

# Traffic Signal Warrant Analysis

## Maple Street & Sagamore Street



**February 2018**



City of Manchester  
Department of Public Works  
475 Valley Street  
Manchester, NH 03101

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## Executive Summary

A traffic signal warrant request was received by the City of Manchester for the intersection of Maple Street and Sagamore Street after a petition was signed by residents requesting the addition of a traffic signal due to crash history and speeds on Maple Street. Vehicular turning movement counts and pedestrian counts for a 12-hour period were collected and analysis was performed in February 2018 to evaluate the need for a traffic control signal at this intersection.

A comprehensive investigation of traffic conditions and physical characteristics of a location is required to determine the necessity for a signal installation. Traffic control signals should not be installed unless at least one of the nine warrants specified in the Manual on Uniform Traffic Control Devices (MUTCD) are met.

As shown in the Table 1, none of traffic signal warrants were met for this intersection. Unwarranted signals can invoke more problems than solving them by causing issues such as excessive delay, encouraging disobedience of signal indication, traffic detours through neighborhoods to avoid the signal, and increases in certain types of accident frequencies.

Table 1. Signal Warrant Summary Results

<b>WARRANT</b>	<b>RESULTS</b>
1- Eight-Hour Vehicular Volume	Not Met
2- Four-Hour Vehicular Volume	Not Met
3- Peak Hour	Not Applicable
4- Pedestrian Volume	Not Met
5- School Crossing	Not Applicable
6- Coordinated Signal System	Not Applicable
7- Crash Experience	Not Met
8- Roadway Network	Not Applicable
9- Intersection Near a Grade Crossing	Not Applicable

Based on these findings, installation of a traffic signal is not warranted or recommended at this time.

## Introduction

A traffic signal warrant request was received by the City of Manchester for the intersection of Maple Street and Sagamore Street after a petition was signed by residents requesting the addition of a traffic signal due to crash history and speeds on Maple Street. The intersection is located in Ward 2. Analysis was performed in February 2018 to evaluate the need for a traffic control signal at this intersection.

Traffic control signals are used for the control of vehicle and pedestrian traffic at an intersection. If the traffic control signals are properly located and operated, they usually have one or more of the following advantages:

- Can provide for the orderly movement of traffic.
- Can increase the traffic handling capacity of the intersection with proper physical layouts and control measures.
- Can reduce frequency of certain types of accidents.
- Can help in continuous traffic movement.
- Can be used to interrupt heavy traffic periodically to permit others to cross.

However, there is a strong public belief that traffic signals are a panacea for all traffic problems at intersections, including speeding. Unwarranted signals can invoke more problems than solving them by causing issues such as excessive delay, encouraging disobedience of signal indication, traffic detours through neighborhoods to avoid the signal, and increases in certain types of accident frequencies.

A comprehensive investigation of traffic conditions and physical characteristics of a location is required to determine the necessity for a signal installation. Traffic control signals should not be installed unless at least one of the nine warrants described in this study are met as specified in the Manual on Uniform Traffic Control Devices (MUTCD).

## Site Conditions

### Study Area

The intersection of Maple Street and Sagamore Street is located approximately 1.5 miles south of the I-93 Exit 9 interchange. It is approximately 1/3 mile south of the existing signalized intersection of Webster Street and Maple Street and 500 feet north of the existing signalized intersection of Blodget Street and Maple Street as seen in Figure 1. It is located in a residential two family zoning district which represents moderate density neighborhoods that are nearly fully developed with a mix of single family and two family structures.

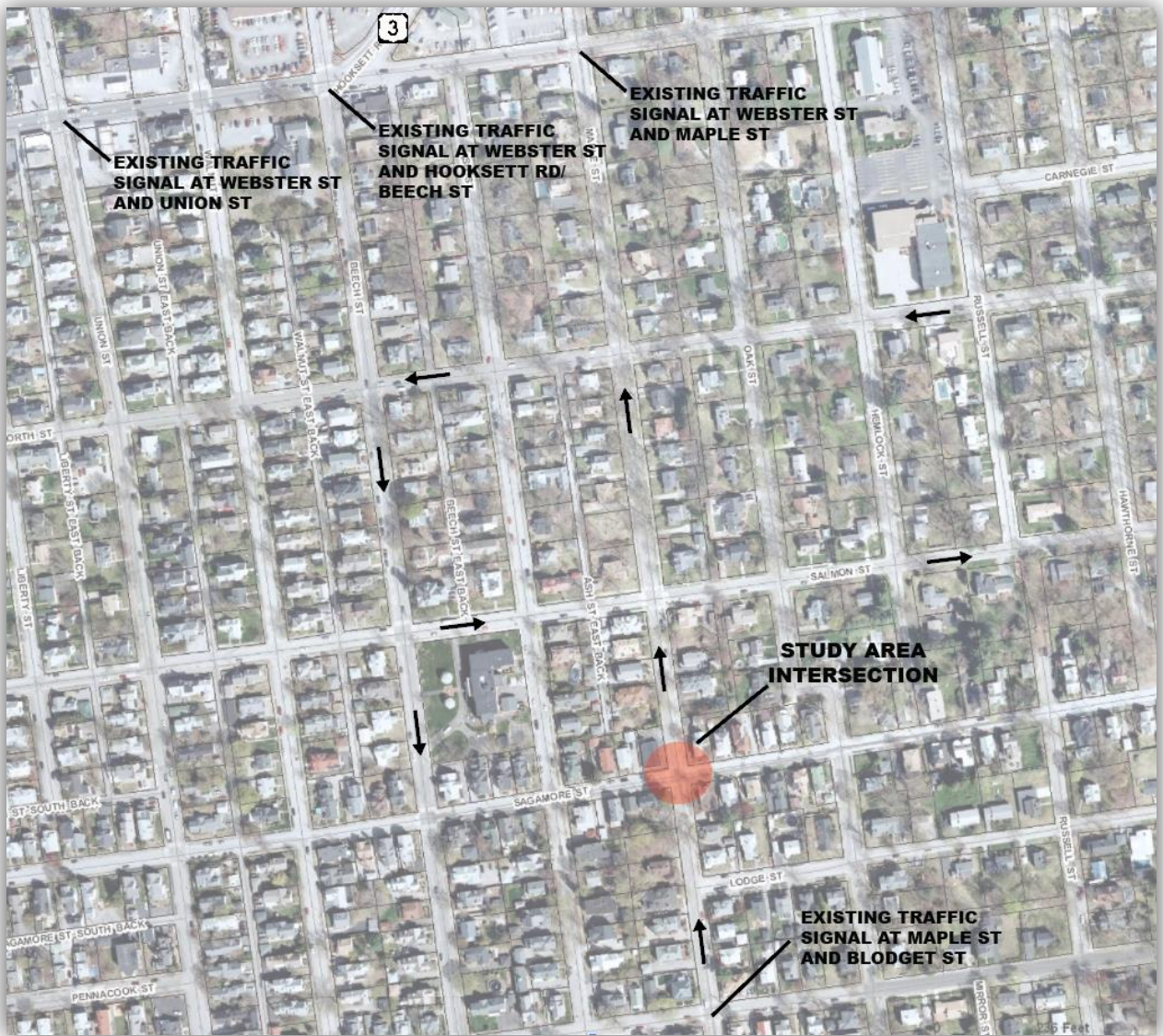


Figure 1. Intersection Location

Maple Street is one-way northbound with no traffic control and has Annual Average Daily Traffic (AADT) of 4,800 vehicles per day (2014). Sagamore Street is two-way east-west with stop control at the intersection. The posted speed limit on both streets is 30 mph. As seen in Figure 2, Maple Street is 30 feet wide with two 11-foot northbound travel lanes and one 8-foot on-street parking lane. On the west side of the intersection, Sagamore Street is 26 feet wide with a 12-foot eastbound lane and 14-foot westbound lane. On the east side of the intersection, Sagamore Street is 26 feet wide with a 13-foot eastbound lane and 13-foot westbound lane. On-street parking is allowed on north side of the street only, although there is no striping to designate parking areas.

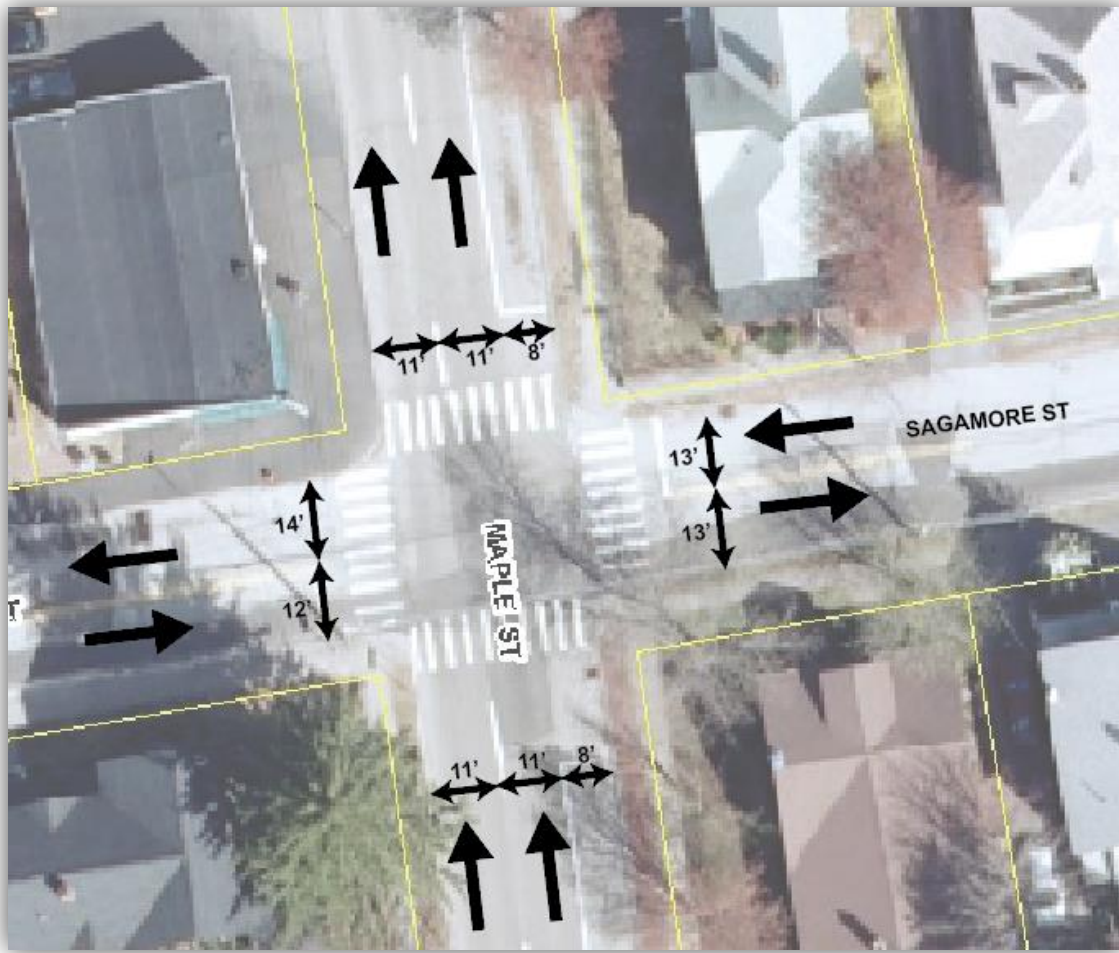


Figure 2. Intersection Geometry

## Traffic Data

### Seasonal Adjustment

Traffic counts are typically adjusted with seasonal factors to represent an average day of the year. The turning movement counts for the project were taken in the month of January. The data was seasonally adjusted based on the 2015 monthly data for NHDOT Group 4 (Urban Highways) Average data provided in Table 2.

Table 2. NHDOT Group 4 Average Data

	AM	Mid	PM	Sat Mid
January	17267	13564	20154	15524
Yearly	19146	15525	22449	18239
Average				
Factor	1.11	1.14	1.11	1.17

## Vehicular Volume

Traffic data was collected for a 12-hour period on Tuesday January 16, 2018; hourly counts are summarized in Table 3.

Table 3. Hourly Traffic Counts

Time	Maple Street NB	Sagamore Street EB	Sagamore Street WB
7AM-8AM	336	28	50
8AM-9AM	264	26	68
9AM-10AM	241	15	28
10AM-11AM	275	13	15
11AM-12PM	296	25	33
12PM-1PM	318	23	30
1PM-2PM	357	24	25
2PM-3PM	363	26	50
3PM-4PM	431	29	48
4PM-5PM	390	37	47
5PM-6PM	282	43	29
6PM-7PM	222	19	31

## Pedestrian Volume

Pedestrian Volumes were collected for the same 12-hour period on Tuesday January 16, 2018; hourly counts are summarized in Table 4.

Table 4. Hourly Pedestrian Volumes

Time of Day	Ped Volume- Maple St	Ped Volume- Sagamore St
7AM-8AM	1	1
8AM-9AM	4	4
9AM-10AM	4	7
10AM-11AM	9	3
11AM-12PM	4	5
12PM-1PM	12	4
1PM-2PM	10	5
2PM-3PM	18	2
3PM-4PM	15	3
4PM-5PM	9	2
5PM-6PM	4	0
6PM-7PM	4	0

## Signal Warrants

When new traffic signals are requested, the Manual on Uniform Traffic Control Devices (MUTCD) requires that an engineering study of traffic conditions, pedestrian characteristics, and physical



characteristics of the location be performed to determine whether installation of a traffic control signal is justified at the particular location. The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location, the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:

- Warrant 1, Eight-Hour Vehicular Volume
- Warrant 2, Four-Hour Vehicular volume
- Warrant 3, Peak Hour
- Warrant 4, Pedestrian Volume
- Warrant 5, School Crossing
- Warrant 6, Coordinated Signal System
- Warrant 7, Crash Experience
- Warrant 8, Roadway Network
- Warrant 9, Intersection Near a Grade Crossing

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

## Warrant 1, Eight-Hour Vehicular Volume

### Explanation of Warrant

The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any eight hours of an average day:

**A. The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches respectively, to the intersection; or**

**B. The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.**

In applying each condition the major-street and minor-street volumes shall be for the same eight hours. On the minor street, the higher volume shall not be required to be on the same approach during each of those 8 hours.

The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems. If the combination is applied, the need for a traffic signal shall be considered if an engineering study finds that both of the following conditions exist for each of any eight hours of an average day:

A. The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches respectively, to the intersection; and

B. The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

**Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume**

**Condition A—Minimum Vehicular Volume**

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% <sup>a</sup>	80% <sup>b</sup>	70% <sup>c</sup>	56% <sup>d</sup>	100% <sup>a</sup>	80% <sup>b</sup>	70% <sup>c</sup>	56% <sup>d</sup>
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

**Condition B—Interruption of Continuous Traffic**

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% <sup>a</sup>	80% <sup>b</sup>	70% <sup>c</sup>	56% <sup>d</sup>	100% <sup>a</sup>	80% <sup>b</sup>	70% <sup>c</sup>	56% <sup>d</sup>
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

<sup>a</sup> Basic minimum hourly volume

<sup>b</sup> Used for combination of Conditions A and B after adequate trial of other remedial measures

<sup>c</sup> May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

<sup>d</sup> May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

**Study Findings**

To meet the eight-hour vehicular warrant, condition A or B must be met for eight hours of the day. Since there is two thru travel lanes on Maple Street and one lane on Sagamore Street, Condition A requires a minimum of 600 vehicles per hour on the major street and 150 vehicles per hour on the higher-volume minor-street approach. Based on the traffic data provided in Table 3, **Condition A is met for zero hours** of the day since the volume on Maple Street never exceeds 600 vehicles per hour and the volume on the higher Sagamore Street approach never exceeds 150 vehicles per hour. Therefore, Condition A is **not met**.

Condition B, interruption of continuous traffic, requires a minimum of 900 vehicles per hour on the major street and 75 vehicles per hour on the higher-volume minor-street approach. Based on the traffic data provided in Table 3, Condition B is **met for zero hours** of the day, since the volume on Maple Street

never exceeds 900 vehicles per hour and the volume on the higher Sagamore Street approach never exceeds 75 vehicles per hour. Therefore, Condition B is **not met**.

The combination of Conditions A and B using the 80% column was also applied. Condition A was met for **zero hours** of the day so the combination of Condition A and B is **not satisfied**.

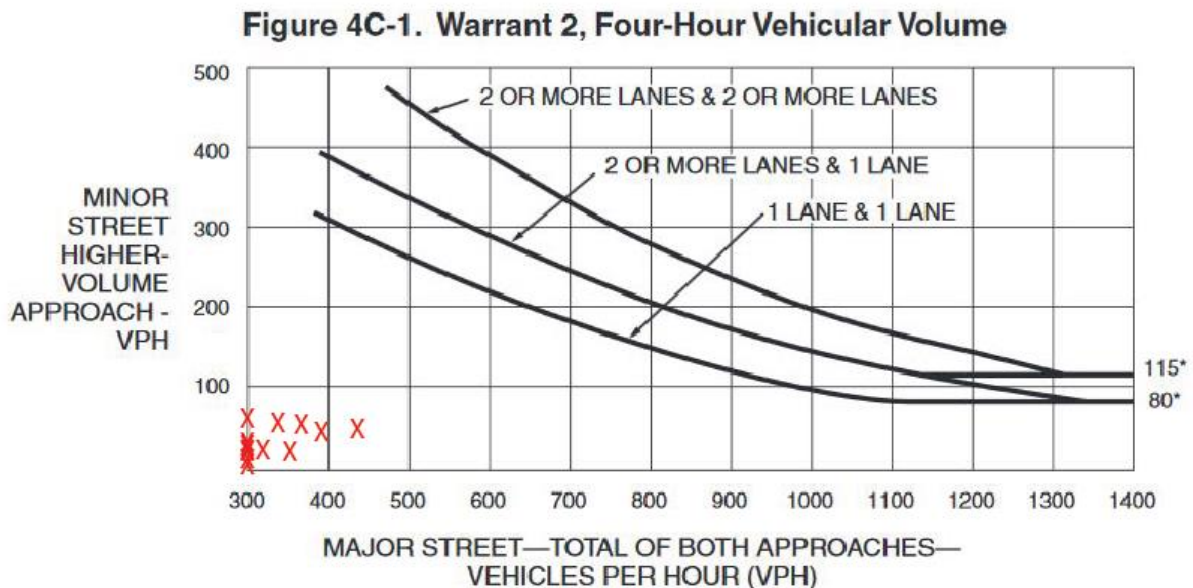
## Warrant 2, Four-Hour Vehicular Volume

### Explanation of Warrant

The need for a traffic control signal shall be considered if an engineering study finds that, for each of any four hours of an average day, the plotted points representing the vehicles per hour on the major street and the corresponding vehicles per hour on the minor-street approach all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes.

### Study Findings

The hourly volumes were plotted, and the warrant was **met for zero hours** of the day; therefore Warrant 2 is **not met**.



\*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

- X Hourly Volume Meeting Warrant Criteria
- X Hourly Volume Not Meeting Warrant Criteria

## Warrant 3, Peak Hour

### Explanation of Warrant

The peak hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of one hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street. The signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

### Study Findings

Since this location does not meet the location criteria, Warrant 3 **does not apply**.

## Warrant 4, Pedestrian Volume

### Explanation of Warrant

The pedestrian volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street. The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that one of the following criteria is met:

**A. For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrian per hour crossing the major street (total of all crossings) all fall above the curve in Figure 4C-5; or**

**B. For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point representing the vehicles per hour on the major street (total of all approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) falls above the curve in Figure 4C-7.**

### Study Findings

The pedestrian volumes, shown in Table 4 were plotted on the MUTCD tables. Condition A, the four-hour warrant, was **met for zero hours**. Condition B, the peak hour warrant, was also **met for zero hours**. Therefore, the Warrant 4 criteria are **not met**.

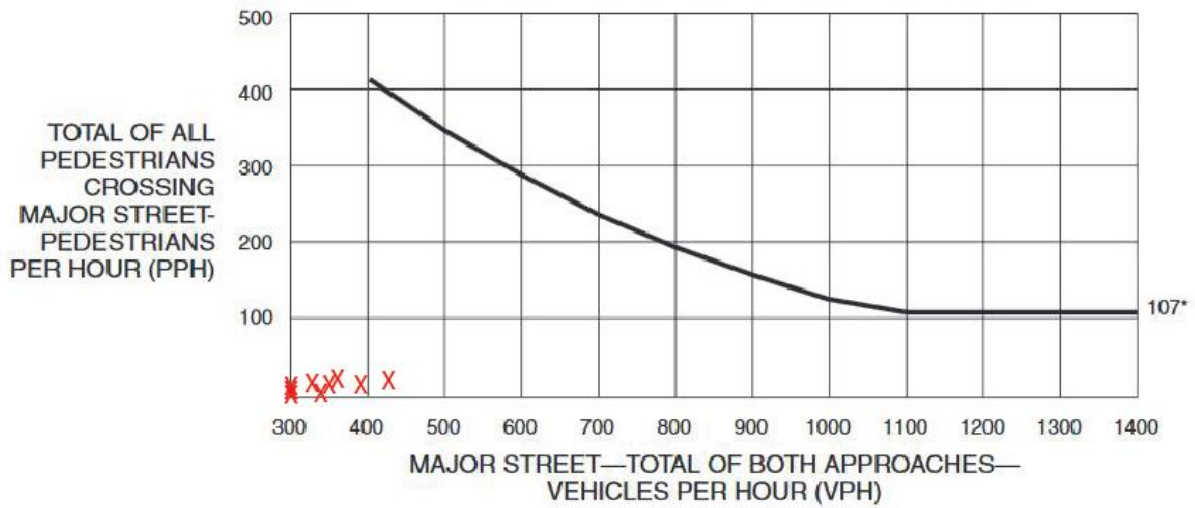
**Figure 4C-7. Warrant 4, Pedestrian Peak Hour**



\*Note: 133 pph applies as the lower threshold volume.

- X Hourly Volume Meeting Warrant Criteria
- X Hourly Volume Not Meeting Warrant Criteria

**Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume**



\*Note: 107 pph applies as the lower threshold volume.

- X Hourly Volume Meeting Warrant Criteria
- X Hourly Volume Not Meeting Warrant Criteria

## Warrant 5, School Crossing

### Explanation of Warrant

The school crossing signal warrant is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word "schoolchildren" includes elementary through high school students.

The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of schoolchildren at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the schoolchildren are using the crossing is less than the number of minutes in the same period and there are a minimum of 20 schoolchildren during the highest crossing hour.

Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

### Study Findings

The intersection of Maple Street and Sagamore Street is not in the vicinity of any schools. Therefore, Warrant 5 **does not apply**.

## Warrant 6, Coordinated Signal System

### Explanation of Warrant

Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles. The need for a traffic signal shall be considered if an engineering study finds that one of the following criteria is met:

**A. On a one-way street or a street that has traffic predominately in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.**

**B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.**

The coordinated signal system warrant should not be applied where the resultant spacing of traffic signals would be less than 1,000 feet.

### Study Findings

Since there is no signal coordination on Maple Street and a significant number of side streets that would make coordination ineffective, Warrant 6 **does not apply**.

## Warrant 7, Crash Experience

### Explanation of Warrant

The crash experience warrant conditions are intended for application where the severity and frequency of the crashes are the principal reasons to consider installing a traffic control signal. The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:

**A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and**

**B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within 1 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requires for a reportable crash; and**

**C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1, or the vph in both the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirement specified in the Pedestrian volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.**

### Study Findings

Three years of crash data was obtained from the Manchester Police Department from January 2015-December 2017. Table 7 provides the total crashes that were reported.

Table 5. Crash History Summary

Accident #	Date	Time	Day of Week	Accident Type
15-001720	2/3/15	12:23 PM	Tuesday	Sideswipe
15-010561	6/24/15	2:11 PM	Wednesday	Head-On; Wrong-Way Driver
15-013371	8/11/15	12:57 PM	Tuesday	<b>Right Angle*</b>
15-016620	10/1/15	1:00 PM	Thursday	<b>Left Turn*</b>
16-002855	2/20/16	3:38 PM	Saturday	Bicycle Hit Car
16-002616	2/22/16	10:19 AM	Monday	<b>Right Angle*</b>
16-013982	9/17/16	1:36 AM	Saturday	<b>Right Angle*</b>
17-005164	4/9/17	11:05 AM	Sunday	Sideswipe
17-019031	11/28/17	6:16 PM	Tuesday	Sideswipe
17-019623	12/8/17	1:01 PM	Friday	Sideswipe

#### \*Reducible Collision Type with Installation of Traffic Signal

Condition B requires that five or more crashes, susceptible to correction by a traffic control signal, be reported within a 12-month period. The highest number of crashes in a 12-month period was in 2015 where four crashes occurred, with only two of the four considered reducible by a traffic signal.

Reducible collision types are typically considered right angle vehicle collisions, left turn collisions, and pedestrian collisions. Rear end, sideswipe, and head-on collisions are typically considered non-reducible

by a traffic control signal. The most common type of crashes at this location were sideswipes, where vehicles traveling northbound on Maple Street in the right lane attempted to make a left onto Sagamore Street and hit the vehicle in the left lane. Based on the number of crashes and crash types, the intersection does not meet the warrant criteria. Traffic volume criteria established by Condition C is also not met. Therefore, warrant criteria 7 are **not met**.

## Warrant 8, Roadway Network

### Explanation of Warrant

Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network. The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:

**A. The intersection has a total existing, or immediate projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during the average weekday; or**

**B. The intersection has a total existing or immediately project entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).**

A major route as used in this signal warrant shall have at least one of the following characteristics:

A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow.

B. It includes rural or suburban highways outside, entering, or traversing a city.

C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

### Study Findings

Maple Street is considered an urban minor arterial and Sagamore Street is considered an urban local road by the NHDOT functional classification system, and therefore, they do not meet the criteria to be considered major routes. Therefore, Warrant 8 **does not apply**.

## Warrant 9, Intersection Near a Grade Crossing

### Explanation of Warrant

The intersection near a grade crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled by STOP or YIELD sign is the principal reason to consider installing a traffic signal.

### Study Findings

The intersection is not in close proximity to a rail crossing, so Warrant 9 **does not apply**.



## Summary of Results

The nine traffic signal warrants were applied to the traffic volumes collected at Maple Street and Sagamore Street over a 12-hour period on January 16, 2018. Table 8 summarizes the results.

Table 6. Summary of Warrant Results

<b>WARRANT</b>	<b>RESULTS</b>
1- Eight-Hour Vehicular Volume	Not Met
2- Four-Hour Vehicular Volume	Not Met
3- Peak Hour	Not Applicable
4- Pedestrian Volume	Not Met
5- School Crossing	Not Applicable
6- Coordinated Signal System	Not Applicable
7- Crash Experience	Not Met
8- Roadway Network	Not Applicable
9- Intersection Near a Grade Crossing	Not Applicable

Based on these findings, installation of a traffic signal is not warranted or recommended at this time. The following recommendations should be considered to improve traffic safety:

- Conduct a speed study on Maple Street to determine if targeted enforcement is necessary