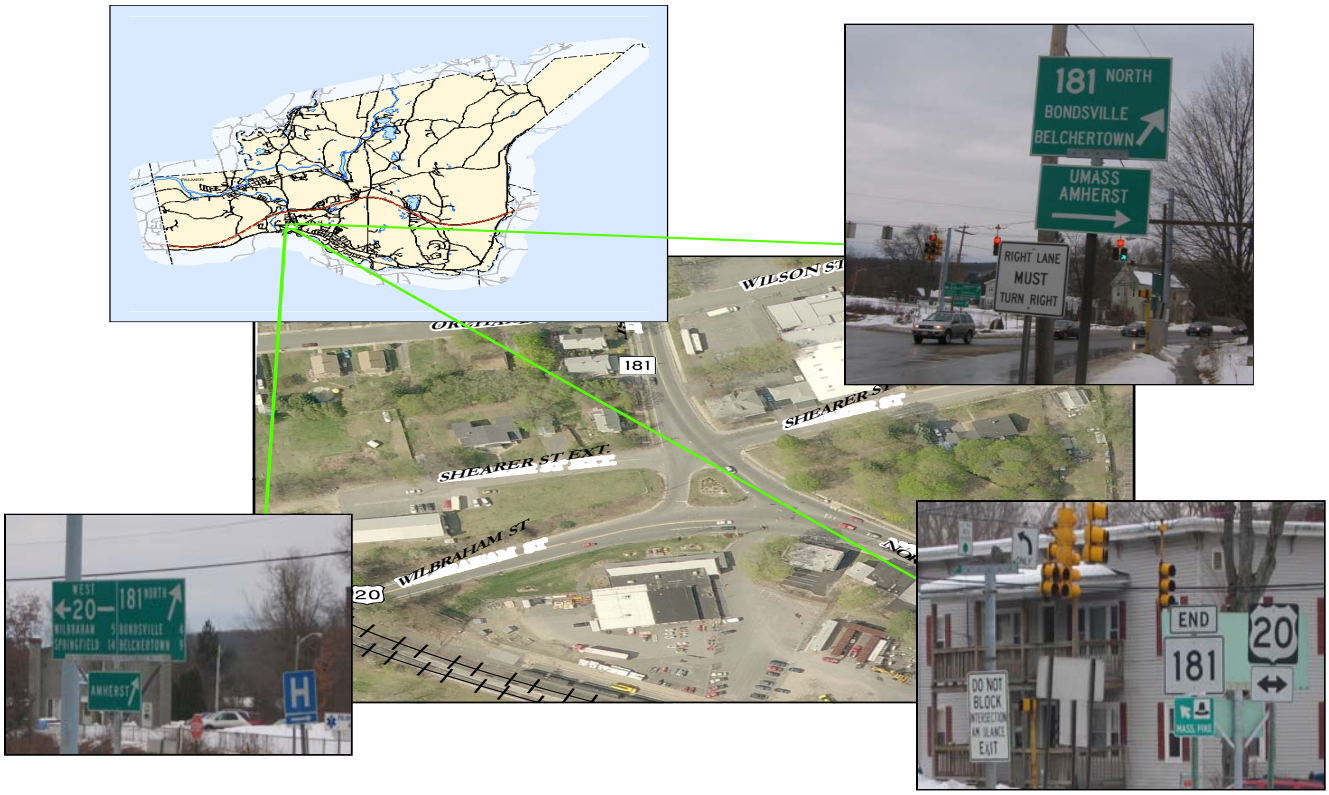
TRANSPORTATION AND SAFETY STUDY

NORTH MAIN STREET (US ROUTE 20 AND MA ROUTE 181), WILBRAHAM STREET (US ROUTE 20) AND SHEARER STREET INTERSECTION

PALMER



PREPARED UNDER THE DIRECTION OF PIONEER VALLEY MPO BY:
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Catalyst for Regional Progress
PVPC
Pioneer Valley Planning Commission

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ABBREVIATIONS

1	AM, a.m.	Afore Meridian
2	LOS	Level of Service
3	MassDOT	Massachusetts Department of Transportation
4	MPH	Miles per Hour
5	MUTCD	Manual on Uniform Traffic Control Devices
6	NHS	National Highway System
7	PM, p.m.	Post Meridian
8	PVPC	Pioneer Valley Planning Commission
9	Rd.	Road
10	St.	Street
11	TMC	Turning Movement Counts

I. INTRODUCTION

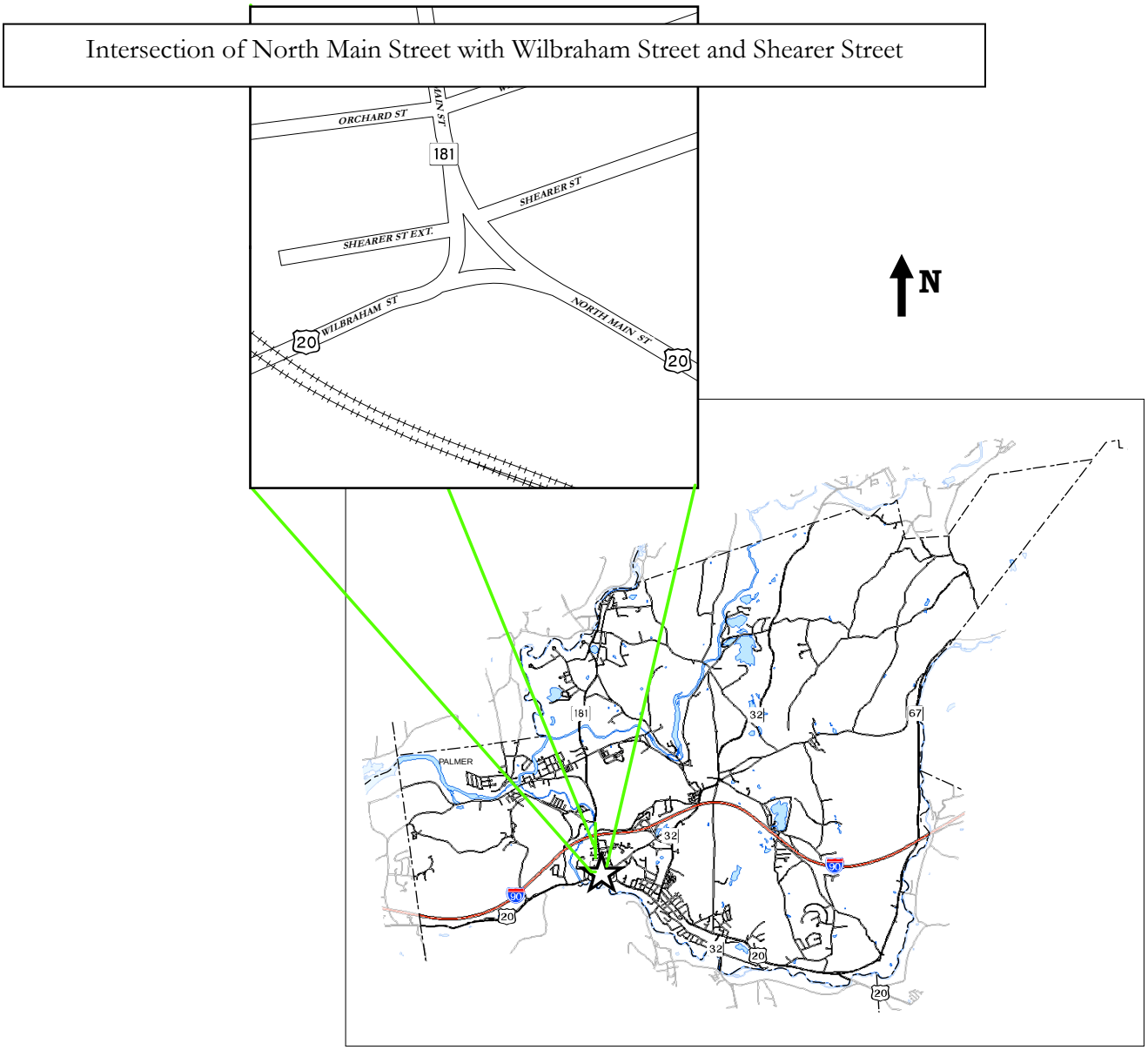
The intersection of North Main Street (US Route 20 and MA Route 181) with Wilbraham Street (US Route 20) and Shearer Street in Palmer currently appears as the 32nd ranked intersection out of the Top 100 High Crash Intersections in the Pioneer Valley Region. This ranking prompted Pioneer Valley Planning Commission (PVPC) to conduct this safety study to verify the factors that could contribute to the crashes at this intersection. The study examines the existing conditions at the intersection and includes a level of service analysis performed on the basis of the traffic data collected in the field. It provides a series of short-term recommendations to improve existing traffic operations and increase safety.

STUDY AREA

The intersection of North Main Street (US Route 20 and MA Route 181) with the Wilbraham Street (US Route 20) and Shearer Street is located in the southwestern end of the Town of Palmer. Due to its location, the intersection serves both regional commuter traffic as well as traffic associated with downtown Palmer. Land uses in the vicinity of the intersection consist of a mixture of residential and commercial sites. There is a median which separates right turning traffic from North Main Street (MA Route 181) and Shearer Street onto Wilbraham Street (US Route 20). The intersection is located in the vicinity of MassCentral rail line. A motor sports shop is located to the south of the intersection next to the MassCentral Rail Road property. Palmer Ambulance is located to the west of the intersection on Shearer Street extension. Wing Memorial hospital is located to the northeast of the intersection.

The intersection can be divided into two intersections; one intersection of North Main Street (US Route 20) and Wilbraham Street (US Route 20) with North Main Street (MA Route 181) and the driveway from the motor sports shop located to the south, and the other intersection of North Main Street (MA Route 181) with Shearer Street. For simplification purposes in this report the intersection of Route 181 with Shearer Street is referred to as *Intersection 1* and the intersection of Route 20 with Route 181 and the motor sports shop driveway is referred to as *Intersection 2*. *Intersection 1* operates under 'Stop' sign control for the Shearer Street approach. *Intersection 2* operates under a traffic signal control. The traffic signal has pedestrian actuated signals for crosswalk across North Main Street (US Route 20).

Figure 1: Study Area



TOWN OF PALMER

NORTH MAIN STREET (US ROUTE 20 / MA ROUTE 181)

North Main Street is classified as urban extension (U3) of a minor arterial. It is a part of the National Highway System (NHS) of US Route 20 which runs east-west and MA Route 181 which runs north-south. Sidewalks are provided along both sides of North Main Street near the vicinity of the intersection and pavement markings have faded in many areas.

US Route 20
This section of North Main Street serves the downtown section of Palmer and provides access to a variety of commercial uses. The posted speed limit for this approach is 25 mph. In the vicinity of the intersection, North Main Street provides two travel lanes; an exclusive left turn lane to continue on Route 20 and a through/right turn lane to access Route 181 and Shearer Street. Both movements are controlled by protected green arrows. 'No Turns on Red' are permitted from this approach.

MA Route 181
This section of North Main Street has two southbound approaches; one at *Intersection 1* with Shearer Street and the other at *Intersection 2*. The southbound approach of Route 181 at *Intersection 1* is prioritized as a through movement and there is a stop line across this approach. There is residential development along the sides. There is a painted signal sign before *Intersection 1*. A right turn lane onto Wilbraham Street (US Route 20) is separated by a median. This right turn lane is controlled by two 'Stop' signs. These signs have faded, alignment has been disturbed, and they also seem to be mounted low. There is an additional left turn not permitted arrow sign in the median. The left lane at this intersection has a stop line before the Shearer Street approach. A 'Do Not Block' intersection sign is located in the median facing this approach.

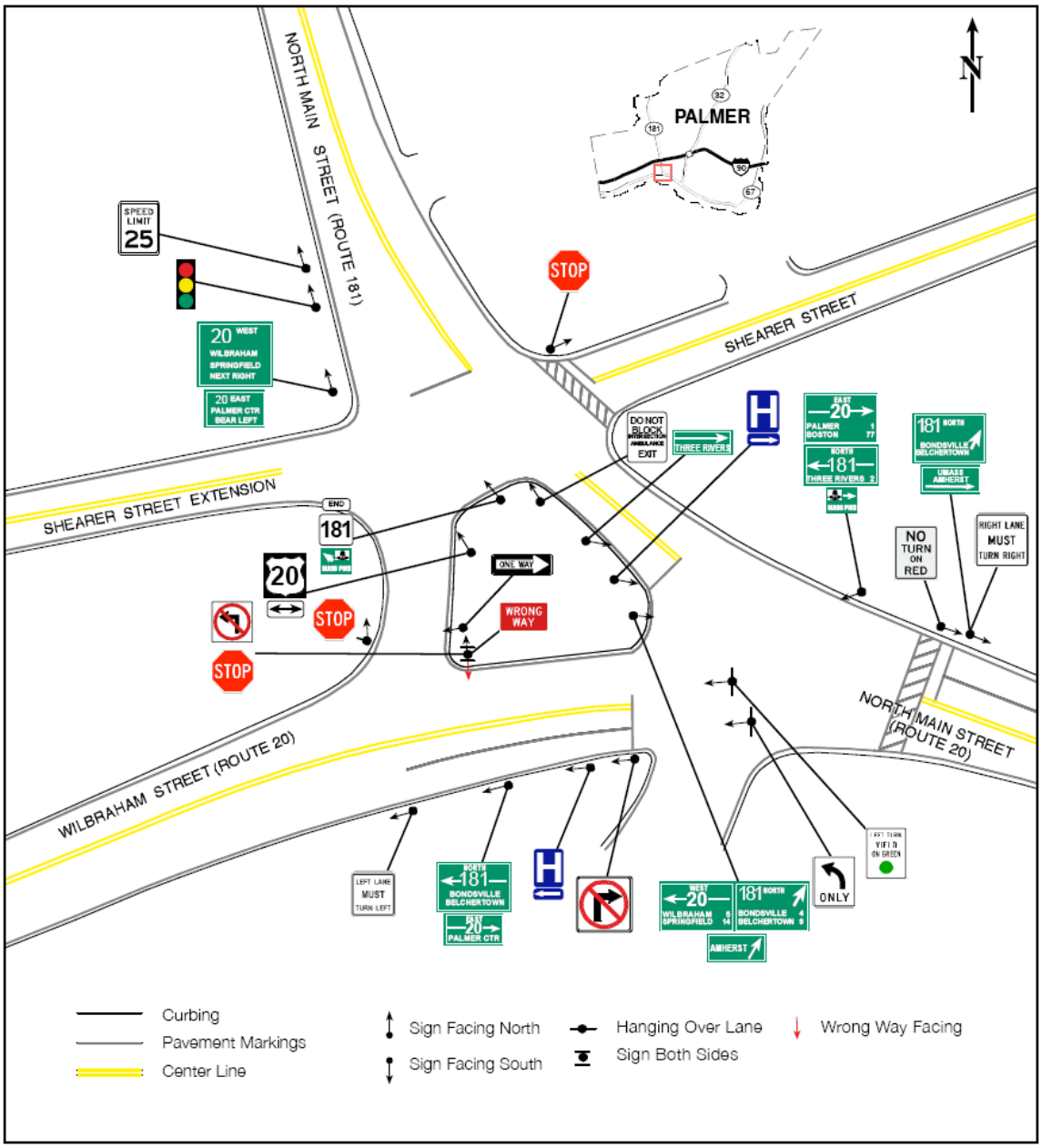
WILBRAHAM STREET (US ROUTE 20)

Wilbraham Street is a part of the National Highway System (NHS) of US Route 20 which is classified as urban extension of a minor arterial (U3). A 'Signal Ahead' sign is located before the intersection. This approach at *Intersection 2* has two lanes. The left lane is designated for left turns only by an overhead sign and the right lane is used by through traffic. A sign on the right side of the approach prohibits right turns from Wilbraham Street into the motor sports driveway.

SHEARER STREET

Shearer Street is classified as an urban minor collector (U6) which provides a connection between MA Route 32 located in the east direction and MA Route 181 at *Intersection 1*. It provides one lane in each direction. The approach is controlled by a Stop sign and a crosswalk is painted across the approach. The street has sidewalks along both sides. Shearer Street is predominantly residential but can act as a bypass to the downtown area. *First Baptist Christian Academy School* is located along Shearer Street approximately half a mile from the *Intersection 1*.

Figure 2: Existing Pavement Markings and Signage



Prepared by the Pioneer Valley Planning Commission, July 2009.

Illustration is not to scale.

Figure 3: Aerial Image of the Intersection

II. EXISTING TRANSPORTATION CONDITIONS

This section provides a technical evaluation of the transportation components for the intersection. It includes a presentation of the data collected, analysis of traffic operations, and a series of observations and conclusions derived from the analysis.

PEAK HOUR VOLUME AND TURNING MOVEMENT COUNTS

Turning Movement Counts (TMCs) were conducted for the intersection during the peak commuter periods. The weekday peak commuter period occurs during the morning hours of 7:00 AM to 9:00 AM and the afternoon hours of 2:00 PM to 6:00 PM. The TMC's were conducted to identify the peak four consecutive 15 minute periods of traffic through the intersection. These consecutive peak 15 minute periods constitute a location's Peak Hour Volume. The peak hour of traffic volume represents the most critical period for operations and will be the focus for some of the analysis conducted in this study.

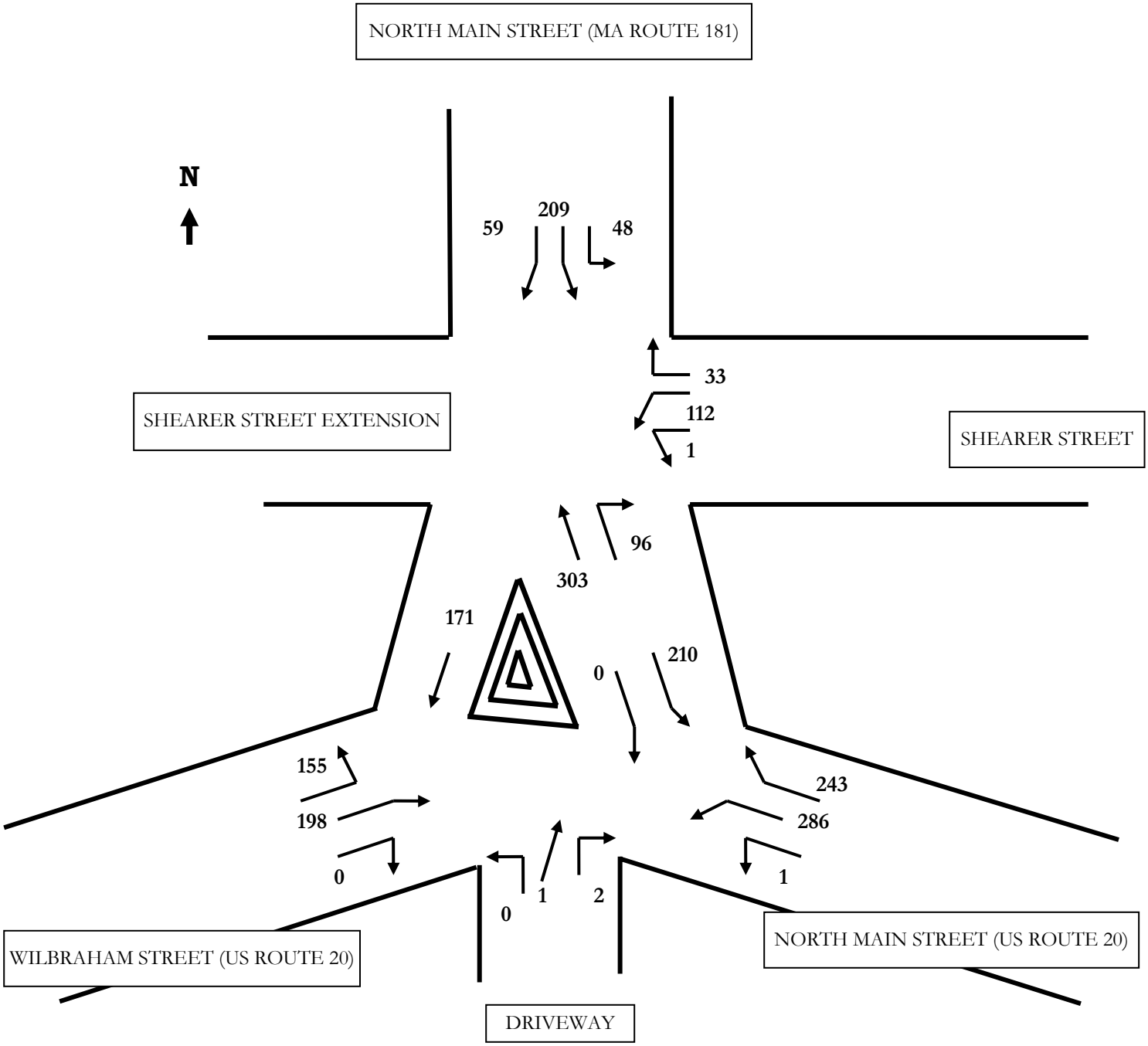
The TMC data also identifies the number of heavy vehicles and pedestrians on the roadway. Heavy vehicles include trucks, recreational vehicles and buses. The percentage of heavy vehicles in the traffic flow is an important component in calculating the serviceability of a corridor or intersection. Trucks impact traffic flow because they occupy more roadway space than passenger cars and have poorer operating capabilities with respect to acceleration, deceleration and maneuverability.

The TMC data was obtained during weekday peak periods. As traffic volumes tend to fluctuate over the course of the year, the Massachusetts Highway Department (MassHighway) develops traffic volume adjustment factors to reflect monthly variations. These factors were examined to determine how traffic conditions at the intersection of North Main Street (US Route 20 and MA Route 181), Wilbraham Street (US Route 20) and Shearer Street compare to average monthly conditions.

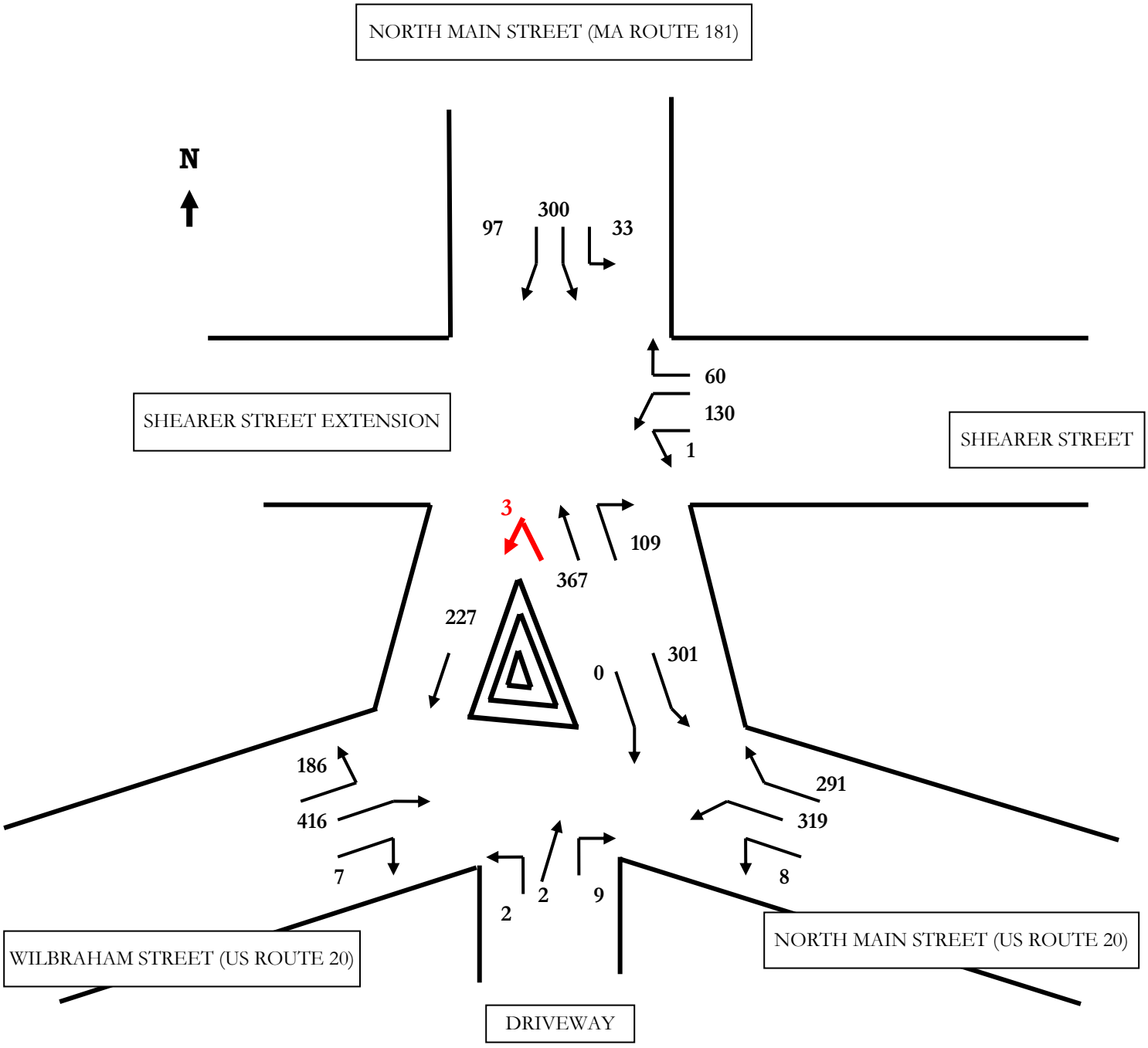
A total of 838 vehicles were recorded to enter *Intersection 1* and a total of 1100 vehicles were recorded to enter *Intersection 2* during the morning peak hour between 7:30 am to 8:30 am. Only one vehicle made a left turn from Shearer Street onto North Main Street during this time. Very few vehicles were observed to enter or exit from the motor sports driveway in the morning peak hour. About 1097 vehicles were recorded to enter *Intersection 1* and a total 1547 vehicles were recorded to enter *Intersection 2* during the afternoon peak hour between 4:15 pm to 5:15 pm. Also in the afternoon peak hour a total of 3 vehicles were observed to turn left at the median at *Intersection 1* after crossing *Intersection 2* to go straight onto Wilbraham Street (US Route 20). These vehicles missed the through movement at *Intersection 2* from North Main Street (Route 20) to Wilbraham Street (Route 20).

Figure 4: Turning Movement Counts

Morning Peak Hour (7:30 am to 8:30 am)



Afternoon Peak Hour (4:15 pm to 5:15 pm)



SAFETY

To study safety PVPC obtained crash history of the intersection from the Massachusetts Highway Department (MassHighway) and the Palmer Police Department. Actual crash reports were studied and analyzed to form collision diagram of the intersection. The crash history for calendar years 2004 and 2005 was provided by MassHighway. The crash history for calendar years 2006 to 2008 (through October) was provided by the Palmer Police Department.

1. Crash Rate Analysis

A crash rate analysis was performed to compare the value at the intersection to the average value for MassHighway District 2 intersections of a similar type. The crash rate per million entering vehicles was calculated. In theory, crash rates can increase as the traffic volume along the roadway increases or as the potential for conflict is increased. The crash rate per million entering vehicles takes into consideration the number of crashes at an intersection and the number of vehicles that enter the intersection over the course of an average day. Based on MassHighway data, the average crash rate for a signalized intersection is 0.94.

For the purpose of calculating the crash rate, both the intersections are considered as one and the volumes entering from all approach legs are summarized. These volumes comprise the total volume entering all the branches of the intersection.

A total of 68 crashes were reported at this intersection between the calendar years of 2004 to 2008. On an average there were 14 crashes reported per year. The crash rate calculated using these numbers is 1.27. A total of 22 crashes were reported in the year 2005 alone. Nearly 60% of the crashes (40 out of 68) were angle type collisions and most of the remaining crashes were rear end type collisions. No fatalities occurred during this time period and about 30% of crashes resulted in some non fatal injury. Also, most of the known crashes occurred in clear weather and dry road conditions.

For further analysis the intersection can be divided into two separate intersections and crash rate can be computed for each intersection individually using the local crash data.

Intersection 1: North Main Street (MA Route 181), Shearer Street and traffic from US Route 20 from south

At this intersection 24 crashes were reported between the calendar years of 2006 and 2008. The afternoon peak hour volume of vehicles entering the intersection is 1097. The calculated crash rate using these numbers is 1.80.

Intersection 2: North Main Street (US Route 20), Wilbraham Street (US Route 20) and traffic from MA Route 181 and Shearer Street from north

At this intersection 6 crashes were reported between the calendar years of 2006 and 2008. The afternoon peak hour volume of vehicles entering the intersection is 1547. The calculated crash rate using these numbers is 0.32.

Table 1: Crash Rate

Year	Total # of Crashes	Type		Severity		Weather Condition		Road Condition		Crash Rate
2004	16	Angle	8	Property Damage	13	Clear	13	Dry	15	
		Rear End	6	Non fatal Injury	3	Cloudy	3	Wet	1	
		Head On	1							
		Single Vehicle	1							
2005	22	Angle	12	Property Damage	14	Clear	19	Dry	14	
		Rear End	9	Non fatal Injury	6	Cloudy	2	Wet	3	
		Side Swipe	1	Not Known	2	Rain	1	Ice	2	
						Unknown		Snow	3	
2006	13	Angle	9	Property Damage	11	Clear	6	Dry	8	
		Rear End	4	Non fatal Injury	3	Cloudy	3	Wet	2	
						Rain	1	Snow	1	
						Snow	1	Unknown	2	
						Unknown	2			
2007	7	Angle	4	Property Damage	3	Unknown	7	Snow	1	
		Rear End	3	Non fatal Injury	4			Unknown	6	
2008	10	Angle	7	Property Damage	7	Unknown	10	Unknown	10	
		Rear End	3	Non fatal Injury	3					
Total	68									**1.27**

Source: MassHighway, Palmer Police Department

When both the intersections are analyzed separately, a large difference is observed between their crash rates. *Intersection 1* has a much higher crash rate than *Intersection 2*. It can be deduced that most of the crashes occur at *Intersection 1*, which has comparatively lesser traffic volumes than *Intersection 2* during both the peak hours.

The intersections average nearly 14 crashes per year over the 5 year analysis period. Over one third of the crashes that occurred at the intersection during the 2005 calendar happened under wet, icy or snowy roadway conditions.

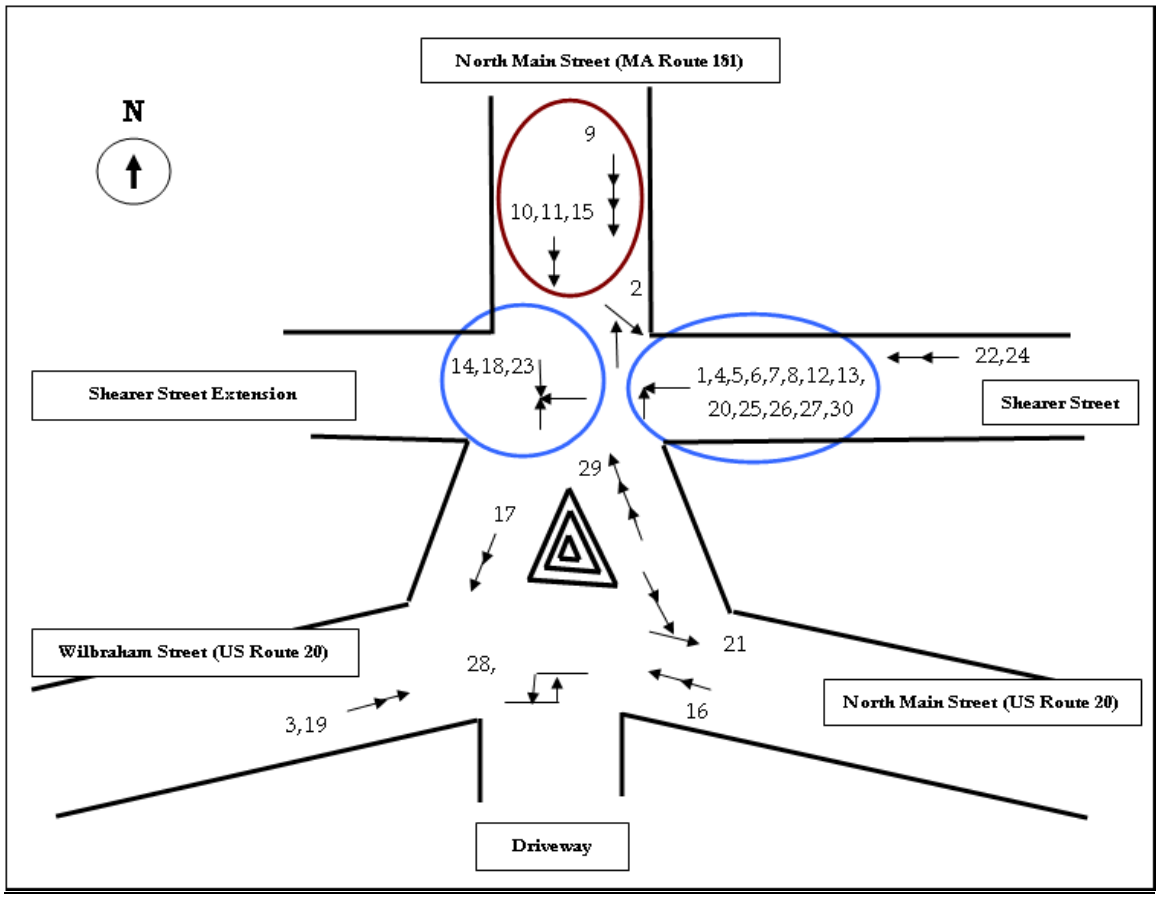
2. Collision Diagram

PVPC obtained the crash reports from the Palmer Police Department for the 2006 to 2008 (through October) calendar years. The objective was to analyze the collision patterns and determine factors that may contribute to crashes at this intersection.

Based upon the data in the crash reports, each crash has been depicted graphically in the collision diagram and patterns of crashes have been grouped. Figure 5 shows the collision diagram for the intersection. The details of the crashes shown in the figure are summarized in Table 2.

The collision diagram shows that most of the crashes (24 out of 30) occurred at *Intersection 1*. Also, most of the crashes occurred between northbound through traffic on North Main Street and westbound traffic on Shearer Street. A total of 6 crashes involved three vehicles colliding with each other and 3 out of these six involved through traffic on Shearer Street and North Main Street. A number of rear end type collisions were observed on the southbound approach of North Main Street (MA Route 181). These rear end collisions on the southbound approach of North Main Street could be because of the vehicles making sudden stops before the intersection to avoid blocking the intersection and the Palmer Ambulance Entrance. It is possible that vehicles attempting to turn left out of Shearer Street have difficulty in reviewing left turning traffic from Wilbraham Street onto North Main Street.

Figure 5: Collision Diagram



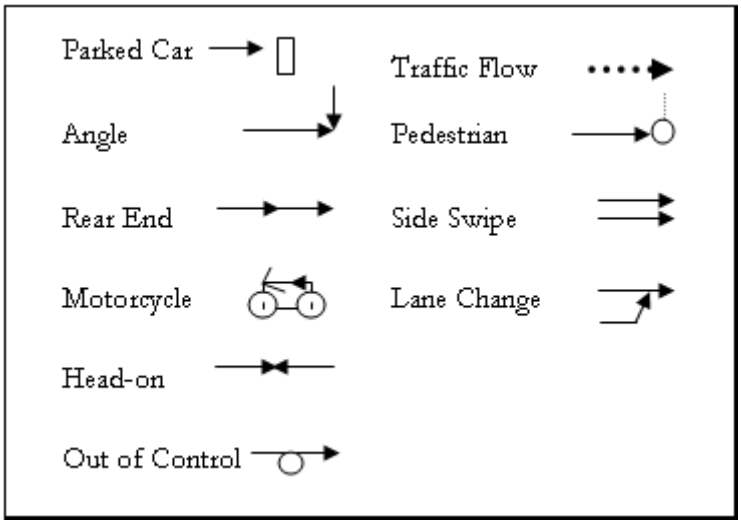
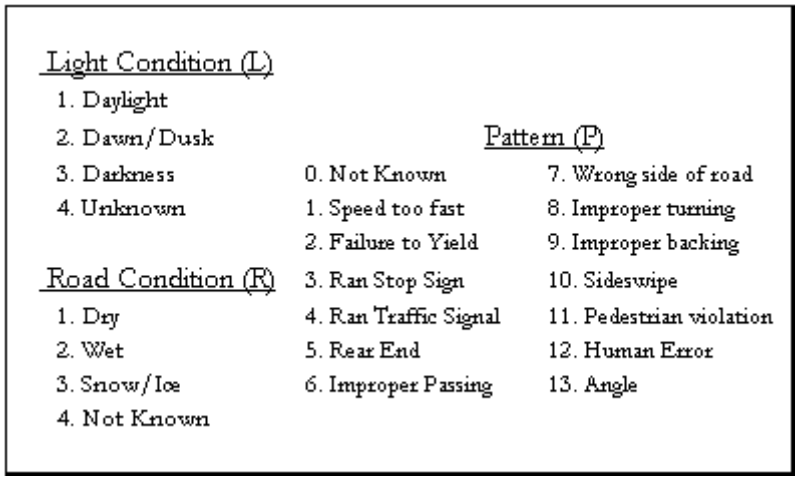


Table 2: Crashes included in Collision Diagram

	DATE	TIME	DAY	SEV.	L	R	P		DATE	TIME	DAY	SEV.	L	R	P
1	01/10/06	9:57 AM	TUE	PD	1	4	13	**16**	03/16/07	5:12 PM	FRI	I	2	3	5
2	02/25/06	8:15 PM	SAT	I	1	4	13	**17**	07/10/07	6:16 PM	TUE	I	1	4	5
3	04/19/06	2:16 PM	WED	PD	1	4	5	**18**	08/07/07	8:01 AM	TUE	I	1	4	13
4	04/26/06	10:06 PM	WED	PD	3	4	13	**19**	11/03/07	9:13 PM	SAT	PD	3	4	12
5	05/09/06	9:19 AM	TUE	PD	1	4	13	**20**	12/21/07	2:05 PM	FRI	PD	1	4	13
6	05/13/06	8:45 PM	SAT	PD	2	4	13	**21**	04/10/08	4:45 PM	THU	PD	1	4	5,13
7	07/26/06	5:05 PM	WED	PD	1	4	13	**22**	05/20/08	4:21 PM	TUE	PD	1	4	5
8	08/27/06	3:43 PM	SUN	I	1	2	13	**23**	08/27/08	3:56 PM	WED	I	1	4	13
9	09/29/06	2:15 PM	FRI	PD	1	4	5	**24**	09/14/08	4:49 PM	SUN	PD	1	4	5
10	10/20/06	6:44 AM	FRI	PD	2	4	5	**25**	09/26/08	2:28 PM	FRI	I	1	4	13
11	11/04/06	9:04 AM	SAT	PD	1	4	5	**26**	09/26/08	3:42 PM	FRI	PD	1	4	13
12	12/02/06	7:55 AM	SAT	I	2	4	13	**27**	09/29/08	3:02 PM	MON	I	1	4	13
13	12/22/06	2:01 PM	FRI	PD	1	4	13	**28**	10/11/08	11:41 AM	SAT	PD	1	4	13
14	02/17/07	11:08 PM	SAT	I	3	4	13	**29**	11/02/08	10:37 AM	SUN	PD	1	4	5
15	02/23/07	10:15 AM	FRI	PD	1	4	5	**30**	11/10/08	10:23 AM	MON	PD	1	4	13

Source: Palmer Police Department



Fatality	F
Personal Injury	I
Property Damage	PD

SIGNAL WARRANT ANALYSIS

After looking at the results of the crash analysis, a signal warrant analysis was performed for *Intersection 1* to examine the feasibility of installing a second signal at this location, in coordination with the signal at *Intersection 2*.

The Manual on Uniform Traffic Control Devices (MUTCD) identifies eight different warrants to evaluate if an intersection meets the minimum requirements for signalization. One or more warrants must be satisfied to justify a traffic signal, however engineering judgment dictates if an intersection warrants the installation of a signal. The installation of a traffic signal must improve the safety and operation of the location under study. Table 3 presents the results of the signal warrant analysis.

Of the eight total warrants for the installation of a traffic signal, Warrant1 – Eight Hour Vehicular Volume is generally considered the most important as it requires minimum volumes to be met on both the major and minor streets for at least eight hours. Warrant 2 – Four Hour Vehicular Volume and Warrant 3 – Peak Hour Volume also requires minimum volumes to be met but over shorter timeframes. Warrant 7 – Crash Experience requires 80% of the volume requirements of Warrant 1 to be satisfied and at least 5 crashes of a type correctable through traffic signalization to have occurred over the last year. This warrant also requires that less restrictive remedies such as improved signage and pavement markings be tried and have failed to reduce crashes before a signal can be installed.

Table 3: Signal Warrant Analysis Results

Warrant	Description	Status
1	Eight Hour Volume	Not Satisfied
2	Four Hour Volume	*Satisfied*
3	Peak Hour	Not Applicable
4	Pedestrian Volume	Not Applicable
5	School Crossing	Not Applicable
6	Coordinated Signal System	Not Applicable
7	Crash Experience	*Satisfied*
8	Roadway Network	Not Required

Source: PVPC

The above table shows that the intersection meets Warrant 2 and Warrant 7. Warrant 2 conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal. The intersection has a documented history of safety problems as most of the reported crashes occurred at this intersection. Such angled collisions could be prevented by a signal which regulates the movements at all the three approaches.

LEVEL OF SERVICE ANALYSIS

The intersection was examined with regard to capacity and delay characteristics to determine the existing Level of Service (LOS). LOS is an indicator of the operating conditions which occur on a roadway under different volumes of traffic and is defined in the 2000 Highway Capacity Manual by six levels, 'A' through 'F'. A number of operational factors can influence the LOS including geometry, travel speeds, delay, and the number of pedestrians. Table 4 presents the LOS designations for a signalized intersection and Table 5 present the LOS designations for an unsignalized intersection.

Depending on the time of day and year, a roadway may operate at varying levels. Level of Service 'A' represents the best operating conditions and is an indicator of ideal travel conditions with vehicles operating at or above posted speed limits with little or no delays. Conversely, LOS 'F', or failure, generally indicates forced flow conditions illustrated by long delays and vehicle queues. Level of Service 'C' indicates a condition of stable flow and is generally considered satisfactory in rural areas. Under LOS 'D' conditions, delays are considerably longer than under LOS 'C', but are considered acceptable in urban areas. At LOS 'E' the roadway begins to operate at unstable flow conditions as the facility is operating at or near its capacity. The existing LOS and delays at the different approaches of the intersection of North Main Street (US Route 20 and MA Route 181) with Wilbraham Street (US Route 20) and Shearer Street is given in Table 6.

Table 4: Level of Service Designations for Signalized Intersections

Category	Description	Delay (in seconds)
LOS A	Describes a condition of free flow, with low volumes and relatively high speeds. There is little or no reduction in maneuverability due to the presence of other vehicles and drivers can maintain their desired speeds. Little or no delays result for side street motorists.	< 10.0
LOS B	Describes a condition of stable flow, with desired operating speeds relatively unaffected, but with a slight deterioration of maneuverability within the traffic stream. Side street motorists experience short delays.	>10.0 to 20.0
LOS C	Describes a condition still representing stable flow, but speeds and maneuverability begin to be restricted. Motorists entering from side streets experience average delays.	>20.0 to 35.0
LOS D	Describes a high-density traffic condition approaching unstable flow. Speeds and maneuverability become more restricted. Side street motorists may experience longer delays.	>35.0 to 55.0
LOS E	Represents conditions at or near the capacity of the facility. Flow is usually unstable, and freedom to maneuver within the traffic stream becomes extremely difficult. Very long delays may result for side street motorists.	>55.0 to 80.0
LOS F	Describes forced flow or breakdown conditions with significant queuing along critical approaches. Operating conditions are highly unstable as characterized by erratic vehicle movements along each approach.	> 80.0

Source: Highway Capacity Manual 2000

Table 5: Level of Service (LOS) Designations for Unsignalized Intersections

LOS	Expected Delay To Minor Street	Average Control Delay (s/veh)
A	Little or no delay	0.0 to 10.0
B	Short traffic delays	>10.0 to 15.0
C	Average traffic delays	>15.0 to 25.0
D	Long traffic delays	>25.0 to 35.0
E	Very long delays	>35.0 to 50.0
F	Extreme delays	>50.0

Source: Highway Capacity Manual 2000

Table 6: Existing Level of Service

INTERSECTION	APPROACH	MOVEMENT	AM Peak Hour		PM Peak Hour	
			Delay*	LOS**	Delay*	LOS**
2 SIGNALIZED	North Main Street (US Route 20) Westbound	Right	11.4	B	20.3	C
		Through/Left	20.2	C	36.5	D
	Motor Sports Driveway Northbound	Through/Right/Left	42.0	D	46.0	D
	Wilbraham Street (US Route 20) Eastbound	Left	27.8	C	30.9	C
		Through/Right	24.9	C	35.8	D
	North Main Street (MA Route 81) Southbound	Through/Left	20.1	C	34.2	C
1 'STOP' SIGN	Shearer Street Westbound	Through/Left/Right	22.1	C	39.5	E

Source: PVPC

* Delay in Seconds
** LOS – Level of Service

Both the intersections were analyzed to determine the level of service during both the peak hours. The Shearer Street approach at *Intersection 1* operates at LOS C and LOS E during morning and afternoon peak hours respectively. Also the traffic queue at the North Main Street (MA Route 181) at the *Intersection 2* was observed to routinely block *Intersection 1* despite 'Do Not Block Intersection' sign. *Intersection 2* operates at LOS C during both peak hours having a total intersection delay of 20.2 seconds during the morning peak hour and 32.2 seconds during the afternoon peak hour.

VHB TRANSPORTATION STUDY MARCH 2009

The Town of Palmer retained the firm of Vanasse Hangen Brustlin, Inc. (VHB) to conduct a preliminary transportation planning assessment of five Priority Development Sites. This study, conducted in March 2009, includes Turning Movement Counts (TMC) and crash data for the intersections of Route 20 with Route 181 and Route 181 with Shearer Street. VHB counts were collected in the month of March were not adjusted to reflect average month condition. The PVPC counts were collected in the month of August and were factored using MassDOT seasonal factors to reflect average month conditions. Both sets of traffic counts were compared for the morning and afternoon peak hours. There is minimal difference between the PVPC and VHB data during the afternoon peak hour. The VHB counts were found to be higher than the PVPC counts for some movements during the morning peak hour. As a result, the VHB counts for the morning peak hour were used for this analysis.

Similarly, PVPC compared the crash data obtained from the Palmer Police Department to the MassDOT and local crash data used in the VHB study. Use of the local data resulted in a higher number of reported crashes in the study area. The local information was also used in this study due to the higher level of detail available from the crash reports.

III. RECOMMENDATIONS

Based on the field survey and analysis, the following short term and long term recommendations have been made to improve transportation and safety conditions at the intersection.

PAVEMENT

Overall, the pavement at the intersection is in good condition. It is recommended that MassDOT and the Town of Palmer keep monitoring the pavement condition and initiate any repair measures required to maintain the quality of the pavement.

The pavement markings on all of the approaches have faded. The lane markings and crosswalk markings across the North Main Street (US Route 20) westbound approach at Intersection 2 and the pavement edge lines have also faded. Stop Lines across both southbound approaches of North Main Street (MA Route 181) at both of the intersections have also faded. There are no pavement arrows within the travel lanes to direct the motorists. It is recommended that pavement arrows be painted within the designated lanes to guide the motorists.

Despite the presence of a 'Do Not Block Intersection' sign, vehicles on the southbound approach of North Main Street were observed to queue back and block the Shearer Street intersection. It is recommended that 'Do Not Block' pavement markings which highlight the *Intersection 1* should also be considered by the MassDOT as an immediate and short term measure to prevent such situations.

PEDESTRIAN REQUIREMENTS

The pedestrian push button signal across the North Main Street (US Route 20) westbound approach at Intersection 2 was not functioning at the time of the field visit. It is recommended that MassDOT conduct necessary repair measures to ensure the proper functioning of this device. Also, North Main Street (MA Route 181) provides access to several residential streets along its path and pedestrians were observed to cross at this intersection at the time of the survey during winter months. It is recommended that MassDOT and the Town of Palmer consider a pedestrian warrant analysis for this approach during more reasonable conditions to verify whether or not a crosswalk is required at this location.

SIGNS

There are a number of guide signs along the street as well as inside the median in the vicinity of both the intersections. According to studies conducted by researchers, one factor that can contribute to crashes is confusion and ambiguity created by too many signs in one location. It is recommended that MassDOT District 2 review the existing sign placement to maintain optimum signage as well as correct alignment and visibility of all the signs to avoid any confusion for motorists.

There is a sign prohibiting right turns into the motor sports driveway from Wilbraham Street (US Route 20). This sign is hidden behind the huge guide sign in front of it. Seven vehicles were observed to make a right turn at this approach during afternoon peak hour. This sign uses just the symbol to convey its message and there is a possibility that this sign could have been put up for large vehicles with huge turning radius or to prohibit right turns on red. It is also possible that such a sign could be intended for the North Main Street (MA Route 181) approach from the north as the right turn lane is separated by a median. It is recommended that MassDOT examine this sign and consider removing or relocating it if necessary.
The following short term signal and signage recommendations were identified as a part of the field inventory of the study area:

- The 'Do Not Block Intersection Ambulance Exit' sign in the median for the North Main Street (MA Route 181) is damaged and needs to be repaired.
- Advance warning signs are required on both sides of the pavement on North Main Street (US Route 20) to inform the motorists of the crosswalk.
- A small poster was observed to be pasted on the 'Stop' sign at the Shearer Street approach which needs to be removed.
- 'Signal Ahead' warning signs already exist along all the approaches of the intersection. It is recommended that MassDOT examine the feasibility of installing a flashing beacon to supplement the with signal ahead warning signs as per Manual on Uniform Traffic Control Devices (MUTCD) guidelines to make them more visible and alert drivers to the approaching intersection.
- It is also recommended that MassDOT District 2 consider installing an 'Intersection Ahead' warning sign for right turning traffic from North Main Street (US Route 20). Further it may be beneficial to accompany this sign with a speed limit sign as per MUTCD guidelines to reduce the speed of this right turn movement and inform drivers of the potential for conflicts with merging traffic.

LONG TERM IMPROVEMENTS

The results of the traffic signal warrant analysis show that *Intersection 1* which is controlled by a 'Stop' sign satisfies the minimum volume for the installation of a traffic signal. As development occurs, there is a high potential for traffic patterns, particularly on Shearer Street, to change and adversely impact congestion in the vicinity of the intersection. It is recommended that the Town of Palmer and MassDOT continue to monitor operations at this intersection and explore opportunities to reconfigure the intersection. Due to the complex geometry and close spacing of the two intersections it is recommended that potential long term improvement alternatives include conversion of the intersection to a five-way signalized intersection or modern roundabout to improve safety and congestion.