

**C.**

**CARPENTER ROAD & ELMS ROAD**

**2015-2019 CRASH DATA**

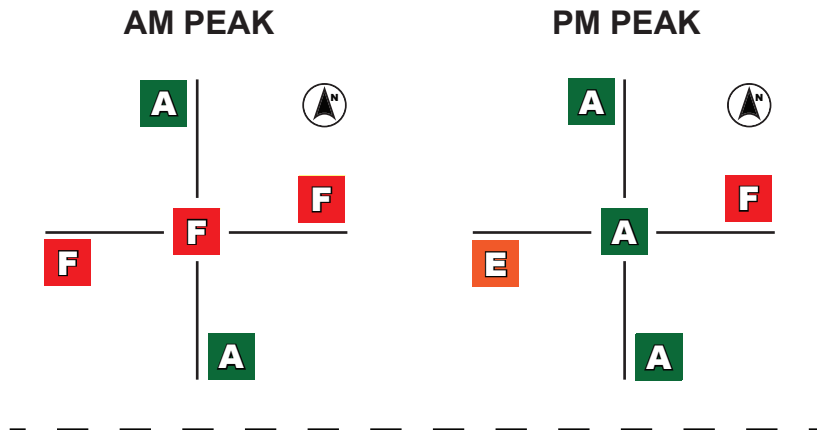
CRASHES	INJURIES			
	FATALITIES	TYPE A	TYPE B	TYPE C
<b>19 ANGLE</b>	<b>0</b>	<b>1</b>	<b>7</b>	<b>20</b>
<b>2 HEAD-ON</b>				

**2045 OPERATIONS**

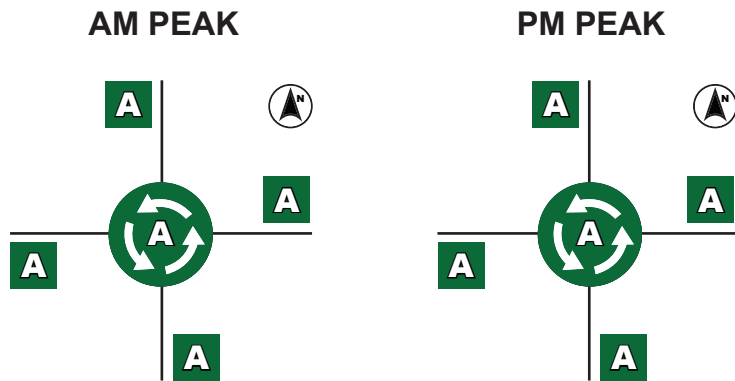
**LEVEL OF SERVICE**

A	B	C	D	E	F
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**NO BUILD**



**ROUNDBABOUT**



Opinion of probable cost for single-lane roundabout

**\$1.12 MILLION**

### C. Carpenter Road and Elms Road

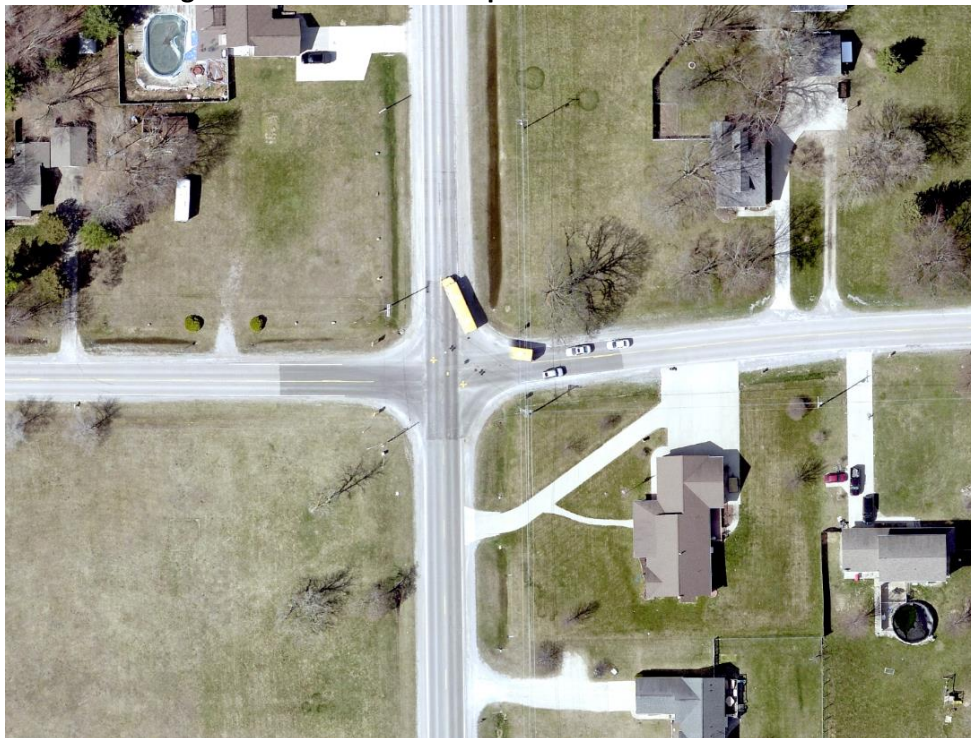
The intersection of Carpenter Road and Elms Road was included in the early preliminary engineering phase with support from Flushing Township due to intersection operations and safety concerns. This intersection is included in the 153 intersections that passed the skim analysis for experiencing crashes correctable by a roundabout and is a secondary analysis Tier Two intersection.

During the skim analysis, it was observed that there were 19 angle crashes and 2 head on left turn crashes over the 5-year period. These crashes resulted in 0 fatalities, 1 type A injury, 7 type B injuries, and 20 type C injuries at the intersection.

#### **Future No-Build Conditions**

The intersection of Carpenter Road and Elms Road is a two-way stop control intersection. Stop signs are present on the Carpenter Road approaches and overhead flashing beacons are present for all approaches. Carpenter Road runs east/west and is a two-lane roadway with one lane in each direction. Elms Road runs north/south and is a two-lane road with one lane in each direction. There is a residence in the southeast quadrant. All other quadrants are currently vacant adjacent to the intersection with the surrounding land use being primarily residential. An aerial of the existing intersection can be seen in Figure 4.

**Figure 4: Aerial view of Carpenter Road and Elms Road**



An operational analysis of the no-build condition was completed for the intersection using the 2045 forecast traffic volumes. The results of the analysis for future no-build conditions reveals that the Carpenter Road stop-controlled approaches operate at LOS E or F in both the AM and PM peak hours. The Elms Road approaches operate at LOS A in both the AM and PM peak hours.

The 95<sup>th</sup> percentile queue lengths were reviewed at the intersection and results showed that the Carpenter Road approaches experienced a maximum queue length of 330 feet (14 vehicles) during the AM peak hour and 76 feet (4 vehicles) during the PM peak hour.

The operational results for future no-build conditions are presented in Table 10.

**Table 10: Operational Analysis for 2045 No-Build Conditions**

Intersection	Approach	AM Peak		PM Peak	
		Delay/LOS	Queue (veh)*	Delay/LOS	Queue (veh)*
Carpenter Road and Elms Road	Eastbound	173.5/F	14 (330 ft)	36.5/E	4 (76 ft)
	Westbound	90.8/F	3 (68 ft)	55.4/F	3 (75 ft)
	Northbound	3.7/A	3 (66 ft)	1.7/A	4 (86 ft)
	Southbound	0.2/A	1 (20 ft)	0.3/A	2 (35 ft)
	<b>Overall</b>	<b>64.4/F</b>		<b>8.6/A</b>	

\* 95<sup>th</sup> percentile queue length

**Roundabout Conditions**

A compact, single-lane roundabout with an inscribed circle diameter of 100 feet would improve traffic operations and safety at this intersection. This design would have a fully mountable central island to facilitate truck movements with the smaller diameter. Compact roundabouts have been implemented over the past 5 years at several similar locations in Washtenaw County, Michigan, with positive results. It is likely that a small amount of permanent right-of-way acquisition would be needed in the northwest, southwest, and northeast quadrants of the intersection. An overhead power pole is located in the southeast quadrant and may be impacted by the proposed roundabout. A concept design exhibit for this intersection can be found at the end of this section. If desired later in the design process, a standard single-lane roundabout with diameter of 130 feet or greater could be considered at this location. A larger roundabout could result in greater right-of-way impacts and cost.

An operational analysis of the roundabout (build) condition was completed for the intersection using Rodel software and the 2045 forecast traffic volumes. The results of the analysis for roundabout (build) conditions reveal that all approaches and movements at the intersection operate at LOS A during the AM and PM peak hours.

The 95<sup>th</sup> percentile queue lengths were reviewed, and results showed that all approaches would experience a maximum queue length of 2.9 vehicles during the AM peak hour and PM peak hour for the compact single-lane roundabout design.

The operational results for future roundabout (build) conditions are presented in Table 11.

**Table 11: Operational Analysis for 2045 with Roundabout**

Intersection	Approach	AM Peak Hour		PM Peak Hour	
		Delay/LOS	Queue (veh)*	Delay/LOS	Queue (veh)*
Carpenter Road and Elms Road	Eastbound	4.0/A	0.5	4.0/A	0.4
	Westbound	4.0/A	0.2	4.5/A	0.2
	Northbound	4.2/A	1.0	5.9/A	2.9
	Southbound	4..7/A	1.3	4.7/A	1.5
	<b>Overall</b>	<b>4.3/A</b>		<b>5.2/A</b>	

\* 95<sup>th</sup> percentile queue length

An opinion of probable cost was developed for the compact single-lane roundabout. The probable cost is \$1.12 million in year 2025 dollars. This cost includes a 20 percent contingency and 3 percent annual inflation. A full breakdown along with all assumptions can be found in Appendix 3.

Potential funding sources for this improvement could include regular road improvement funding, safety funds, CMAQ, or an earmark. A TOR was computed with a result of 7.30.

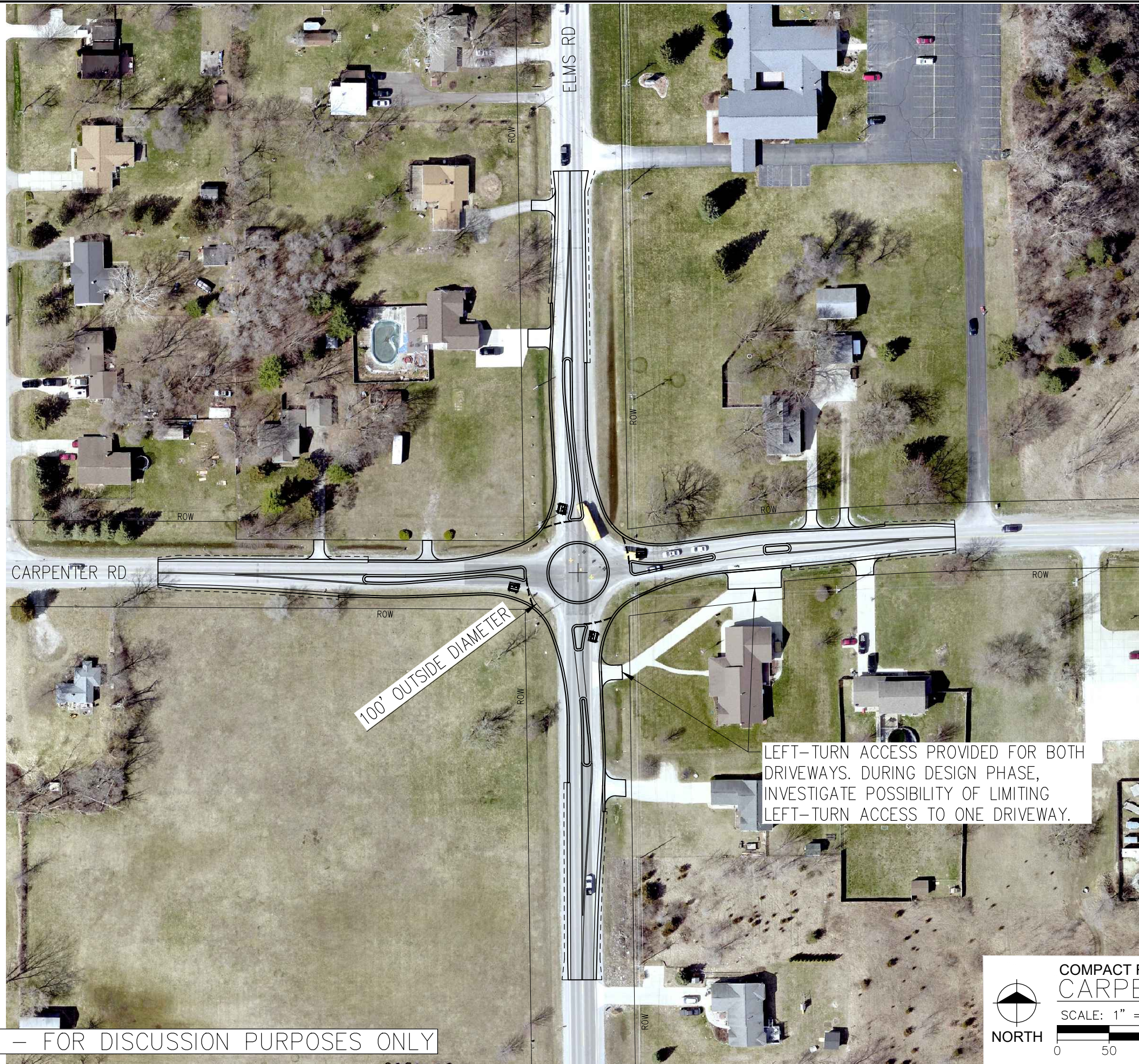
**Recommendation**

A roundabout appears feasible at this location, assuming GCRC can acquire the limited right-of-way that may be needed.



PLOT INFO: Z:\2020\201202\CAD\PRECED\CARPENTER AND ELMS.DWG LAYOUT: EXHIBIT DATE: 6/2/2021 TIME: 8:40:38 PM USER: A.LEPPEK

CONCEPT PLAN – FOR DISCUSSION PURPOSES ONLY



100' OUTSIDE DIAMETER

LEFT-TURN ACCESS PROVIDED FOR BOTH DRIVEWAYS. DURING DESIGN PHASE, INVESTIGATE POSSIBILITY OF LIMITING LEFT-TURN ACCESS TO ONE DRIVEWAY.



NORTH

COMPACT ROUNDABOUT  
CARPENTER AND ELMS

SCALE: 1" = 100'



Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

6/2/2021

PROJECT NO.

FIGURE NO.

21



**Carpenter Road & Elms Road - TMC**

Tue Mar 9, 2021

Full Length (7 AM-9 AM, 4 PM-6 PM)

All Classes (Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)

All Movements

ID: 817406, Location: 43.07827, -83.813345



Provided by: Gewalt Hamilton Associates Inc.  
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Carpenter Rd Eastbound						Carpenter Rd Westbound						Elms Rd Northbound						Elms Rd Southbound						Int
Time	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	
2021-03-09 7:00AM	2	6	6	0	14	0	4	7	0	0	11	0	7	14	4	0	25	0	0	36	1	0	37	0	87
7:15AM	0	11	6	0	17	0	0	8	0	0	8	0	16	14	1	0	31	0	5	40	2	0	47	0	103
7:30AM	3	15	28	0	46	0	4	11	4	0	19	0	45	21	1	0	67	0	1	58	17	0	76	0	208
7:45AM	6	27	48	0	81	0	2	14	4	0	20	0	43	29	3	0	75	0	1	52	14	0	67	0	243
Hourly Total	11	59	88	0	158	0	10	40	8	0	58	0	111	78	9	0	198	0	7	186	34	0	227	0	641
8:00AM	5	20	24	0	49	0	1	6	2	0	9	0	4	28	2	0	34	0	3	47	2	0	52	0	144
8:15AM	2	5	13	0	20	0	4	3	0	0	7	0	5	42	0	0	47	0	2	42	1	0	45	0	119
8:30AM	3	13	11	0	27	0	3	3	5	0	11	0	5	34	1	0	40	0	1	58	0	0	59	0	137
8:45AM	0	6	7	0	13	0	1	3	2	0	6	1	7	45	0	0	52	0	4	105	2	0	111	0	182
Hourly Total	10	44	55	0	109	0	9	15	9	0	33	1	21	149	3	0	173	0	10	252	5	0	267	0	582
4:00PM	2	9	13	0	24	0	2	6	2	0	10	0	12	98	3	0	113	0	2	62	3	0	67	0	214
4:15PM	2	3	14	0	19	0	2	7	2	0	11	0	30	87	4	0	121	0	4	71	11	0	86	0	237
4:30PM	3	9	20	0	32	0	2	11	1	0	14	0	19	75	6	0	100	0	2	54	3	0	59	0	205
4:45PM	0	5	11	0	16	0	1	6	0	0	7	0	25	73	2	0	100	0	3	55	2	0	60	0	183
Hourly Total	7	26	58	0	91	0	7	30	5	0	42	0	86	333	15	0	434	0	11	242	19	0	272	0	839
5:00PM	4	8	11	0	23	0	3	7	2	0	12	0	12	93	1	0	106	0	2	36	1	0	39	0	180
5:15PM	4	6	11	0	21	0	1	8	1	0	10	0	21	75	3	0	99	0	1	48	3	0	52	0	182
5:30PM	1	7	9	0	17	0	1	13	2	1	17	0	21	66	2	0	89	0	0	46	3	0	49	0	172
5:45PM	1	3	4	0	8	0	1	9	1	0	11	0	27	81	2	0	110	0	1	44	7	0	52	0	181
Hourly Total	10	24	35	0	69	0	6	37	6	1	50	0	81	315	8	0	404	0	4	174	14	0	192	0	715
<b>Total</b>	38	153	236	0	427	0	32	122	28	1	183	1	299	875	35	0	1209	0	32	854	72	0	958	0	2777
<b>% Approach</b>	8.9%	35.8%	55.3%	0%	-	-	17.5%	66.7%	15.3%	0.5%	-	-	24.7%	72.4%	2.9%	0%	-	-	3.3%	89.1%	7.5%	0%	-	-	-
<b>% Total</b>	1.4%	5.5%	8.5%	0%	15.4%	-	1.2%	4.4%	1.0%	0%	6.6%	-	10.8%	31.5%	1.3%	0%	43.5%	-	1.2%	30.8%	2.6%	0%	34.5%	-	-
<b>Lights</b>	36	151	231	0	418	-	28	116	27	1	172	-	296	863	32	0	1191	-	31	845	68	0	944	-	2725
<b>% Lights</b>	94.7%	98.7%	97.9%	0%	97.9%	-	87.5%	95.1%	96.4%	100%	94.0%	-	99.0%	98.6%	91.4%	0%	98.5%	-	96.9%	98.9%	94.4%	0%	98.5%	-	98.1%
<b>Single-Unit Trucks</b>	0	0	0	0	0	-	3	4	0	0	7	-	0	4	1	0	5	-	1	3	0	0	4	-	16
<b>% Single-Unit Trucks</b>	0%	0%	0%	0%	0%	-	9.4%	3.3%	0%	0%	3.8%	-	0%	0.5%	2.9%	0%	0.4%	-	3.1%	0.4%	0%	0%	0.4%	-	0.6%
<b>Articulated Trucks</b>	0	0	0	0	0	-	0	0	0	0	0	-	0	2	0	0	2	-	0	4	0	0	4	-	6
<b>% Articulated Trucks</b>	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0.2%	0%	0%	0.2%	-	0%	0.5%	0%	0%	0.4%	-	0.2%
<b>Buses</b>	2	2	5	0	9	-	1	2	1	0	4	-	3	6	2	0	11	-	0	2	4	0	6	-	30
<b>% Buses</b>	5.3%	1.3%	2.1%	0%	2.1%	-	3.1%	1.6%	3.6%	0%	2.2%	-	1.0%	0.7%	5.7%	0%	0.9%	-	0%	0.2%	5.6%	0%	0.6%	-	1.1%
<b>Bicycles on Road</b>	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0
<b>% Bicycles on Road</b>	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%
<b>Pedestrians</b>	-	-	-	-	-	0	-	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	0	
<b>% Pedestrians</b>	-	-	-	-	-	-	-	-	-	-	-	100%	-	-	-	-	-	-	-	-	-	-	-	-	
<b>Bicycles on Crosswalk</b>	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	
<b>% Bicycles on Crosswalk</b>	-	-	-	-	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-	-	

\*Pedestrians and Bicycles on Crosswalk. L: Left, R: Right, T: Thru, U: U-Turn

**Carpenter Road & Elms Road - TMC**

Tue Mar 9, 2021

Full Length (7 AM-9 AM, 4 PM-6 PM)

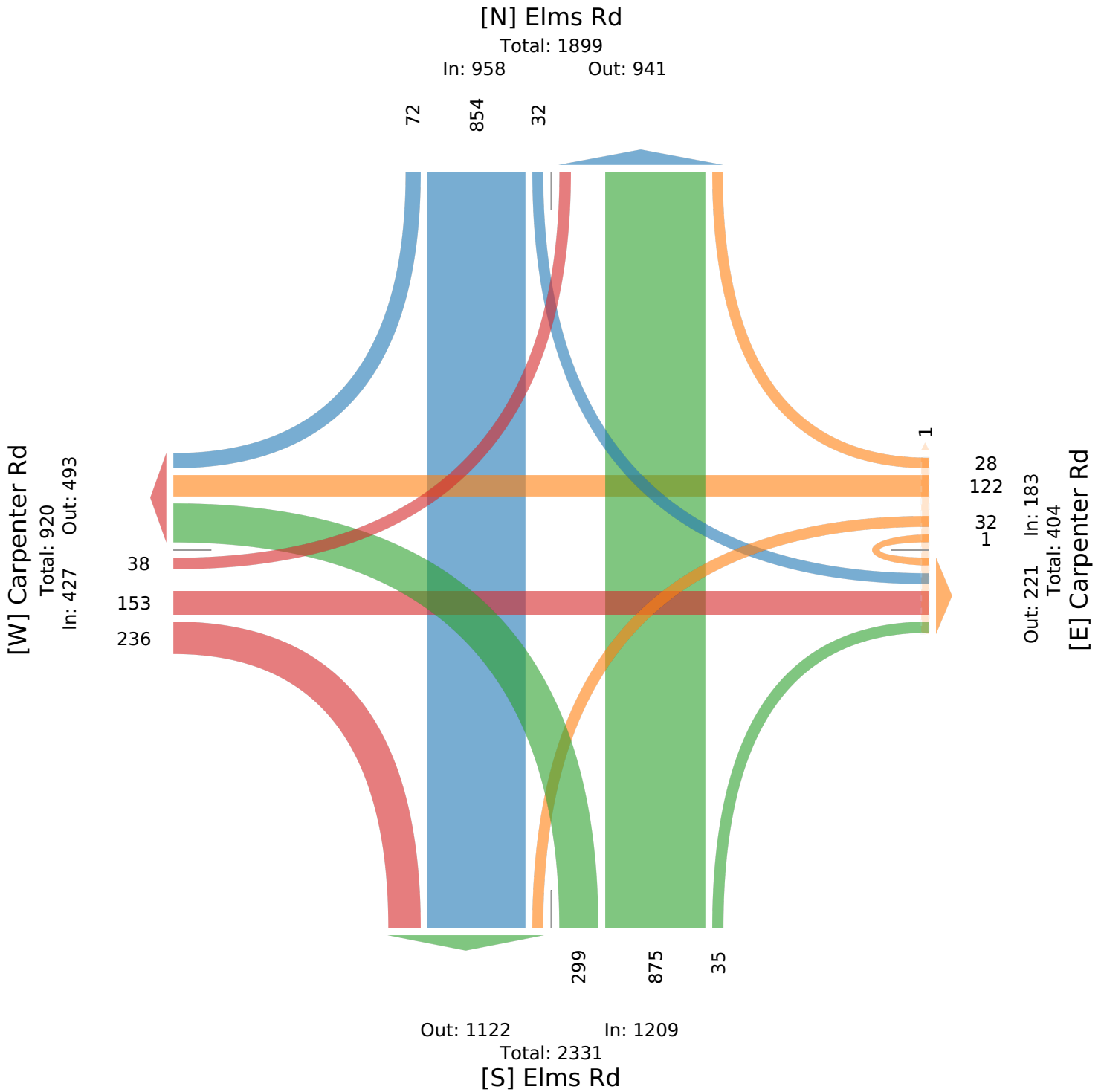
All Classes (Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)

All Movements

ID: 817406, Location: 43.07827, -83.813345



Provided by: Gewalt Hamilton Associates Inc.  
625 Forest Edge Drive, Vernon Hills, IL, 60061, US



Carpenter Road & Elms Road - TMC

Tue Mar 9, 2021

AM Peak (7:30 AM - 8:30 AM)

All Classes (Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)

All Movements

ID: 817406, Location: 43.07827, -83.813345



Provided by: Gewalt Hamilton Associates Inc.  
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Carpenter Rd Eastbound						Carpenter Rd Westbound						Elms Rd Northbound						Elms Rd Southbound						
Time	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	L	T	R	U	App	Ped*	Int
2021-03-09 7:30AM	3	15	28	0	46	0	4	11	4	0	19	0	45	21	1	0	67	0	1	58	17	0	76	0	208
7:45AM	6	27	48	0	81	0	2	14	4	0	20	0	43	29	3	0	75	0	1	52	14	0	67	0	243
8:00AM	5	20	24	0	49	0	1	6	2	0	9	0	4	28	2	0	34	0	3	47	2	0	52	0	144
8:15AM	2	5	13	0	20	0	4	3	0	0	7	0	5	42	0	0	47	0	2	42	1	0	45	0	119
<b>Total</b>	16	67	113	0	196	0	11	34	10	0	55	0	97	120	6	0	223	0	7	199	34	0	240	0	714
<b>% Approach</b>	8.2%	34.2%	57.7%	0%	-	-	20.0%	61.8%	18.2%	0%	-	-	43.5%	53.8%	2.7%	0%	-	-	2.9%	82.9%	14.2%	0%	-	-	-
<b>% Total</b>	2.2%	9.4%	15.8%	0%	27.5%	-	1.5%	4.8%	1.4%	0%	7.7%	-	13.6%	16.8%	0.8%	0%	31.2%	-	1.0%	27.9%	4.8%	0%	33.6%	-	-
<b>PHF</b>	0.667	0.620	0.589	-	0.605	-	0.688	0.607	0.625	-	0.688	-	0.539	0.714	0.500	-	0.743	-	0.583	0.858	0.500	-	0.789	-	0.735
<b>Lights</b>	14	67	108	0	189	-	9	32	10	0	51	-	95	115	5	0	215	-	7	195	32	0	234	-	689
<b>% Lights</b>	87.5%	100%	95.6%	0%	96.4%	-	81.8%	94.1%	100%	0%	92.7%	-	97.9%	95.8%	83.3%	0%	96.4%	-	100%	98.0%	94.1%	0%	97.5%	-	96.5%
<b>Single-Unit Trucks</b>	0	0	0	0	0	-	2	1	0	0	3	-	0	2	1	0	3	-	0	2	0	0	2	-	8
<b>% Single-Unit Trucks</b>	0%	0%	0%	0%	0%	-	18.2%	2.9%	0%	0%	5.5%	-	0%	1.7%	16.7%	0%	1.3%	-	0%	1.0%	0%	0%	0.8%	-	1.1%
<b>Articulated Trucks</b>	0	0	0	0	0	-	0	0	0	0	0	-	0	1	0	0	1	-	0	0	0	0	0	-	1
<b>% Articulated Trucks</b>	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0.8%	0%	0%	0.4%	-	0%	0%	0%	0%	0%	-	0.1%
<b>Buses</b>	2	0	5	0	7	-	0	1	0	0	1	-	2	2	0	0	4	-	0	2	2	0	4	-	16
<b>% Buses</b>	12.5%	0%	4.4%	0%	3.6%	-	0%	2.9%	0%	0%	1.8%	-	2.1%	1.7%	0%	0%	1.8%	-	0%	1.0%	5.9%	0%	1.7%	-	2.2%
<b>Bicycles on Road</b>	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0
<b>% Bicycles on Road</b>	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%
<b>Pedestrians</b>	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	0
<b>% Pedestrians</b>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Bicycles on Crosswalk</b>	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	0
<b>% Bicycles on Crosswalk</b>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

\*Pedestrians and Bicycles on Crosswalk. L: Left, R: Right, T: Thru, U: U-Turn



**Carpenter Road & Elms Road - TMC**

Tue Mar 9, 2021

AM Peak (7:30 AM - 8:30 AM)

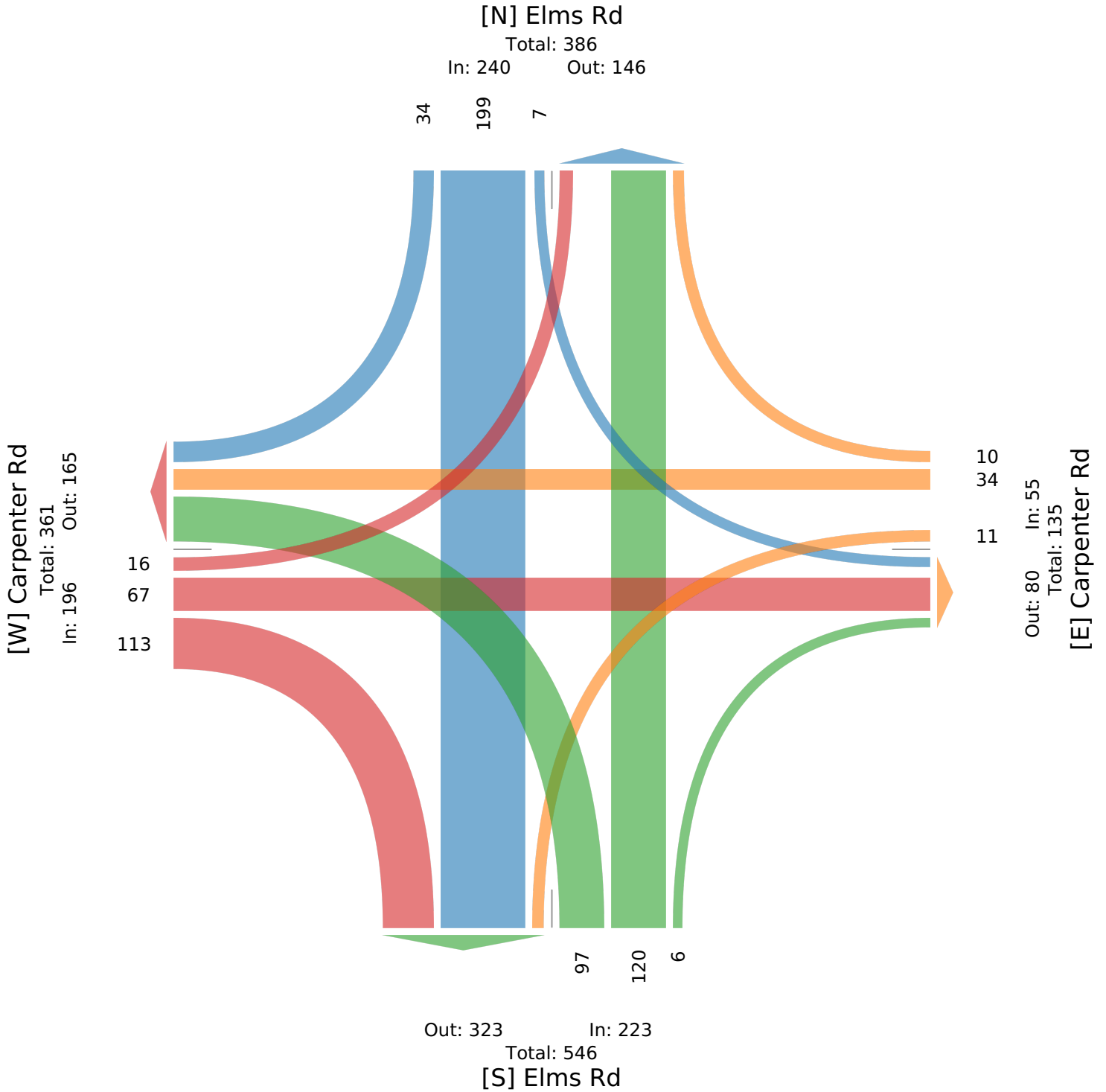
All Classes (Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)

All Movements

ID: 817406, Location: 43.07827, -83.813345



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**Carpenter Road & Elms Road - TMC**

Tue Mar 9, 2021

PM Peak (4 PM - 5 PM) - Overall Peak Hour

All Classes (Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)

All Movements

ID: 817406, Location: 43.07827, -83.813345



Provided by: Gewalt Hamilton Associates Inc.  
625 Forest Edge Drive, Vernon Hills, IL, 60061, US

Leg Direction	Carpenter Rd Eastbound					Carpenter Rd Westbound					Elms Rd Northbound					Elms Rd Southbound					Int				
	L	T	R	U	App Ped*	L	T	R	U	App Ped*	L	T	R	U	App Ped*	L	T	R	U	App Ped*					
2021-03-09 4:00PM	2	9	13	0	24	0	2	6	2	0	10	0	12	98	3	0	113	0	2	62	3	0	67	0	214
4:15PM	2	3	14	0	19	0	2	7	2	0	11	0	30	87	4	0	121	0	4	71	11	0	86	0	237
4:30PM	3	9	20	0	32	0	2	11	1	0	14	0	19	75	6	0	100	0	2	54	3	0	59	0	205
4:45PM	0	5	11	0	16	0	1	6	0	0	7	0	25	73	2	0	100	0	3	55	2	0	60	0	183
<b>Total</b>	7	26	58	0	91	0	7	30	5	0	42	0	86	333	15	0	434	0	11	242	19	0	272	0	839
<b>% Approach</b>	7.7%	28.6%	63.7%	0%	-	-	16.7%	71.4%	11.9%	0%	-	-	19.8%	76.7%	3.5%	0%	-	-	4.0%	89.0%	7.0%	0%	-	-	-
<b>% Total</b>	0.8%	3.1%	6.9%	0%	10.8%	-	0.8%	3.6%	0.6%	0%	5.0%	-	10.3%	39.7%	1.8%	0%	51.7%	-	1.3%	28.8%	2.3%	0%	32.4%	-	-
<b>PHF</b>	0.583	0.722	0.725	-	0.711	-	0.875	0.682	0.625	-	0.750	-	0.717	0.849	0.625	-	0.897	-	0.688	0.852	0.432	-	0.791	-	0.885
<b>Lights</b>	7	25	58	0	90	-	7	28	4	0	39	-	86	330	14	0	430	-	11	240	18	0	269	-	828
<b>% Lights</b>	100%	96.2%	100%	0%	98.9%	-	100%	93.3%	80.0%	0%	92.9%	-	100%	99.1%	93.3%	0%	99.1%	-	100%	99.2%	94.7%	0%	98.9%	-	98.7%
<b>Single-Unit Trucks</b>	0	0	0	0	0	-	0	1	0	0	1	-	0	1	0	0	1	-	0	1	0	0	1	-	3
<b>% Single-Unit Trucks</b>	0%	0%	0%	0%	0%	-	0%	3.3%	0%	0%	2.4%	-	0%	0.3%	0%	0%	0.2%	-	0%	0.4%	0%	0%	0.4%	-	0.4%
<b>Articulated Trucks</b>	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	1	0	0	1	-	1
<b>% Articulated Trucks</b>	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0.4%	0%	0%	0.4%	-	0.1%
<b>Buses</b>	0	1	0	0	1	-	0	1	1	0	2	-	0	2	1	0	3	-	0	0	1	0	1	-	7
<b>% Buses</b>	0%	3.8%	0%	0%	1.1%	-	0%	3.3%	20.0%	0%	4.8%	-	0%	0.6%	6.7%	0%	0.7%	-	0%	0%	5.3%	0%	0.4%	-	0.8%
<b>Bicycles on Road</b>	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0
<b>% Bicycles on Road</b>	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%	0%	0%	0%	0%	-	0%
Pedestrians	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	0
% Pedestrians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicycles on Crosswalk	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	-	0
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

\*Pedestrians and Bicycles on Crosswalk. L: Left, R: Right, T: Thru, U: U-Turn

Carpenter Road & Elms Road - TMC

Tue Mar 9, 2021

PM Peak (4 PM - 5 PM) - Overall Peak Hour

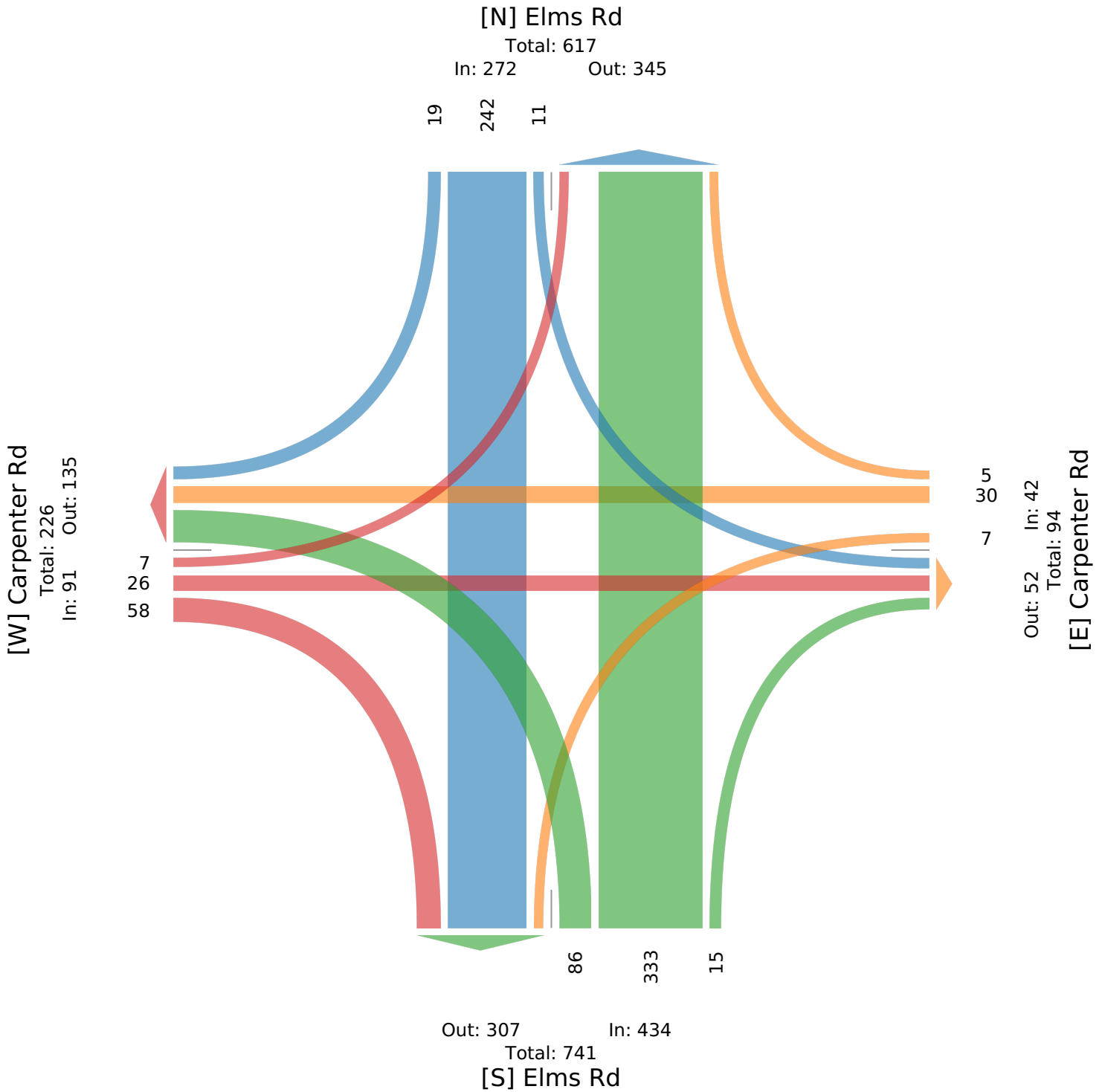
All Classes (Lights, Single-Unit Trucks, Articulated Trucks, Buses, Pedestrians, Bicycles on Road, Bicycles on Crosswalk)

All Movements

ID: 817406, Location: 43.07827, -83.813345



Provided by: Gewalt Hamilton Associates Inc.  
625 Forest Edge Drive, Vernon Hills, IL, 60061, US





Intersection												
Int Delay, s/veh	64.4											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	21	87	147	14	44	13	126	156	8	9	259	44
Future Vol, veh/h	21	87	147	14	44	13	126	156	8	9	259	44
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	60	60	60	69	69	69	74	74	74	79	79	79
Heavy Vehicles, %	4	4	4	7	7	7	4	4	4	2	2	2
Mvmt Flow	35	145	245	20	64	19	170	211	11	11	328	56

Major/Minor	Minor2		Minor1		Major1			Major2				
Conflicting Flow All	976	940	356	1130	963	217	384	0	0	222	0	0
Stage 1	378	378	-	557	557	-	-	-	-	-	-	-
Stage 2	598	562	-	573	406	-	-	-	-	-	-	-
Critical Hdwy	7.14	6.54	6.24	7.17	6.57	6.27	4.14	-	-	4.12	-	-
Critical Hdwy Stg 1	6.14	5.54	-	6.17	5.57	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.14	5.54	-	6.17	5.57	-	-	-	-	-	-	-
Follow-up Hdwy	3.536	4.036	3.336	3.563	4.063	3.363	2.236	-	-	2.218	-	-
Pot Cap-1 Maneuver	228	262	684	177	251	810	1164	-	-	1347	-	-
Stage 1	640	612	-	506	504	-	-	-	-	-	-	-
Stage 2	485	506	-	496	589	-	-	-	-	-	-	-
Platoon blocked, %								-	-	-	-	-
Mov Cap-1 Maneuver	148	216	684	46	207	810	1164	-	-	1347	-	-
Mov Cap-2 Maneuver	148	216	-	46	207	-	-	-	-	-	-	-
Stage 1	533	606	-	421	420	-	-	-	-	-	-	-
Stage 2	335	421	-	240	583	-	-	-	-	-	-	-

Approach	EB		WB		NB		SB	
HCM Control Delay, s	173.5		90.8		3.7		0.2	
HCM LOS	F		F					

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1164	-	-	336	133	1347	-
HCM Lane V/C Ratio	0.146	-	-	1.265	0.774	0.008	-
HCM Control Delay (s)	8.6	0	-	173.5	90.8	7.7	0
HCM Lane LOS	A	A	-	F	F	A	A
HCM 95th %tile Q(veh)	0.5	-	-	19.4	4.6	0	-

Intersection: 9006: Carpenter Rd & Elms Rd

Movement	EB	WB	NB	SB
Directions Served	LTR	LTR	LTR	LTR
Maximum Queue (ft)	436	82	97	40
Average Queue (ft)	118	36	29	3
95th Queue (ft)	330	68	66	20
Link Distance (ft)	565	557	554	559
Upstream Blk Time (%)	1			
Queuing Penalty (veh)	0			
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 0

Intersection												
Int Delay, s/veh	8.6											
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	9	34	75	9	39	7	112	433	20	14	315	25
Future Vol, veh/h	9	34	75	9	39	7	112	433	20	14	315	25
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	71	71	71	75	75	75	90	90	90	79	79	79
Heavy Vehicles, %	1	1	1	7	7	7	1	1	1	1	1	1
Mvmt Flow	13	48	106	12	52	9	124	481	22	18	399	32

Major/Minor	Minor2		Minor1		Major1			Major2				
Conflicting Flow All	1222	1202	415	1268	1207	492	431	0	0	503	0	0
Stage 1	451	451	-	740	740	-	-	-	-	-	-	-
Stage 2	771	751	-	528	467	-	-	-	-	-	-	-
Critical Hdwy	7.11	6.51	6.21	7.17	6.57	6.27	4.11	-	-	4.11	-	-
Critical Hdwy Stg 1	6.11	5.51	-	6.17	5.57	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.11	5.51	-	6.17	5.57	-	-	-	-	-	-	-
Follow-up Hdwy	3.509	4.009	3.309	3.563	4.063	3.363	2.209	-	-	2.209	-	-
Pot Cap-1 Maneuver	157	185	640	142	179	567	1134	-	-	1067	-	-
Stage 1	590	573	-	401	416	-	-	-	-	-	-	-
Stage 2	394	420	-	525	553	-	-	-	-	-	-	-
Platoon blocked, %								-	-	-	-	-
Mov Cap-1 Maneuver	98	153	640	79	148	567	1134	-	-	1067	-	-
Mov Cap-2 Maneuver	98	153	-	79	148	-	-	-	-	-	-	-
Stage 1	500	560	-	340	353	-	-	-	-	-	-	-
Stage 2	280	356	-	392	541	-	-	-	-	-	-	-

Approach	EB		WB		NB		SB	
HCM Control Delay, s	36.5		55.4		1.7		0.3	
HCM LOS	E		F					

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1134	-	-	274	141	1067	-
HCM Lane V/C Ratio	0.11	-	-	0.607	0.52	0.017	-
HCM Control Delay (s)	8.6	0	-	36.5	55.4	8.4	0
HCM Lane LOS	A	A	-	E	F	A	A
HCM 95th %tile Q(veh)	0.4	-	-	3.6	2.5	0.1	-



Intersection: 9006: Carpenter Rd & Elms Rd

Movement	EB	WB	NB	SB
Directions Served	LTR	LTR	LTR	LTR
Maximum Queue (ft)	104	95	151	60
Average Queue (ft)	43	35	33	9
95th Queue (ft)	76	75	86	35
Link Distance (ft)	565	557	554	559
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Network Summary

Network wide Queuing Penalty: 0

## Carpenter & Elms AM Peak

Rodel - \\corp.ftch.com\AllProjects\2020\201202\WORK\Calcs\TRANSPORTATION\Rodel\Carpenter & Elms.rod

File View Help

Project: Carpenter & Elms, Date: 12-May-2021, Model: Rodel 2017, Timeslice: 7.5, Full Geometry, Peak: AM, Feet: RHD, Name: Mini Roundabout, Flows: 2045, Delay: Queuing, Results: Veh, Peak60/15m, Synthetic Flow Profile, Conf: 50, Light: 35

Approach Geometry					Entry Geometry					Circ Geom			Exit Geometry				Entry Capacity Mods	
Leg Name	Bearing	G	V	n	E	n	L'	R	Φ	D	C	n	Ex	n	Vx	n	→ Cap (v/h)	Xwalk Fact
1 SB Elms	Y	0	0	11.00	16.00	1	30.00	75.00	30.00	100.00	20.00	1	16.00	1	11.00	1	0	1.000
2 EB Carpenter	Y	90	0	11.00	16.00	1	30.00	75.00	30.00	100.00	20.00	1	16.00	1	11.00	1	0	1.000
3 NB Elms	Y	180	0	11.00	16.00	1	30.00	75.00	30.00	100.00	20.00	1	16.00	1	11.00	1	0	1.000
4 WB Carpenter	Y	270	0	11.00	16.00	1	30.00	75.00	30.00	100.00	20.00	1	16.00	1	11.00	1	0	1.000

Volume Modifiers			Turning Volumes (veh/hr)						Arrival Volume Ratios			Arrival Volume Times (min)			PHF
Leg Name	%Truck	Factor	U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Ratio1	Ratio2	Ratio3	Time1	Time2	Time3		
1 SB Elms	3.5	1.00	0	9	259	44	0	0.750	1.125	0.750	0	30	60		
2 EB Carpenter	3.6	1.00	0	21	34	75	0	0.750	1.125	0.750	0	30	60		
3 NB Elms	3.6	1.00	0	126	156	8	0	0.750	1.125	0.750	0	30	60		
4 WB Carpenter	7.3	1.00	0	14	44	13	0	0.750	1.125	0.750	0	30	60		

Calibration Accidents Economics Bypass Run

	Peak 60min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)		Max Q (veh)		Max Q95% (veh)		LOSA-F			
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB Elms	None	312		184		1052		0.2965		4.69		4.69	0.49		1.27		A		A
2	EB Carpenter	None	130		282		998		0.1303		4.02		4.02	0.17		0.45		A		A
3	NB Elms	None	290		64		1117		0.2596		4.19		4.19	0.40		1.04		A		A
4	WB Carpenter	None	71		303		919		0.0772		3.96		3.96	0.09		0.24		A		A
All	Intersection										4.33									A

Results 60 Results 15 Int / Slope - 60 Int / Slope - 15 Economics Global Results

## Carpenter & Elms PM Peak

Rodel - \\corp.ftch.com\AllProjects\2020\201202\WORK\Calcs\TRANSPORTATION\Rodel\Carpenter & Elms.rod

File View Help

Project: Carpenter & Elms, Date: 12-May-2021, Model: Rodel 2017, Timeslice: 7.5, Full Geometry, Peak: PM, Feet: RHD, Name: Mini Roundabout, Flows: 2045, Delay: Queuing, Results: Veh, Peak60/15m, Synthetic Flow Profile, Conf: 50, Light: 41

Approach Geometry					Entry Geometry					Circ Geom			Exit Geometry				Entry Capacity Mods	
Leg Name	Bearing	G	V	n	E	n	L'	R	Φ	D	C	n	Ex	n	Vx	n	→ Cap (v/h)	Xwalk Fact
1 SB Elms	Y	0	0	11.00	16.00	1	30.00	75.00	30.00	100.00	20.00	1	16.00	1	11.00	1	0	1.000
2 EB Carpenter	Y	90	0	11.00	16.00	1	30.00	75.00	30.00	100.00	20.00	1	16.00	1	11.00	1	0	1.000
3 NB Elms	Y	180	0	11.00	16.00	1	30.00	75.00	30.00	100.00	20.00	1	16.00	1	11.00	1	0	1.000
4 WB Carpenter	Y	270	0	11.00	16.00	1	30.00	75.00	30.00	100.00	20.00	1	16.00	1	11.00	1	0	1.000

Volume Modifiers			Turning Volumes (veh/hr)						Arrival Volume Ratios			Arrival Volume Times (min)			PHF
Leg Name	%Truck	Factor	U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Ratio1	Ratio2	Ratio3	Time1	Time2	Time3		
1 SB Elms	1.3	1.00	0	14	315	25	0	0.750	1.125	0.750	0	30	60		
2 EB Carpenter	1.1	1.00	0	9	34	75	0	0.750	1.125	0.750	0	30	60		
3 NB Elms	0.9	1.00	0	112	433	20	0	0.750	1.125	0.750	0	30	60		
4 WB Carpenter	7.1	1.00	0	9	39	7	0	0.750	1.125	0.750	0	30	60		

Calibration Accidents Economics Bypass Run

	Peak 60min Results	Bypass Type	Flow Rate (veh/hr)		Opp Rate (veh/hr)		Capacity (veh/hr)		Ave VCR		Ave Del (sec/veh)		Max Q (veh)		Max Q95% (veh)		LOSA-F			
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Entry	Byp	Leg
1	SB Elms	None	354		160		1114		0.3177		4.70		4.70	0.56		1.45		A		A
2	EB Carpenter	None	118		338		1019		0.1157		3.98		3.98	0.15		0.40		A		A
3	NB Elms	None	565		57		1183		0.4777		5.85		5.85	1.15		2.94		A		A
4	WB Carpenter	None	55		554		801		0.0686		4.53		4.53	0.08		0.22		A		A
All	Intersection										5.21									A

Results 60 Results 15 Int / Slope - 60 Int / Slope - 15 Economics Global Results

**Intersection**

Carpenter Road &amp; Elms Road

Opinion of Probable Cost

By: Fishbeck

Date: 5/7/2021

PAY ITEM DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
Mobilization (10%)	1	LSUM	\$75,500.00	\$75,500.00
Pavt, Rem	4820	Syd	\$10.00	\$48,200.00
Embankment, CIP	1000	Cyd	\$15.00	\$15,000.00
Excavation, Earth	1500	Cyd	\$10.00	\$15,000.00
Aggregate Base	2450	Ton	\$21.00	\$51,450.00
Shoulder, CI II	155	Ton	\$25.00	\$3,875.00
HMA Approach	25	Ton	\$50.00	\$1,250.00
Conc Pavt, Nonreinf, 8 inch	5120	Syd	\$45.00	\$230,400.00
Joint, Contraction, Cp	3920	Ft	\$10.00	\$39,200.00
Joint, Expansion, E3	200	Ft	\$15.00	\$3,000.00
Driveway, Nonreinf Conc, 9 inch	240	Syd	\$50.00	\$12,000.00
Curb and Gutter, Conc, Det B2	1645	Ft	\$25.00	\$41,125.00
Curb and Gutter, Conc, Det D1	1320	Ft	\$25.00	\$33,000.00
Conc Pavt, Decorative Colored, 9 inch	4620	Sft	\$12.50	\$57,750.00
Turf Establishment, Performance	5050	Syd	\$5.00	\$25,250.00
Signal Removal	1	LSUM	\$2,000.00	\$2,000.00
Drainage	1	LSUM	\$85,000.00	\$85,000.00
MOT	1	LSUM	\$56,000.00	\$56,000.00
Pavement Markings	1	LSUM	\$15,000.00	\$15,000.00
Signing	1	LSUM	\$20,000.00	\$20,000.00
<b>ESTIMATED CONSTRUCTION COST</b>				<b>\$830,000</b>

	<i>CONTINGENCY (20%)</i>	\$166,000.0
	<b>ESTIMATED TOTAL CONSTRUCTION COST (YEAR 2021)</b>	<b>\$996,000.0</b>
	<i>3% ANNUAL INFLATION 2021 TO 2025</i>	<i>\$125,006.77</i>
	<b>ESTIMATED TOTAL CONSTRUCTION COST (YEAR 2025)</b>	<b>\$1,121,006.77</b>

**Assumptions:**

Full Depth Concrete Reconstruct assumed for all pavements (HMA Paving, HMA base crushing and shaping, or cold milling and overlay could be utilized as a cost savings)

Pavement section assumed to be 8" Nonreinforced Concrete over 6" Aggregate Base for roadway

HMA Driveway section assumed to be 3" HMA over 6" Aggregate Base

Existing Gravel Drives paved with HMA to ROW or 20', whichever comes first

HMA and Concrete removal incorporated under Pavt, Rem

Joints assumed for concrete roadway and central island/splitter islands

Drainage includes enclosed storm for all curbed areas, spillways, and underdrain

MOT taken as approximately ~8% of total before mobilization; based on previous roundabout projects

ROW acquisition costs not included



### NUMBER OF CRASHES OR INJURED PERSONS.

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
	2015	2016	2017	2018	2019

<b>Fatal and A-Injury Reduction</b>	%REDUCTION	78%	Roundabout		
Number of Crashes	0	0	0	0	1

A-Injured or Killed Persons	0	0	0	0	1
-----------------------------	---	---	---	---	---

<b>Minor Crash Reduction</b>	%REDUCTION	57%	0		
Number of Crashes	0	0	0	0	32
	0	0	0	0	27
	0	0	0	0	7

	%REDUCTION	0%			
Number of Crashes	0	0	0	0	0
	0	0	0	0	0
A-Injured or Killed Persons	0	0	0	0	0

	%REDUCTION	0%			
Number of Crashes	0	0	0	0	0
	0	0	0	0	0
A-Injured or Killed Persons	0	0	0	0	0

	%REDUCTION	0%			
Number of Crashes	0	0	0	0	0
	0	0	0	0	0
A-Injured or Killed Persons	0	0	0	0	0

# of A-injuries:	1	For reference only
# of Fatalities:	0	For reference only; "Q" accounts

		for the risk of a fatality.
PROJECT COST ESTIMATE :	\$1,121,007	If unknown, enter "0" (zero).
ADTb (before-volume)	1.0	You may change these
ADTa (after-volume)	1.1	default ADT values.
# OF YEARS OF DATA:	5.00	3 to 5 years should be used.
RATE OF INFLATION:	2.50%	
AREA TYPE:	Urban	"Rural", "Urban", or "Between"

**REMARKS:**

Carpenter Road and Elms Road  
 Genesee County Roundabout Study  
 1523901, 1536401  
 11.3841866, 1.5015062  
 Roundabout

## COMPUTED BENEFITS DERIVED THROUGH CRASH REDUCTION

**TOR 2021**

Date **9-Jul-21**

Project: **Carpenter Road and Elms Road**

City/Twp. **Mt. Morris Township**

Prepared By: **ROWE Professional Services Company**

County **Genesee County**

PR: **1523901, 1536401**

PR MP Range: **11.3841866, 1.5015062**

The method of evaluating crash costs, used below, is given on page 67 of Roy Jorgensen's report of Highway Safety Improvement Criteria, 1966 edition. This same method is given in the Bureau of Public Roads IM21-3-67. In 1994 we have adapted the Q formula to blend Fatalities and A-injuries only.

In the following analysis the costs provided by the National Safety Council are :

**2019 NSC VALUES:**

Death	\$1,659,000	=FATCOST
Disabling (A) injury:	\$96,200	=ACOST
B-injury:	\$27,800	=BCOST
PDO and/or Minor Injury Crash:	\$12,200	=PDOCOST

$$BTOTAL = ADTa / ADTb \times [(Q \times R1) + (BCOST \times R2) + (PDOCOST \times R3)]$$

WHERE:

BTOTAL =	Total Benefit in Dollars Over Years Used	\$600,019
ADTa =	Average traffic volume after the improvement	1.1
ADTb =	Average traffic volume before the improvement	1.0
R1 =	Reduction in fatalities and A-Injuries Combined.	0.8
R2 =	Reduction in B-Injury crashes:	4.0
R3 =	Reduction in PDO and C-injury crashes:	15.4
Q =	$[FATCOST + ((I/F) \times INJCOST)] / [1 + (I/F)]$	
=	$[1,659,000 + (6.10 \times 96,200)] / [1 + 6.10]$	\$316,400
	for AREA TYPE "Urban"	
I/F =		6.10

Q-Reference	Q	A-Inuries	Fatalities	I/F
RURAL	\$363,900	6,072	1,255	4.84
URBAN	\$316,400	9,902	1,624	6.10
BETWEEN	\$334,900	15,974	2,879	5.55

Data from Safety Programs Unit  
5-Year Statewide Non-Trunkline Crash Figures Used.  
(\*From 1-1-2015 Through 12-31-2019).

Time of Return (T.O.R.) is based on .... 5 years of data.

NOINFB =No-Inflation Annual Benefit=BTOTAL/years \$120,004

With an inflation rate of ..... 2.50%

B=Annual Benefit=Present Value (with Inflation) \$153,615

C = Project Cost \$1,121,007

TOR=C/B=COST/ANNUAL BENEFIT= **7.30**

C. Carpenter and Elms

1. [2045 AM Peak Hour No Build](#)
2. [2045 PM Peak Hour No Build](#)
3. [2045 AM Peak Hour Roundabout](#)
4. [2045 PM Peak Hour Roundabout](#)