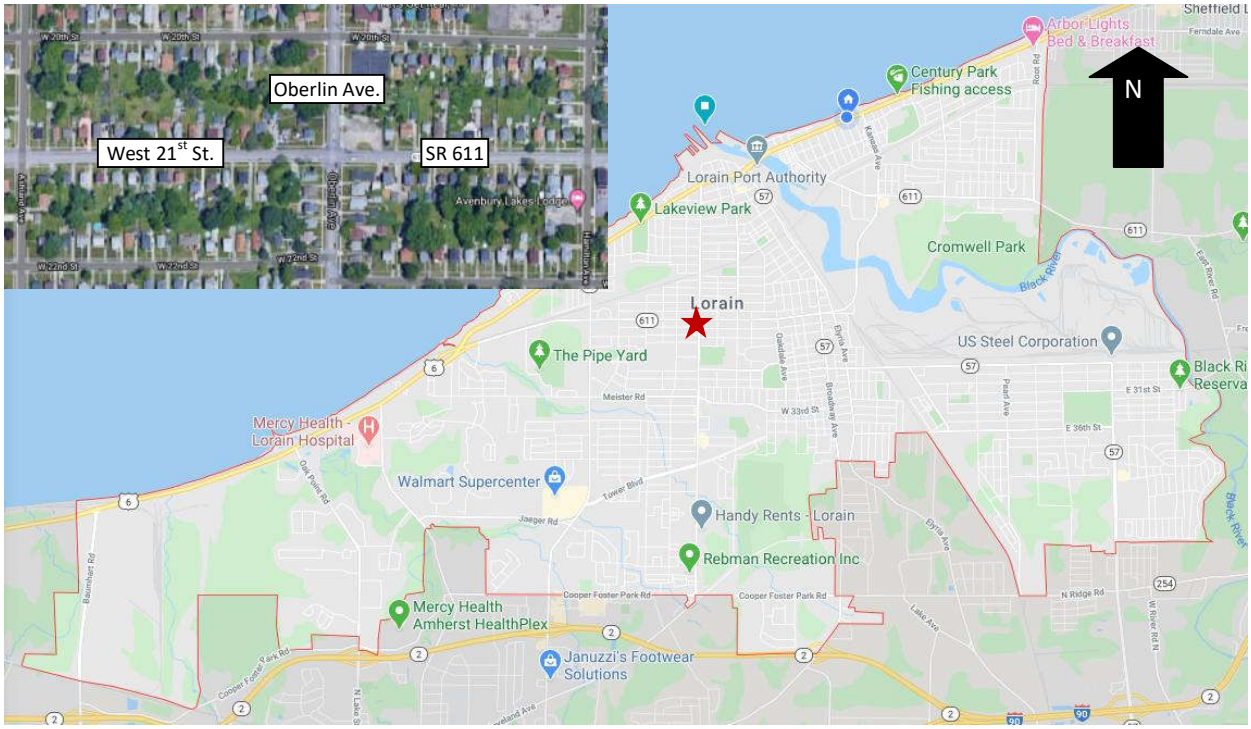

City of Lorain
Engineering Department
Intersection list:
#478 Statewide
#5 Citywide

ABBREVIATED SAFETY STUDY

OBERLIN AVENUE AND SR 611

(OBERLIN AVENUE AT WEST 21ST STREET)

CITY OF LORAIN, LORAIN COUNTY

Prepared by: Veronica A Newsome, P.E. and Jessica Potter

July 2020

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Background

The City of Lorain reached out for guidance at ODOT District 3 to evaluate the intersection of Oberlin Avenue and West 21st Street (SR611). The intersection of Oberlin Avenue and West 21st Street (SR611) ranked #478 statewide Urban Intersections on the 2018 Ohio Department of Transportation Highway Safety Improvement Program list and #5 citywide on the 2018 City of Lorain Safety Priority Intersection List. Please see **Appendix I** for details.

Ohio is one of the first states in the country to fully implement AASHTOWare's Safety Analyst to prioritize safety locations across Ohio. Safety Analyst uses state-of-the-art statistical methodologies to identify roadway locations with the highest potential for reducing crashes. The software system flags spot locations and road segments that have higher-than-predicted crash frequencies. It also flags locations for review based on crash severity. For further explanation on the criteria terminology, refer to the following link:
http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/HighwaySafety/HSIP/Pages/Priority-Lists-Initiatives.aspx

A preliminary crash analysis using the ODOT Economic Crash Analyst Tool (ECAT) found the following statistical results based on the existing conditions and traffic volumes:

Expected Crash Frequency – 6.75 crashes/year
Ratio of observed fatal and serious injuries to observed total crashes 0.00%
Percentage of the potential for safety improvement to total expected crashes 43.56%
Relative severity index $24,986
Equivalent property damage only index 2.65

As can be seen above, the study intersection currently has a potential for safety improvement of 43.56%. This means that there are approximately 44% more crashes occurring at the intersection than would be expected at a similar intersection.

Existing/Future Conditions

The Oberlin Avenue and West 21st Street (SR611) intersection is located in northern Lorain County. It is approximately 1.1 miles from US6 which runs parallel to Lake Erie and 1.4 miles from Lorain City Hall. There are primarily residences and a former commercial site the northeast corner.

The Oberlin Avenue and West 21st Street (SR611) intersection is a four-leg, signalized intersection located within the City of Lorain in Lorain County. The intersection is relatively flat grade and has adequate intersection and stopping sight distance for all approaches.

The north-south roadway (Oberlin Avenue) is a two-lane major collector on the north and south approaches and a 25 MPH speed limit.

The east-west roadway (West 21st Street) is currently undergoing a road diet to the west of Oberlin Avenue. Overhead lighting is present along Oberlin Avenue and West 21st Street.

Stop lines are offset from the intersection for vehicle turning movements. Left turn lanes are on the north (200’ storage), south (185’ storage), east (600’ storage), and west (400’ storage) approaches.

All approaches are curbed and 36’ pavement width. The development of turn lanes on the east and west approaches is not conventional. The surrounding area is urban residential and former commercial.

Figure 1 North Approach

Figure 2 South Approach

Figure 3 East Approach

Figure 4 NW corner of intersection

The nearby schools create a combination of multimodal travel at this intersection. Local residents may cross at this intersection to reach nearby Elementary, Middle, and High Schools.

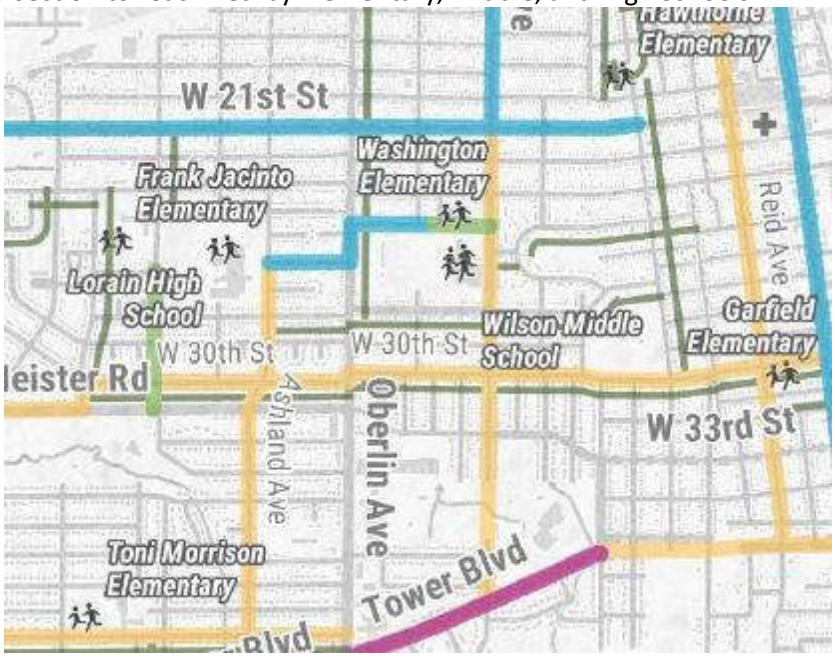


Figure 5 Plan View of Intersection – City of Lorain Active Transportation Plan (2018)

Traffic Volumes

From 2014 to 2020, the average daily traffic (ADT) volumes on the north and south approaches have decreased while the volumes on the east and west approaches shown an increase as seen below in **Table 1**.

Table 1. Average Daily Traffic (ADT)

Year	Approach ADT (Both Directions)			
	North	South	East	West
2014	7,810	8,940	9,910	8,660
2020	6,990	8,420	12,380	10,310

A turning movement count was taken at the intersection on Tuesday, March 10th, 2020. Based on the count data, the morning peak occurs between 11:00 AM and 12:00 PM and the evening peak occurs between 3:15 PM and 4:15 PM. The detailed traffic count report can be found in **Appendix A**.

Pedestrian movements were also counted on Tuesday, March 10th, 2020. A total of 26 crossing movements were counted during the 24 hour period – 4% crossing the south approach, 50% crossing the west approach, 12% crossing the north approach, and 34% crossing at the east approach.

Signal Operations

The traffic signal is a 90 foot long rectangular span with strain poles at each corner. All signal heads are three-sections consisting of 12 inch red, amber, and green lenses with LED bulbs. All approaches have two signal heads without back plates controlling the approach. The signal head housings are constructed of aluminum painted yellow and are hung by wire. A view of the signal from the westbound approach is provided in **Figure 6**.

Figure 6 - Westbound Intersection Approach - Courtesy Google Street View

The traffic signal operates with protected-only left turn phasing all four approaches to the intersection. Since neither approaching roadway is located along a coordinated signal system, this intersection operates in free mode with the EB and WB approaches operating on minimum recall with all other approaches with no recall. Stop bar induction loop detectors are present on all eight (8) approach lanes to this intersection. This detection allows each signal phase to be actuated only when a vehicle is present and also allows the signal to gap out once the minimum green time has been provided and no other vehicles are present on the detector. A passage time of 1.5 seconds exists for all signal phases, which is shorter than the typical 3 seconds. Intersection Capacity Analysis was performed for the signalized intersection utilizing the Highway Capacity Software (HCS7), which is based upon the Highway Capacity Manual, 6th Edition. Additionally, the ODOT preferred balanced approach delay methodology was used in this analysis utilizing the existing traffic signal timings. Traffic volumes from the March 12th, 2020 turning movement count were used for the analyses. **Table 2** displays the intersection operating conditions for the AM and PM peak hours. At current traffic volume levels, the intersection overall operates at an acceptable Level of Service (LOS) C in the AM peak hour and LOS D in the PM peak hour. The HCS reports are in **Appendix B**.

Table 2. Existing Year 2020 'No-Build' Intersection Capacity Analysis Results Summary

Peak Period	NB LOS (Delay)	SB LOS (Delay)	EB LOS (Delay)	WB LOS (Delay)	Overall LOS (Delay)
AM Peak	C (32.6)	C (30.5)	C (26.3)	C (32.7)	C (30.8)
PM Peak	E (69.2)	D (35.1)	D (36.2)	E (68.2)	D (54.9)

Signal clearance times were also evaluated for the intersection. The current and ITE (Institute of Transportation Engineers) formula values for the yellow change intervals and the red clearance intervals are found in Table 3 below and a detailed calculation sheet can be found in **Appendix C**.

Table 3. Yellow Change and Red Clearance Intervals

Interval	West 21st Street (SR611)		Oberlin Avenue	
	Current	ITE Formula	Current	ITE Formula
Yellow Change Interval (sec)	4.00	3.30	4.00	3.10
Red Clearance Interval (sec)	2.00	1.00	2.00	1.00

Crash Data and Analysis

The most recent five years (2015-2019) of crash data was analyzed. The OH-1 report for each documented crash was reviewed for accuracy and to locate crashes properly within the study limit. The crash diagram is included in **Appendix D**. A total of 55 intersection related crashes were reported from 1/1/2015 to 12/31/2019. The general breakdown of the crash data and observable trends can be found below.

Total Crashes = 55
(1/1/15-12/31/19)

Crashes by Year	
2015	14
2016	7
2017	15
2018	11
2019	8
Grand Total	**55**

Crashes by Type	
Rear End	35
Angle	8
Sideswipe - Passing	4
Backing	4
Parked Vehicle	1
Fixed Object	1
Left Turn	1
Right Turn	1
Grand Total	**55**

Crashes by Time of Day	
2	2
5	1
8	6
9	6
10	2
11	1
12	5
13	5
14	5
15	4
16	3
17	1
18	2
19	2
20	6
21	3
22	1
Grand Total	**55**

Crashes by Severity	
Injury Crash	18
Property Damage Crash	37
Grand Total	**55**

Crashes by Road Condition	
Dry	45
Wet	6
Snow	4
Grand Total	**55**

Young Drivers

-23/55 (42%) total crashes involved 25 year old or younger driver at fault.

Older Drivers

-11/55 (20%) total crashes involved 65 year old or older driver at fault.

Distracted Drivers

-6/55 (11%) total crashes involved distracted drivers at fault.

Rear end Crashes

-35/55 (64%) total crashes were classified as rear end crashes.

Probable Causes

The main crash type found at the subject intersection is rear-end related crashes, which account for approximately 64% of the total crashes. There are numerous causes that could be contributing factors to the crashes occurring at this intersection, including distracted driving and lack of driver experience. Distracted driving has become more common in recent years and approximately 42% of the crashes occurred due to a motorist being 25 years old or younger. However, these causes cannot be addressed from an engineering perspective. Other factors that could be causing the crashes at this intersection were also investigation that could be mitigated from an engineering perspective.

Looking at the existing conditions at the intersection, it was noted that the current traffic signal installation is an older, span wire installation that lacks traffic signal backplates which affects the visibility of the existing traffic signal, contributing to the rear-end and angle crashes that were found to occur. The below image shows the existing signal heads for the east approach to the intersection.

The existing traffic signal timings and clearance intervals could be leading to the presence of both rear-end and angle crashes occurring at the intersection. The existing signal timings have not been revised for over 5 years, including the clearance intervals. If the clearance intervals are too short for motorists to clear the intersection during the phase change, angle crashes could be occurring as traffic isn't clearing the intersection before the phase changes.

While the intersection appears to have adequate capacity, the current intersection phasing could be creating unnecessary delay at the intersection. Currently, all four left turn phases at the intersection are protected-only. Under the protected only phasing, additional green time is allocated to the left turn phases since this traffic cannot make the left turn movement under a permissive phase. Based on the traffic volumes and existing conditions at this intersection, there is not a need for the left turn movements to be protected-only.

Several sideswipe – passing crashes occurred on the west leg of the intersection due to the lane drop condition for eastbound traffic. When approaching the intersection there are two approach lanes, one of which becomes a drop left turn onto northbound Oberlin Avenue. This condition could lead to vehicles making sudden lane changes while approaching the intersection. This lane drop configuration contributes to the rear-end and sideswipe – passing crashes identified on the west leg.

The rear-end and sideswipe-passing crashes occurring on the east leg of the intersection could be attributed to the pavement markings that exist between Hamilton Avenue and Oberlin Avenue. For westbound traffic, there is a small section of a center two-way left turn lane followed by a section of roadway that appears to have two thru travel lanes, which then becomes a drop left turn lane onto southbound Oberlin Avenue. The confusing pavement markings could lead to vehicles making sudden lane changes while approaching the intersection.

Lastly, rear-end crashes were found on the north and south legs of the intersection. These crashes appear to be related to the signal visibility issue noted earlier and due to the congestion that occurs, particularly in the PM peak hour.

Countermeasures

In order to address the safety deficiencies at the intersection, as noted in the previous section, the following improvements are recommended at the intersection:

1. Implement updated signal timings and clearance intervals
2. Reconstruct the traffic signal at the intersection and include backplates on the traffic signal heads.
3. Convert the left turn phasing at the intersection to protected/permissive for all intersection approaches.
4. Restripe SR 611 between Oberlin Avenue and Hamilton Avenue.
5. Upgrade the pedestrian accommodations at the intersection to include a pedestrian countdown timer.
6. Investigate signal coordination on SR 611
7. Community and school promotion of driver safety to students and parents

The above improvement list will help to mitigate the existing crash patterns that were identified at the study intersection. It should be noted that the existing span wire signal installation will be unable to accommodate the traffic signal backplates and the 5 section signal heads required to be installed in order to provide the protected/permissive traffic signal phasing. Therefore, the existing traffic signal installation will need to be reconstructed. The traffic signals should be reconstructed and upgraded to include full vehicular detection, meet current design standards, and incorporate current technology. All traffic signals should be designed to accommodate traffic signal backplates on all approaches to increase signal visibility and add target value to the signal heads. Additionally, the upgraded signals should provide full pedestrian accommodations with pushbuttons and countdown displays. The new traffic signal should also have updated signal timings and clearance intervals incorporated. The city will also investigate the addition of advance warning signs with street name plaques during the detailed design phase of this project.

This project also proposes to restripe SR 611 between Oberlin Avenue and Hamilton Avenue. This restriping proposes to create a 250’ westbound left turn lane at Oberlin Avenue, with 200’ of storage and a 50’ diverging taper. The eastbound left turn lane at Hamilton Avenue will remain and the area between the two turn lanes will be striped as a center, two-way left turn lane.

The estimated cost for this project is $416,500, which includes the design, right-of-way, construction, and construction inspection services necessary for the reconstruction project. The cost estimate is included in **Appendix E**. The City of Lorain is requesting 100% of this funding from the ODOT Highway

Safety Improvement program. The construction is proposed to occur in ODOT State Fiscal Year 2023, which begins on July 1st, 2022.

Implementation Plan

Intersection Improvements Under Design

Safety improvements are currently underway along SR 611 with the construction of PID 110315 – Lorain TLCI. This project restripes SR 611 from SR58 to Oberlin Avenue. The project is comprised of a road diet, that right sizes the roadway cross section in this residential area to include bike lanes, a center turn lane, and two travel lanes; one in each direction.

Future safety improvements will occur in 2021 along SR 611 with the construction of PID 109068 – SR 611 sidewalk and pedestrian improvements. This project will improve sidewalks, curb ramps, and pedestrian crossings along SR 611 from SR58 to Oakdale Avenue.

Please refer to **Appendix J** for an Intersection Concept Plan.

Requested Intersection Safety Improvements

This safety study is requesting funding for intersection improvements listed in the 'Countermeasures' section of this document. These improvements are proposed to be constructed in ODOT FY 2023.

Long Term Intersection Improvements

The City of Lorain has an active transportation team, Lorain Connected that is working towards building a better Lorain. Lorain Connected applies for SRTS infrastructure and non-infrastructure yearly as well as other grants from public and private sources. This interdisciplinary team meets monthly to discuss safety concerns in the community and addresses issues. The goal is to engage the community in safety issues and improvements. Over the past 3 years, Lorain Connected has leveraged over $1 Million dollars in grant funding to host bike and walk to school days, implement temporary safety improvements for study, and assisted in the building of an inclusive playground in the City of Lorain.

In the future the City of Lorain would like to improve travelling along the SR611 corridor by implementing signal coordination. Signal coordination could reduce the number of stops along the corridor, improving air quality from idling vehicles and provide for a continuous flow of traffic at the target speed, by adjusting cycle lengths.

The City of Lorain would look to the ODOT task order consultant to assist in evaluating citywide signal coordination for other intersecting routes.

Benefit to Cost Analysis

The reduction of crashes within the State of Ohio is the top priority of ODOT's Highway Safety Improvement Program. ECAT analysis was performed at the study intersection in order to perform a Benefit to Cost analysis on the proposed intersection improvements. **Table 4** provides a summary of

the Benefit to Cost Ratio for the proposed intersection improvements and **Appendix F** contains the Benefit to Cost Analysis worksheets. Additionally, the formal safety application for this improvement project is contained in **Appendix G**.

Table 4. Benefit to Cost Summary Chart

	Net Present Value of Project	Net Present Value of Safety Benefits	Benefit to Cost Ratio
Benefit to Cost Results	$356,500	$440,398.91	1.24

The Benefit to Cost Ratio analysis was performed based upon a project cost of $356,500 (which is the total cost of the State Route 611 /Oberlin Avenue intersection improvement project, not including the construction inspection or inflation). This results in a Benefit to Cost Ratio of 1.24. Based on the Benefit to Cost Ratio being significantly greater than 1.00, this intersection safety improvement project should be considered a fundable project and should receive the consideration of the funding committee.

Traffic Signal Warrant Analysis

In order to determine whether the study intersection meets a traffic signal warrant based on the current traffic conditions, the existing traffic volumes were compared to the volumes thresholds and criteria outlined in Section 402-2 of the ODOT Traffic Engineering Manual (TEM). The results of the Existing Year 2020 traffic signal warrant analysis are shown in **Table 5** below and the traffic signal warrant analysis printouts are contained in **Appendix H**.

Table 5. Existing Year 2019 Traffic Signal Warrant Analysis Summary

Intersection	Signal Warrant		
	Warrant #1 (Eight Hour Vehicular Volume)	**Warrant #2** (Four Hour Vehicular Volume)	**Warrant #3** (Peak Hour Vehicular Volume)
State Route 611 / Oberlin Avenue	**Satisfied**	**Satisfied**	**Satisfied**

'Build' Intersection Capacity Analysis

Intersection capacity analysis was performed for the 'Build' conditions in order to determine the anticipated operating conditions once the proposed improvements are implemented at the study intersection. This analysis was performed utilizing the computer program HCS7 and following the ODOT preferred balanced approach delay methodology. **Table 6** displays the intersection operating conditions for the AM and PM peak hours. Under the proposed intersection operations, the overall intersection is anticipated to operate at an improved LOS C in the AM peak hour and LOS C in the PM peak hour. The HCS reports are contained in **Appendix B**.

Table 6. Existing Year 2020 'Build' Intersection Capacity Analysis Results Summary

Peak Period	NB LOS (Delay)	SB LOS (Delay)	EB LOS (Delay)	WB LOS (Delay)	Overall LOS (Delay)
AM Peak	C (24.2)	C (22.7)	C (22.7)	C (24.3)	C (23.6)
PM Peak	D (35.5)	C (26.2)	C (27.5)	D (35.9)	C (32.1)

When comparing the capacity analysis results between the 'No-Build' (shown in **Table 1**) and 'Build' (shown in **Table 6**) conditions, there is a significant reduction in overall delay noted between the two conditions. In the AM peak hour, the overall intersection is anticipated to operate at LOS C during the 'No-Build' and 'Build' conditions; however the overall intersection delay is reduced from 30.8 seconds of delay to 23.6 seconds. In the PM peak hour, the overall intersection improves from a LOS D in the 'No-Build' conditions to a LOS C in the 'Build' and the overall intersection delay decreases from 54.9 seconds to 32.1 seconds.

APPENDIX A

Traffic Count Data

Oberlin Ave and West 21st St
Lorain Ohio
03/10/2020 07:00:00

Time	Southbound Oberlin Ave						Westbound West 21st St						Northbound Oberlin Ave						Eastbound West 21st St						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
12:00 AM	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**
12:15 AM	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**
12:30 AM	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**
12:45 AM	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**
Hourly Total	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**
1:00 AM	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**
1:15 AM	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**
1:30 AM	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**
1:45 AM	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**
Hourly Total	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**
2:00 AM	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**
2:15 AM	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**
2:30 AM	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**
2:45 AM	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**
Hourly Total	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**
3:00 AM	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**
3:15 AM	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**
3:30 AM	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**
3:45 AM	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**
Hourly Total	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**
4:00 AM	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**
4:15 AM	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**
4:30 AM	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**
4:45 AM	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**
Hourly Total	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**
5:00 AM	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**
5:15 AM	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**
5:30 AM	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**
5:45 AM	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**
Hourly Total	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**
6:00 AM	0	7	25	0	0	*32*	0	4	22	0	0	*26*	0	6	12	6	0	*24*	0	4	18	2	0	*24*	**106**
6:15 AM	0	3	20	4	0	*27*	0	5	27	3	0	*35*	0	7	9	11	0	*27*	0	1	27	2	0	*30*	**119**
6:30 AM	0	4	18	4	0	*26*	0	13	28	3	0	*44*	0	1	14	8	0	*23*	0	2	29	0	0	*31*	**124**
6:45 AM	0	4	19	3	0	*26*	0	10	35	3	0	*48*	0	4	18	9	0	*31*	0	6	35	2	0	*43*	**148**
Hourly Total	0	18	82	11	0	*111*	0	32	112	9	0	*153*	0	18	53	34	0	*105*	0	13	109	6	0	*128*	**497**
7:00 AM	0	11	25	3	0	*39*	0	8	42	3	0	*53*	0	6	9	6	0	*21*	0	0	28	5	0	*33*	**146**
7:15 AM	0	14	32	6	0	*52*	0	5	30	7	0	*42*	0	6	26	8	0	*40*	0	6	37	4	0	*47*	**181**
7:30 AM	0	10	27	5	0	*42*	0	22	53	6	0	*81*	0	3	20	11	0	*34*	0	4	55	8	0	*67*	**224**
7:45 AM	0	20	37	5	0	*62*	0	26	68	5	0	*99*	0	6	36	24	0	*66*	0	6	71	8	0	*85*	**312**
Hourly Total	0	55	121	19	0	*195*	0	61	193	21	0	*275*	0	21	91	49	0	*161*	0	16	191	25	0	*232*	**863**

Oberlin Ave and West 21st St
Lorain Ohio
03/10/2020 07:00:00

Time	Southbound Oberlin Ave						Westbound West 21st St						Northbound Oberlin Ave						Eastbound West 21st St						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
8:00 AM	0	9	36	3	0	*48*	0	27	73	9	1	*109*	0	1	35	19	0	*55*	0	7	56	10	0	*73*	**285**
8:15 AM	0	4	32	3	0	*39*	0	18	84	4	0	*106*	0	6	37	14	0	*57*	0	2	51	5	0	*58*	**260**
8:30 AM	0	9	29	7	0	*45*	0	16	67	3	0	*86*	0	3	18	5	0	*26*	0	6	49	2	0	*57*	**214**
8:45 AM	0	7	30	6	0	*43*	0	24	69	5	0	*98*	0	3	30	12	0	*45*	0	8	42	6	0	*56*	**242**
Hourly Total	0	29	127	19	0	*175*	0	85	293	21	1	*399*	0	13	120	50	0	*183*	0	23	198	23	0	*244*	**1001**
9:00 AM	0	5	21	4	0	*30*	0	18	51	4	0	*73*	0	3	32	12	0	*47*	0	7	47	2	0	*56*	**206**
9:15 AM	0	10	29	5	0	*44*	0	13	64	7	1	*84*	0	11	20	12	0	*43*	0	5	54	8	0	*67*	**238**
9:30 AM	0	12	26	9	0	*47*	0	20	59	8	0	*87*	0	5	37	9	0	*51*	0	11	38	4	0	*53*	**238**
9:45 AM	0	13	31	8	0	*52*	0	23	59	7	0	*89*	0	3	29	17	0	*49*	0	3	45	7	0	*55*	**245**
Hourly Total	0	40	107	26	0	*173*	0	74	233	26	1	*333*	0	22	118	50	0	*190*	0	26	184	21	0	*231*	**927**
10:00 AM	0	10	35	5	0	*50*	0	17	66	9	0	*92*	0	7	29	18	0	*54*	0	6	42	7	0	*55*	**251**
10:15 AM	0	6	25	6	0	*37*	0	14	71	12	0	*97*	0	7	23	13	0	*43*	0	11	52	2	0	*65*	**242**
10:30 AM	0	6	31	9	0	*46*	0	20	63	6	0	*89*	0	7	24	20	0	*51*	0	8	48	3	0	*59*	**245**
10:45 AM	0	9	36	7	1	*52*	0	22	84	6	0	*112*	0	8	25	15	0	*48*	0	4	47	5	0	*56*	**268**
Hourly Total	0	31	127	27	1	*185*	0	73	284	33	0	*390*	0	29	101	66	0	*196*	0	29	189	17	0	*235*	**1006**
11:00 AM	0	4	16	4	0	*24*	0	21	66	8	0	*95*	0	3	28	20	0	*51*	0	12	53	10	0	*75*	**245**
11:15 AM	0	13	50	9	0	*72*	0	20	61	8	0	*89*	0	6	44	15	1	*65*	0	5	44	4	0	*53*	**279**
11:30 AM	0	7	37	4	0	*48*	0	32	73	10	0	*115*	0	7	39	17	0	*63*	0	12	52	15	0	*79*	**305**
11:45 AM	0	11	46	6	0	*63*	0	35	65	8	0	*108*	0	7	41	19	0	*67*	0	10	36	8	0	*54*	**292**
Hourly Total	0	35	149	23	0	*207*	0	108	265	34	0	*407*	0	23	152	71	1	*246*	0	39	185	37	0	*261*	**1121**
12:00 PM	0	9	36	9	0	*54*	0	23	79	8	0	*110*	0	7	37	16	0	*60*	0	7	61	8	0	*76*	**300**
12:15 PM	0	5	30	8	0	*43*	0	32	64	8	1	*104*	0	5	34	17	0	*56*	0	10	53	9	0	*72*	**275**
12:30 PM	0	11	48	7	0	*66*	0	25	71	12	1	*108*	0	8	33	25	0	*66*	0	11	57	12	0	*80*	**320**
12:45 PM	0	18	55	5	0	*78*	0	31	78	12	0	*121*	0	7	50	24	0	*81*	0	8	74	9	0	*91*	**371**
Hourly Total	0	43	169	29	0	*241*	0	111	292	40	2	*443*	0	27	154	82	0	*263*	0	36	245	38	0	*319*	**1266**
1:00 PM	0	15	44	5	0	*64*	0	17	80	3	0	*100*	0	7	41	22	0	*70*	0	11	71	4	0	*86*	**320**
1:15 PM	0	9	53	3	0	*65*	0	26	80	9	0	*115*	0	9	70	21	0	*100*	0	5	54	5	0	*64*	**344**
1:30 PM	0	11	43	10	0	*64*	0	36	76	15	0	*127*	0	6	48	21	0	*75*	0	10	68	5	0	*83*	**349**
1:45 PM	0	15	51	6	0	*72*	0	38	93	15	0	*146*	0	7	38	18	0	*63*	0	9	61	11	3	*81*	**362**
Hourly Total	0	50	191	24	0	*265*	0	117	329	42	0	*488*	0	29	197	82	0	*308*	0	35	254	25	3	*314*	**1375**
2:00 PM	0	12	44	5	0	*61*	0	37	85	9	1	*131*	0	7	49	30	0	*86*	0	10	72	8	0	*90*	**368**
2:15 PM	0	13	63	12	0	*88*	0	32	85	6	0	*123*	0	11	56	13	0	*80*	0	11	57	14	1	*82*	**373**
2:30 PM	0	9	44	14	0	*67*	0	50	108	15	3	*173*	0	13	52	24	0	*89*	0	16	67	9	0	*92*	**421**
2:45 PM	0	13	39	5	0	*57*	0	33	95	14	1	*142*	0	20	43	20	0	*83*	0	9	79	8	1	*96*	**378**
Hourly Total	0	47	190	36	0	*273*	0	152	373	44	5	*569*	0	51	200	87	0	*338*	0	46	275	39	2	*360*	**1540**
3:00 PM	0	10	66	1	0	*77*	0	40	100	20	0	*160*	0	12	68	29	0	*109*	0	15	65	11	1	*91*	**437**
3:15 PM	0	9	54	9	0	*72*	0	37	108	19	0	*164*	0	9	60	17	0	*86*	0	11	82	18	0	*111*	**433**
3:30 PM	0	20	44	14	0	*78*	0	37	92	20	1	*149*	0	11	69	26	0	*106*	0	12	75	13	0	*100*	**433**
3:45 PM	0	13	53	15	0	*81*	0	48	84	15	0	*147*	0	16	71	30	0	*117*	0	19	72	7	0	*98*	**443**
Hourly Total	0	52	217	39	0	*308*	0	162	384	74	1	*620*	0	48	268	102	0	*418*	0	57	294	49	1	*400*	**1746**

Oberlin Ave and West 21st St
Lorain Ohio
03/10/2020 07:00:00

Time	Southbound Oberlin Ave						Westbound West 21st St						Northbound Oberlin Ave						Eastbound West 21st St						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
4:00 PM	0	12	59	11	0	*82*	0	36	100	13	0	*149*	0	15	57	30	1	*102*	0	11	90	13	0	*114*	**447**
4:15 PM	0	9	48	7	0	*64*	0	33	106	15	0	*154*	0	16	54	20	0	*90*	0	9	70	9	1	*88*	**396**
4:30 PM	0	13	59	12	0	*84*	0	47	120	11	0	*178*	0	11	46	20	0	*77*	0	23	80	8	1	*111*	**450**
4:45 PM	0	12	49	12	0	*73*	0	28	94	17	0	*139*	0	15	74	19	0	*108*	0	20	87	16	0	*123*	**443**
Hourly Total	0	46	215	42	0	*303*	0	144	420	56	0	*620*	0	57	231	89	1	*377*	0	63	327	46	2	*436*	**1736**
5:00 PM	0	18	39	8	0	*65*	0	25	107	20	0	*152*	0	9	68	19	0	*96*	0	12	64	19	0	*95*	**408**
5:15 PM	0	18	53	5	0	*76*	0	30	92	20	1	*142*	0	11	57	28	0	*96*	0	11	98	10	0	*119*	**433**
5:30 PM	0	10	47	11	0	*68*	0	28	87	24	0	*139*	0	9	55	25	0	*89*	0	21	73	8	0	*102*	**398**
5:45 PM	0	17	45	6	0	*68*	0	42	93	20	1	*155*	0	11	48	25	0	*84*	0	10	85	11	0	*106*	**413**
Hourly Total	0	63	184	30	0	*277*	0	125	379	84	2	*588*	0	40	228	97	0	*365*	0	54	320	48	0	*422*	**1652**
6:00 PM	0	18	35	6	0	*59*	0	25	70	11	0	*106*	0	13	39	28	1	*80*	0	11	64	8	1	*83*	**328**
6:15 PM	0	13	36	5	0	*54*	0	31	64	13	1	*108*	0	8	45	19	0	*72*	0	11	68	10	0	*89*	**323**
6:30 PM	0	15	40	6	0	*61*	0	26	75	10	0	*111*	0	9	38	22	0	*69*	0	9	64	10	0	*83*	**324**
6:45 PM	0	9	36	3	0	*48*	0	25	63	13	0	*101*	0	11	56	26	0	*93*	0	10	65	12	0	*87*	**329**
Hourly Total	0	55	147	20	0	*222*	0	107	272	47	1	*426*	0	41	178	95	1	*314*	0	41	261	40	1	*342*	**1304**
7:00 PM	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**
7:15 PM	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**
7:30 PM	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**
7:45 PM	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**
Hourly Total	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**
8:00 PM	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**
8:15 PM	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**
8:30 PM	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**
8:45 PM	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**
Hourly Total	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**
9:00 PM	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**
9:15 PM	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**
9:30 PM	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**
9:45 PM	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**
Hourly Total	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**
10:00 PM	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**
10:15 PM	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**
10:30 PM	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**
10:45 PM	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**
Hourly Total	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**
11:00 PM	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**
11:15 PM	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**
11:30 PM	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**
11:45 PM	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**
Hourly Total	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**
DAILY TOTAL	**0**	**564**	**2026**	**345**	**1**	***2935***	**0**	**1351**	**3829**	**531**	**13**	***5711***	**0**	**419**	**2091**	**954**	**3**	***3464***	**0**	**478**	**3032**	**414**	**9**	***3924***	**16034**
Cars	0	560	2012	338	1	*2910*	0	1333	3726	526	12	*5585*	0	417	2079	941	3	*3437*	0	473	2943	411	8	*3827*	**15759**
Heavy Vehicles	0	4	14	7	0	*25*	0	18	103	5	1	*126*	0	2	12	13	0	*27*	0	5	89	3	1	*97*	**275**
Heavy Vehicle %	0.00%	0.71%	0.69%	2.03%	0.00%	*0.85%*	0.00%	1.33%	2.69%	0.94%	7.69%	*2.21%*	0.00%	0.48%	0.57%	1.36%	0.00%	*0.78%*	0.00%	1.05%	2.94%	0.72%	11.11%	*2.47%*	**1.72%**

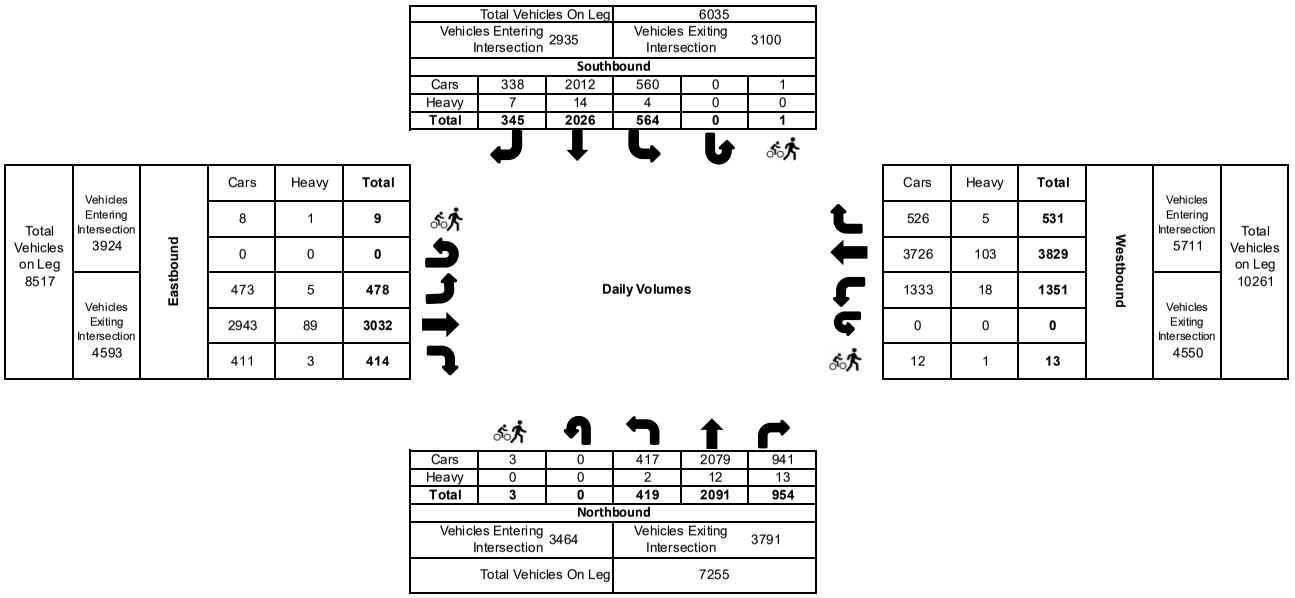
Oberlin Ave and West 21st St
Lorain Ohio
03/10/2020 07:00:00

AM Peak Hour

Time	Southbound						Westbound						Northbound						Eastbound						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehide Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
11:00 AM	0	4	16	4	0	*24*	0	21	66	8	0	*95*	0	3	28	20	0	*51*	0	12	53	10	0	*75*	**245**
11:15 AM	0	13	50	9	0	*72*	0	20	61	8	0	*89*	0	6	44	15	1	*65*	0	5	44	4	0	*53*	**279**
11:30 AM	0	7	37	4	0	*48*	0	32	73	10	0	*115*	0	7	39	17	0	*63*	0	12	52	15	0	*79*	**305**
11:45 AM	0	11	46	6	0	*63*	0	35	65	8	0	*108*	0	7	41	19	0	*67*	0	10	36	8	0	*54*	**292**
Peak Hour Total	0	35	149	23	0	*207*	0	108	265	34	0	*407*	0	23	152	71	1	*246*	0	39	185	37	0	*261*	**1121**
PHF	0.000	0.673	0.745	0.639	0.000	*0.719*	0.000	0.771	0.908	0.850	0.000	*0.885*	0.000	0.821	0.864	0.888	0.250	*0.918*	0.000	0.813	0.873	0.617	0.000	*0.826*	**0.919**

PM Peak Hour

Time	Southbound						Westbound						Northbound						Eastbound						VEHICLE TOTAL
	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehide Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	U Turns	Left Turns	Straight Through	Right Turns	Crosswalk Crossings	*Vehicle Approach Total*	
3:15 PM	0	9	54	9	0	*72*	0	37	108	19	0	*164*	0	9	60	17	0	*86*	0	11	82	18	0	*111*	**433**
3:30 PM	0	20	44	14	0	*78*	0	37	92	20	1	*149*	0	11	69	26	0	*106*	0	12	75	13	0	*100*	**433**
3:45 PM	0	13	53	15	0	*81*	0	48	84	15	0	*147*	0	16	71	30	0	*117*	0	19	72	7	0	*98*	**443**
4:00 PM	0	12	59	11	0	*82*	0	36	100	13	0	*149*	0	15	57	30	1	*102*	0	11	90	13	0	*114*	**447**
Peak Hour Total	0	54	210	49	0	*313*	0	158	384	67	1	*609*	0	51	257	103	1	*411*	0	53	319	51	0	*423*	**1756**
PHF	0.000	0.675	0.890	0.817	0.000	*0.954*	0.000	0.823	0.889	0.838	0.250	*0.928*	0.000	0.797	0.905	0.858	0.250	*0.878*	0.000	0.697	0.886	0.708	0.000	*0.928*	**0.982**

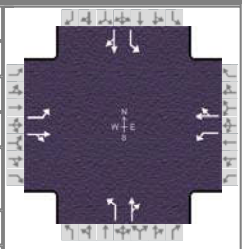


APPENDIX B

Capacity Analysis – 'No Build' and 'Build' Conditions

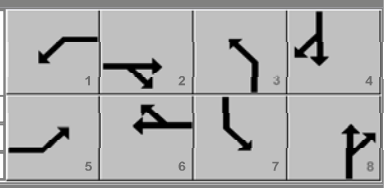
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.250
Analyst		Analysis Date	Jun 22, 2020	Area Type	Other
Jurisdiction	City of Lorain	Time Period	AM Peak Hour	PHF	0.92
Urban Street	State Route 611	Analysis Year	Existing Year 2020 'No-Build'	Analysis Period	1> 7:00
Intersection	State Route 611 / Oberli…	File Name	611 and Oberlin - AM Peak - 2020 NB.xus		
Project Description	State Route 611 / Oberlin Avenue Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	50	210	40	130	310	40	30	180	80	40	170	30

Signal Information										
Cycle, s	90.0	Reference Phase	2							
Offset, s	0	Reference Point	End	Green	10.0	29.4	8.0	22.6	0.0	0.0
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	4.0	4.0	4.0	4.0	0.0	0.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	1.0	1.0	0.0	0.0



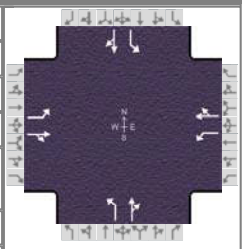
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0
Phase Duration, s	15.0	34.4	15.0	34.4	13.0	27.6	13.0	27.6
Change Period, (*Y+R c*), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Queue Clearance Time (*g s*), s	4.5	12.5	8.8	17.6	3.5	14.6	4.0	11.0
Green Extension Time (*g e*), s	0.0	0.7	0.0	0.7	0.0	0.5	0.0	0.5
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.00	0.00	1.00	0.00	0.02	0.01	0.06	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	54	272		141	380		33	283		43	217	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1847		1810	1862		1810	1800		1810	1850	
Queue Service Time (*g s*), s	2.5	10.5		6.8	15.6		1.5	12.6		2.0	9.0	
Cycle Queue Clearance Time (*g c*), s	2.5	10.5		6.8	15.6		1.5	12.6		2.0	9.0	
Green Ratio (*g/C*)	0.11	0.33		0.11	0.33		0.09	0.25		0.09	0.25	
Capacity (*c*), veh/h	201	603		201	608		161	452		161	465	
Volume-to-Capacity Ratio (*X*)	0.270	0.450		0.703	0.626		0.203	0.625		0.270	0.468	
Back of Queue (*Q*), ft/ln (50 th percentile)	27.1	110.3		85.8	170.8		16.6	137.1		22.3	96.9	
Back of Queue (*Q*), veh/ln (50 th percentile)	1.1	4.4		3.4	6.8		0.7	5.5		0.9	3.9	
Queue Storage Ratio (*RQ*) (50 th percentile)	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00	
Uniform Delay (*d 1*), s/veh	36.7	23.9		38.6	25.6		38.0	29.9		38.3	28.6	
Incremental Delay (*d 2*), s/veh	0.3	0.2		9.0	1.5		0.2	2.0		0.3	0.3	
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	36.9	24.1		47.6	27.2		38.3	32.0		38.6	28.9	
Level of Service (LOS)	D	C		D	C		D	C		D	C	
Approach Delay, s/veh / LOS	26.3	C		32.7	C		32.6	C		30.5	C	
Intersection Delay, s/veh / LOS	30.8						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.92	B	1.92	B	1.93	B	1.93	B
Bicycle LOS Score / LOS	1.03	A	1.35	A	1.01	A	0.92	A

HCS7 Signalized Intersection Results Summary

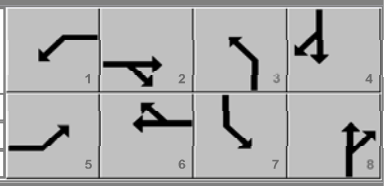
General Information				Intersection Information	
Agency				Duration, h	0.250
Analyst		Analysis Date	Jun 22, 2020	Area Type	Other
Jurisdiction	City of Lorain	Time Period	PM Peak Hour	PHF	0.92
Urban Street	State Route 611	Analysis Year	Existing Year 2020 'No-Build'	Analysis Period	1> 7:00
Intersection	State Route 611 / Oberli…	File Name	611 and Oberlin - PM Peak - 2020 NB.xus		
Project Description	State Route 611 / Oberlin Avenue Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	60	370	60	180	450	80	60	300	120	60	240	60

Signal Information			
Cycle, s	90.0	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	11.0	28.1	8.0	22.9	0.0	0.0
Yellow	4.0	4.0	4.0	4.0	0.0	0.0
Red	1.0	1.0	1.0	1.0	0.0	0.0



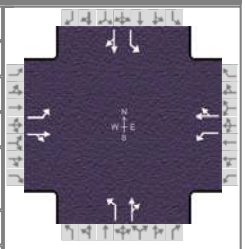
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0
Phase Duration, s	16.0	33.1	16.0	33.1	13.0	27.9	13.0	27.9
Change Period, ($Y+R_c$), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Queue Clearance Time (g_s), s	5.0	22.9	11.6	30.0	5.1	24.7	5.1	16.5
Green Extension Time (g_e), s	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.7
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.00	0.31	1.00	1.00	0.56	1.00	0.56	0.12

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	467		196	576		65	457		65	326	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1853		1810	1850		1810	1807		1810	1834	
Queue Service Time (g_s), s	3.0	20.9		9.6	28.0		3.1	22.7		3.1	14.5	
Cycle Queue Clearance Time (g_c), s	3.0	20.9		9.6	28.0		3.1	22.7		3.1	14.5	
Green Ratio (*g/C*)	0.12	0.31		0.12	0.31		0.09	0.25		0.09	0.25	
Capacity (*c*), veh/h	221	579		221	578		161	460		161	467	
Volume-to-Capacity Ratio (*X*)	0.295	0.808		0.885	0.997		0.405	0.993		0.405	0.699	
Back of Queue (*Q*), ft/ln (50 th percentile)	32.3	250.9		150.6	441.9		33.9	365.1		33.9	166.8	
Back of Queue (*Q*), veh/ln (50 th percentile)	1.3	10.0		6.0	17.7		1.4	14.6		1.4	6.7	
Queue Storage Ratio (*RQ*) (50 th percentile)	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00	
Uniform Delay (d_1), s/veh	36.0	28.5		38.9	30.9		38.8	33.5		38.8	30.4	
Incremental Delay (d_2), s/veh	0.3	7.7		30.8	36.8		0.6	40.0		0.6	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	36.2	36.2		69.7	67.7		39.4	73.4		39.4	34.3	
Level of Service (LOS)	D	D		E	E		D	E		D	C	
Approach Delay, s/veh / LOS	36.2	D		68.2	E		69.2	E		35.1	D	
Intersection Delay, s/veh / LOS	54.9						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.92	B	1.92	B	1.93	B	1.93	B
Bicycle LOS Score / LOS	1.37	A	1.76	B	1.35	A	1.13	A

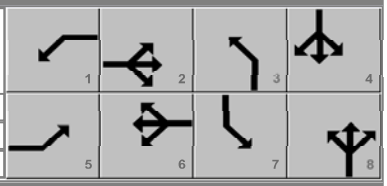
HCS7 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.250
Analyst		Analysis Date	Jun 22, 2020	Area Type	Other
Jurisdiction	City of Lorain	Time Period	AM Peak Hour	PHF	0.92
Urban Street	State Route 611	Analysis Year	Existing Year 2020 'Build'	Analysis Period	1> 7:00
Intersection	State Route 611 / Oberli…	File Name	611 and Oberlin - AM Peak - 2020 B.xus		
Project Description	State Route 611 / Oberlin Avenue Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	50	210	40	130	310	40	30	180	80	40	170	30

Signal Information										
Cycle, s	90.0	Reference Phase	2							
Offset, s	0	Reference Point	End							
Uncoordinated	Yes	Simult. Gap E/W	On	Green	7.0	30.3	7.0	29.1	0.0	0.0
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.1	3.3	3.0	3.1	0.0	0.0
				Red	1.0	1.0	1.1	1.0	0.0	0.0



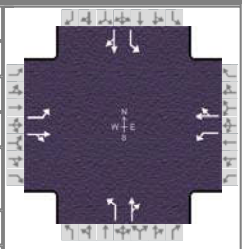
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	1.1	4.0	1.1	4.0	1.1	4.0	1.1	4.0
Phase Duration, s	11.1	34.6	11.1	34.6	11.1	33.2	11.1	33.2
Change Period, ($Y+R_c$), s	4.1	4.3	4.1	4.3	4.1	4.1	4.1	4.1
Max Allow Headway (*MAH*), s	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Queue Clearance Time (g_s), s	3.6	12.3	6.5	17.3	3.0	13.3	3.3	10.1
Green Extension Time (g_e), s	0.0	2.3	0.0	2.0	0.0	1.6	0.0	1.7
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	1.00	0.01	1.00	0.06	1.00	0.01	1.00	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	54	272		141	380		33	283		43	217	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1847		1810	1862		1810	1800		1810	1850	
Queue Service Time (g_s), s	1.6	10.3		4.5	15.3		1.0	11.3		1.3	8.1	
Cycle Queue Clearance Time (g_c), s	1.6	10.3		4.5	15.3		1.0	11.3		1.3	8.1	
Green Ratio (*g/C*)	0.41	0.34		0.41	0.34		0.40	0.32		0.40	0.32	
Capacity (*c*), veh/h	367	622		446	627		470	582		416	598	
Volume-to-Capacity Ratio (*X*)	0.148	0.437		0.317	0.607		0.069	0.485		0.105	0.363	
Back of Queue (*Q*), ft/ln (50 th percentile)	16.5	109.3		45.1	168.2		10	118.1		13.5	86.5	
Back of Queue (*Q*), veh/ln (50 th percentile)	0.7	4.4		1.8	6.7		0.4	4.7		0.5	3.5	
Queue Storage Ratio (*RQ*) (50 th percentile)	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00	
Uniform Delay (d_1), s/veh	17.7	23.2		17.7	24.9		17.0	24.4		17.6	23.3	
Incremental Delay (d_2), s/veh	0.2	0.5		0.4	1.7		0.1	0.6		0.1	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	17.9	23.7		18.1	26.6		17.1	25.1		17.7	23.7	
Level of Service (LOS)	B	C		B	C		B	C		B	C	
Approach Delay, s/veh / LOS	22.7	C		24.3	C		24.2	C		22.7	C	
Intersection Delay, s/veh / LOS	23.6						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.92	B	1.92	B	1.92	B	1.92	B
Bicycle LOS Score / LOS	1.03	A	1.35	A	1.01	A	0.92	A

HCS7 Signalized Intersection Results Summary

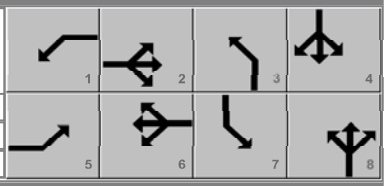
General Information				Intersection Information	
Agency				Duration, h	0.250
Analyst		Analysis Date	Jun 22, 2020	Area Type	Other
Jurisdiction	City of Lorain	Time Period	PM Peak Hour	PHF	0.92
Urban Street	State Route 611	Analysis Year	Existing Year 2020 'Build'	Analysis Period	1> 7:00
Intersection	State Route 611 / Oberli…	File Name	611 and Oberlin - PM Peak - 2020 B.xus		
Project Description	State Route 611 / Oberlin Avenue Safety Study				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	60	370	60	180	450	80	60	300	120	60	240	60

Signal Information			
Cycle, s	90.0	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	7.0	31.7	7.0	27.7	0.0	0.0
Yellow	3.1	3.3	3.0	3.1	0.0	0.0
Red	1.0	1.0	1.1	1.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	1.1	4.0	1.1	4.0	1.1	4.0	1.1	4.0
Phase Duration, s	11.1	36.0	11.1	36.0	11.1	31.8	11.1	31.8
Change Period, (*Y+R c*), s	4.1	4.3	4.1	4.3	4.1	4.1	4.1	4.1
Max Allow Headway (*MAH*), s	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Queue Clearance Time (*g s*), s	3.9	21.7	8.2	28.4	4.1	23.1	4.1	15.5
Green Extension Time (*g e*), s	0.0	1.2	0.0	0.7	0.0	0.6	0.0	0.9
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.43	0.04	1.00	0.71	0.57	0.32	0.57	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	65	467		196	576		65	457		65	326	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810	1853		1810	1850		1810	1807		1810	1834	
Queue Service Time (*g s*), s	1.9	19.7		6.2	26.4		2.1	21.1		2.1	13.5	
Cycle Queue Clearance Time (*g c*), s	1.9	19.7		6.2	26.4		2.1	21.1		2.1	13.5	
Green Ratio (*g/C*)	0.43	0.35		0.43	0.35		0.39	0.31		0.39	0.31	
Capacity (*c*), veh/h	252	653		326	652		366	556		270	564	
Volume-to-Capacity Ratio (*X*)	0.259	0.716		0.601	0.884		0.178	0.821		0.242	0.578	
Back of Queue (*Q*), ft/ln (50 th percentile)	19.1	219.5		65.7	333.9		20.8	251.7		20.9	144.6	
Back of Queue (*Q*), veh/ln (50 th percentile)	0.8	8.8		2.6	13.4		0.8	10.1		0.8	5.8	
Queue Storage Ratio (*RQ*) (50 th percentile)	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00	
Uniform Delay (*d 1*), s/veh	20.0	25.3		19.7	27.4		19.0	28.9		20.8	26.2	
Incremental Delay (*d 2*), s/veh	0.2	3.2		2.2	13.2		0.1	8.9		0.2	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	20.2	28.5		21.9	40.7		19.1	37.8		21.0	27.2	
Level of Service (LOS)	C	C		C	D		B	D		C	C	
Approach Delay, s/veh / LOS	27.5	C		35.9	D		35.5	D		26.2	C	
Intersection Delay, s/veh / LOS	32.1						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.92	B	1.92	B	1.92	B	1.92	B
Bicycle LOS Score / LOS	1.37	A	1.76	B	1.35	A	1.13	A

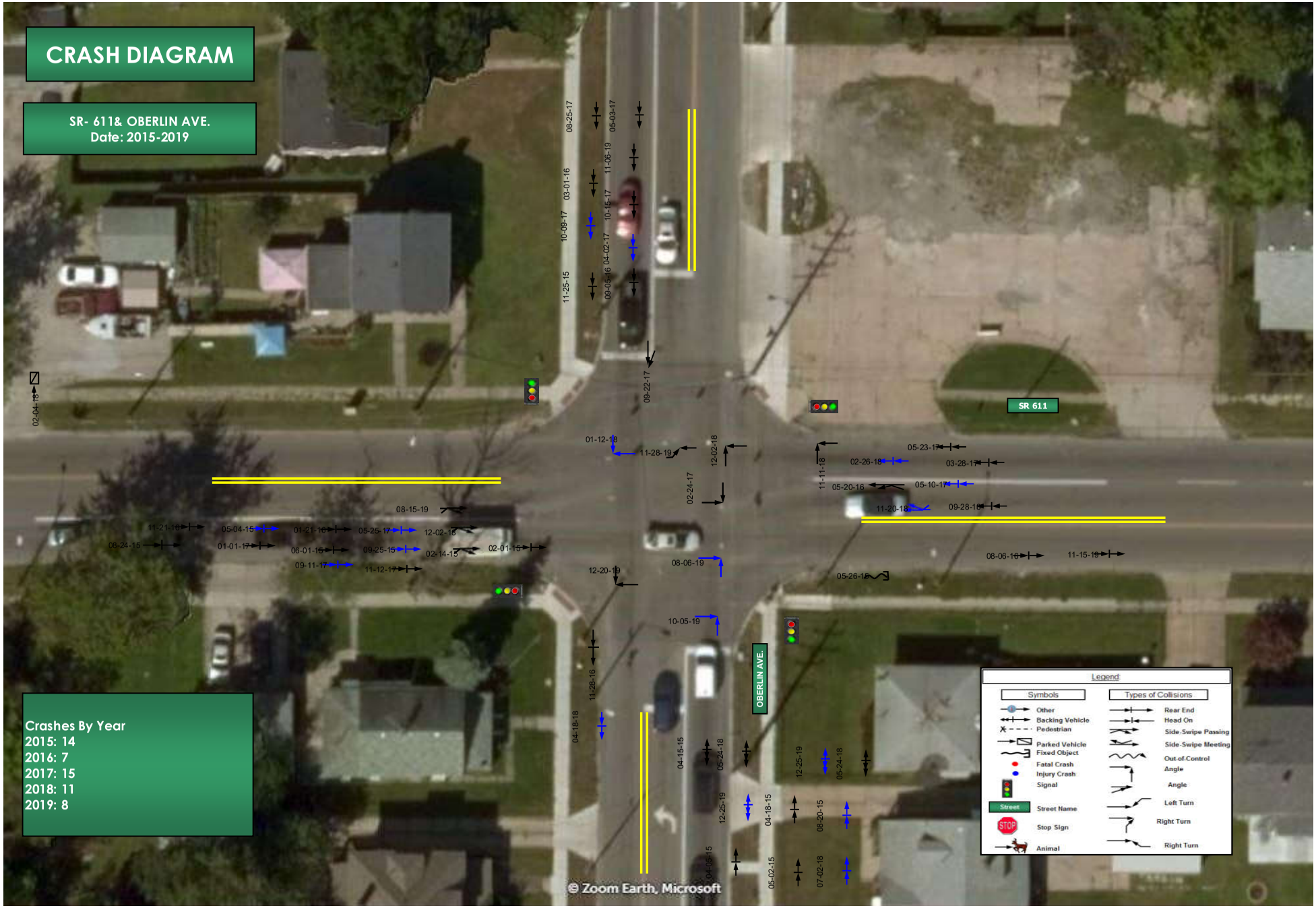
APPENDIX C

Yellow Change and Red Clearance Intervals Calculations

ASSOCIATED PHASE	DIRECTION	MOVEMENT	TRAFFIC SIGNAL														PEDESTRIAN													
			FACTORS *(TEM 403-2)								CALCULATED (TEM 403-2)			FINAL CLEARANCE								OMUTCD 4E.06-12	OMUTCD 4E.06-07		3 fps CHECKS (OMUTCD 4E.06, 01-14)				FINAL PED TIMING	
			POSTED SPEED LIMIT	PERCEPTION/REACTION 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	PED MOVEMENT	ASSOCIATED PHASE	CROSSWALK LENGTH	PUSHBUTTON PROVIDED	DISTANCE TO PUSHBUTTON FROM CURB	WALK INTERVAL (4-7s TYP)	CALCULATED PED CLEARANCE	PED CHANGE INTERVAL (FDW)	(L+P)/(3 fps) (NOTE: P=6 IF NO PUSHBUTTON)	WALK + PED CHANGE INTERVALS	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			L		P		= 3.5 fps WALK TIME	= 3.5 fps WALK TIME - 3 sec BUFFER	X	Y				
			MPH	SEC	MPH	MPH	FPS	FT	FT	%	SEC	SEC	SEC	SEC	SEC	SEC			FT		FT	SEC	SEC	SEC	SEC	SEC		SEC	SEC	SEC
1	WB LT	LEFT TURN	35	1	30	25	10	40	20	-0.25	3.2	0.6	3.8	3.1	1	4.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	EB	THROUGH/RT	35	1	42	42	10	56	20	0	4.1	0.2	4.3	3.3	1	4.3	EB	2	54	NO	-	7	15.4	12.4	20.0	19.4	NO	0.6	8	13
3	NB LT	LEFT TURN	25	1	20	25	10	65	20	-0.5	2.5	1.3	3.8	3	1.1	4.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	SB	THROUGH/RT	25	1	32	32	10	58	20	0.25	3.3	0.7	4.0	3.1	1	4.1	SB	4	54	NO	-	7	15.4	12.4	20.0	19.4	NO	0.6	8	13
5	EB LT	LEFT TURN	35	1	30	25	10	50	20	0	3.2	0.9	4.1	3.1	1	4.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	WB	THROUGH/RT	35	1	42	42	10	56	20	-0.25	4.1	0.2	4.3	3.3	1	4.3	WB	6	50	NO	-	7	14.3	11.3	18.7	18.3	NO	0.4	8	12
7	SB LT	LEFT TURN	25	1	20	25	10	75	20	0.25	2.5	1.6	4.1	3	1.1	4.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	NB	THROUGH/RT	25	1	32	32	10	60	20	-0.5	3.4	0.7	4.1	3.1	1	4.1	NB	8	52	NO	-	7	14.9	11.9	19.3	18.9	NO	0.5	8	12

APPENDIX D

Crash Diagram


CRASH DIAGRAM
SR- 611& OBERLIN AVE.
Date: 2015-2019
SR 611
OBERLIN AVE.
Crashes By Year
2015: 14
2016: 7
2017: 15
2018: 11
2019: 8
Legend
Symbols
Other
Backing Vehicle
Pedestrian
Parked Vehicle
Fixed Object
Fatal Crash
Injury Crash
Signal
Street
Street Name
STOP
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
© Zoom Earth, Microsoft

APPENDIX E

Cost Estimate

Preliminary Opinion of Probable Cost

ITEM	DESCRIPTION	TOTAL QUANTITY	UNIT	ESTIMATED PRICE	TOTAL COST
	TRAFFIC CONTROL				
	SIGNING	1	LS	$5,000	$5,000
	STRIPING	1	LS	$15,000	$15,000
	TRAFFIC CONTROL SUBTOTAL:				**$20,000**
	SIGNALIZATION				
632	TRAFFIC SIGNAL	1	EACH	$167,500	$167,500
	SIGNALIZATION SUBTOTAL:				**$167,500**
	MISCELLANEOUS				
623	CONSTRUCTION LAYOUT STAKES	1	LS	$2,000	$2,000
624	MOBILIZATION	1	LS	$10,000	$10,000
SPECIAL	PERFORMANCE BOND	1	LS	$2,000	$2,000
	MISCELLANEOUS SUBTOTAL:				**$14,000**
	RIGHT OF WAY				
	PERMANENT R/W TAKE - MINOR - COMMERCIAL	3	EACH	$10,000	$30,000
	PERMANENT R/W TAKE - MINOR - RESIDENTIAL	1	EACH	$5,000	$5,000
	ACQUISITION SERVICES	4	EACH	$5,000	$20,000
	APPRAISAL REVIEW SERVICES	4	EACH	$500	$2,000
	RIGHT OF WAY SUBTOTAL:				**$57,000**
	TOTAL CONSTRUCTION AND RIGHT OF WAY COST:				**$258,500**
	DESIGN ENGINEERING COST:	(20% OF CONSTR. & R/W COST)			**$49,000**
	DESIGN CONTINGENCY COSTS	(20% OF CONSTR. & R/W COST)			**$49,000**
	PROJECT SUBTOTAL:				**$356,500**
	3% INFLATION CONTINGENCY OVER 2 YEARS (6%):				**$22,000**
	PROJECT TOTAL WITHOUT CONSTRUCTION INSPECTION				**$378,500**
	CONSTRUCTION INSPECTION COST:	(10% OF PROJECT TOTAL)			**$38,000**
				TOTAL:	**$416,500**

APPENDIX F

Benefit to Cost Analysis

Safety Benefit - Cost Analysis

General Information

Project Name	State Route 611 / Oberlin Avenue	Contact Email	cdeibel@gpdgroup.com
Project Description	Intersection Safety Improvement	Contact Phone	(330) 572-2495
Reference Number	2020050.15	Date Performed	6/22/2020
Analyst	Curtis J. Deibel, PE, RSP	Analysis Year	2020
Agency/Company	GPD Group		

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
Convert left turn phasing to protected/permissing on all four approach legs	20	$6,895.55			$6,895.55	$6,895.55	1.554	($562,022)
		$0.00			$0.00	$0.00		
		$0.00			$0.00	$0.00		
		$0.00			$0.00	$0.00		
CMF 1 - Improve Signal Visibility	20	$328,917.80			$328,917.80	$328,917.80	-1.902	$807,840
CMF 2 - Install Pedestrian Countdown Timer	20	$20,686.65			$20,686.65	$20,686.65	-0.564	$194,581
		$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		**$356,500.00**	**$0.00**	**$0.00**	**$356,500.00**	**$356,500.00**	**-0.912**	**$440,399**

Safety Benefit - Cost Analysis

General Information

Project Name	State Route 611 / Oberlin Avenue	Contact Email	cdeibel@gpdgroup.com
Project Description	Intersection Safety Improvement	Contact Phone	(330) 572-2495
Reference Number	2020050.15	Date Performed	6/22/2020
Analyst	Curtis J. Deibel, PE, RSP	Analysis Year	2020
Agency/Company	GPD Group		

Benefit - Cost Calculator

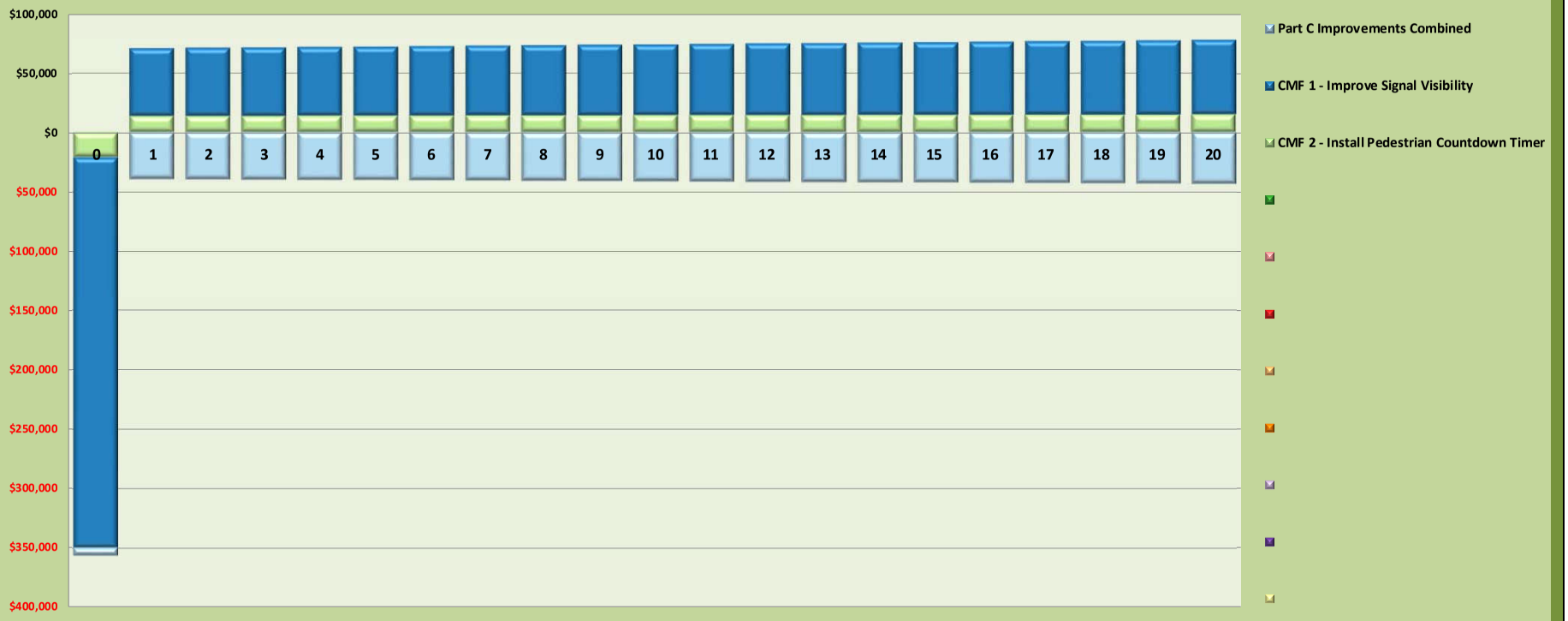
Net Present Value of Project	$356,500.00
Net Present Value of Safety Benefits	$440,398.91
Net Benefit	$83,898.91
Benefit / Cost Ratio	1.24

Expected Annual Crash Adjustment

Number of Fatal & Incapacitating Injury Crashes	-0.026
Number of Injury Crashes	-0.327
Number of Total Crashes	-0.912

Comments:

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

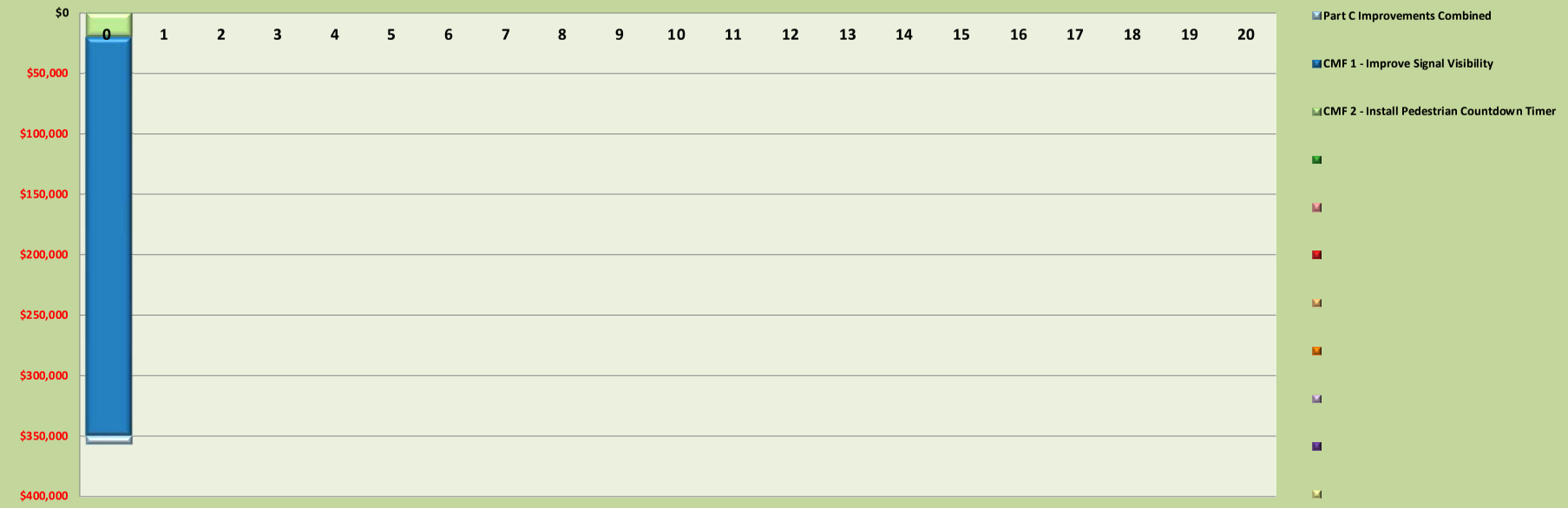


Safety Benefit - Cost Analysis

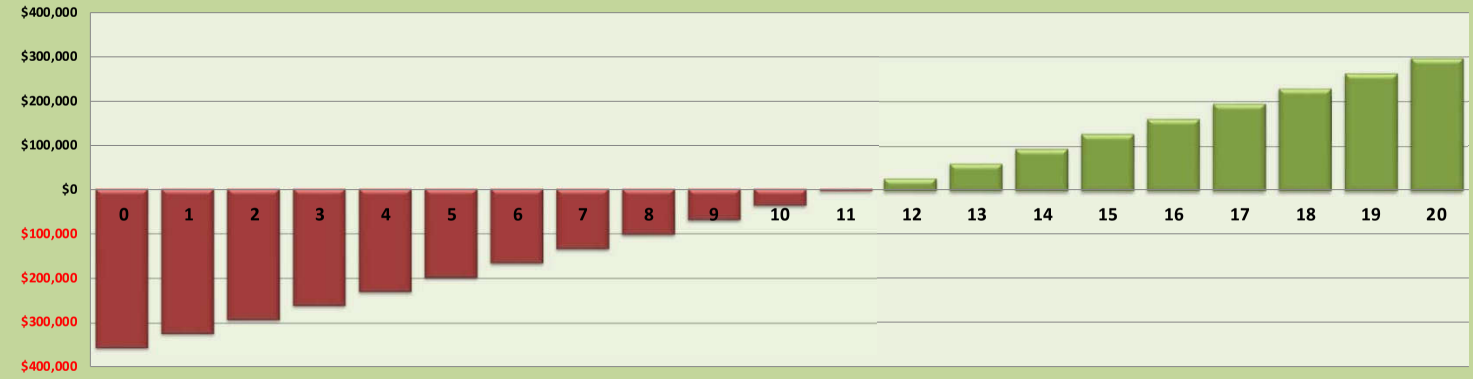
General Information

Project Name	State Route 611 / Oberlin Avenue	Contact Email	cdeibel@gpdgroup.com
Project Description	Intersection Safety Improvement	Contact Phone	(330) 572-2495
Reference Number	2020050.15	Date Performed	6/22/2020
Analyst	Curtis J. Deibel, PE, RSP	Analysis Year	2020
Agency/Company	GPD Group		

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 investiment: 2032 (12

Percentage of Service Life to observe a continuous Positive Return on Investment: 45.00%

APPENDIX G

Formal Safety Application

OHIO DEPARTMENT OF TRANSPORTATION

Safety Funding Application

General Project Information	
Project Sponsoring Agency	City of Lorain
Project Name	State Route 611 / Oberlin Avenue Intersection Safety Improvement
PID	Not Assigned
Project Manager	Veronica A. Newsome. P.E.
Contact Phone	(440) 204-2003
Contact Email	veronica_newsome@cityoflorain.org

Location Information			
ODOT District	3	**County**	LOR
Route Number	SR-611R	**Road Name**	West 21st Street
Begin Logpoint	2.030	**End Logpoint**	2.030
Begin Latitude	41.451	**Begin Longitude**	-82.185
End Latitude	41.451	**End Longitude**	-82.185

Project Description

Summary of Crash Patterns

Looking at the existing conditions at the intersection, it was noted that the current traffic signal installation is an older, span wire installation that lacks traffic signal backplates which affects the visibility of the existing traffic signal, contributing to the rear-end and angle crashes that were found to occur. The below image shows the existing signal heads for the east approach.

The existing traffic signal timings and clearance intervals could be leading to both rear-end and angle crashes occurring at the intersection. The existing signal timings have not been revised for over 5 years, including the clearance intervals. If the clearance intervals are too short for motorists to clear the intersection during the phase change, angle crashes could be occurring.

While the intersection appears to have adequate capacity, the current intersection phasing could be creating unnecessary delay at the intersection. Currently, all four left turn phases at the intersection are protected-only. Under the protected only phasing, additional green time is allocated to the left turn phases since this traffic cannot make the left turn movement under a permissive phase. Based on the traffic volumes and existing conditions at this intersection, there is not a need for the left turn movements to be protected-only.

Several sideswipe – passing crashes occurred on the west leg due to the lane drop condition for EB traffic. When approaching the intersection there are 2 approach lanes, one of which becomes a drop left turn onto NB Oberlin Avenue. This lane drop configuration contributes to the rear-end and sideswipe – passing crashes identified on the west leg.

The rear-end and sideswipe-passing crashes occurring on the east leg of the intersection could be attributed to the pavement markings that exist between Hamilton Avenue and Oberlin Avenue. For westbound traffic, there is a small section of a center two-way left turn lane followed by a section of roadway that appears to have two thru travel lanes, which then becomes a drop left turn lane onto southbound Oberlin Avenue. The confusing pavement markings could lead to vehicles making sudden lane changes while approaching the intersection.

Lastly, rear-end crashes were found on the north and south legs of the intersection. These crashes appear to be related to the signal visibility issue noted earlier and due to the congestion that occurs, particularly in the PM peak hour.

Summary of Recommended Countermeasures

1.Implement updated signal timings and clearance intervals
2.Reconstruct the traffic signal at the intersection and include backplates on the traffic signal heads.
3.Convert the left turn phasing at the intersection to protected/permissive for all intersection approaches.
4.Restripe SR 611 between Oberlin Avenue and Hamilton Avenue.
5.Upgrade the pedestrian accommodations at the intersection to include a pedestrian countdown timer.
6.Investigate signal coordination on SR 611
7.Community and school promotion of driver safety to students and parents

The above improvement list will help to mitigate the existing crash patterns that were identified at the study intersection. It should be noted that the existing span wire signal installation will be unable to accommodate the traffic signal backplates and the 5 section signal heads required to be installed in order to provide the protected/permissive traffic signal phasing. Therefore, the existing traffic signal installation will need to be reconstructed. The traffic signals should be reconstructed and upgraded to include full vehicular detection, meet current design standards, and incorporate current technology. All traffic signals should be designed to accommodate traffic signal backplates on all approaches to increase signal visibility and add target value to the signal heads. Additionally, the upgraded signals should provide full pedestrian accommodations with pushbuttons and countdown displays. The new traffic signal should also have updated signal timings and clearance intervals incorporated. The city will also investigate the addition of advance warning signs with street name plaques during the detailed design phase of this project.

Project Priority Information

The State Route 611 / Oberlin Avenue intersection is the #478 ranked urban intersection on a statewide basis and the 5th highest ranked intersection within the City of Lorain. These rankings are provided from the 2018 ODOT HSIP safety priority list.

Safety Funding Application

Crash Data

Crash Totals

	Fatal & Serious Injury (KA)	Visible Injury (B)	Non-Visible (C)	Property Damage Only (O)	Total
Existing Conditions: Predicted Crash Frequency	0.0864	0.3900	0.5411	2.8003	3.82
Existing Conditions: Expected Crash Frequency	0.1266	0.5965	0.8758	5.1559	6.75
Potential for Safety Improvement	0.0402	0.2065	0.3347	2.3556	2.94
Proposed Conditions: Expected Crash Frequency	0.1006	0.4746	0.6972	4.5704	5.84
Observed Crashes	0.0000	0.8000	2.8000	7.4000	11.00

Observed People Injury Totals

	Fatal Injury (K)	Serious Injury (A)	Visible Injury (B)	Non-Visible (C)	Total
Observed People Injury Totals	0.0000	0.0000	1.0000	3.6000	4.60

Application Scoring

Category	Scoring Value	Points Awarded	Points Possible
Expected Crash Frequency	6.75	4	10
Ratio of Observed Fatal and Serious Injuries to Observed Total Crashes	0.00	0	5
% of the Potential for Safety Improvement to Total Expected Crashes	43.56%	20	20
Relative Severity Index	$24,986	2	10
Equivalent Property Damage Only Index	2.65	2	5
Volume to Capacity Ratio	0.99	10	10
Benefit Cost Ratio	1.29	6	30
Safety Funding Request Percentage	100.00%	10	10
Total		54	100

Strategic Highway Safety Plan

Functional Class	Other Principal Arterial Roadway
Major Route AADT	12,380
Ohio Emphasis Area	Serious Crash Types
Ohio Emphasis Area Subcategory	Intersection
FHWA Emphasis Area	Improving the design and operation of highway intersections
FHWA Improvement Category	Intersection traffic control
FHWA Improvement Subcategory	Modify traffic signal - add additional signal heads

Work Locations

NLFID	Begin Logpoint	End Logpoint	Begin Latitude	Begin Longitude	Location Termini (i.e. from Street 1 to Street 2)
SLORSR00611**C	2.030	2.030	41.451	-82.1852	State Route 611 / Oberlin Avenue Intersection

OHIO DEPARTMENT OF TRANSPORTATION

Safety Funding Application

Project Funding

Project Phase	Safety Study	Interchange Mod. Study	PE - Environmental	PE - Detailed Design	Right of Way /Utilities	Construction	Total
Fiscal Year	2021		2021	2021	2022	2023	
Project Phase Completed	☑	☐	☐	☐	☐	N/A	
Previous Safety	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
New Safety	$0.00	$0.00	$33,000.00	$16,000.00	$57,000.00	$310,500.00	$416,500.00
Sponsor Funding	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	$0.00	$0.00	$33,000.00	$16,000.00	$57,000.00	$310,500.00	$416,500.00

Additional Funding Detail

The City of Lorain is requesting 100% funding for this project with an anticipated construction in ODOT State Fiscal Year 2023, which will begin on July 1st, 2022. This will give the City of Lorain two years to design and acquire any necessary R/W for this project to move forward.

At this time, the R/W funding is being requested as it is assumed that corner roundings will be necessary on all 4 corners of the intersection.

Project Development

Project Phase	Completed by	Completion Date
Safety Study	City of Lorain	Jul-20

Applicant Information

Name	Title	Phone Number
Dale Vandersommen, P.E.	City Engineer	(440) 204-2003
Signature		**Date**

Version: 20150917

The following information should be included in submission of the safety project application:

1. An electronic copy of the Safety Engineering Study
2. All Excel Analysis Files
   May include Crash Analysis Module (CAM) Tool, Economic Crash Analysis Tool (ECAT), HSIP Application and Scoring Tool.
3. Benefit-Cost Results (Economic Analysis)
4. DSRT approval signatures

APPENDIX H

Signal Warrants

Study Name: Oberlin and W 21
Study Date : 6/22/2020

Signal Warrants - Summary

Major Street Approaches

Eastbound: West 21st Street
Number of Lanes : 1

Total Approach Volume: 3,924

Westbound: West 21st Street
Number of Lanes :1

Total Approach Volume: 5,711

Minor Street Approaches

Northbound: Oberlin Avenue
Number of Lanes :1

Total Approach Volume: 3,464

Southbound: Oberlin Avenue
Number of Lanes :1

Total Approach Volume: 2,935

Warrant Summary (Urban 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 ..... **Not Satisfied**
Required volumes reached for 7 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 10 hours, 8 are needed

Warrant 2 - Four Hour Volumes ..... **Satisfied**
Number of hours (9) volumes exceed minimum >= minimum required (4).

Warrant 3 - Peak Hour ..... **Satisfied**

Warrant 3A - Peak Hour Delay ..... **Not Satisfied**
Total approach volumes and delays on minor street do not exceed minimums for any one hour period.

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**

Study Name: Oberlin and W 21

Study Date : 6/22/2020

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 = **False**
Number of Major Lanes = **1**
Number of Minor Lanes = **1**

Volume Requirements

Veh/Hr Major = **500**

Veh/Hr Minor = **150**

	Major Road West 21st Street					Minor Road Oberlin Avenue		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
16:00 - 17:00	436	+	620	=	1056	377	303	Yes
15:00 - 16:00	400	+	620	=	1020	418	308	Yes
17:00 - 18:00	422	+	588	=	1010	365	277	Yes
14:00 - 15:00	360	+	569	=	929	338	273	Yes
13:00 - 14:00	314	+	488	=	802	308	265	Yes
18:00 - 19:00	342	+	426	=	768	314	222	Yes
12:00 - 13:00	319	+	443	=	762	263	241	Yes
11:00 - 12:00	261	+	407	=	668	246	207	Yes
08:00 - 09:00	244	+	399	=	643	183	175	Yes
10:00 - 11:00	235	+	390	=	625	196	185	Yes
09:00 - 10:00	231	+	333	=	564	190	173	Yes
07:00 - 08:00	232	+	275	=	507	161	195	Yes
06:45 - 07:45	190	+	224	=	414	126	159	No
06:30 - 07:30	154	+	187	=	341	115	143	No
06:15 - 07:15	137	+	180	=	317	102	118	No
06:00 - 07:00	128	+	153	=	281	105	111	No
05:45 - 06:45	85	+	105	=	190	74	85	No
05:30 - 06:30	54	+	61	=	115	51	59	No
05:15 - 06:15	24	+	26	=	50	24	32	No
23:00 - 00:00	0	+	0	=	0	0	0	No
05:00 - 06:00	0	+	0	=	0	0	0	No
04:30 - 05:30	0	+	0	=	0	0	0	No
04:45 - 05:45	0	+	0	=	0	0	0	No
23:15 - 00:15	0	+	0	=	0	0	0	No
23:30 - 00:30	0		0		0	0	0	No

Study Name: Oberlin and W 21

Study Date : 6/22/2020

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

Only 7 one hour periods meet minimums.
Warrant is NOT met.

Site Data Required

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

Volume Requirements

Veh/Hr Major = **750**

Veh/Hr Minor = **75**

	Major Road West 21st Street					Minor Road Oberlin Avenue		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
16:00 - 17:00	436	+	620	=	1056	377	303	Yes
15:00 - 16:00	400	+	620	=	1020	418	308	Yes
17:00 - 18:00	422	+	588	=	1010	365	277	Yes
14:00 - 15:00	360	+	569	=	929	338	273	Yes
13:00 - 14:00	314	+	488	=	802	308	265	Yes
18:00 - 19:00	342	+	426	=	768	314	222	Yes
12:00 - 13:00	319	+	443	=	762	263	241	Yes
11:30 - 12:30	281	+	437	=	718	246	208	No
11:45 - 12:45	282	+	430	=	712	249	226	No
11:15 - 12:15	262	+	422	=	684	255	237	No
07:30 - 08:30	283	+	395	=	678	212	191	No
10:45 - 11:45	263	+	411	=	674	227	196	No
07:45 - 08:45	273	+	400	=	673	204	194	No
11:00 - 12:00	261	+	407	=	668	246	207	No
10:15 - 11:15	255	+	393	=	648	193	159	No
08:00 - 09:00	244	+	399	=	643	183	175	No
10:30 - 11:30	243	+	385	=	628	215	194	No
10:00 - 11:00	235	+	390	=	625	196	185	No
07:15 - 08:15	272	+	331	=	603	195	204	No
09:45 - 10:45	234	+	367	=	601	197	185	No
09:30 - 10:30	228	+	365	=	593	197	186	No
08:15 - 09:15	227	+	363	=	590	175	157	No
09:15 - 10:15	230	+	352	=	582	197	193	No
08:30 - 09:30	236	+	341	=	577	161	162	No
08:45 - 09:45	232		342		574	186	164	No

Study Name: Oberlin and W 21

Study Date : 6/22/2020

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.
10 hours meet 1B minimums.
Warrant IS met.

Site Data Required

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

Volume Requirements

Warrant	1A	1B
Veh/Hr Major =	**400**	**600**
Veh/Hr Minor =	**120**	**60**

Major Road	Minor Road
West 21st Street	Oberlin Avenue

Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met1A?
15:45 - 16:45	411	+	628	=	1039	386	311	Yes
14:45 - 15:45	398	+	615	=	1013	384	284	Yes
16:45 - 17:45	439	+	572	=	1011	389	282	Yes
13:45 - 14:45	345	+	573	=	918	318	288	Yes
17:45 - 18:45	361	+	480	=	841	305	242	Yes
12:45 - 13:45	324	+	463	=	787	326	271	Yes
11:45 - 12:45	282	+	430	=	712	249	226	Yes
10:45 - 11:45	263	+	411	=	674	227	196	Yes
07:45 - 08:45	273	+	400	=	673	204	194	Yes
09:45 - 10:45	234	+	367	=	601	197	185	Yes
08:45 - 09:45	232	+	342	=	574	186	164	Yes
06:45 - 07:45	190		224		414	126	159	Yes

Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met1B?
15:45 - 16:45	411	+	628	=	1039	386	311	Yes
14:45 - 15:45	398	+	615	=	1013	384	284	Yes
16:45 - 17:45	439	+	572	=	1011	389	282	Yes
13:45 - 14:45	345	+	573	=	918	318	288	Yes
17:45 - 18:45	361	+	480	=	841	305	242	Yes
12:45 - 13:45	324	+	463	=	787	326	271	Yes
11:45 - 12:45	282	+	430	=	712	249	226	Yes
10:45 - 11:45	263	+	411	=	674	227	196	Yes
07:15 - 08:15	272	+	331	=	603	195	204	Yes
09:45 - 10:45	234	+	367	=	601	197	185	Yes
09:30 - 10:30	228	+	365	=	593	197	186	No
08:15 - 09:15	227		363		590	175	157	No

Study Name: Oberlin and W 21

Study Date : 6/22/2020

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.

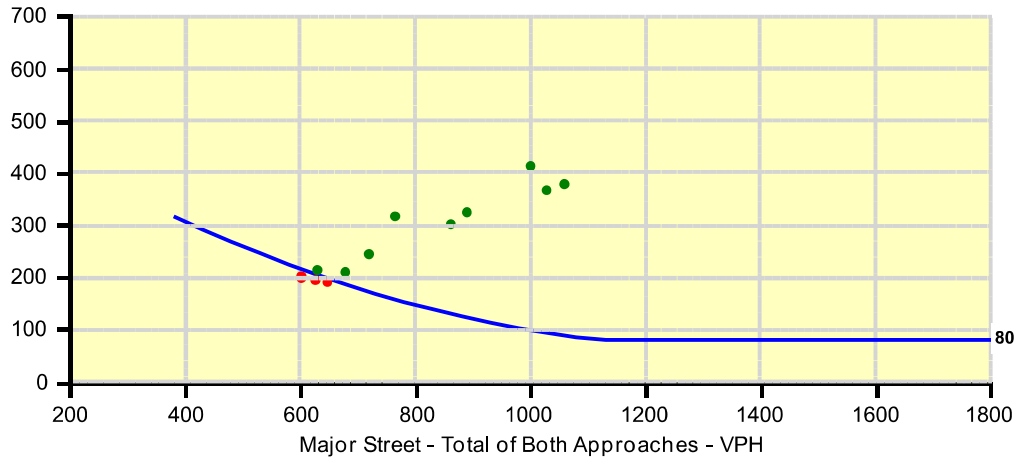
Summary

9 one hour periods meet minimums.
Warrant IS met.

Site Data Required

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

	Major Road West 21st Street					Minor Road Oberlin Avenue		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
16:30 - 17:30	448	+	611	=	1059	377	298	Yes
14:30 - 15:30	390	+	639	=	1029	367	273	Yes
15:30 - 16:30	400	+	599	=	999	415	305	Yes
17:30 - 18:30	380	+	508	=	888	325	249	Yes
13:30 - 14:30	336	+	527	=	863	304	285	Yes
12:30 - 13:30	321	+	444	=	765	317	273	Yes
11:30 - 12:30	281	+	437	=	718	246	208	Yes
07:30 - 08:30	283	+	395	=	678	212	191	Yes
10:30 - 11:30	243	+	385	=	628	215	194	Yes
10:15 - 11:15	255	+	393	=	648	193	159	No
10:00 - 11:00	235	+	390	=	625	196	185	No
							204	No



Study Name: Oberlin and W 21

Study Date : 6/22/2020

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

46 one hour periods meet minimums.
Warrant is NOT 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			
	West 21st Street					Oberlin Avenue			
Time	Total of All Approaches	Met?	Minor NB	Delay NB	Met?	Minor SB	Delay SB	Met?	Warrant Met?
15:15 - 16:15	1756	Yes	411	0.0	---	313	0.0	---	No
15:00 - 16:00	1746	Yes	418	0.0	---	308	0.0	---	No
15:45 - 16:45	1736	Yes	386	0.0	---	311	0.0	---	No
16:00 - 17:00	1736	Yes	377	0.0	---	303	0.0	---	No
16:30 - 17:30	1734	Yes	377	0.0	---	298	0.0	---	No
15:30 - 16:30	1719	Yes	415	0.0	---	305	0.0	---	No
16:15 - 17:15	1697	Yes	371	0.0	---	286	0.0	---	No
16:45 - 17:45	1682	Yes	389	0.0	---	282	0.0	---	No
14:45 - 15:45	1681	Yes	384	0.0	---	284	0.0	---	No
14:30 - 15:30	1669	Yes	367	0.0	---	273	0.0	---	No
17:00 - 18:00	1652	Yes	365	0.0	---	277	0.0	---	No
14:15 - 15:15	1609	Yes	361	0.0	---	289	0.0	---	No
17:15 - 18:15	1572	Yes	349	0.0	---	271	0.0	---	No
14:00 - 15:00	1540	Yes	338	0.0	---	273	0.0	---	No
13:45 - 14:45	1524	Yes	318	0.0	---	288	0.0	---	No
17:30 - 18:30	1462	Yes	325	0.0	---	249	0.0	---	No
13:30 - 14:30	1452	Yes	304	0.0	---	285	0.0	---	No
13:15 - 14:15	1423	Yes	324	0.0	---	262	0.0	---	No
17:45 - 18:45	1388	Yes	305	0.0	---	242	0.0	---	No
12:45 - 13:45	1384	Yes	326	0.0	---	271	0.0	---	No
13:00 - 14:00	1375	Yes	308	0.0	---	265	0.0	---	No
12:30 - 13:30	1355	Yes	317	0.0	---	273	0.0	---	No
18:00 - 19:00	1304	Yes	314	0.0	---	222	0.0	---	No
12:15 - 13:15	1286	Yes	273	0.0	---	251	0.0	---	No
12:00 - 13:00	1266	Yes	263	0.0	---	241	0.0	---	No

Study Name: Oberlin and W 21

Study Date : 6/22/2020

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.

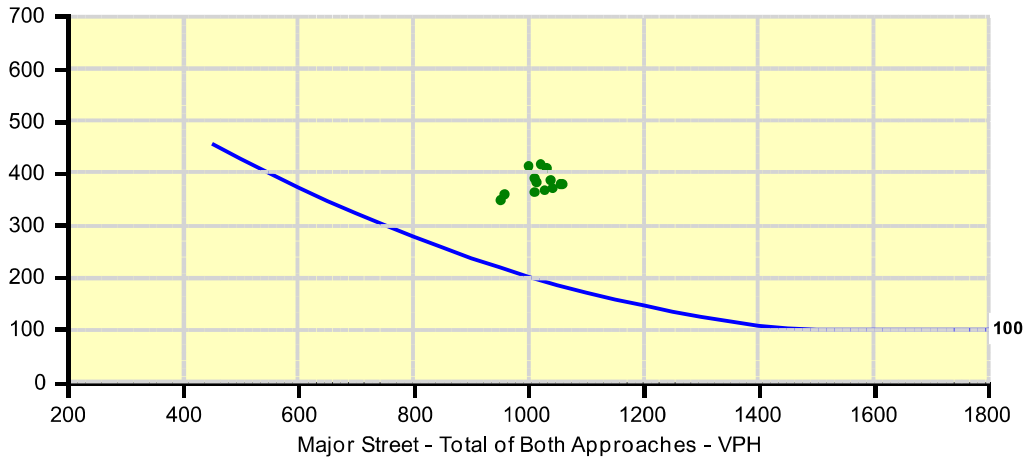
Summary

23 one hour periods meet minimums.
Warrant IS met.

Site Data Required

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

	Major Road West 21st Street					Minor Road Oberlin Avenue		
Time	Major EB	+	Major WB	=	Total	Minor NB	Minor SB	Met?
16:30 - 17:30	448	+	611	=	1059	377	298	Yes
16:00 - 17:00	436	+	620	=	1056	377	303	Yes
16:15 - 17:15	417	+	623	=	1040	371	286	Yes
15:45 - 16:45	411	+	628	=	1039	386	311	Yes
15:15 - 16:15	423	+	609	=	1032	411	313	Yes
14:30 - 15:30	390	+	639	=	1029	367	273	Yes
15:00 - 16:00	400	+	620	=	1020	418	308	Yes
14:45 - 15:45	398	+	615	=	1013	384	284	Yes
16:45 - 17:45	439	+	572	=	1011	389	282	Yes
17:00 - 18:00	422	+	588	=	1010	365	277	Yes
15:30 - 16:30	400	+	599	=	999	415	305	Yes
							289	Yes



APPENDIX I

City of Lorain Priority List

City Priority	Roadway1	Roadway2	Total Crashes (2014-2018)	FSI Crashes
1	SR611 (W. 21st St)	Kansas Ave	71	2
2	SR58 (Leavitt Rd)	Tower Blvd	64	5
3	SR611 (W. 21st St)	Broadway Ave	60	2
4	SR58 (Leavitt Rd)	SR611 (W. 21st St)	57	1
5	SR611 (W. 21st St)	Oberlin Ave	56	0
6	SR57 (Grove Ave)	Fairless Dr	53	3
7	SR611 (W. 21st St)	Washington Ave	46	0
8	SR57 (Grove Ave)	East 31st St	42	3
9	Oberlin Ave	Meister Rd	42	1
10	SR57 (Grove Ave)	Broadway Ave	40	1
11	SR58 (Leavitt Rd)	Jaeger Rd	40	0
12	SR611 (W. 21st St)	Reid Ave	39	1
13	SR58 (Leavitt Rd)	Meister Rd	38	1
14	SR611 (W. 21st St)	Root Rd	38	1
15	SR611 (W. 21st St)	Oakdale Ave	36	4
16	Tower Blvd	Oberlin Ave	36	0
17	SR611 (W. 21st St)	Elyria Ave	35	3
18	SR57 (Grove Ave)	Elyria Ave	35	2
19	Broadway Ave	W. 33rd St	34	0
20	US6 (W. Erie Ave)	Oberlin Ave	33	0
21	SR58 (Leavitt Rd)	W. 40th St	31	1
22	Broadway Ave	E. 30th St	31	0
23	US6 (W. Erie Ave)	Broadway Ave	31	0
24	Missouri Ave	SR611 (W. 21st St)	30	0
25	SR254 (Cooper Foster Park Rd.)	Broadway Ave	30	0
26	SR57 (Grove Ave)	E. 28th St	29	0
27	Broadway Ave	W. 39th St	28	0
28	SR57 (Grove Ave)	Pearl Ave	27	1
29	US6 (W. Erie Ave)	Leavitt Rd	27	0
30	SR254 (Cooper Foster Park Rd.)	Pearl Ave	27	0
31	W. 37th St	Oberlin Ave	26	1
32	US6 (W. Erie Ave)	Oakpoint Rd.	26	1
33	Reeves Ave	SR611 (W. 21st St)	26	0
34	Tower Blvd	Ashland Ave	24	1
35	SR254 (Cooper Foster Park Rd.)	Oberlin Ave	24	0
36	Fulton Rd	E. 28th St	23	0
37	W. 33rd St	Falbo Ave	22	0
38	SR2	Broadway Ave	22	0
39	SR57 (Grove Ave)	E. 42nd St	21	0
40	W. 28th St	Reid Ave	20	0
41	Pearl Ave	E. 36th St	19	1
42	North Ridge Rd	Cooper Foster Parkway	19	0
43	SR611 (W. 21st St)	Access Dr	18	2
44	US6 (E. Erie Ave)	Colorado Ave	18	0
45	Beech Ave	W. 22nd St	16	1
46	Cooper Foster Park	Oakpoint Rd.	16	0
47	Elyria Ave	E. 36th St	16	0
48	US6	Frankie Dr	15	1

APPENDIX J

Intersection Concept Plan

Placeholder for diagram showing signal replacement plans and proposed/existing striping

July 31, 2020

EB approach restriped to TWLHT with dedicated storage with channellizing line at intersection turn area

WB approach to be restriped to TWLHT with dedicated storage with channellizing line at intersection turn area

TLCI 2020 Project