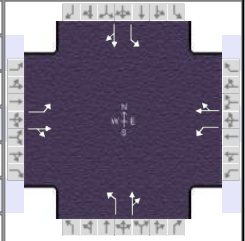
HCS Signalized Intersection Results Graphical Summary

General Information

Agency	Lanham Engineering LLC		
Analyst	MJB	Analysis Date	11/21/2023
Jurisdiction	ODOT D3	Time Period	PM Peak
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043
Intersection	SR-82 at SR-83	File Name	2043 No Build PM Peak.xus
Project Description	2043 No Build PM Peak Hour		

Intersection Information

Duration, h	0.250
Area Type	Other
PHF	0.96
Analysis Period	1> 16:00



Demand Information

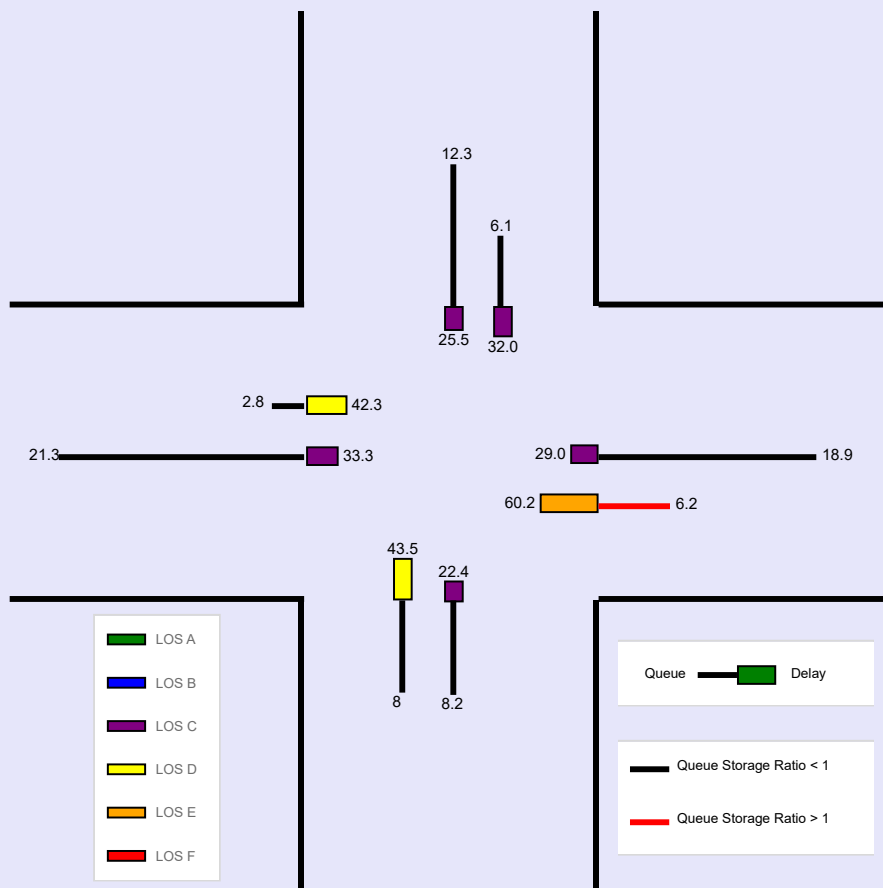
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	62	447	182	106	509	83	171	223	47	156	347	56

Signal Information

Cycle, s	109.3	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Back of Queue (Q), ft/ln (95 th percentile)	74	555		162	490.7		210.8	214.5		161.8	328.2	
Back of Queue (Q), veh/ln (95 th percentile)	2.8	21.3		6.2	18.9		8.0	8.2		6.1	12.3	
Queue Storage Ratio (RQ) (95 th percentile)	0.44	0.34		1.12	0.11		0.94	0.12		0.67	0.07	
Control Delay (d), s/veh	42.3	33.3		60.2	29.0		43.5	22.4		32.0	25.5	
Level of Service (LOS)	D	C		E	C		D	C		C	C	
Approach Delay, s/veh / LOS	34.1	C		33.7	C		30.6	C		27.3	C	
Intersection Delay, s/veh / LOS	31.8						C					



--- Messages ---

WARNING: Since queue spillover from turn lanes and spillback into upstream intersections is not accounted for in the HCM procedures, use of a simulation tool may be advised in situations where the Queue Storage Ratio exceeds 1.0.

--- Comments ---

Appendix D – Existing Crash Analysis (Diagram & CAM Output)



SR 82 & SR 83 Crash Data

Crash Summary Sheet

Fatalities	0
Serious Injuries	2
Other Injuries	18

Crash Severity	Crashes	%
(2) Serious Injury Suspected	1	3.57%
(3) Minor Injury Suspected	4	14.29%
(4) Injury Possible	7	25.00%
(5) PDO/No Injury	16	57.14%
Grand Total	28	100.00%

Day of Week	Crashes	%
(2) Monday	8	28.57%
(3) Tuesday	4	14.29%
(4) Wednesday	5	17.86%
(5) Thursday	4	14.29%
(6) Friday	3	10.71%
(7) Saturday	4	14.29%
Grand Total	28	100.00%

Hour of Day	Crashes	%
3	1	3.57%
5	1	3.57%
6	1	3.57%
7	2	7.14%
8	2	7.14%
9	3	10.71%
11	2	7.14%
12	1	3.57%
14	1	3.57%
15	5	17.86%
16	1	3.57%
17	2	7.14%
18	2	7.14%
19	2	7.14%
21	1	3.57%
22	1	3.57%
Grand Total	28	100.00%

Crashes Per Year	5.60
Fatal and All Injury Crashes	12
Percent Injury	42.9%
Equivalent PDO Index Value	4.26

Year	Crashes	%
2018	3	10.71%
2019	8	28.57%
2020	5	17.86%
2021	8	28.57%
2022	4	14.29%
Grand Total	28	100.00%

Crash Type	Crashes	%
Rear End	18	64.29%
Angle	4	14.29%
Left Turn	3	10.71%
Sideswipe - Passing	1	3.57%
U-Turn	1	3.57%
Other Non-Collision	1	3.57%
Grand Total	28	100.00%

Month	Crashes	%
1	3	10.71%
2	2	7.14%
3	3	10.71%
4	1	3.57%
5	2	7.14%
6	1	3.57%
7	1	3.57%
8	3	10.71%
9	3	10.71%
10	6	21.43%
12	3	10.71%
Grand Total	28	100.00%

SR 82 & SR 83 Crash Data

Crash Summary Sheet

Weather Condition	Crashes	%
Clear	16	57.14%
Cloudy	7	25.00%
Rain	3	10.71%
Snow	2	7.14%
Grand Total	28	100.00%

Road Condition	Crashes	%
Dry	19	67.86%
Wet	7	25.00%
Snow	1	3.57%
Slush	1	3.57%
Grand Total	28	100.00%

Light Condition	Crashes	%
Daylight	20	71.43%
Dark - Roadway Not Lighted	5	17.86%
Dark - Lighted Roadway	2	7.14%
Dawn/Dusk	1	3.57%
Grand Total	28	100.00%

Number of Units	Crashes	%
2	25	89.29%
3	2	7.14%
1	1	3.57%
Grand Total	28	100.00%

ODOT Location	Crashes	%
Four-Way Intersection	21	75.00%
Data Not Valid or Not Provided	4	14.29%
Not An Intersection	3	10.71%
Grand Total	28	100.00%

Work Zone Related	Crashes	%
No	28	100.00%
Grand Total	28	100.00%

Alcohol Related	Crashes	%
No	26	92.86%
Yes	2	7.14%
Grand Total	28	100.00%

Drug Related (Inc. Marijuana)	Crashes	%
No	25	89.29%
Yes	3	10.71%
Grand Total	28	100.00%

Marijuana Related	Crashes	%
No	27	96.43%
Yes	1	3.57%
Grand Total	28	100.00%

Older Driver (65+)	Crashes	%
No	26	92.86%
Yes	2	7.14%
Grand Total	28	100.00%

Young Driver (15-25)	Crashes	%
No	17	60.71%
Yes	11	39.29%
Grand Total	28	100.00%

Motorcycle Involved	Crashes	%
No	28	100.00%
Grand Total	28	100.00%

Contour	Crashes	%
Straight Grade	1	3.57%
Straight Level	27	96.43%
Grand Total	28	100.00%

Roadway Departure	Crashes	%
No	27	96.43%
Yes	1	3.57%
Grand Total	28	100.00%

Intersection Related	Crashes	%
Yes	25	89.29%
No	3	10.71%
Grand Total	28	100.00%

Speed Related	Crashes	%
No	25	89.29%
Yes	3	10.71%
Grand Total	28	100.00%

SR 82 & SR 83 Crash Data

Crash Summary Sheet

Unit 1 Summary

Unit 1 Pre-Crash Action	Crashes	%
Straight Ahead	17	60.71%
Slowing or Stopped In Traffic	4	14.29%
Making Left Turn	4	14.29%
Overtaking/Passing	1	3.57%
Changing Lanes	1	3.57%
Making U-Turn	1	3.57%
Grand Total	28	100.00%

Unit 1 Contributing Factor	Crashes	%
Following Too Closely/ACDA	12	42.86%
Failure to Yield	4	14.29%
Unsafe Speed	3	10.71%
Other Improper Action	2	7.14%
Ran Red Light	2	7.14%
Improper Start From a Parked Position	1	3.57%
Improper Passing	1	3.57%
Improper Lane Change	1	3.57%
None	1	3.57%
Improper Turn	1	3.57%
Grand Total	28	100.00%

Unit 1 Object Struck	Crashes	%
Nothing Struck	28	100.00%
Grand Total	28	100.00%

Unit 1 Traffic Control	Crashes	%
Signal	24	85.71%
No Control	4	14.29%
Grand Total	28	100.00%

Unit 1 Posted Speed	Crashes	%
45	3	10.71%
50	14	50.00%
55	11	39.29%
Grand Total	28	100.00%

Unit 1 Direction From	Crashes	%
North	10	35.71%
West	7	25.00%
East	6	21.43%
South	5	17.86%
Grand Total	28	100.00%

Unit 1 Direction To	Crashes	%
East	9	32.14%
South	8	28.57%
West	6	21.43%
North	5	17.86%
Grand Total	28	100.00%

SR 82 & SR 83 Crash Data

Crash Summary Sheet

Unit 1 Summary

Unit 1 Type	Crashes	%
Passenger Car	16	57.14%
Sport Utility Vehicle	6	21.43%
Pick up	3	10.71%
Unknown or Hit/Skip	1	3.57%
Heavy Equipment	1	3.57%
Passenger Van (minivan)	1	3.57%
Grand Total	28	100.00%

Unit 1 Special Function	Crashes	%
None	26	92.86%
Public Utility	1	3.57%
Other / Unknown	1	3.57%
Grand Total	28	100.00%

SR 82 & SR 83 Crash Data

Crash Summary Sheet

Unit 2 Summary

Unit 2 Pre-Crash Action	Crashes	%
Slowing or Stopped In Traffic	16	57.14%
Straight Ahead	9	32.14%
	1	3.57%
Making Left Turn	1	3.57%
Parked	1	3.57%
Grand Total	28	100.00%

Unit 2 Contributing Factor	Crashes	%
None	27	96.43%
	1	3.57%
Grand Total	28	100.00%

Unit 2 Direction From	Crashes	%
	1	3.57%
East	5	17.86%
North	8	28.57%
South	6	21.43%
Unknown	1	3.57%
West	7	25.00%
Grand Total	28	100.00%

Unit 2 Direction To	Crashes	%
	1	3.57%
East	8	28.57%
North	6	21.43%
South	7	25.00%
Unknown	1	3.57%
West	5	17.86%
Grand Total	28	100.00%

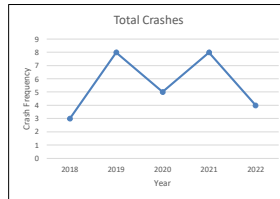
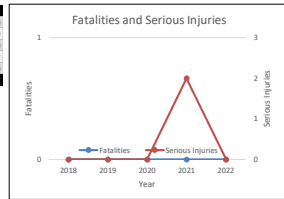
Unit 2 Type	Crashes	%
Passenger Car	13	46.43%
Sport Utility Vehicle	7	25.00%
Pick up	3	10.71%
Passenger Van (minivan)	2	7.14%
Cargo Van	1	3.57%
	1	3.57%
Semi-Tractor	1	3.57%
Grand Total	28	100.00%

Unit 2 Special Function	Crashes	%
None	26	92.86%
Police	1	3.57%
	1	3.57%
Grand Total	28	100.00%

SR 82 & SR 83 Crash Data Crash Summary Sheet

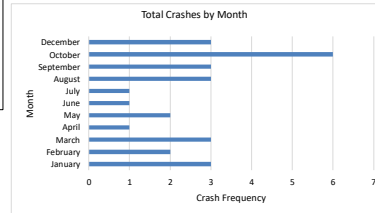
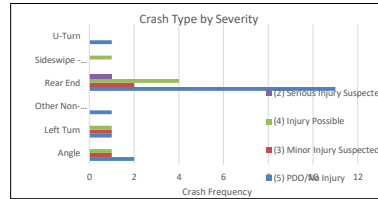
Crashes Per Year	5.6%	Percent Injury	42.9%	EPDO	4.26
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Year	Total Crashes	Fatalities	Serious Injuries
2018	3	0	0
2019	8	0	0
2020	5	0	0
2021	8	0	0
2022	4	0	0
Grand Total	28	0	2



Total Crashes	Column Labels	SV	FI	MV	POD	Grand Total
Year						
2018		0	1	2	3	
2019		0	4	4	8	
2020		0	2	3	5	
2021		1	3	4	8	
2022		0	2	2	4	
Grand Total		1	12	15	28	

Total Crashes	Injury Level	(2) Serious Inj	(3) Minor Injury	(4) Injury Poss	(5) PDO/No Inj	Grand Total
Crash Type						
Rear End		1	2	2	11	16
Angle		0	1	1	2	4
Left Turn		0	1	1	1	3
Sidewipe - Passing		0	0	1	0	1
U-Turn		0	0	0	1	1
Other Non-Collision		0	0	0	1	1
Grand Total		1	4	7	16	28

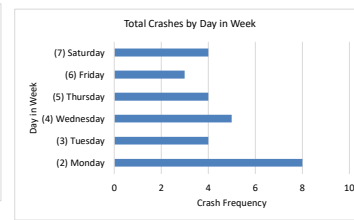
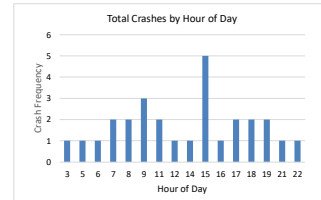


Road Condition	Total Crashes	Fatalities	Serious Injuries
Dry	19	0	2
Slush	1	0	0
Snow	1	0	0
Wet	7	0	0
Grand Total	28	0	2

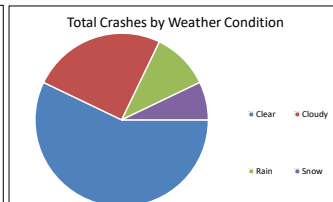
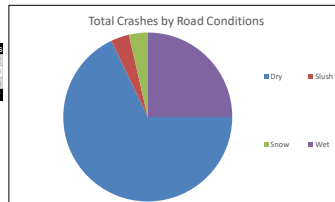
Hour of Day	Total Crashes
3	1
5	1
6	1
7	2
8	2
9	3
11	2
12	1
14	1
15	5
16	1
17	2
18	2
19	2
21	1
22	1
Grand Total	28

Month	Total Crashes
January	3
February	2
March	3
April	1
May	2
June	1
July	1
August	3
September	3
October	6
December	3
Grand Total	28

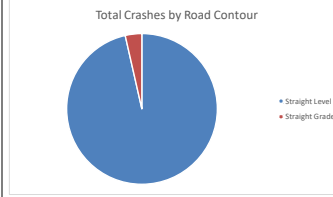
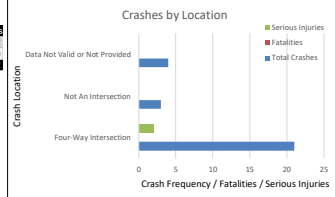
Day in Week	Total Crashes
(2) Monday	8
(3) Tuesday	4
(4) Wednesday	5
(5) Thursday	4
(6) Friday	3
(7) Saturday	4
Grand Total	28



Crash Location	Total Crashes	Fatalities	Serious Injuries
Four-Way Intersection	21	0	2
Not An Intersection	3	0	0
Data Not Valid or Not Provided	4	0	0
Grand Total	28	0	2



Roadway Contour	Total Crashes	Fatalities	Serious Injuries
Straight Level	27	0	2
Straight Grade	1	0	0
Grand Total	28	0	2



Appendix E – Existing Safety Analysis (ECAT)

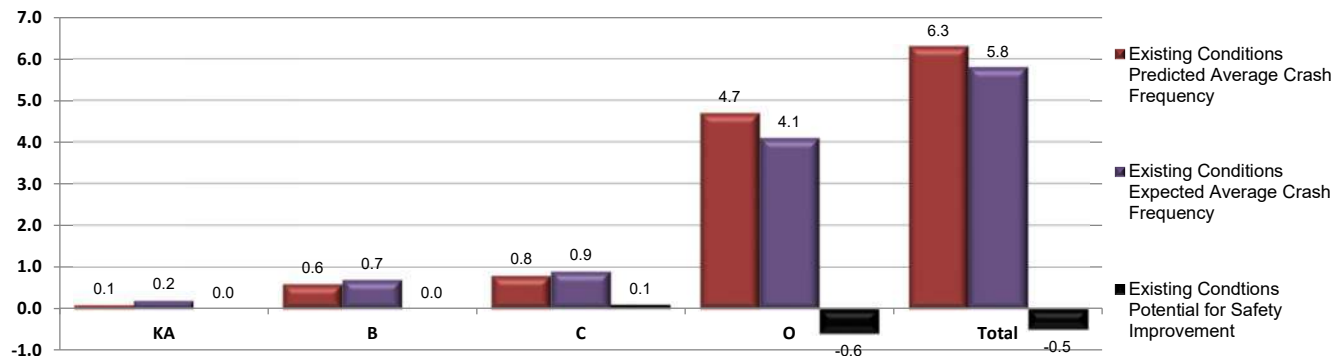


Project Safety Performance Report

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	November 2023
Analyst	Jimmy Masters	Analysis Year	2023
Agency/Company	Burgess & Niple		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
N_{predicted} - Existing Conditions	0.1471	0.6251	0.7901	4.7222	6.2845
N_{expected} - Existing Conditions	0.1586	0.6744	0.8523	4.1334	5.8187
N_{potential for improvement} - Existing Conditions	0.0115	0.0493	0.0622	-0.5888	-0.4658



Project Safety Performance Report

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	November 2023
Analyst	Jimmy Masters	Analysis Year	2023
Agency/Company	Burgess & Niple		

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.1471	0.6251	0.7901	4.7222	6.2845

Existing Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.1586	0.6744	0.8523	4.1334	5.8187

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

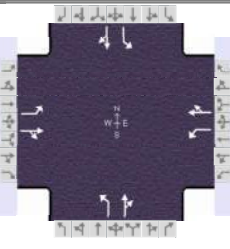
Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.0115	0.0493	0.0622	-0.5888	-0.4658

Summary by Crash Type

Crash Type	Existing			Proposed
	Predicted Crash Frequency	Expected Crash Frequency	PSI	Expected Crash Frequency
Unknown	0.0074	0.0068	-0.0006	
Head On	0.0462	0.0449	-0.0013	
Rear End	2.7826	2.5626	-0.2200	
Backing	0.3009	0.2644	-0.0365	
Sideswipe - Meeting	0.1278	0.1180	-0.0098	
Sideswipe - Passing	0.4352	0.3889	-0.0463	
Angle	1.2779	1.1988	-0.0791	
Parked Vehicle	0.2355	0.2102	-0.0253	
Pedestrian	0.0587	0.0616	0.0029	
Animal	0.0000	0.0000	0.0000	
Train	0.0000	0.0000	0.0000	
Pedalcycles	0.0389	0.0396	0.0007	
Other Non-Vehicle	0.0000	0.0000	0.0000	
Fixed Object	0.4018	0.3706	-0.0312	
Other Object	0.0128	0.0114	-0.0014	
Overturning	0.0251	0.0249	-0.0002	
Other Non-Collision	0.0360	0.0326	-0.0034	
Left Turn	0.5301	0.5048	-0.0253	
Right Turn	0.0000	0.0000	0.0000	

Appendix F – Proposed Capacity Analysis (HCS)

HCS Signalized Intersection Input Data

General Information				Intersection Information		
Agency	Lanham Engineering LLC			Duration, h	0.250	
Analyst	MJB	Analysis Date	11/21/2023	Area Type	Other	
Jurisdiction	ODOT D3	Time Period	AM Peak	PHF	0.94	
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043	Analysis Period	1> 7:15	
Intersection	SR-82 at SR-83	File Name	2043 Prot-Perm Left AM Peak.xus			
Project Description	2043 Prot/Perm Lefts AM Peak Hour					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	77	448	140	49	427	117	212	320	81	123	180	42

Signal Information												
Cycle, s	116.8	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	44.2	1.7	5.7	19.4	5.2	6.9		
				Yellow	5.5	0.0	4.3	6.0	6.0	4.6		
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	0.0	2.5	1.0	1.0	1.9		

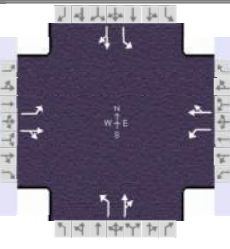
														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Traffic Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	77	448	140	49	427	117	212	320	81	123	180	42
Initial Queue (Q_0), veh/h	0	0	0	0	0	0	0	0	0	0	0	0
Base Saturation Flow Rate (s_0), veh/h	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Parking (N_m), man/h		None			None			None			None	
Heavy Vehicles (P_{HV}), %	9	9		13	13		11	11		14	14	
Ped / Bike / RTOR, /h	0	0	0	0	0	0	0	0	0	0	0	0
Buses (N_b), buses/h	0	0	0	0	0	0	0	0	0	0	0	0
Arrival Type (AT)	3	3	3	3	3	3	3	3	3	3	3	3
Upstream Filtering (I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lane Width (W), ft	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Turn Bay Length, ft	600	1650		600	4300		500	1800		525	4950	
Grade (P_g), %		0			0			0			0	
Speed Limit, mi/h	50	50	50	50	50	50	55	55	55	55	55	55

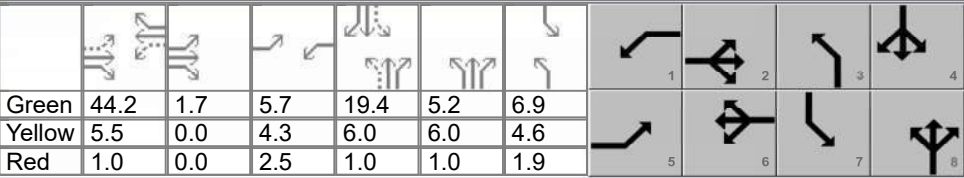
Phase Information	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Maximum Green (G_{max}) or Phase Split, s	7.0	51.0	7.0	53.0	7.0	33.0	15.0	34.0
Yellow Change Interval (Y), s	4.3	5.5	4.3	5.5	4.6	6.0	4.6	6.0
Red Clearance Interval (R_c), s	2.5	1.0	2.5	1.0	1.9	1.0	1.9	1.0
Minimum Green (G_{min}), s	7	20	7	20	7	12	7	12
Start-Up Lost Time (l_t), s	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Extension of Effective Green (e), s	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Passage (PT), s	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0
Recall Mode	Off	Min	Off	Min	Off	Off	Off	Off
Dual Entry	No	Yes	No	Yes	No	Yes	No	Yes
Walk ($Walk$), s		0.0		0.0		0.0		0.0
Pedestrian Clearance Time (PC), s		0.0		0.0		0.0		0.0

Multimodal Information	EB			WB			NB			SB		
85th % Speed / Rest in Walk / Corner Radius	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0
Walkway / Crosswalk Width / Length, ft	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0
Street Width / Island / Curb, ft	0.0	0	No	0.0	0	No	0.0	0	No	0.0	0	No
Width Outside / Bike Lane / Shoulder, ft	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0
Pedestrian Signal / Occupied Parking	No	0.50		No	0.50		No	0.50		No	0.50	

HCS Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	Lanham Engineering LLC			Duration, h	0.250	
Analyst	MJB	Analysis Date	11/21/2023	Area Type	Other	
Jurisdiction	ODOT D3	Time Period	AM Peak	PHF	0.94	
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043	Analysis Period	1> 7:15	
Intersection	SR-82 at SR-83	File Name	2043 Prot-Perm Left AM Peak.xus			
Project Description	2043 Prot/Perm Lefts AM Peak Hour					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	77	448	140	49	427	117	212	320	81	123	180	42

Signal Information											
Cycle, s	116.8	Reference Phase	2		Green	44.2	1.7	5.7	19.4	5.2	6.9
Offset, s	0	Reference Point	End								
Uncoordinated	Yes	Simult. Gap E/W	On								
Force Mode	Fixed	Simult. Gap N/S	On								
				Yellow		5.5	0.0	4.3	6.0	6.0	4.6
				Red		1.0	0.0	2.5	1.0	1.0	1.9

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	1.4	4.0	1.4	4.0	1.4	4.0	1.4	4.0
Phase Duration, s	14.1	52.4	12.5	50.7	25.6	38.6	13.4	26.4
Change Period, ($Y+R_c$), s	6.8	6.5	6.8	6.5	6.5	7.0	6.5	7.0
Max Allow Headway (MAH), s	3.0	5.0	3.0	5.0	2.9	4.9	2.9	4.9
Queue Clearance Time (g_s), s	2.0	43.6	2.0	41.5	11.6	31.1	6.9	18.4
Green Extension Time (g_e), s	0.1	2.3	0.0	2.7	0.0	0.5	0.1	1.0
Phase Call Probability	0.93	1.00	0.82	1.00	1.00	1.00	0.99	1.00
Max Out Probability	0.08	0.59	0.08	0.22	1.00	1.00	0.01	0.01

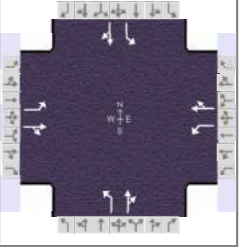
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	82	626		52	579		226	427		131	236	
Adjusted Saturation Flow Rate (s), veh/h/ln	1682	1694		1626	1644		1654	1676		1612	1637	
Queue Service Time (g_s), s	0.0	41.6		0.0	39.5		9.6	29.1		4.9	16.4	
Cycle Queue Clearance Time (g_c), s	0.0	41.6		0.0	39.5		9.6	29.1		4.9	16.4	
Green Ratio (g/C)	0.44	0.39		0.43	0.38		0.31	0.27		0.23	0.17	
Capacity (c), veh/h	199	665		157	622		341	453		157	272	
Volume-to-Capacity Ratio (X)	0.411	0.940		0.332	0.930		0.662	0.941		0.834	0.867	
Back of Queue (Q), ft/ln (95 th percentile)	106.6	713.9		71.2	676.4		274	569.9		189.6	322.8	
Back of Queue (Q), veh/ln (95 th percentile)	4.0	26.6		2.6	24.5		10.1	21.0		6.8	11.6	
Queue Storage Ratio (RQ) (95 th percentile)	0.18	0.43		0.12	0.16		0.55	0.32		0.36	0.07	
Uniform Delay (d_1), s/veh	50.4	34.2		52.5	34.9		43.4	41.7		52.9	47.5	
Incremental Delay (d_2), s/veh	0.5	19.5		0.5	17.2		3.8	27.1		4.4	11.2	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	50.9	53.7		53.0	52.1		47.2	68.8		57.2	58.7	
Level of Service (LOS)	D	D		D	D		D	E		E	E	
Approach Delay, s/veh / LOS	53.4	D		52.2	D		61.4	E		58.1	E	
Intersection Delay, s/veh / LOS	56.0						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.96	B	1.96	B	1.96	B	1.95	B
Bicycle LOS Score / LOS	1.65	B	1.53	B	1.56	B	1.09	A

HCS Signalized Intersection Intermediate Values

General Information

Agency	Lanham Engineering LLC		
Analyst	MJB	Analysis Date	11/21/2023
Jurisdiction	ODOT D3	Time Period	AM Peak
Urban Street	SR-82 (Royaltan Rd)	Analysis Year	2043
Intersection	SR-82 at SR-83	File Name	2043 Prot-Perm L
Project Description	2043 Prot/Perm Lefts AM Peak Hour		



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	77	448	140	49	427	117	212	320	81	123	180	42

Signal Information

Cycle, s	116.8	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	44.2	1.7	5.7	19.4	5.2	6.9		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	0.0	4.3	6.0	6.0	4.6		
				Red	1.0	0.0	2.5	1.0	1.0	1.9		

Saturation Flow / Delay

	L	T	R	L	T	R	L	T	R	L	T	R
Lane Width Adjustment Factor (f_w)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Heavy Vehicles and Grade Factor (f_{HVg})	0.930	0.930	1.000	0.899	0.899	1.000	0.914	0.914	1.000	0.891	0.891	1.000
Parking Activity Adjustment Factor (f_p)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Bus Blockage Adjustment Factor (f_{bb})	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Area Type Adjustment Factor (f_a)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Lane Utilization Adjustment Factor (f_{LU})	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Left-Turn Adjustment Factor (f_{LT})	0.952	0.000		0.952	0.000		0.952	0.000		0.952	0.000	
Right-Turn Adjustment Factor (f_{RT})		0.959	0.959		0.963	0.963		0.965	0.965		0.967	0.967
Left-Turn Pedestrian Adjustment Factor (f_{LPB})	1.000			1.000			1.000			1.000		
Right-Turn Ped-Bike Adjustment Factor (f_{RPB})			1.000			1.000			1.000			1.000
Work Zone Adjustment Factor (f_{WZ})	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
DDI Factor (f_{DDI})	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Left-Turn Prot. CAV Adj. Factor ($f_{CAV,prot}$)	1.00			1.00			1.00			1.00		
Left-Turn Perm. CAV Adj. Factor ($f_{CAV,perm}$)												
Movement Saturation Flow Rate (s), veh/h	1682	1291	403	1626	1290	354	1654	1337	339	1612	1327	310
Proportion of Vehicles Arriving on Green (P)	0.06	0.39	0.39	0.05	0.38	0.38	0.16	0.27	0.27	0.06	0.17	0.17
Incremental Delay Factor (k)	0.04	0.39		0.04	0.35		0.19	0.43		0.04	0.15	

Signal Timing / Movement Groups

	EBL	EBT/R	WBL	WBT/R	NBL	NBT/R	SBL	SBT/R
Lost Time (t_L)	6.8	6.5	6.8	6.5	6.5	7.0	6.5	7.0
Green Ratio (g/C)	0.44	0.39	0.43	0.38	0.31	0.27	0.23	0.17
Permitted Saturation Flow Rate (s_p), veh/h/ln	789	0	730	0	1062	0	870	0
Shared Saturation Flow Rate (s_{sh}), veh/h/ln								
Permitted Effective Green Time (g_p), s	44.2	0.0	44.2	0.0	17.5	0.0	19.5	0.0
Permitted Service Time (g_u), s	4.7	0.0	2.7	0.0	1.0	0.0	0.0	0.0
Permitted Queue Service Time (g_{ps}), s	4.7		2.7		1.0		0.0	
Time to First Blockage (g_t), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Queue Service Time Before Blockage (g_{ts}), s								
Protected Right Saturation Flow (s_R), veh/h/ln								
Protected Right Effective Green Time (g_R), s								

Multimodal

	EB		WB		NB		SB	
Pedestrian F_w / F_v	1.198	0.000	1.198	0.000	1.198	0.000	1.198	0.000
Pedestrian F_s / F_{delay}	0.000	0.159	0.000	0.158	0.000	0.159	0.000	0.149
Pedestrian M_{corner} / M_{cw}	0.00		0.00		0.00		0.00	
Bicycle c_b / d_b	102.13	52.61	130.61	51.04	109.69	52.19	317.80	41.33
Bicycle F_w / F_v	-3.64	1.17	-3.64	1.04	-3.64	1.08	-3.64	0.61

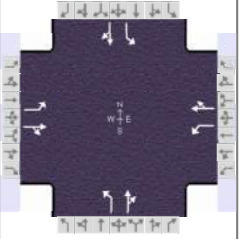
HCS Signalized Intersection Results Graphical Summary

General Information

Agency	Lanham Engineering LLC		
Analyst	MJB	Analysis Date	11/21/2023
Jurisdiction	ODOT D3	Time Period	AM Peak
Urban Street	SR-82 (Royaltown Rd)	Analysis Year	2043
Intersection	SR-82 at SR-83	File Name	2043 Prot-Perm L
Project Description	2043 Prot/Perm Lefts AM Peak Hour		

Intersection Information

Duration, h	0.250
Area Type	Other
PHF	0.94
Analysis Period	1> 7:15

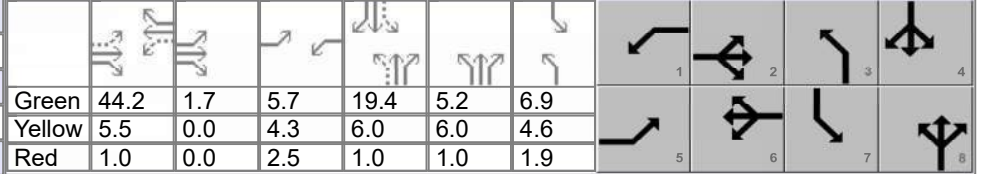


Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	77	448	140	49	427	117	212	320	81	123	180	42

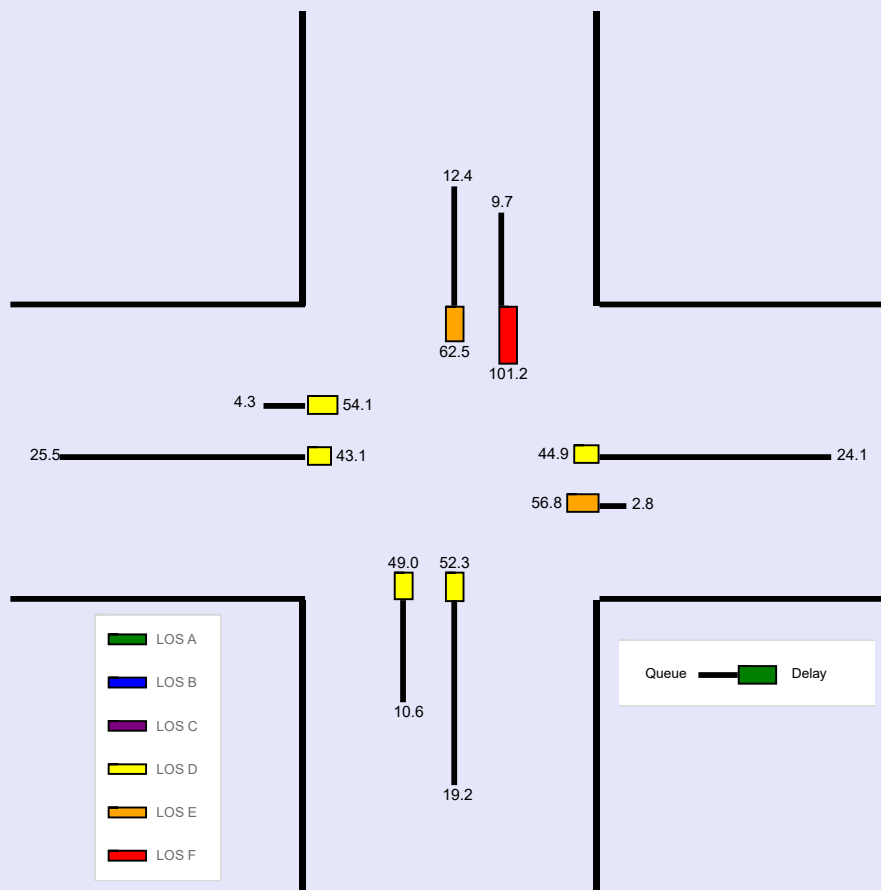
Signal Information

Cycle, s	116.8	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Back of Queue (Q), ft/ln (95 th percentile)	106.6	713.9		71.2	676.4		274	569.9		189.6	322.8	
Back of Queue (Q), veh/ln (95 th percentile)	4.0	26.6		2.6	24.5		10.1	21.0		6.8	11.6	
Queue Storage Ratio (RQ) (95 th percentile)	0.18	0.43		0.12	0.16		0.55	0.32		0.36	0.07	
Control Delay (d), s/veh	50.9	53.7		53.0	52.1		47.2	68.8		57.2	58.7	
Level of Service (LOS)	D	D		D	D		D	E		E	E	
Approach Delay, s/veh / LOS	53.4		D	52.2		D	61.4		E	58.1		E
Intersection Delay, s/veh / LOS	56.0						E					

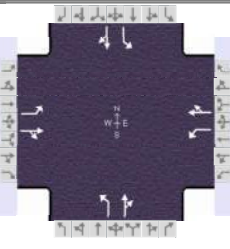


--- Messages ---

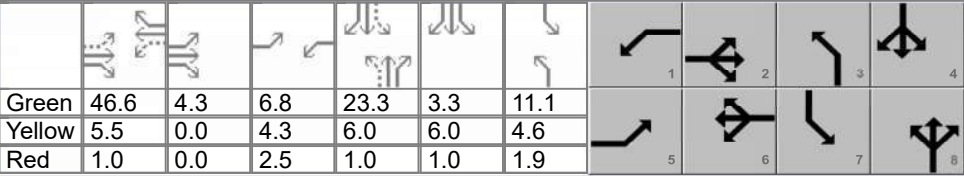
No errors or warnings exist.

--- Comments ---

HCS Signalized Intersection Input Data

General Information				Intersection Information		
Agency	Lanham Engineering LLC			Duration, h	0.250	
Analyst	MJB	Analysis Date	11/21/2023	Area Type	Other	
Jurisdiction	ODOT D3	Time Period	PM Peak	PHF	0.96	
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043	Analysis Period	1> 16:00	
Intersection	SR-82 at SR-83	File Name	2043 Prot-Perm Left PM Peak.xus			
Project Description	2043 Prot/Perm Lefts PM Peak Hour					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	62	447	182	106	509	83	171	223	47	156	347	56

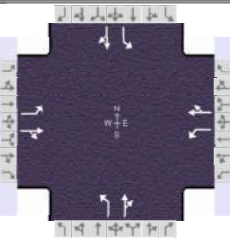
Signal Information											
Cycle, s	129.3	Reference Phase	2		Green	46.6	4.3	6.8	23.3	3.3	11.1
Offset, s	0	Reference Point	End								
Uncoordinated	Yes	Simult. Gap E/W	On								
Force Mode	Fixed	Simult. Gap N/S	On								
				Yellow	5.5	0.0	4.3	6.0	6.0	4.6	
				Red	1.0	0.0	2.5	1.0	1.0	1.9	

Traffic Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	62	447	182	106	509	83	171	223	47	156	347	56
Initial Queue (Q_0), veh/h	0	0	0	0	0	0	0	0	0	0	0	0
Base Saturation Flow Rate (s_0), veh/h	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Parking (N_m), man/h		None			None			None			None	
Heavy Vehicles (P_{HV}), %	5	5		5	5		6	6		8	8	
Ped / Bike / RTOR, /h	0	0	0	0	0	0	0	0	0	0	0	0
Buses (N_b), buses/h	0	0	0	0	0	0	0	0	0	0	0	0
Arrival Type (AT)	3	3	3	3	3	3	3	3	3	3	3	3
Upstream Filtering (I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lane Width (W), ft	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Turn Bay Length, ft	600	1650		600	4300		500	1800		525	4950	
Grade (P_g), %		0			0			0			0	
Speed Limit, mi/h	50	50	50	50	50	50	55	55	55	55	55	55

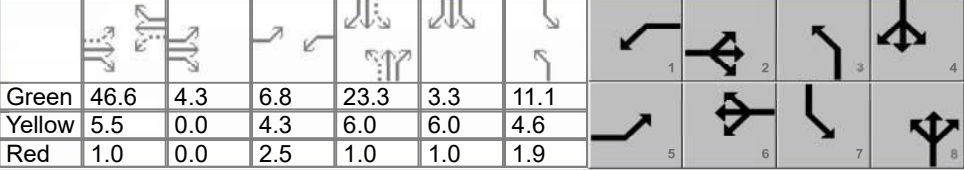
Phase Information	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Maximum Green (G_{max}) or Phase Split, s	7.0	53.0	13.0	48.0	19.0	35.0	7.0	38.0
Yellow Change Interval (Y), s	4.3	5.5	4.3	5.5	4.6	6.0	4.6	6.0
Red Clearance Interval (R_c), s	2.5	1.0	2.5	1.0	1.9	1.0	1.9	1.0
Minimum Green (G_{min}), s	7	20	7	20	7	12	7	12
Start-Up Lost Time (l_t), s	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Extension of Effective Green (e), s	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Passage (PT), s	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0
Recall Mode	Off	Min	Off	Off	Off	Off	Off	Off
Dual Entry	No	Yes	No	Yes	No	Yes	No	Yes
Walk ($Walk$), s		0.0		0.0		0.0		0.0
Pedestrian Clearance Time (PC), s		0.0		0.0		0.0		0.0

Multimodal Information	EB			WB			NB			SB		
85th % Speed / Rest in Walk / Corner Radius	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0
Walkway / Crosswalk Width / Length, ft	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0
Street Width / Island / Curb, ft	0.0	0	No	0.0	0	No	0.0	0	No	0.0	0	No
Width Outside / Bike Lane / Shoulder, ft	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0
Pedestrian Signal / Occupied Parking	No		0.50	No		0.50	No		0.50	No		0.50

HCS Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	Lanham Engineering LLC			Duration, h	0.250	
Analyst	MJB	Analysis Date	11/21/2023	Area Type	Other	
Jurisdiction	ODOT D3	Time Period	PM Peak	PHF	0.96	
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043	Analysis Period	1> 16:00	
Intersection	SR-82 at SR-83	File Name	2043 Prot-Perm Left PM Peak.xus			
Project Description	2043 Prot/Perm Lefts PM Peak Hour					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	62	447	182	106	509	83	171	223	47	156	347	56

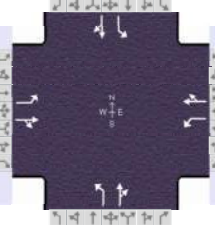
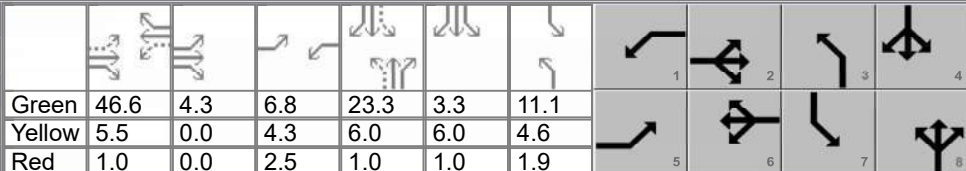
Signal Information											
Cycle, s	129.3	Reference Phase	2								
Offset, s	0	Reference Point	End								
Uncoordinated	Yes	Simult. Gap E/W	On								
Force Mode	Fixed	Simult. Gap N/S	On	Green	46.6	4.3	6.8	23.3	3.3	11.1	
				Yellow	5.5	0.0	4.3	6.0	6.0	4.6	
				Red	1.0	0.0	2.5	1.0	1.0	1.9	

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	1.4	4.0	1.4	4.0	1.4	4.0	1.4	4.0
Phase Duration, s	17.9	57.4	13.6	53.1	17.6	30.3	27.9	40.6
Change Period, ($Y+R_c$), s	6.8	6.5	6.8	6.5	6.5	7.0	6.5	7.0
Max Allow Headway (MAH), s	3.0	5.0	3.0	4.9	2.9	4.9	2.9	4.9
Queue Clearance Time (g_s), s	2.0	49.5	5.9	45.8	11.0	22.2	7.9	32.5
Green Extension Time (g_e), s	0.1	1.3	0.1	0.8	0.2	1.1	0.0	1.1
Phase Call Probability	0.90	1.00	0.98	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.10	1.00	0.01	1.00	0.01	0.03	1.00	0.81

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	65	655		110	617		178	281		163	420	
Adjusted Saturation Flow Rate (s), veh/h/ln	1739	1736		1739	1781		1725	1756		1697	1738	
Queue Service Time (g_s), s	0.0	47.5		3.9	43.8		9.0	20.2		5.9	30.5	
Cycle Queue Clearance Time (g_c), s	0.0	47.5		3.9	43.8		9.0	20.2		5.9	30.5	
Green Ratio (g/C)	0.45	0.39		0.41	0.36		0.27	0.18		0.33	0.26	
Capacity (c), veh/h	222	684		147	643		204	317		346	452	
Volume-to-Capacity Ratio (X)	0.291	0.958		0.750	0.959		0.871	0.887		0.470	0.929	
Back of Queue (Q), ft/ln (95 th percentile)	88.6	816.2		166	789.6		266.4	392		210.6	580.1	
Back of Queue (Q), veh/ln (95 th percentile)	3.4	31.4		6.4	30.4		10.2	15.0		7.9	21.8	
Queue Storage Ratio (RQ) (95 th percentile)	0.15	0.49		0.28	0.18		0.53	0.22		0.40	0.12	
Uniform Delay (d_1), s/veh	53.7	38.2		58.9	40.4		56.7	51.7		46.3	46.7	
Incremental Delay (d_2), s/veh	0.3	23.8		2.9	25.2		11.0	14.9		0.4	22.9	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	53.9	62.0		61.8	65.7		67.7	66.6		46.7	69.6	
Level of Service (LOS)	D	E		E	E		E	E		D	E	
Approach Delay, s/veh / LOS	61.3	E		65.1	E		67.0	E		63.2	E	
Intersection Delay, s/veh / LOS	63.9						E					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.96	B	1.96	B	1.95	B	1.96	B
Bicycle LOS Score / LOS	1.68	B	1.69	B	1.25	A	1.45	A

HCS Signalized Intersection Intermediate Values

General Information					Intersection Information																			
Agency	Lanham Engineering LLC				Duration, h	0.250																		
Analyst	MJB	Analysis Date	11/21/2023		Area Type	Other																		
Jurisdiction	ODOT D3	Time Period	PM Peak		PHF	0.96																		
Urban Street	SR-82 (Royaltown Rd)	Analysis Year	2043		Analysis Period	1> 16:00																		
Intersection	SR-82 at SR-83	File Name	2043 Prot-Perm Left PM Peak.xus																					
Project Description	2043 Prot/Perm Lefts PM Peak Hour																							
																								
Demand Information				EB			WB			NB			SB											
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R									
Demand (v), veh/h				62	447	182	106	509	83	171	223	47	156	347	56									
Signal Information																								
Cycle, s	129.3	Reference Phase	2																					
Offset, s	0	Reference Point	End																					
Uncoordinated	Yes	Simult. Gap E/W	On																					
Force Mode	Fixed	Simult. Gap N/S	On	Green	46.6	4.3	6.8	23.3	3.3	11.1	Yellow	5.5	0.0	4.3	6.0	6.0	4.6	Red	1.0	0.0	2.5	1.0	1.0	1.9
Saturation Flow / Delay				L	T	R	L	T	R	L	T	R	L	T	R									
Lane Width Adjustment Factor (f_w)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000									
Heavy Vehicles and Grade Factor (f_{HVg})				0.961	0.961	1.000	0.961	0.961	1.000	0.953	0.953	1.000	0.938	0.938	1.000									
Parking Activity Adjustment Factor (f_p)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000									
Bus Blockage Adjustment Factor (f_{bb})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000									
Area Type Adjustment Factor (f_a)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000									
Lane Utilization Adjustment Factor (f_{LU})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000									
Left-Turn Adjustment Factor (f_{LT})				0.952	0.000		0.952	0.000		0.952	0.000		0.952	0.000										
Right-Turn Adjustment Factor (f_{RT})					0.950	0.950		0.975	0.975		0.970	0.970		0.976	0.976									
Left-Turn Pedestrian Adjustment Factor (f_{LPb})				1.000			1.000			1.000			1.000											
Right-Turn Ped-Bike Adjustment Factor (f_{RPb})						1.000			1.000			1.000			1.000									
Work Zone Adjustment Factor (f_{wz})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000									
DDI Factor (f_{DDI})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000									
Left-Turn Prot. CAV Adj. Factor (f_{CAV,prot})				1.00			1.00			1.00			1.00											
Left-Turn Perm. CAV Adj. Factor (f_{CAV,perm})																								
Movement Saturation Flow Rate (s), veh/h				1739	1233	502	1739	1531	250	1725	1450	306	1697	1496	242									
Proportion of Vehicles Arriving on Green (P)				0.09	0.39	0.39	0.05	0.36	0.36	0.09	0.18	0.18	0.17	0.26	0.26									
Incremental Delay Factor (k)				0.04	0.45		0.04	0.45		0.11	0.22		0.04	0.38										
Signal Timing / Movement Groups				EBL	EBT/R	WBL	WBT/R	NBL	NBT/R	SBL	SBT/R													
Lost Time (t_L)				6.8	6.5	6.8	6.5	6.5	7.0	6.5	7.0													
Green Ratio (g/C)				0.45	0.39	0.41	0.36	0.27	0.18	0.33	0.26													
Permitted Saturation Flow Rate (s_p), veh/h/ln				787	0	759	0	936	0	1046	0													
Shared Saturation Flow Rate (s_{sh}), veh/h/ln																								
Permitted Effective Green Time (g_p), s				46.7	0.0	46.7	0.0	23.4	0.0	21.4	0.0													
Permitted Service Time (g_u), s				2.9	0.0	0.0	0.0	0.0	0.0	1.2	0.0													
Permitted Queue Service Time (g_{ps}), s				2.9		0.0		0.0		1.2														
Time to First Blockage (g_r), s				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0													
Queue Service Time Before Blockage (g_{fs}), s																								
Protected Right Saturation Flow (s_R), veh/h/ln																								
Protected Right Effective Green Time (g_R), s																								
Multimodal				EB			WB			NB			SB											
Pedestrian F_w / F_v				1.198	0.000	1.198	0.000	1.198	0.000	1.198	0.000	1.198	0.000											
Pedestrian F_s / F_{delay}				0.000	0.163	0.000	0.160	0.000	0.153	0.000	0.160	0.000	0.160											
Pedestrian M_{corner} / M_{cw}				0.00		0.00		0.00		0.00		0.00												
Bicycle c_b / d_b				110.05	57.72	176.07	53.76	323.31	45.43	164.73	54.43													
Bicycle F_w / F_v				-3.64	1.19	-3.64	1.20	-3.64	0.76	-3.64	0.96													

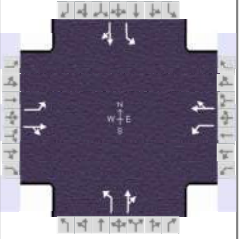
HCS Signalized Intersection Results Graphical Summary

General Information

Agency	Lanham Engineering LLC		
Analyst	MJB	Analysis Date	11/21/2023
Jurisdiction	ODOT D3	Time Period	PM Peak
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043
Intersection	SR-82 at SR-83	File Name	2043 Prot-Perm Left PM Peak.xus
Project Description	2043 Prot/Perm Lefts PM Peak Hour		

Intersection Information

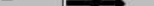
Duration, h	0.250
Area Type	Other
PHF	0.96
Analysis Period	1 > 16:00



Demand Information

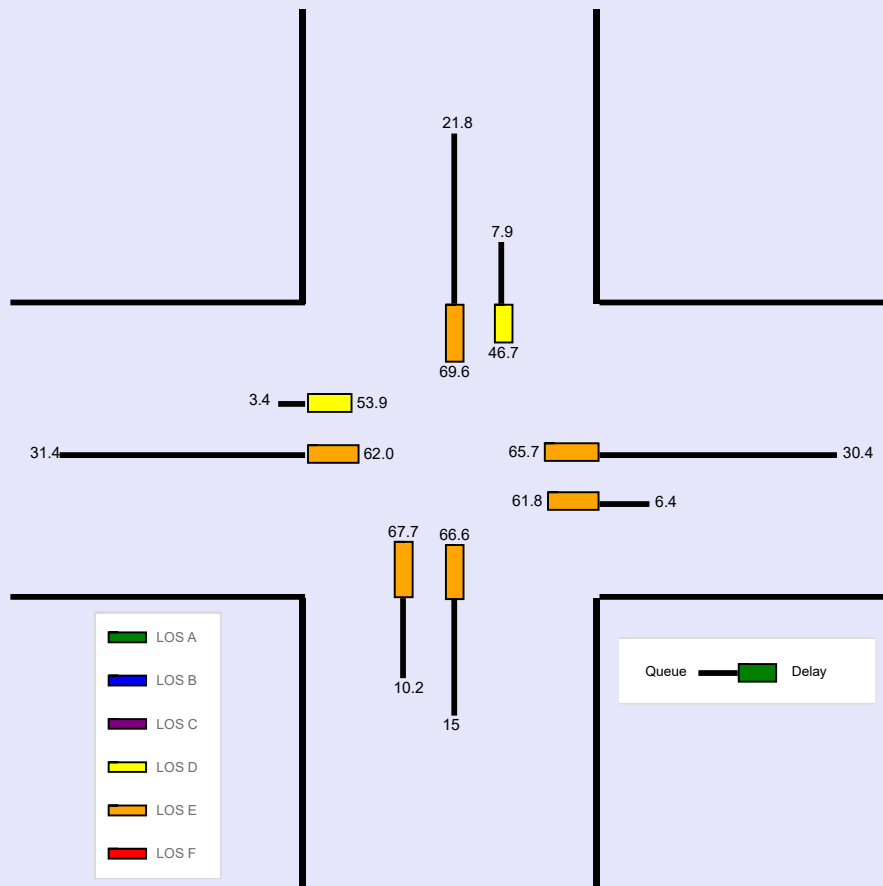
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	62	447	182	106	509	83	171	223	47	156	347	56

Signal Information

Cycle, s	129.3	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On									
Force Mode	Fixed	Simult. Gap N/S	On									
Green	46.6	4.3	6.8	23.3	3.3	11.1						
Yellow	5.5	0.0	4.3	6.0	6.0	4.6						
Red	1.0	0.0	2.5	1.0	1.0	1.9						

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Back of Queue (Q), ft/ln (95 th percentile)	88.6	816.2		166	789.6		266.4	392		210.6	580.1	
Back of Queue (Q), veh/ln (95 th percentile)	3.4	31.4		6.4	30.4		10.2	15.0		7.9	21.8	
Queue Storage Ratio (RQ) (95 th percentile)	0.15	0.49		0.28	0.18		0.53	0.22		0.40	0.12	
Control Delay (d), s/veh	53.9	62.0		61.8	65.7		67.7	66.6		46.7	69.6	
Level of Service (LOS)	D	E		E	E		E	E		D	E	
Approach Delay, s/veh / LOS	61.3	E		65.1	E		67.0	E		63.2	E	
Intersection Delay, s/veh / LOS	63.9						E					



--- Messages ---

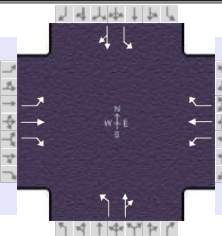
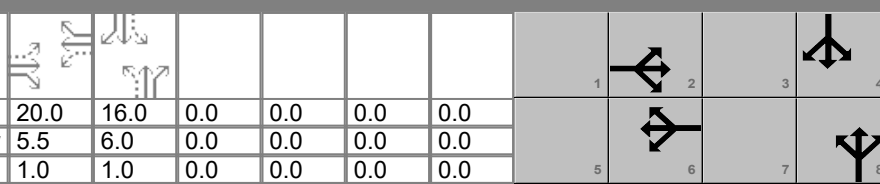
No errors or warnings exist.

--- Comments ---

HCS Signalized Intersection Input Data

General Information						Intersection Information																			
Agency	Lanham Engineering LLC					Duration, h	0.250																		
Analyst	MJB	Analysis Date	11/21/2023			Area Type	Other																		
Jurisdiction	ODOT D3	Time Period	AM Peak			PHF	0.94																		
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043			Analysis Period	1 > 7:15																		
Intersection	SR-82 at SR-83	File Name	2043 Perm Left & RTs AM Peak.xus																						
Project Description	2043 Perm Lefts & EBR/WBR AM Peak Hour																								
Demand Information				EB			WB			NB			SB												
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R										
Demand (v), veh/h				77	448	140	49	427	117	212	320	81	123	180	42										
Signal Information																									
Cycle, s	49.5	Reference Phase	2																						
Offset, s	0	Reference Point	End																						
Uncoordinated	Yes	Simult. Gap E/W	On																						
Force Mode	Fixed	Simult. Gap N/S	On																						
Green				20.0	16.0	0.0	0.0	0.0	0.0	1				2				3				4			
Yellow				5.5	6.0	0.0	0.0	0.0	0.0	5				6				7				8			
Red				1.0	1.0	0.0	0.0	0.0	0.0	5				6				7				8			
Traffic Information				EB			WB			NB			SB												
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R										
Demand (v), veh/h				77	448	140	49	427	117	212	320	81	123	180	42										
Initial Queue (Q_0), veh/h				0	0	0	0	0	0	0	0	0	0	0	0										
Base Saturation Flow Rate (s_0), veh/h				1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900										
Parking (N_m), man/h				None			None			None			None												
Heavy Vehicles (P_{HV}), %				9	9	9	13	13	13	11	11		14	14											
Ped / Bike / RTOR, /h				0	0	0	0	0	0	0	0	0	0	0	0										
Buses (N_b), buses/h				0	0	0	0	0	0	0	0	0	0	0	0										
Arrival Type (AT)				3	3	3	3	3	3	3	3	3	3	3	3										
Upstream Filtering (I)				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00										
Lane Width (W), ft				11.0	11.0	12.0	11.0	11.0	12.0	11.0	11.0		11.0	11.0											
Turn Bay Length, ft				375	1650	375	400	4300	400	340	1800		325	4950											
Grade (P_g), %					0			0			0		0												
Speed Limit, mi/h				50	50	50	50	50	50	55	55	55	55	55	55										
Phase Information				EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT														
Maximum Green (G_{max}) or Phase Split, s					20.0		22.0		16.0		12.0														
Yellow Change Interval (Y), s					5.5		5.5		6.0		6.0														
Red Clearance Interval (R_c), s					1.0		1.0		1.0		1.0														
Minimum Green (G_{min}), s					20		20		12		12														
Start-Up Lost Time (l_t), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0														
Extension of Effective Green (e), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0														
Passage (PT), s					4.0		4.0		4.0		4.0														
Recall Mode					Min		Min		Off		Off														
Dual Entry					Yes		Yes		Yes		Yes														
Walk ($Walk$), s					0.0		0.0		0.0		0.0														
Pedestrian Clearance Time (PC), s					0.0		0.0		0.0		0.0														
Multimodal Information				EB			WB			NB			SB												
85th % Speed / Rest in Walk / Corner Radius				0.0	No	25.0	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0										
Walkway / Crosswalk Width / Length, ft				9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0										
Street Width / Island / Curb, ft				0.0	0	No	0.0	0	No	0.0	0	No	0.0	0	No										
Width Outside / Bike Lane / Shoulder, ft				12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0										
Pedestrian Signal / Occupied Parking				No	0.50		No	0.50		No	0.50		No	0.50											

HCS Signalized Intersection Results Summary

General Information						Intersection Information															
Agency		Lanham Engineering LLC						Duration, h		0.250											
Analyst		MJB		Analysis Date		11/21/2023		Area Type		Other											
Jurisdiction		ODOT D3		Time Period		AM Peak		PHF		0.94											
Urban Street		SR-82 (Royalton Rd)		Analysis Year		2043		Analysis Period		1> 7:15											
Intersection		SR-82 at SR-83		File Name		2043 Perm Left & RTs AM Peak.xus															
Project Description		2043 Perm Lefts & EBR/WBR AM Peak Hour																			
Demand Information						EB			WB			NB			SB						
Approach Movement						L	T	R	L	T	R	L	T	R	L	T	R				
Demand (v), veh/h						77	448	140	49	427	117	212	320	81	123	180	42				
Signal Information																					
Cycle, s	49.5	Reference Phase	2																		
Offset, s	0	Reference Point	End																		
Uncoordinated	Yes	Simult. Gap E/W	On																		
Force Mode	Fixed	Simult. Gap N/S	On																		
						Green	20.0	16.0	0.0	0.0	0.0	0.0									
						Yellow	5.5	6.0	0.0	0.0	0.0	0.0									
						Red	1.0	1.0	0.0	0.0	0.0	0.0									
Timer Results						EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase								2				6				8				4	
Case Number								5.0				5.0				6.0				6.0	
Phase Duration, s								26.5				26.5				23.0				23.0	
Change Period, (Y+R c), s								6.5				6.5				7.0				7.0	
Max Allow Headway (MAH), s								5.1				5.1				5.3				5.3	
Queue Clearance Time (g s), s								16.8				15.6				18.0				18.0	
Green Extension Time (g e), s								2.2				3.9				0.0				0.0	
Phase Call Probability								1.00				1.00				1.00				1.00	
Max Out Probability								1.00				0.90				1.00				1.00	
Movement Group Results						EB			WB			NB			SB						
Approach Movement						L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate (v), veh/h						82	477	149	52	454	124	226	427		131	236					
Adjusted Saturation Flow Rate (s), veh/h/ln						885	1767	1497	838	1707	1447	1062	1676		870	1637					
Queue Service Time (g s), s						4.1	10.9	3.3	2.7	10.7	2.8	10.4	11.4		4.6	5.6					
Cycle Queue Clearance Time (g c), s						14.8	10.9	3.3	13.6	10.7	2.8	16.0	11.4		16.0	5.6					
Green Ratio (g/C)						0.40	0.40	0.40	0.40	0.40	0.40	0.32	0.32		0.32	0.32					
Capacity (c), veh/h						312	714	605	299	690	585	368	542		226	529					
Volume-to-Capacity Ratio (X)						0.263	0.668	0.246	0.174	0.658	0.213	0.614	0.787		0.580	0.446					
Back of Queue (Q), ft/ln (95 th percentile)						34.7	164.9	37.5	22	155.8	31.6	113.7	207.2		77.6	79.4					
Back of Queue (Q), veh/ln (95 th percentile)						1.3	6.2	1.4	0.8	5.6	1.1	4.2	7.6		2.8	2.9					
Queue Storage Ratio (RQ) (95 th percentile)						0.09	0.10	0.10	0.06	0.04	0.08	0.33	0.12		0.24	0.02					
Uniform Delay (d 1), s/veh						18.0	12.0	9.8	17.6	12.0	9.6	19.7	15.2		23.4	13.2					
Incremental Delay (d 2), s/veh						0.6	2.7	0.3	0.4	2.2	0.3	3.5	8.0		4.5	0.8					
Initial Queue Delay (d 3), s/veh						0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0					
Control Delay (d), s/veh						18.6	14.7	10.1	18.0	14.2	9.9	23.2	23.2		27.9	14.1					
Level of Service (LOS)						B	B	B	B	B	A	C	C		C	B					
Approach Delay, s/veh / LOS						14.2		B		13.6		B		23.2		C		19.0		B	
Intersection Delay, s/veh / LOS						17.3						B									
Multimodal Results						EB			WB			NB			SB						
Pedestrian LOS Score / LOS						1.88		B		1.88		B		2.09		B		2.09		B	
Bicycle LOS Score / LOS						1.65		B		1.53		B		1.56		B		1.09		A	

HCS Signalized Intersection Intermediate Values

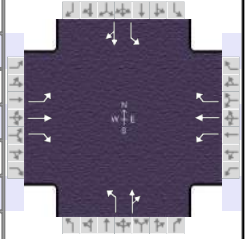
General Information													Intersection Information			
Agency	Lanham Engineering LLC						Duration, h	0.250								
Analyst	MJB		Analysis Date	11/21/2023		Area Type	Other									
Jurisdiction	ODOT D3		Time Period	AM Peak		PHF	0.94									
Urban Street	SR-82 (Royaltown Rd)		Analysis Year	2043		Analysis Period	1 > 7:15									
Intersection	SR-82 at SR-83		File Name	2043 Perm Left & RTs AM Peak.xus												
Project Description	2043 Perm Lefts & EBR/WBR AM Peak Hour															
Demand Information				EB			WB			NB			SB			
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R	
Demand (v), veh/h				77	448	140	49	427	117	212	320	81	123	180	42	
Signal Information																
Cycle, s	49.5	Reference Phase	2													
Offset, s	0	Reference Point	End													
Uncoordinated	Yes	Simult. Gap E/W	On													
Force Mode	Fixed	Simult. Gap N/S	On													
Green	20.0	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Yellow	5.5	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Red	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Saturation Flow / Delay				L	T	R	L	T	R	L	T	R	L	T	R	
Lane Width Adjustment Factor (f_w)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Heavy Vehicles and Grade Factor (f_{HVg})				0.930	0.930	0.930	0.899	0.899	0.899	0.914	0.914	1.000	0.891	0.891	1.000	
Parking Activity Adjustment Factor (f_p)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Bus Blockage Adjustment Factor (f_{bb})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Area Type Adjustment Factor (f_a)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Lane Utilization Adjustment Factor (f_{LU})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Left-Turn Adjustment Factor (f_{LT})				0.466	0.000		0.441	0.000		0.559	0.000		0.458	0.000		
Right-Turn Adjustment Factor (f_{RT})					0.000	0.847		0.000	0.847		0.965	0.965		0.967	0.967	
Left-Turn Pedestrian Adjustment Factor (f_{LPB})				1.000			1.000			1.000			1.000			
Right-Turn Ped-Bike Adjustment Factor (f_{RPB})						1.000			1.000			1.000			1.000	
Work Zone Adjustment Factor (f_{WZ})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
DDI Factor (f_{DDI})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Left-Turn Prot. CAV Adj. Factor ($f_{CAV,prot}$)																
Left-Turn Perm. CAV Adj. Factor ($f_{CAV,perm}$)				1.00			1.00			1.00			1.00			
Movement Saturation Flow Rate (s), veh/h				885	1767	1497	838	1707	1447	1062	1337	339	870	1327	310	
Proportion of Vehicles Arriving on Green (P)				0.40	0.40	0.40	0.40	0.40	0.40	0.32	0.32	0.32	0.32	0.32	0.32	
Incremental Delay Factor (k)				0.15	0.27	0.15	0.15	0.22	0.15	0.23	0.35		0.21	0.15		
Signal Timing / Movement Groups				EBL	EBT/R	WBL	WBT/R	NBL	NBT/R	SBL	SBT/R					
Lost Time (t_L)					6.5		6.5		7.0		7.0					
Green Ratio (g/C)					0.40		0.40		0.32		0.32					
Permitted Saturation Flow Rate (s_p), veh/h/ln					885		838		1062		870					
Shared Saturation Flow Rate (s_{sh}), veh/h/ln																
Permitted Effective Green Time (g_p), s					20.0		20.0		16.0		16.0					
Permitted Service Time (g_u), s					9.3		9.1		10.4		4.6					
Permitted Queue Service Time (g_{ps}), s					4.1		2.7		10.4		4.6					
Time to First Blockage (g_t), s					0.0		0.0		0.0		0.0					
Queue Service Time Before Blockage (g_s), s																
Protected Right Saturation Flow (s_R), veh/h/ln					0		0									
Protected Right Effective Green Time (g_R), s					0.0		0.0									
Multimodal				EB		WB		NB		SB						
Pedestrian F_w / F_v				1.198	0.000	1.198	0.000	1.389	0.000	1.389	0.000					
Pedestrian F_s / F_{delay}				0.000	0.087	0.000	0.087	0.000	0.097	0.000	0.097					
Pedestrian M_{corner} / M_{cw}				0.00		0.00		0.00		0.00						
Bicycle c_b / d_b				808.08	8.79	808.08	8.79	646.46	11.34	646.46	11.34					
Bicycle F_w / F_v				-3.64	1.17	-3.64	1.04	-3.64	1.08	-3.64	0.61					

HCS Signalized Intersection Results Graphical Summary

General Information

Agency	Lanham Engineering LLC		
Analyst	MJB	Analysis Date	11/21/2023
Jurisdiction	ODOT D3	Time Period	AM Peak
Urban Street	SR-82 (Royaltown Rd)	Analysis Year	2043
Intersection	SR-82 at SR-83	File Name	2043 Perm Left &
Project Description	2043 Perm Lefts & EBR/WBR AM Peak Hour		

Intersection Information



Demand Information

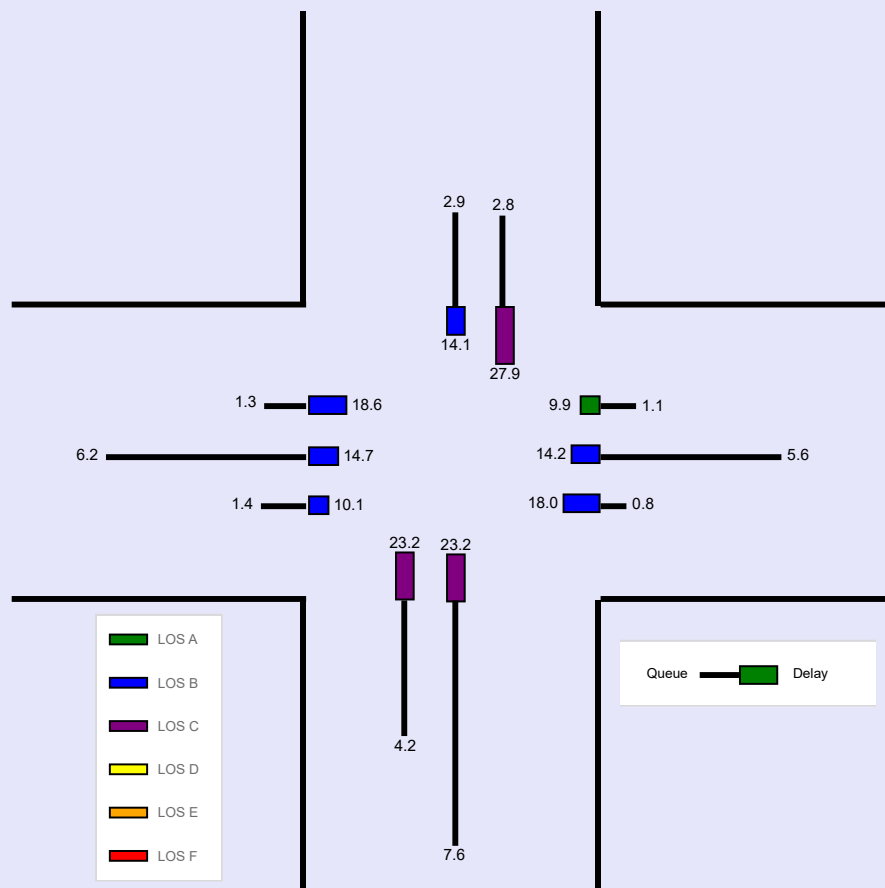
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	77	448	140	49	427	117	212	320	81	123	180	42

Signal Information

Cycle, s	49.5	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	20.0	16.0	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	5.5	6.0	0.0	0.0	0.0	0.0		
				Red	1.0	1.0	0.0	0.0	0.0	0.0		

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Back of Queue (Q), ft/ln (95 th percentile)	34.7	164.9	37.5	22	155.8	31.6	113.7	207.2		77.6	79.4	
Back of Queue (Q), veh/ln (95 th percentile)	1.3	6.2	1.4	0.8	5.6	1.1	4.2	7.6		2.8	2.9	
Queue Storage Ratio (RQ) (95 th percentile)	0.09	0.10	0.10	0.06	0.04	0.08	0.33	0.12		0.24	0.02	
Control Delay (d), s/veh	18.6	14.7	10.1	18.0	14.2	9.9	23.2	23.2		27.9	14.1	
Level of Service (LOS)	B	B	B	B	B	A	C	C		C	B	
Approach Delay, s/veh / LOS	14.2		B	13.6		B	23.2		C	19.0		B
Intersection Delay, s/veh / LOS	17.3						B					



--- Messages ---

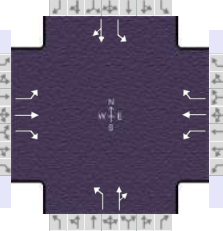
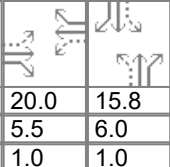
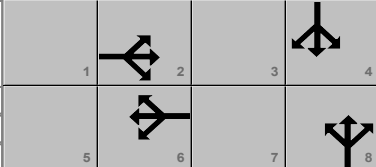
No errors or warnings exist.

--- Comments ---

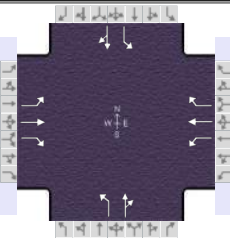
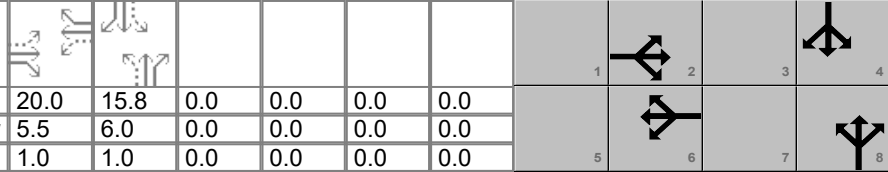
HCS Signalized Intersection Input Data

General Information						Intersection Information									
Agency	Lanham Engineering LLC					Duration, h	0.250								
Analyst	MJB	Analysis Date	11/21/2023			Area Type	Other								
Jurisdiction	ODOT D3	Time Period	PM Peak			PHF	0.96								
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043			Analysis Period	1> 16:00								
Intersection	SR-82 at SR-83	File Name	2043 Perm Left & RTs PM Peak.xus												
Project Description	2043 Perm Lefts & EBR/WBR PM Peak Hour														
Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				62	447	182	106	509	83	171	223	47	156	347	56
Signal Information															
Cycle, s	49.3	Reference Phase	2												
Offset, s	0	Reference Point	End												
Uncoordinated	Yes	Simult. Gap E/W	On												
Force Mode	Fixed	Simult. Gap N/S	On												
Green	20.0	15.8	0.0	0.0	0.0	0.0									
Yellow	5.5	6.0	0.0	0.0	0.0	0.0									
Red	1.0	1.0	0.0	0.0	0.0	0.0									
Traffic Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				62	447	182	106	509	83	171	223	47	156	347	56
Initial Queue (Q_0), veh/h				0	0	0	0	0	0	0	0	0	0	0	0
Base Saturation Flow Rate (s_0), veh/h				1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Parking (N_m), man/h				None			None			None			None		
Heavy Vehicles (P_{HV}), %				5	5	5	5	5	5	6	6		8	8	
Ped / Bike / RTOR, /h				0	0	0	0	0	0	0	0	0	0	0	0
Buses (N_b), buses/h				0	0	0	0	0	0	0	0	0	0	0	0
Arrival Type (AT)				3	3	3	3	3	3	3	3	3	3	3	3
Upstream Filtering (I)				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lane Width (W), ft				11.0	11.0	12.0	11.0	11.0	12.0	11.0	11.0		11.0	11.0	
Turn Bay Length, ft				375	1650	375	400	4300	400	340	1800		325	4950	
Grade (P_g), %					0			0			0			0	
Speed Limit, mi/h				50	50	50	50	50	50	55	55	55	55	55	55
Phase Information				EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Maximum Green (G_{max}) or Phase Split, s					20.0		20.0		12.0		16.0				
Yellow Change Interval (Y), s					5.5		5.5		6.0		6.0				
Red Clearance Interval (R_c), s					1.0		1.0		1.0		1.0				
Minimum Green (G_{min}), s					20		20		12		12				
Start-Up Lost Time (l_t), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Extension of Effective Green (e), s				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Passage (PT), s					4.0		4.0		4.0		4.0				
Recall Mode					Min		Min		Off		Off				
Dual Entry					Yes		Yes		Yes		Yes				
Walk ($Walk$), s					0.0		0.0		0.0		0.0				
Pedestrian Clearance Time (PC), s					0.0		0.0		0.0		0.0				
Multimodal Information				EB			WB			NB			SB		
85th % Speed / Rest in Walk / Corner Radius				0.0	No	25.0	0.0	No	25.0	0.0	No	25.0	0.0	No	25.0
Walkway / Crosswalk Width / Length, ft				9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0	9.0	12.0	0.0
Street Width / Island / Curb, ft				0.0	0	No	0.0	0	No	0.0	0	No	0.0	0	No
Width Outside / Bike Lane / Shoulder, ft				12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0	12.0	5.0	2.0
Pedestrian Signal / Occupied Parking				No		0.50	No		0.50	No		0.50	No		0.50

HCS Signalized Intersection Results Summary

General Information						Intersection Information													
Agency		Lanham Engineering LLC				Duration, h		0.250											
Analyst		MJB		Analysis Date		11/21/2023		Area Type						Other					
Jurisdiction		ODOT D3		Time Period		PM Peak		PHF						0.96					
Urban Street		SR-82 (Royalton Rd)		Analysis Year		2043		Analysis Period						1> 16:00					
Intersection		SR-82 at SR-83		File Name		2043 Perm Left & RTs PM Peak.xus													
Project Description		2043 Perm Lefts & EBR/WBR PM Peak Hour																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand (v), veh/h				62	447	182	106	509	83	171	223	47	156	347	56				
Signal Information																			
Cycle, s		49.3	Reference Phase									2							
Offset, s		0	Reference Point									End							
Uncoordinated		Yes	Simult. Gap E/W									On							
Force Mode		Fixed	Simult. Gap N/S									On							
				Green	20.0	15.8	0.0	0.0	0.0	0.0									
				Yellow	5.5	6.0	0.0	0.0	0.0	0.0									
				Red	1.0	1.0	0.0	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2				6				8				4	
Case Number						5.0				5.0				6.0				6.0	
Phase Duration, s						26.5				26.5				22.8				22.8	
Change Period, ($Y+R_c$), s						6.5				6.5				7.0				7.0	
Max Allow Headway (MAH), s						5.1				5.1				5.2				5.2	
Queue Clearance Time (g_s), s						17.4				17.5				17.8				15.7	
Green Extension Time (g_e), s						1.9				1.8				0.0				0.1	
Phase Call Probability						1.00				1.00				1.00				1.00	
Max Out Probability						1.00				1.00				1.00				1.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate (v), veh/h				65	466	190	110	530	86	178	281		163	420					
Adjusted Saturation Flow Rate (s), veh/h/ln				853	1826	1547	905	1826	1547	936	1756		1046	1738					
Queue Service Time (g_s), s				3.4	10.0	4.1	5.5	12.0	1.7	5.2	6.4		7.3	10.7					
Cycle Queue Clearance Time (g_c), s				15.4	10.0	4.1	15.5	12.0	1.7	15.8	6.4		13.7	10.7					
Green Ratio (g/C)				0.41	0.41	0.41	0.41	0.41	0.41	0.32	0.32		0.32	0.32					
Capacity (c), veh/h				284	740	627	329	740	627	244	563		346	558					
Volume-to-Capacity Ratio (X)				0.227	0.629	0.302	0.336	0.716	0.138	0.731	0.499		0.470	0.753					
Back of Queue (Q), ft/ln (95 th percentile)				27.2	146.8	47.2	45.5	187.2	19.8	117.6	90.8		71.3	184.3					
Back of Queue (Q), veh/ln (95 th percentile)				1.0	5.6	1.8	1.8	7.2	0.8	4.5	3.5		2.7	6.9					
Queue Storage Ratio (RQ) (95 th percentile)				0.07	0.09	0.13	0.11	0.04	0.05	0.35	0.05		0.22	0.04					
Uniform Delay (d_1), s/veh				18.7	11.7	9.9	17.9	12.3	9.2	23.2	13.5		19.1	15.0					
Incremental Delay (d_2), s/veh				0.6	2.0	0.4	0.9	3.6	0.1	11.5	1.0		1.4	6.0					
Initial Queue Delay (d_3), s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0					
Control Delay (d), s/veh				19.3	13.7	10.3	18.7	15.9	9.4	34.7	14.5		20.5	21.0					
Level of Service (LOS)				B	B	B	B	B	A	C	B		C	C					
Approach Delay, s/veh / LOS				13.3		B		15.6		B		22.4		C		20.9		C	
Intersection Delay, s/veh / LOS				17.4						B									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.88		B		1.88		B		2.09		B		2.09		B	
Bicycle LOS Score / LOS				1.68		B		1.69		B		1.25		A		1.45		A	

HCS Signalized Intersection Intermediate Values

General Information								Intersection Information											
Agency		Lanham Engineering LLC						Duration, h		0.250									
Analyst		MJB		Analysis Date		11/21/2023		Area Type		Other									
Jurisdiction		ODOT D3		Time Period		PM Peak		PHF		0.96									
Urban Street		SR-82 (Royaltown Rd)		Analysis Year		2043		Analysis Period		1 > 16:00									
Intersection		SR-82 at SR-83		File Name		2043 Perm Left & RTs PM Peak.xus													
Project Description		2043 Perm Lefts & EBR/WBR PM Peak Hour																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand (v), veh/h				62	447	182	106	509	83	171	223	47	156	347	56				
Signal Information																			
Cycle, s	49.3	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	Yes	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	20.0	15.8	0.0	0.0	0.0	0.0									
				Yellow	5.5	6.0	0.0	0.0	0.0	0.0									
				Red	1.0	1.0	0.0	0.0	0.0	0.0									
Saturation Flow / Delay				L	T	R	L	T	R	L	T	R	L	T	R				
Lane Width Adjustment Factor (f _w)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000				
Heavy Vehicles and Grade Factor (f _{HVg})				0.961	0.961	0.961	0.961	0.961	0.961	0.953	0.953	1.000	0.938	0.938	1.000				
Parking Activity Adjustment Factor (f _p)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000				
Bus Blockage Adjustment Factor (f _{bb})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000				
Area Type Adjustment Factor (f _a)				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000				
Lane Utilization Adjustment Factor (f _{LU})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000				
Left-Turn Adjustment Factor (f _{LT})				0.449	0.000		0.476	0.000		0.493	0.000		0.550	0.000					
Right-Turn Adjustment Factor (f _{RT})					0.000	0.847		0.000	0.847		0.970	0.970		0.976	0.976				
Left-Turn Pedestrian Adjustment Factor (f _{LPb})				1.000			1.000			1.000			1.000						
Right-Turn Ped-Bike Adjustment Factor (f _{RPb})						1.000			1.000			1.000			1.000				
Work Zone Adjustment Factor (f _{wz})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000				
DDI Factor (f _{DDI})				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000				
Left-Turn Prot. CAV Adj. Factor (f _{CAV,prot})																			
Left-Turn Perm. CAV Adj. Factor (f _{CAV,perm})				1.00			1.00			1.00			1.00						
Movement Saturation Flow Rate (s), veh/h				853	1826	1547	905	1826	1547	936	1450	306	1046	1496	242				
Proportion of Vehicles Arriving on Green (P)				0.41	0.41	0.41	0.41	0.41	0.41	0.32	0.32	0.32	0.32	0.32	0.32				
Incremental Delay Factor (k)				0.15	0.24	0.15	0.15	0.30	0.15	0.31	0.15		0.15	0.32					
Signal Timing / Movement Groups				EBL		EBT/R		WBL		WBT/R		NBL		NBT/R		SBL		SBT/R	
Lost Time (t _L)						6.5				6.5				7.0				7.0	
Green Ratio (g/C)						0.41				0.41				0.32				0.32	
Permitted Saturation Flow Rate (s _p), veh/h/ln						853				905				936				1046	
Shared Saturation Flow Rate (s _{sh}), veh/h/ln																			
Permitted Effective Green Time (g _p), s						20.0				20.0				15.8				15.8	
Permitted Service Time (g _u), s						8.0				10.0				5.2				9.4	
Permitted Queue Service Time (g _{ps}), s						3.4				5.5				5.2				7.3	
Time to First Blockage (g _t), s						0.0				0.0				0.0				0.0	
Queue Service Time Before Blockage (g _{ts}), s																			
Protected Right Saturation Flow (s _R), veh/h/ln						0				0									
Protected Right Effective Green Time (g _R), s						0.0				0.0									
Multimodal				EB		WB		NB		SB									
Pedestrian F _w / F _v				1.198		0.000		1.198		0.000		1.389		0.000		1.389		0.000	
Pedestrian F _s / F _{delay}				0.000		0.087		0.000		0.087		0.000		0.098		0.000		0.098	
Pedestrian M _{corner} / M _{cw}				0.00				0.00				0.00				0.00			
Bicycle c _b / d _b				810.96		8.72		810.96		8.72		641.65		11.38		641.65		11.38	
Bicycle F _w / F _v				-3.64		1.19		-3.64		1.20		-3.64		0.76		-3.64		0.96	

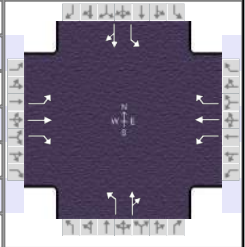
HCS Signalized Intersection Results Graphical Summary

General Information

Agency	Lanham Engineering LLC		
Analyst	MJB	Analysis Date	11/21/2023
Jurisdiction	ODOT D3	Time Period	PM Peak
Urban Street	SR-82 (Royalton Rd)	Analysis Year	2043
Intersection	SR-82 at SR-83	File Name	2043 Perm Left &
Project Description	2043 Perm Lefts & EBR/WBR PM Peak Hour		

Intersection Information

Duration, h	0.250
Area Type	Other
PHF	0.96
Analysis Period	1> 16:00
RTs PM Peak.xus	



Demand Information

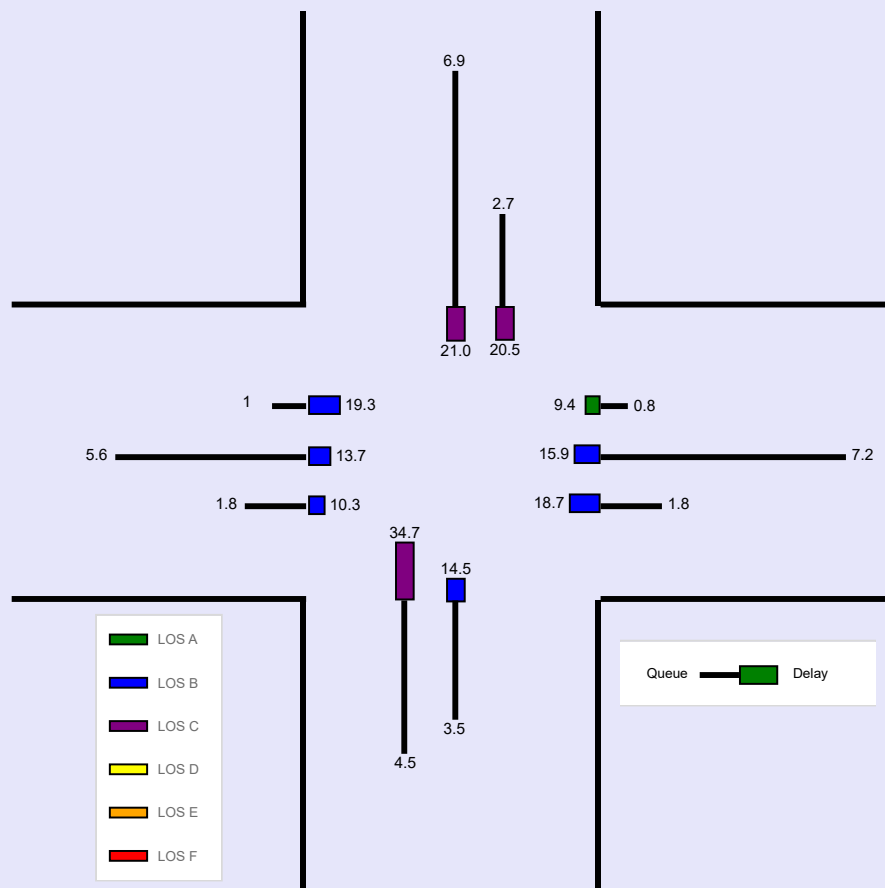
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	62	447	182	106	509	83	171	223	47	156	347	56

Signal Information

Cycle, s	49.3	Reference Phase	2													
Offset, s	0	Reference Point	End		Green	20.0	15.8	0.0	0.0	0.0		0.0	1	2	3	4
Uncoordinated	Yes	Simult. Gap E/W	On		Yellow	5.5	6.0	0.0	0.0	0.0		0.0	5	6	7	8
Force Mode	Fixed	Simult. Gap N/S	On		Red	1.0	1.0	0.0	0.0	0.0		0.0				

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Back of Queue (Q), ft/ln (95 th percentile)	27.2	146.8	47.2	45.5	187.2	19.8	117.6	90.8		71.3	184.3	
Back of Queue (Q), veh/ln (95 th percentile)	1.0	5.6	1.8	1.8	7.2	0.8	4.5	3.5		2.7	6.9	
Queue Storage Ratio (RQ) (95 th percentile)	0.07	0.09	0.13	0.11	0.04	0.05	0.35	0.05		0.22	0.04	
Control Delay (d), s/veh	19.3	13.7	10.3	18.7	15.9	9.4	34.7	14.5		20.5	21.0	
Level of Service (LOS)	B	B	B	B	B	A	C	B		C	C	
Approach Delay, s/veh / LOS	13.3		B	15.6		B	22.4		C	20.9		C
Intersection Delay, s/veh / LOS	17.4						B					



--- Messages ---

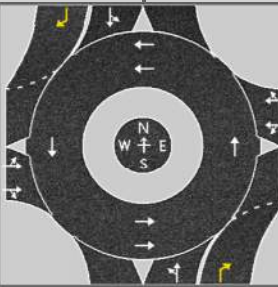
No errors or warnings exist.

--- Comments ---

HCS Roundabouts Report

General Information

Analyst	MJB
Agency or Co.	Lanham Engineering
Date Performed	12/7/2023
Analysis Year	2043
Time Analyzed	AM Peak Hour
Project Description	2x1 Roundabout



Site Information

Intersection	SR-82 at SR-83
E/W Street Name	SR 82
N/S Street Name	SR 83
Analysis Time Period, hrs	0.25
Peak Hour Factor	0.94
Jurisdiction	ODOT D3

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	2	0	0	0	2	0	0	0	1	0	0	0	1	0
Lane Assignment	LT		TR		LT		TR				LT				LT	
Volume (V), veh/h	0	77	448	140	0	49	427	117	0	212	320	81	0	123	180	42
Percent Heavy Vehicles, %	9	9	9	9	13	13	13	13	11	11	11	11	14	14	14	14
Flow Rate (v _{PCE}), pc/h	0	89	519	162	0	59	513	141	0	250	378	96	0	149	218	51
Right-Turn Bypass	None				None				Yielding				Yielding			
Conflicting Lanes	1				1				2				2			
Pedestrians Crossing, p/h	0				0				0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway, s	4.5436	4.5436		4.5436	4.5436			4.3276	4.9763		4.3276	4.9763
Follow-Up Headway, s	2.5352	2.5352		2.5352	2.5352			2.5352	2.6087		2.5352	2.6087

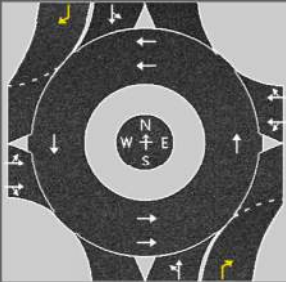
Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h	362	408		335	378			628	96		367	51
Entry Volume, veh/h	332	374		297	334			566	86		322	45
Circulating Flow (v_c), pc/h	426			717			757			822		
Exiting Flow (v_{ex}), pc/h	668			763			608			439		
Capacity (C_{pce}), pc/h	964	964		739	739			746	698		706	634
Capacity (c), veh/h	884	884		654	654			672	629		619	556
v/c Ratio (x)	0.38	0.42		0.45	0.51			0.84	0.14		0.52	0.08

Delay and Level of Service

Approach	EB			WB			NB			SB						
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass				
Lane Control Delay (d), s/veh	8.4	9.1		12.2	13.7			31.4	7.3		14.5	7.4				
Lane LOS	A	A		B	B			D	A		B	A				
95% Queue, veh	1.8	2.1		2.4	2.9			9.4	0.5		3.0	0.3				
Approach Delay, s/veh LOS	8.8		A		13.0		B		28.2		D		13.7		B	
Intersection Delay, s/veh LOS	16.0						C									

HCS Roundabouts Report

General Information			Site Information		
Analyst	MJB		Intersection	SR-82 at SR-83	
Agency or Co.	Lanham Engineering		E/W Street Name	SR 82	
Date Performed	12/7/2023		N/S Street Name	SR 83	
Analysis Year	2043		Analysis Time Period, hrs	0.25	
Time Analyzed	PM Peak Hour		Peak Hour Factor	0.96	
Project Description	2x1 Roundabout		Jurisdiction	ODOT D3	

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	2	0	0	0	2	0	0	0	1	0	0	0	1	0
Lane Assignment	LT		TR		LT		TR				LT				LT	
Volume (V), veh/h	0	62	447	182	0	106	509	83	0	171	223	47	0	156	347	56
Percent Heavy Vehicles, %	5	5	5	5	5	5	5	5	6	6	6	6	8	8	8	8
Flow Rate (v _{PCE}), pc/h	0	68	489	199	0	116	557	91	0	189	246	52	0	176	390	63
Right-Turn Bypass	None				None				Yielding				Yielding			
Conflicting Lanes	1				1				2				2			
Pedestrians Crossing, p/h	0				0				0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway, s	4.5436	4.5436		4.5436	4.5436			4.3276	4.9763		4.3276	4.9763
Follow-Up Headway, s	2.5352	2.5352		2.5352	2.5352			2.5352	2.6087		2.5352	2.6087

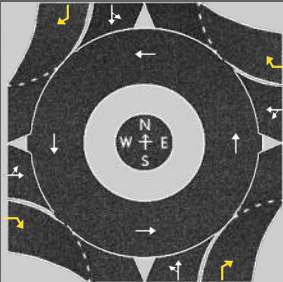
Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h	355	401		359	405			435	52		566	63
Entry Volume, veh/h	338	382		342	386			410	49		524	58
Circulating Flow (v_c), pc/h	682			503			733			862		
Exiting Flow (v_{ex}), pc/h	665			746			405			705		
Capacity (C_{pce}), pc/h	763	763		898	898			762	700		682	645
Capacity (c), veh/h	727	727		856	856			718	661		632	597
v/c Ratio (x)	0.47	0.52		0.40	0.45			0.57	0.07		0.83	0.10

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh	11.5	12.9		9.0	9.9			14.3	6.3		31.5	7.2
Lane LOS	B	B		A	A			B	A		D	A
95% Queue, veh	2.5	3.1		1.9	2.4			3.7	0.2		8.8	0.3
Approach Delay, s/veh LOS	12.3		B	9.4		A	13.5		B	29.0		D
Intersection Delay, s/veh LOS	15.6						C					

HCS Roundabouts Report

General Information			Site Information		
Analyst	MJB		Intersection	SR-82 at SR-83	
Agency or Co.	Lanham Engineering		E/W Street Name	SR 82	
Date Performed	1/3/2023		N/S Street Name	SR 83	
Analysis Year	2033		Analysis Time Period, hrs	0.25	
Time Analyzed	AM Peak Hour		Peak Hour Factor	0.94	
Project Description	1x1 Roundabout		Jurisdiction	ODOT D3	

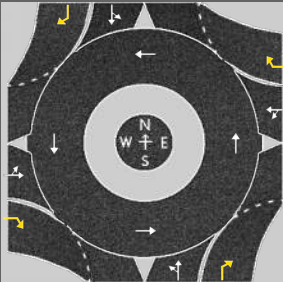
Volume Adjustments and Site Characteristics																
Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LT				LT				LT				LT	
Volume (V), veh/h	0	73	425	133	0	46	404	110	0	204	308	78	0	121	176	41
Percent Heavy Vehicles, %	9	9	9	9	13	13	13	13	11	11	11	11	14	14	14	14
Flow Rate (V _{PCE}), pc/h	0	85	493	154	0	55	486	132	0	241	364	92	0	147	213	50
Right-Turn Bypass	Yielding				Yielding				Yielding				Yielding			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Critical Headway, s		4.9763	4.9763		4.9763	4.9763		4.9763	4.9763		4.9763	4.9763	
Follow-Up Headway, s		2.6087	2.6087		2.6087	2.6087		2.6087	2.6087		2.6087	2.6087	

Flow Computations, Capacity and v/c Ratios													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Entry Flow (v _e), pc/h		578	154		541	132		605	92		360	50	
Entry Volume, veh/h		530	141		479	117		545	83		316	44	
Circulating Flow (v _c), pc/h	415			690			725			782			
Exiting Flow (v _{ex}), pc/h	640			727			449			268			
Capacity (c _{pce}), pc/h		904	1050		683	873		659	718		622	657	
Capacity (c), veh/h		829	963		604	773		593	647		545	577	
v/c Ratio (x)		0.64	0.15		0.79	0.15		0.92	0.13		0.58	0.08	

Delay and Level of Service																
Approach	EB			WB			NB			SB						
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass				
Lane Control Delay (d), s/veh		14.9	5.1		28.8	6.2		45.6	7.0		18.2	7.1				
Lane LOS		B	A		D	A		E	A		C	A				
95% Queue, veh		4.7	0.5		7.7	0.5		11.6	0.4		3.7	0.2				
Approach Delay, s/veh LOS	12.8		B		24.4		C		40.5		E		16.8		C	
Intersection Delay, s/veh LOS	24.2								C							

HCS Roundabouts Report

General Information			Site Information		
Analyst	MJB		Intersection	SR-82 at SR-83	
Agency or Co.	Lanham Engineering		E/W Street Name	SR 82	
Date Performed	12/7/2023		N/S Street Name	SR 83	
Analysis Year	2033		Analysis Time Period, hrs	0.25	
Time Analyzed	PM Peak Hour		Peak Hour Factor	0.96	
Project Description	1x1 Roundabout		Jurisdiction	ODOT D3	

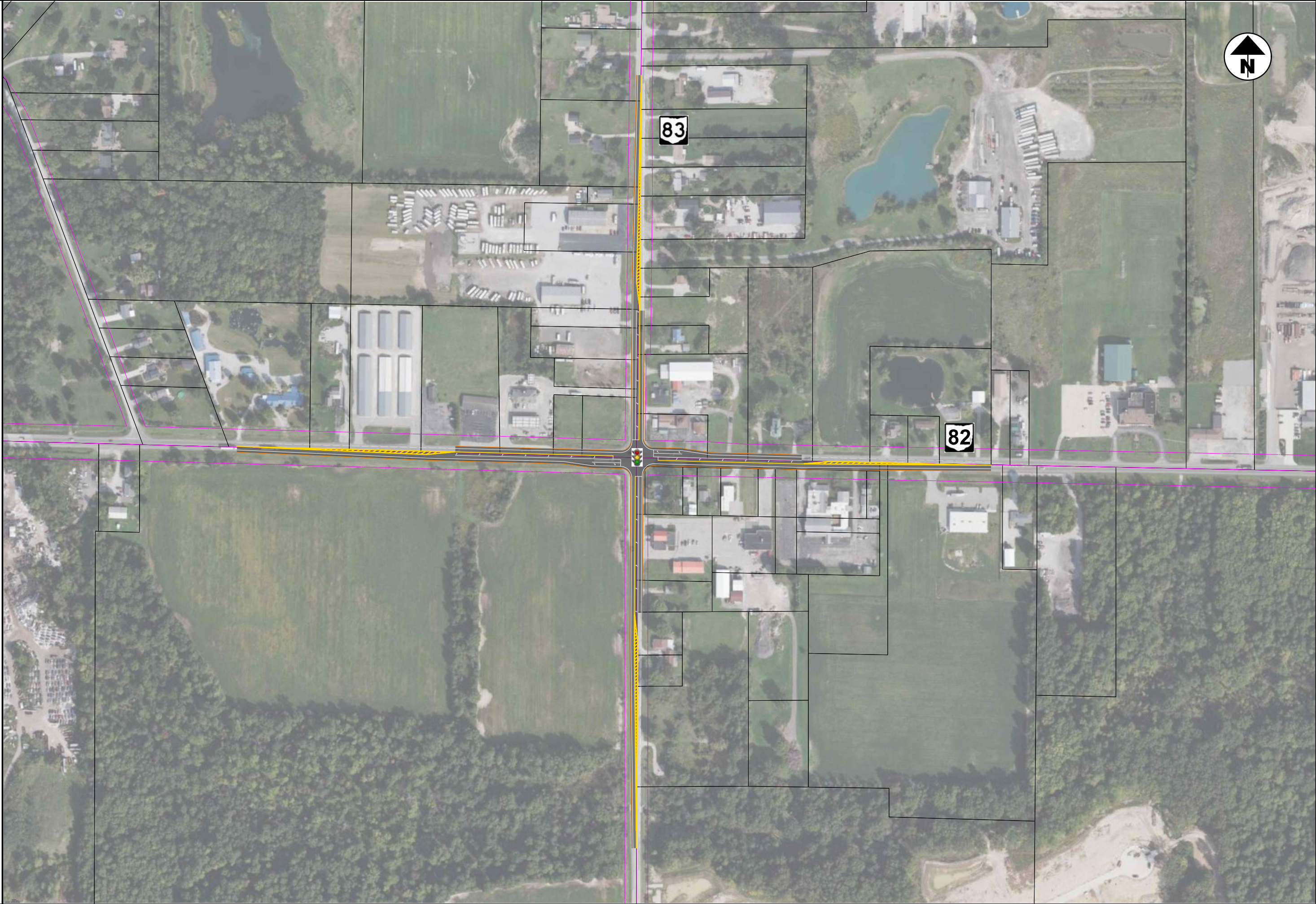
Volume Adjustments and Site Characteristics																	
Approach	EB				WB				NB				SB				
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	
Lane Assignment			LT				LT				LT				LT		
Volume (V), veh/h	0	59	423	173	0	101	482	78	0	165	215	45	0	152	339	55	
Percent Heavy Vehicles, %	5	5	5	5	5	5	5	5	6	6	6	6	8	8	8	8	
Flow Rate (V _{PCE}), pc/h	0	65	463	189	0	110	527	85	0	182	237	50	0	171	381	62	
Right-Turn Bypass	Yielding				Yielding				Yielding				Yielding				
Conflicting Lanes	1				1				1				1				
Pedestrians Crossing, p/h	0				0				0				0				
Proportion of CAVs	0																

Critical and Follow-Up Headway Adjustment													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Critical Headway, s		4.9763	4.9763		4.9763	4.9763		4.9763	4.9763		4.9763	4.9763	
Follow-Up Headway, s		2.6087	2.6087		2.6087	2.6087		2.6087	2.6087		2.6087	2.6087	

Flow Computations, Capacity and v/c Ratios													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Entry Flow (v _e), pc/h		528	189		637	85		419	50		552	62	
Entry Volume, veh/h		503	180		607	81		395	47		511	57	
Circulating Flow (v _c), pc/h	662			484			699			819			
Exiting Flow (v _{ex}), pc/h	634			709			302			491			
Capacity (C _{pce}), pc/h		702	836		842	1014		676	723		599	670	
Capacity (c), veh/h		669	797		802	966		638	682		554	620	
v/c Ratio (x)		0.75	0.23		0.76	0.08		0.62	0.07		0.92	0.09	

Delay and Level of Service												
Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		23.6	7.0		20.8	4.5		17.5	6.0		48.4	6.9
Lane LOS		C	A		C	A		C	A		E	A
95% Queue, veh		6.8	0.9		7.2	0.3		4.3	0.2		11.4	0.3
Approach Delay, s/veh LOS	19.2	C		18.9	C		16.3	C		44.2	E	
Intersection Delay, s/veh LOS	24.5						C					

Appendix G – Proposed Concept Designs





Appendix H – Proposed Safety Analysis (ECAT)

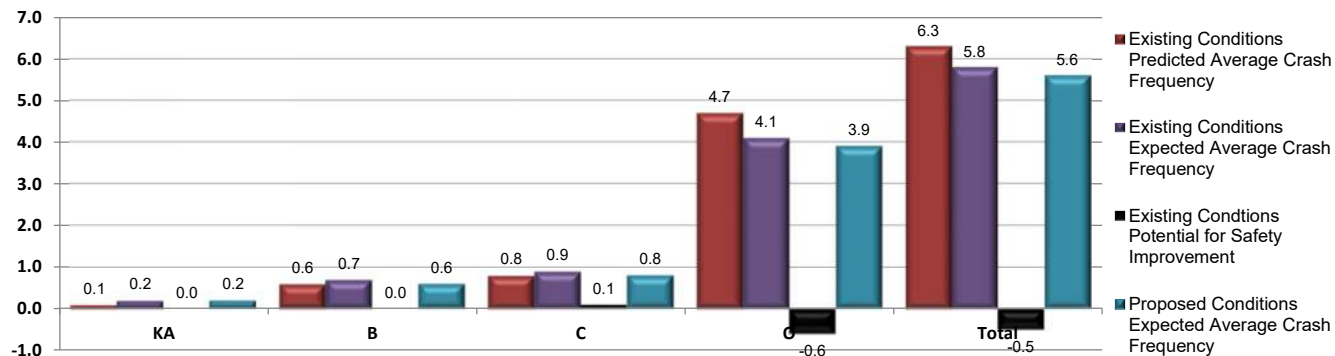


Project Safety Performance Report

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study Prop. Short Term	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	December 2023
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
N_{predicted} - Existing Conditions	0.1471	0.6251	0.7901	4.7222	6.2845
N_{expected} - Existing Conditions	0.1586	0.6744	0.8523	4.1334	5.8187
N_{potential for improvement} - Existing Conditions	0.0115	0.0493	0.0622	-0.5888	-0.4658
N_{expected} - Proposed Conditions	0.1515	0.6441	0.8139	3.9474	5.5569



Project Safety Performance Report

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	December 2023
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level			
		KA	B	C	O
SR 82 & SR 83	SR 82 & SR 83	0.1471	0.6251	0.7901	4.7222

Existing Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level			
		KA	B	C	O
SR 82 & SR 83	SR 82 & SR 83	0.1586	0.6744	0.8523	4.1334

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level			
		KA	B	C	O
SR 82 & SR 83	SR 82 & SR 83	0.0115	0.0493	0.0622	-0.5888

Proposed Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level			
		KA	B	C	O
SR 82 & SR 83	SR 82 & SR 83	0.1515	0.6441	0.8139	3.9474

Summary by Crash Type

Crash Type	Existing			Proposed
	Predicted Crash Frequency	Expected Crash Frequency	PSI	Expected Crash Frequency
Unknown	0.0074	0.0068	-0.0006	0.0065
Head On	0.0462	0.0449	-0.0013	0.0429
Rear End	2.7826	2.5626	-0.2200	2.4473
Backing	0.3009	0.2644	-0.0365	0.2525
Sideswipe - Meeting	0.1278	0.1180	-0.0098	0.1127
Sideswipe - Passing	0.4352	0.3889	-0.0463	0.3714
Angle	1.2779	1.1988	-0.0791	1.1449
Parked Vehicle	0.2355	0.2102	-0.0253	0.2007
Pedestrian	0.0587	0.0616	0.0029	0.0588
Animal	0.0000	0.0000	0.0000	0.0000
Train	0.0000	0.0000	0.0000	0.0000
Pedalcycles	0.0389	0.0396	0.0007	0.0378
Other Non-Vehicle	0.0000	0.0000	0.0000	0.0000
Fixed Object	0.4018	0.3706	-0.0312	0.3539
Other Object	0.0128	0.0114	-0.0014	0.0109
Overturning	0.0251	0.0249	-0.0002	0.0238
Other Non-Collision	0.0360	0.0326	-0.0034	0.0311
Left Turn	0.5301	0.5048	-0.0253	0.4821
Right Turn	0.0000	0.0000	0.0000	0.0000



Home » CMF / CRF Details

CMF / CRF DETAILS

CMF ID: 8922

IMPLEMENT SYSTEMIC SIGNING AND VISIBILITY IMPROVEMENTS AT SIGNALIZED INTERSECTIONS

DESCRIPTION: REPLACE ALL SIGNAL HEADS. REPLACE PEDESTRIAN SIGNAL HEADS, PUSHBUTTONS, AND SIGNS. INSTALL BACKPLATES WITH RETROREFLECTIVE BORDERS ON ALL SIGNAL HEADS. RE-STRIPE STOP LINES. RE-STRIPE CROSSWALK ADVANCE WARNING SIGNS. INSTALL OVERHEAD SIGNS (E.G., R10-12, R3-5L, R3-5R IN THE MUTCD(4)). INSTALL CURB RAMPS.

PRIOR CONDITION: SIGNALIZED INTERSECTION WITHOUT SYSTEMIC SIGNING AND VISIBILITY IMPROVEMENTS

CATEGORY: INTERSECTION TRAFFIC CONTROL

STUDY: [SAFETY EFFECTS OF LOW-COST SYSTEMIC SAFETY IMPROVEMENTS AT SIGNALIZED AND STOP-CONTROLLED INTERSECTIONS, LE ET AL., 2017](#)

Star Quality Rating:	[VIEW SCORE DETAILS]
Rating Points Total:	120
Crash Modification Factor (CMF)	
Value:	0.955
Adjusted Standard Error:	
Unadjusted Standard Error:	0.023
Crash Reduction Factor (CRF)	
Value:	4.5 (This value indicates a <i>decrease</i> in crashes)
Adjusted Standard Error:	
Unadjusted Standard Error:	2.3
Applicability	
Crash Type:	All
Crash Severity:	All
Roadway Types:	All
Street Type:	
Minimum Number of Lanes:	2
Maximum Number of Lanes:	4
Number of Lanes Direction:	
Number of Lanes Comment:	

Crash Weather:	Not specified
Road Division Type:	
Minimum Speed Limit:	
Maximum Speed Limit:	
Speed Unit:	
Speed Limit Comment:	
Area Type:	All
Traffic Volume:	
Average Traffic Volume:	
Time of Day:	All
<i>If countermeasure is intersection-based</i>	
Intersection Type:	
Intersection Geometry:	3-leg,4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	Minimum of 4272 to Maximum of 41100 Annual Average Daily Traffic (AADT)
Minor Road Traffic Volume:	Minimum of 111 to Maximum of 20000 Annual Average Daily Traffic (AADT)
Average Major Road Volume :	20447 Annual Average Daily Traffic (AADT)
Average Minor Road Volume :	5864 Annual Average Daily Traffic (AADT)
Development Details	
Date Range of Data Used:	2005 to 2014
Municipality:	
State:	SC
Country:	
Type of Methodology Used:	Before/after using empirical Bayes or full Bayes
Sample Size (crashes):	5132 crashes before, 2675 crashes after
Sample Size (sites):	84 sites before, 84 sites after
Sample Size (site-years):	411 site-years before, 209 site-years after
Other Details	
Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Nov 17, 2017
Comments:	

[VIEW THE FULL STUDY DET.](#)



This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center. For more information, contact Sarah Weissman Pascual at saral@unc.edu

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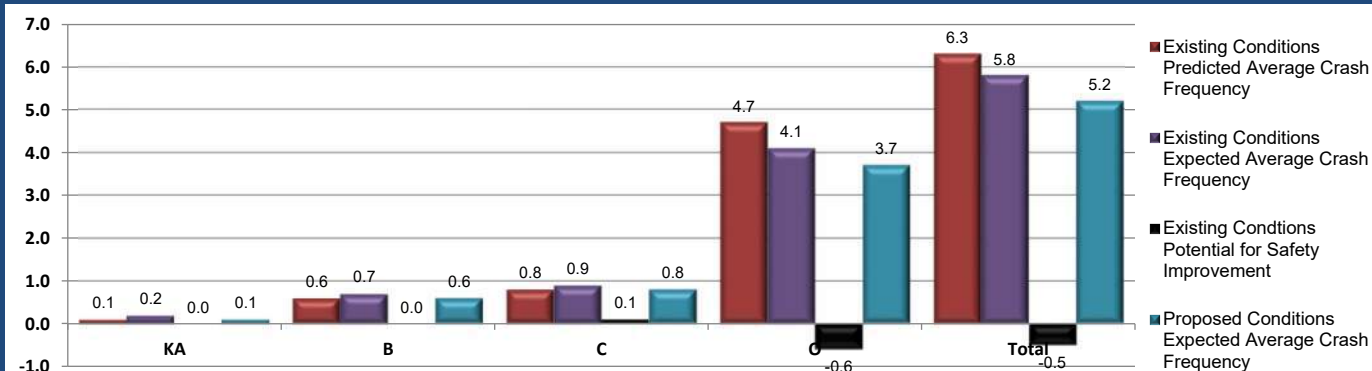


Project Safety Performance Report

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study Prop. Med Term	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	January 2024
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
N_{predicted} - Existing Conditions	0.1471	0.6251	0.7901	4.7222	6.2845
N_{expected} - Existing Conditions	0.1586	0.6744	0.8523	4.1334	5.8187
N_{potential for improvement} - Existing Conditions	0.0115	0.0493	0.0622	-0.5888	-0.4658
N_{expected} - Proposed Conditions	0.1415	0.6018	0.7606	3.6886	5.1925



Project Safety Performance Report

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	January 2024
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.1471	0.6251	0.7901	4.7222	6.2845

Existing Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.1586	0.6744	0.8523	4.1334	5.8187

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.0115	0.0493	0.0622	-0.5888	-0.4658

Proposed Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.1415	0.6018	0.7606	3.6886	5.1925

Summary by Crash Type

Crash Type	Existing			Proposed
	Predicted Crash Frequency	Expected Crash Frequency	PSI	Expected Crash Frequency
Unknown	0.0074	0.0068	-0.0006	0.0061
Head On	0.0462	0.0449	-0.0013	0.0403
Rear End	2.7826	2.5626	-0.2200	2.2932
Backing	0.3009	0.2644	-0.0365	0.2360
Sideswipe - Meeting	0.1278	0.1180	-0.0098	0.1056
Sideswipe - Passing	0.4352	0.3889	-0.0463	0.3475
Angle	1.2779	1.1988	-0.0791	1.0738
Parked Vehicle	0.2355	0.2102	-0.0253	0.1878
Pedestrian	0.0587	0.0616	0.0029	0.0555
Animal	0.0000	0.0000	0.0000	0.0000
Train	0.0000	0.0000	0.0000	0.0000
Pedalcycles	0.0389	0.0396	0.0007	0.0356
Other Non-Vehicle	0.0000	0.0000	0.0000	0.0000
Fixed Object	0.4018	0.3706	-0.0312	0.3317
Other Object	0.0128	0.0114	-0.0014	0.0102
Overturning	0.0251	0.0249	-0.0002	0.0224
Other Non-Collision	0.0360	0.0326	-0.0034	0.0292
Left Turn	0.5301	0.5048	-0.0253	0.4525
Right Turn	0.0000	0.0000	0.0000	0.0000



CRASH MODIFICATION FACTORS CLEARINGHOUSE

[ABOUT THE CLEARINGHOUSE](#) | [USING CMFs](#) | [DEVELOPING CMFs](#) | [ADDITIONAL](#)[Home](#) » [CMF / CRF Details](#)

CMF / CRF DETAILS

CMF ID: 9404

CONVERT SIGNAL FROM SPAN WIRE TO MAST ARM

DESCRIPTION: CONVERT SIGNALS MOUNTED ON SPAN WIRE TO SIGNALS MOUNTED ON MAST ARM

PRIOR CONDITION: SIGNALIZED INTERSECTION WITH SIGNALS MOUNTED ON SPAN WIRE.

CATEGORY: INTERSECTION TRAFFIC CONTROL

STUDY: [EVALUATING THE SAFETY EFFECTS OF SPAN WIRE TO MAST ARM SIGNAL CONVERSION, KHATTAK AND FONTAINE, 2018](#)Star Quality Rating:  [\[VIEW SCORE DETAILS\]](#)

Rating Points Total: 80

Crash Modification Factor (CMF)

Value: 0.97

Adjusted Standard Error:

Unadjusted Standard Error: 0.069

Crash Reduction Factor (CRF)

Value: 3 (This value indicates a **decrease** in crashes)

Adjusted Standard Error:

Unadjusted Standard Error: 6.9

Applicability

Crash Type: All

Crash Severity: All

Roadway Types: Not specified

Street Type:

Minimum Number of Lanes:

Maximum Number of Lanes:

Number of Lanes Direction:

Number of Lanes Comment:

Crash Weather:	Not specified
Road Division Type:	
Minimum Speed Limit:	
Maximum Speed Limit:	
Speed Unit:	
Speed Limit Comment:	
Area Type:	All
Traffic Volume:	
Average Traffic Volume:	
Time of Day:	All
<i>If countermeasure is intersection-based</i>	
Intersection Type:	Not specified
Intersection Geometry:	3-leg,4-leg
Traffic Control:	Signalized
Major Road Traffic Volume:	Minimum of 2874 to Maximum of 46185 Annual Average Daily Traffic (AADT)
Minor Road Traffic Volume:	Minimum of 476 to Maximum of 31443 Annual Average Daily Traffic (AADT)
Average Major Road Volume :	19156 Annual Average Daily Traffic (AADT)
Average Minor Road Volume :	6502 Annual Average Daily Traffic (AADT)
Development Details	
Date Range of Data Used:	
Municipality:	
State:	VA
Country:	United States
Type of Methodology Used:	Before/after using empirical Bayes or full Bayes
Sample Size (crashes):	608 crashes before, 331 crashes after
Sample Size (sites):	30 sites before, 30 sites after
Sample Size (site-years):	91 site-years before, 69 site-years after
Other Details	
Included in Highway Safety Manual?	No
Date Added to Clearinghouse:	Oct 27, 2018
Comments:	This CMF applies to all crashes at signalized intersections.

[VIEW THE FULL STUDY DET.](#)



This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center. For more information, contact Sarah Weissman Pascual at saral@unc.edu

The information contained in the Crash Modification Factors (CMF) Clearinghouse is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in the CMF Clearinghouse. The information contained in the CMF Clearinghouse does not constitute a standard, specification, or regulation, nor is it a substitute for sound engineering judgment.

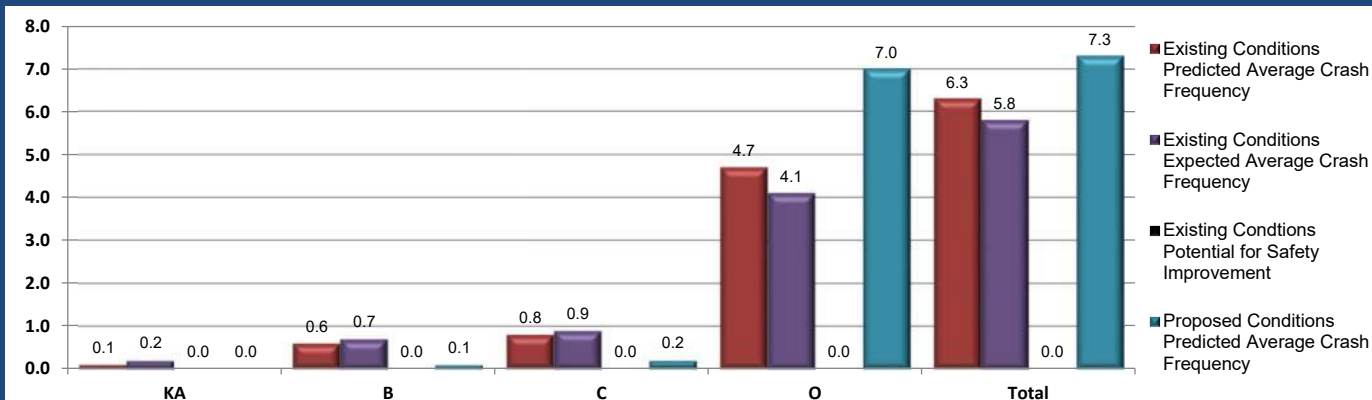


Project Safety Performance Report

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study Prop. Long Term	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	December 2023
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
N_{predicted} - Existing Conditions	0.1471	0.6251	0.7901	4.7222	6.2845
N_{expected} - Existing Conditions	0.1586	0.6744	0.8523	4.1334	5.8187
N_{potential for improvement} - Existing Conditions	0.0000	0.0000	0.0000	0.0000	0.0000
N_{expected} - Proposed Conditions	0.0176	0.1479	0.1834	6.9724	7.3213



Project Safety Performance Report

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	December 2023
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.1471	0.6251	0.7901	4.7222	6.2845

Existing Conditions Project Element Expected Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.1586	0.6744	0.8523	4.1334	5.8187

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.0115	0.0493	0.0622	-0.5888	-0.4658

Proposed Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				Total
		KA	B	C	O	
SR 82 & SR 83	SR 82 & SR 83	0.0176	0.1479	0.1834	6.9724	7.3213

Summary by Crash Type

Crash Type	Existing			Proposed
	Predicted Crash Frequency	Expected Crash Frequency	PSI	Predicted Crash Frequency
Unknown	0.0074	0.0068		0.2915
Head On	0.0462	0.0449		0.0055
Rear End	2.7826	2.5626		1.4831
Backing	0.3009	0.2644		0.0953
Sideswipe - Meeting	0.1278	0.1180		0.0000
Sideswipe - Passing	0.4352	0.3889		3.1658
Angle	1.2779	1.1988		2.8176
Parked Vehicle	0.2355	0.2102		0.0000
Pedestrian	0.0587	0.0616		0.0055
Animal	0.0000	0.0000		0.1008
Train	0.0000	0.0000		0.0000
Pedalcycles	0.0389	0.0396		0.0055
Other Non-Vehicle	0.0000	0.0000		0.0000
Fixed Object	0.4018	0.3706		1.0081
Other Object	0.0128	0.0114		0.0000
Overturning	0.0251	0.0249		0.0055
Other Non-Collision	0.0360	0.0326		0.1961
Left Turn	0.5301	0.5048		0.2126
Right Turn	0.0000	0.0000		0.6892

Appendix I – Cost Estimates & Benefit-Cost Analysis

Traffic Signal w/ Right-Turn Lanes
02/07/24

ITEM	ITEM EXTENSION	DESCRIPTION	TOTAL QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE (2024 dollars)
ROADWAY						
202		Pavement Removed	5,878	SQ YD	\$15.00	\$88,167
203		Excavation	1,500	FT	\$25.00	\$37,500
203		Embankment	1,500	CU YD	\$25.00	\$37,500
201		Clearing and Grubbing	1	LUMP	\$10,000.00	\$10,000
ROADWAY SUBTOTAL						\$173,200
DRAINAGE						
670		Drainage (10% of Estimate Total)	1	LUMP	\$160,000.00	\$160,000
DRAINAGE SUBTOTAL						\$160,000
EROSION CONTROL & BMP ELEMENTS						
670		Erosion Control	1	LUMP	\$25,000.00	\$25,000
EROSION CONTROL SUBTOTAL						\$25,000
PAVEMENT						
FULL DEPTH PAVEMENT - ASPHALT						
441		Asphalt Pavement Build-up	9,144	SQ YD	\$90.00	\$823,000
RESURFACING - ASPHALT						
251		Asphalt Resurfacing	11,689	SQ YD	\$18.00	\$210,400
PAVEMENT SUBTOTAL						\$1,033,400
MAINTENANCE OF TRAFFIC						
614		MOT (10% of Estimate Total)	1	LUMP	\$160,000.00	\$160,000
MAINTENANCE OF TRAFFIC SUBTOTAL						\$160,000
TRAFFIC CONTROL						
640		Traffic Control	1	LUMP	\$30,000.00	\$30,000
TRAFFIC CONTROL SUBTOTAL						\$30,000
TRAFFIC SIGNALS						
632		Signal Upgrades	1	LUMP	\$250,000.00	\$250,000
TRAFFIC SIGNALS SUBTOTAL						\$250,000
LIGHTING						
625		Lighting	1	LUMP	\$30,000.00	\$30,000
LIGHTING SUBTOTAL						\$30,000
INCIDENTALS						
619	16020	Field Office, Type B	9	MONTH	\$1,050.00	\$9,450
623	10000	Construction Layout Stakes (0.75% of Total)	1	LUMP	\$13,737.00	\$13,737
624	10000	Mobilization	1	LUMP	\$40,000.00	\$40,000
INCIDENTALS SUBTOTAL						\$63,200
CONSTRUCTION TOTAL, 2024						\$1,925,000
RIGHT-OF-WAY (ROW)						
		Right-of-Way	1	LUMP	\$50,000.00	\$50,000
RIGHT-OF-WAY SUBTOTAL						\$50,000
DESIGN FEE						
		Design Fee (12% of Construction and ROW)	12.0%			\$237,000
DESIGN SUBTOTAL						\$237,000
COST CONTINGENCY						
		Cost Contingency - Preliminary Engineering (25% of Construction and ROW)	25.0%			\$493,750
CONTINGENCY SUBTOTAL						\$493,800
TOTAL COST, 2024						\$2,705,800
		Construction Cost Inflation Rate (2024 to 2027)	17.0%			\$460,000
TOTAL COST, 2027						\$3,165,800
TOTAL COST, 2027 DOLLARS						\$3,166,000



Safety Benefit - Cost Analysis

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR 82 and SR 83	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	January 2024
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Select Site Types to be used in Benefit-Cost Analysis:

All Sites

Comments:

Countermeasure Service Lives, Costs, and Safety Benefits								
Countermeasures	Service Life (Years)	Initial Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value	Net Present Cost of Countermeasure	Total Cost of Countermeasures	Summary of Annual Crash Modifications	Net Present Value of Safety Benefits
Add Right Turn Lanes	20	\$2,363,250.00			\$2,363,250.00	\$2,363,250.00	-0.466	\$187,979
Site Characteristic Improvements (i.e. Lighting)		\$0.00			\$0.00	\$0.00		
Site Characteristic Improvements (i.e. Signal Phasing)		\$0.00			\$0.00	\$0.00		
Site Characteristic Improvements (i.e. Added Right Turn Lane)		\$0.00			\$0.00	\$0.00		
CMF 1 - Install Mast Arm Signal	20	\$342,550.00			\$342,550.00	\$342,550.00	-0.161	\$64,932
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
Totals		\$2,705,800.00	\$0.00	\$0.00	\$2,705,800.00	\$2,705,800.00	-0.626	\$252,911

Safety Benefit - Cost Analysis

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR 82 and SR 83	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	January 2024
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Benefit - Cost Calculator

Net Present Value of Project	\$2,705,800.00
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Net Present Value of Safety Benefits	\$252,910.88
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Net Benefit (\$2,452,889.12)

Benefit / Cost Ratio	0.09
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Expected Annual Crash Adjustment

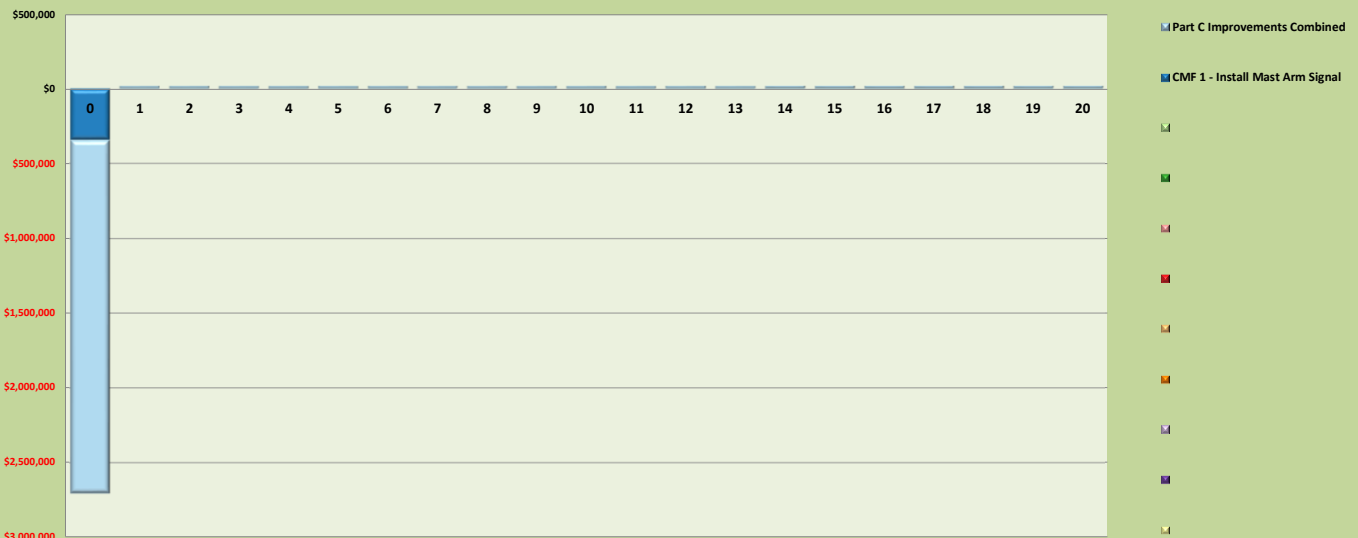
Number of Fatal & Incapacitating Injury Crashes	-0.017
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Number of Injury Crashes	-0.181
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Number of Total Crashes	-0.626
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Comments:

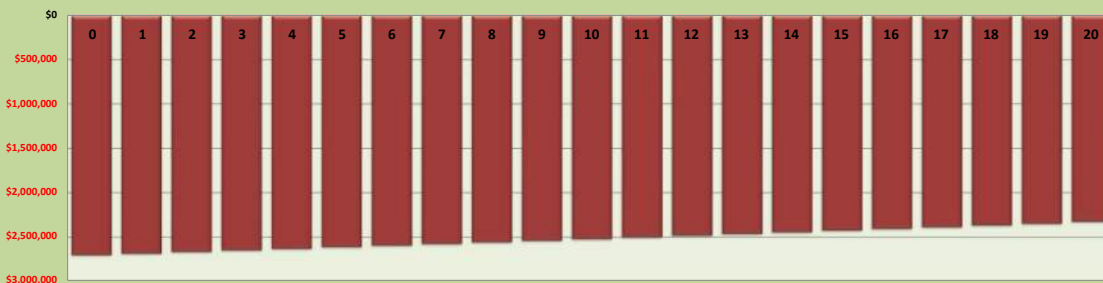
Safety Benefits and Project Costs Combined Cash Flows By Countermeasure Per Year



Project Costs Only Cash Flows By Countermeasure Per Year



Return on Investment (Safety Benefits and Project Investments)



First year to observe a positive return on investment: Unknown (Unknown years)

Percentage of Service Life to observe a continuous Positive Return on Investment: Unknown%

Roundabout
04/01/24



Safety Benefit - Cost Analysis

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR 82 and SR 83	Contact Email	jimmy.masters@burgessniple.com
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Reference Number	PR61801	Date Performed	December 2023
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Select Site Types to be used in Benefit-Cost Analysis:

All Sites

Comments:

Countermeasure Service Lives, Costs, and Safety Benefits								
Countermeasures	Service Life (Years)	Initial Cost of Countermeasure	Annual Maintenance & Energy Costs	Salvage Value	Net Present Cost of Countermeasure	Total Cost of Countermeasures	Summary of Annual Crash Modifications	Net Present Value of Safety Benefits
Install new roundabout	20	\$4,130,100.00			\$4,130,100.00	\$4,130,100.00	1.037	\$1,784,111
Site Characteristic Improvements (i.e. Lighting)		\$0.00			\$0.00	\$0.00		
Site Characteristic Improvements (i.e. Signal Phasing)		\$0.00			\$0.00	\$0.00		
Site Characteristic Improvements (i.e. Added Right Turn Lane)		\$0.00			\$0.00	\$0.00		
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
		\$0.00			\$0.00	\$0.00	0.000	\$0
Totals		\$4,130,100.00	\$0.00	\$0.00	\$4,130,100.00	\$4,130,100.00	1.037	\$1,784,111

Safety Benefit - Cost Analysis

General Information

Project Name	Lanham-ODOT Safety Studies Task 3A: SR 82 and SR 83	Contact Email	jimmy.masters@burgessniple.com
Project Description	Lorain County SR 82 & SR 83 Intersection Safety Study	Contact Phone	614.459.2050 x1261
Reference Number	PR61801	Date Performed	December 2023
Analyst	JZM	Analysis Year	2023
Agency/Company	B&N		

Benefit - Cost Calculator

Net Present Value of Project	\$4,130,100.00
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Net Present Value of Safety Benefits	\$1,784,110.50
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Net Benefit **(\$2,345,989.50)**

Benefit / Cost Ratio	0.43
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Expected Annual Crash Adjustment

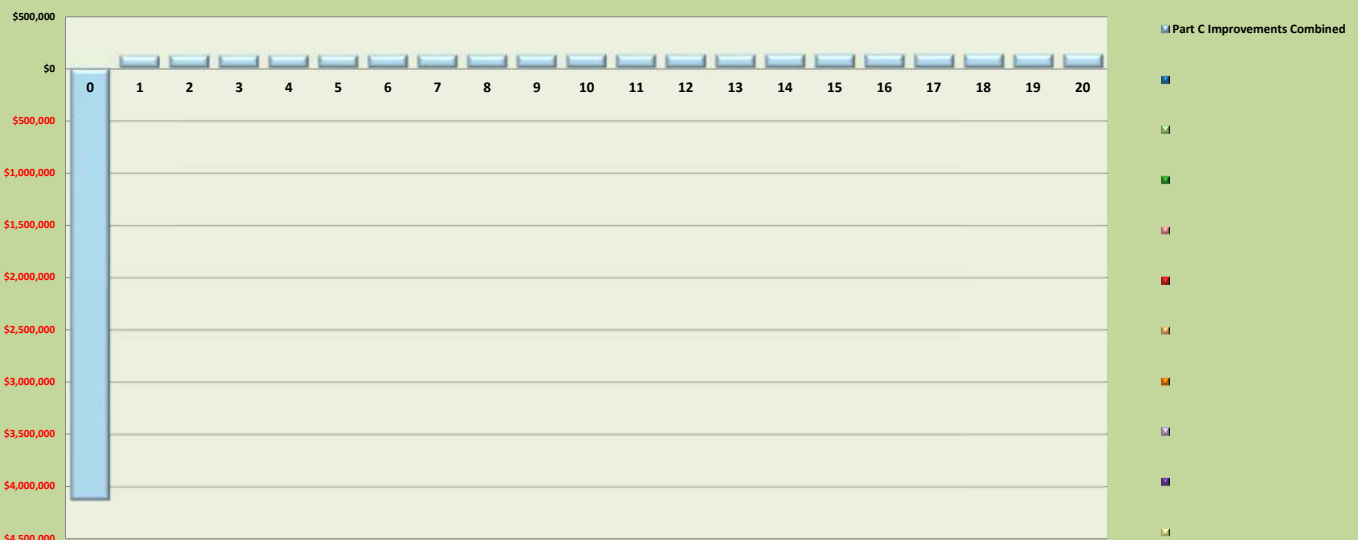
Number of Fatal & Incapacitating Injury Crashes	-0.130
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Number of Injury Crashes	-1.213
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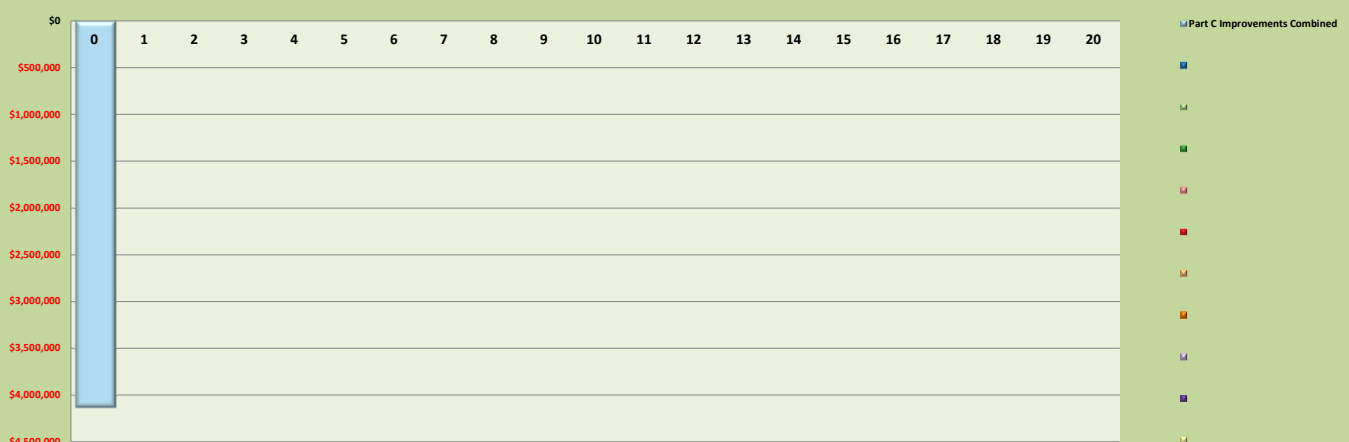
Number of Total Crashes	1.037
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Comments:

Safety Benefits and Project Costs Combined Cash Flows By Countermeasure Per Year



Project Costs Only Cash Flows By Countermeasure Per Year



Return on Investment (Safety Benefits and Project Investments)

