

TRANSPORTATION SAFETY STUDY

BELCHERTOWN

Intersection of Federal Steet (Route 9) and Bay Road



MAY 2012

**Prepared Under the Direction of Pioneer Valley MPO By:
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DECEMBER 2011

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Prepared in cooperation with the Town of Belchertown, Massachusetts Department of Transportation and the U.S. Department of Transportation - Federal Highway Administration and the Federal Transit Administration.

The views and opinions of the Pioneer Valley Planning Commission expressed herein do not necessarily state or reflect those of the U.S. Department of Transportation.

ABBREVIATIONS

1	a.m.	Afore Meridian
2	AADT	Average Annual Daily Traffic
3	ADT	Average Daily Traffic
4	ATR	Automatic Traffic Recorders
5	Ave.	Avenue
6	FY	For Year
7	LOS	Level of Service
8	MassDOT	Massachusetts Department of Transportation
9	MPH	Miles per Hour
10	MUTCD	Manual on Uniform Traffic Control Devices
11	p.m.	Post Meridian
12	PVPC	Pioneer Valley Planning Commission
13	Rd.	Road
14	St.	Street
15	TMC	Turning Movement Counts
16	TRB	Transportation Research Board
17	VPH	Vehicles per Hour

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I. INTRODUCTION

The Pioneer Valley Planning Commission (PVPC) conducted a transportation and safety study at the intersection of Federal Street (Route 9) and Bay Road in Belchertown as part of the FY 2011 Unified Planning Work Program. Existing conditions were studied and the impact of a potential change in zoning in the vicinity of the intersection was analyzed. PVPC also performed a traffic signal warrant analysis to examine the feasibility of installing a traffic signal at the intersection. A series of short-term and long-term recommendations have been developed to improve the existing traffic operations, reduce congestion, and increase safety at this location.

A. STUDY AREA

The intersection of Federal Street and Bay Road is a three way intersection located in the central part of the Town of Belchertown. It is an unsignalized intersection with Bay Road operating as the minor street under 'STOP' sign control. The intersection is characterized by a turn lane separated from the intersection by an island; used by left turning vehicles from Bay Road onto Federal Street and also by right tuning vehicles from Federal Street onto Bay Road. This approximately 20 feet wide section of pavement was found to be in very poor condition at the time of field inventory and did not have any pavement markings or regulatory signs to allocate the movements or guide the drivers. Bay Road intersects Federal Street at an acute angle which restricts sight distance to the north for right turns from Bay Road onto Federal Street. Bus stops for Pioneer Valley Transit Authority's (UMass Transit) service (Route 45 – Belchertown/UMass) buses are located at the intersection for both eastbound and westbound buses. The stop provided for the eastbound buses is located directly across from the island separating the Bay Road turning lanes.

Pavement on Bay Road was noted to be in poor condition at the time of the field inventory. Overall Federal Street pavement was in much better condition than Bay Road. A difference between the elevation of the pavement at Bay Road Approach and Federal Street was found to create some drainage issues. Pavement markings were also inferior along Bay Road and the 'Stop' line at the Bay Road approach was extremely faded. Bituminous curbing in the vicinity of the intersection was damaged in some areas. The driveways in the vicinity of the intersection for all the commercial and residential properties were not well defined by appropriate curbing and signage.

Federal Street (Route 9) is a part of National Highway System and is classified as a principal arterial; it is under the jurisdiction of Massachusetts Department of Transportation (MassDOT), Highway Division District 2 office. Bay Road is classified as a major collector in the vicinity of the intersection. The posted speed limit on Federal Street is 40 miles per hour and 25 miles per hour on Bay Road.

Figures 1 and 2 depict the study area and an aerial image of the intersection of Federal Street and Bay Road.

Figure 1: Study Area

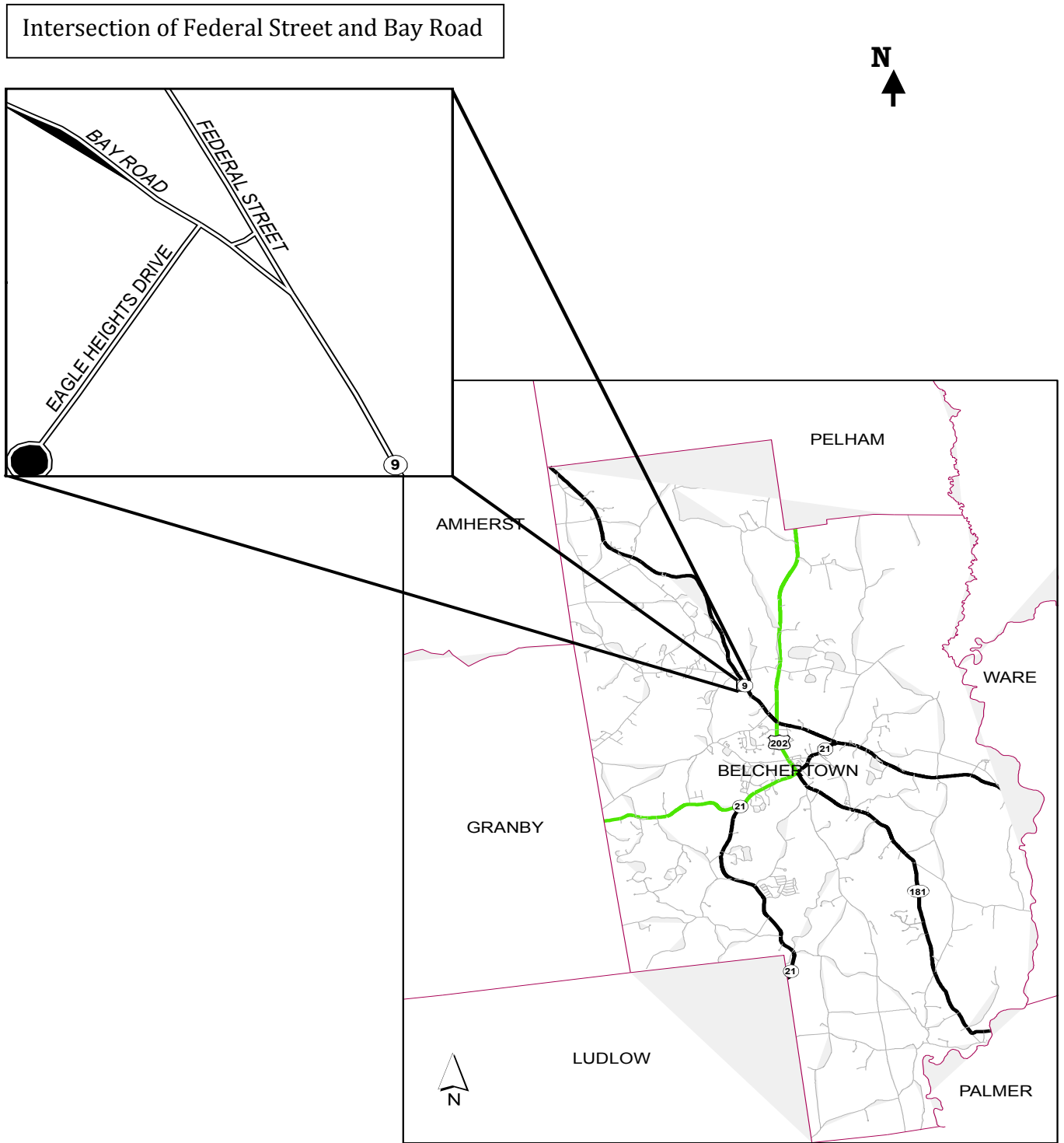


Figure 2: Aerial Image of the Intersection

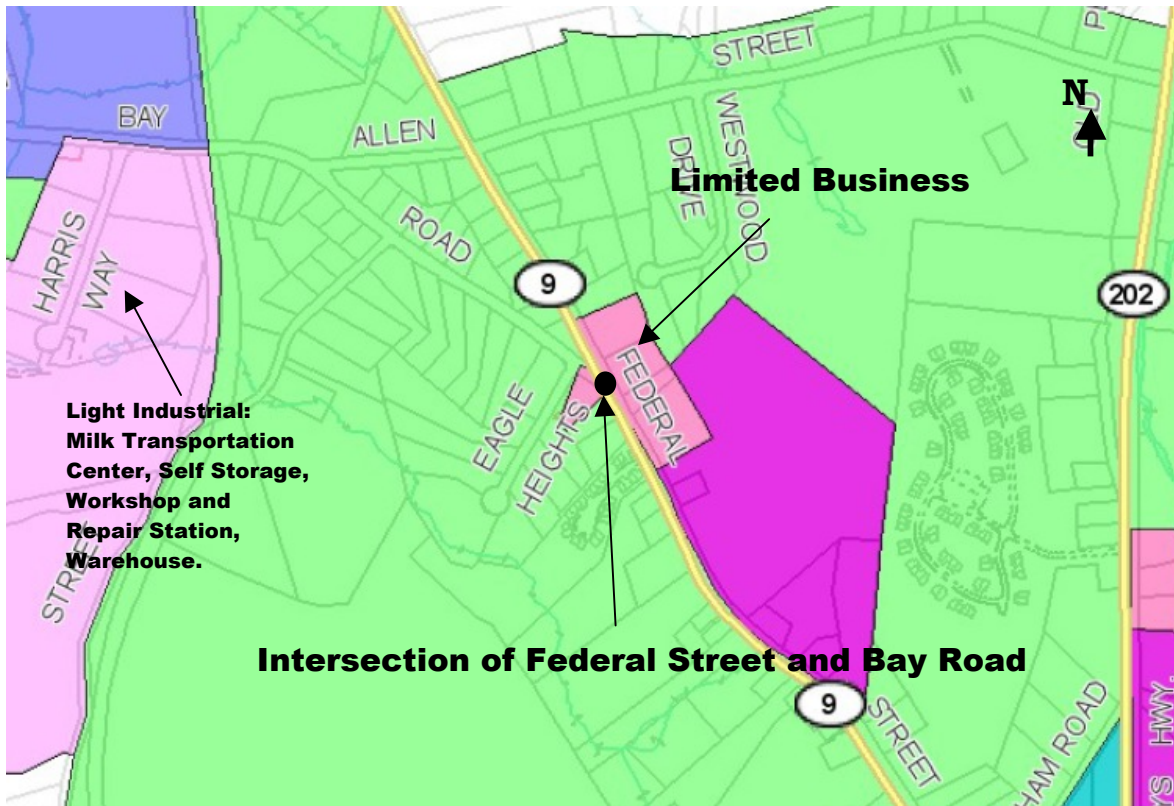


B. ZONING

The zoning in the immediate vicinity of the intersection is a mix of residential and commercial land uses. An apartment building with retail use on first floor occupied by Country Hair Stylist is located in the west of the intersection. A residential local street called Eagle Heights Drive intersects Bay Road in the northwest of the intersection and provides access to single family residential neighborhood. Houses are located adjacent to the intersection in north and northeast along Federal Street. The eastern side of the Federal Street is located at a higher elevation; therefore in all the residential driveways intersect Federal Street at a steep downward gradient. Roadside Café and an auto service garage/workstation are located in the east of the intersection followed by apartment units and general business zone in southeast.

Figure 3 depicts the zoning in the vicinity of the intersection.

Figure 3: Zoning in the Vicinity of the Intersection



LEGEND

- Zoning
- Primary Agricultural
 - Rural Residential
 - Village Residential
 - Lake Residential
 - Limited Business
 - General Business
 - Industrial
 - Light Industrial
 - Mobile Home Park
 - Multiple Dwelling Res
- Miscellaneous Lines
- Hooks
 - ROW
 - Utility
 - Priv Rd RW
- Water
- Streams
 - Open Water
 - Parcels

II. EXISTING TRANSPORTATION CONDITIONS

This section provides a technical evaluation of the existing transportation conditions of 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.

A. AVERAGE DAILY TRAFFIC VOLUME

Average Daily Traffic (ADT) volumes were compiled for a typical weekday at all three approaches of the intersection using Automatic Traffic Recorders (ATRs). All ADT volumes were factored to represent Average Annual Daily Traffic (AADT) using factors developed by the Massachusetts Department of Transportation (MassDOT). Table 1 identifies the AADT at these locations.

Table 1: Average Annual Daily Traffic Volumes

Approach	Northbound/Eastbound	Southbound/Westbound	Total
Federal Street South of Bay Road	6328	6219	12,547
Federal Street North of Bay Road	3883	3906	7,789
Bay Road West of Federal Street	2184	2325	4,509

Source: PVPC

B. PEAK HOUR VOLUME AND TURNING MOVEMENT COUNTS

Turning Movement Counts (TMC's) 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 4:00 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 an 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 Department of Transportation (MassDOT) develops traffic volume adjustment factors to reflect monthly variations. These factors were examined to determine the traffic conditions at the intersection of Federal Street and Bay Road.

Figure 4 depicts the turning movement counts during the morning and afternoon peak hours at the intersection.

It can be seen that the northbound and southbound approaches of Federal Street carry almost equivalent volumes during the afternoon peak hour. The volume of through moving vehicles on the southbound approach of Federal Street is nearly double during the afternoon peak hour when compared to the morning peak hour. Peak Hour volumes on the northbound approach do not show any major change. The number of vehicles that turn right from Federal Street onto Bay Road is negligible.

At the Bay Road approach, right turns onto Federal Street are the predominant movement. During conversations with local residents at the time of the field inventory, it was noted that vehicles intending to turn left onto Route 9 (Federal Street) use Allen Street, located north of the intersection, to avoid the sharp left turn maneuver from Bay Road onto Federal Street.

The volume of heavy vehicles at the intersection was approximately 4% during the morning peak hour and 5% during the afternoon peak hour for all three approaches. Most of these vehicles were noted to be through moving traffic and therefore did not have any major turning or maneuvering difficulties.

The intersection was observed to have a very negligible level of pedestrian traffic. A total of 2 and 4 pedestrians were observed crossing the intersection during the morning and afternoon peak hours respectively. No bicyclists were observed at the time of the survey on either of the roads.

Figure 4: Turning Movement Counts

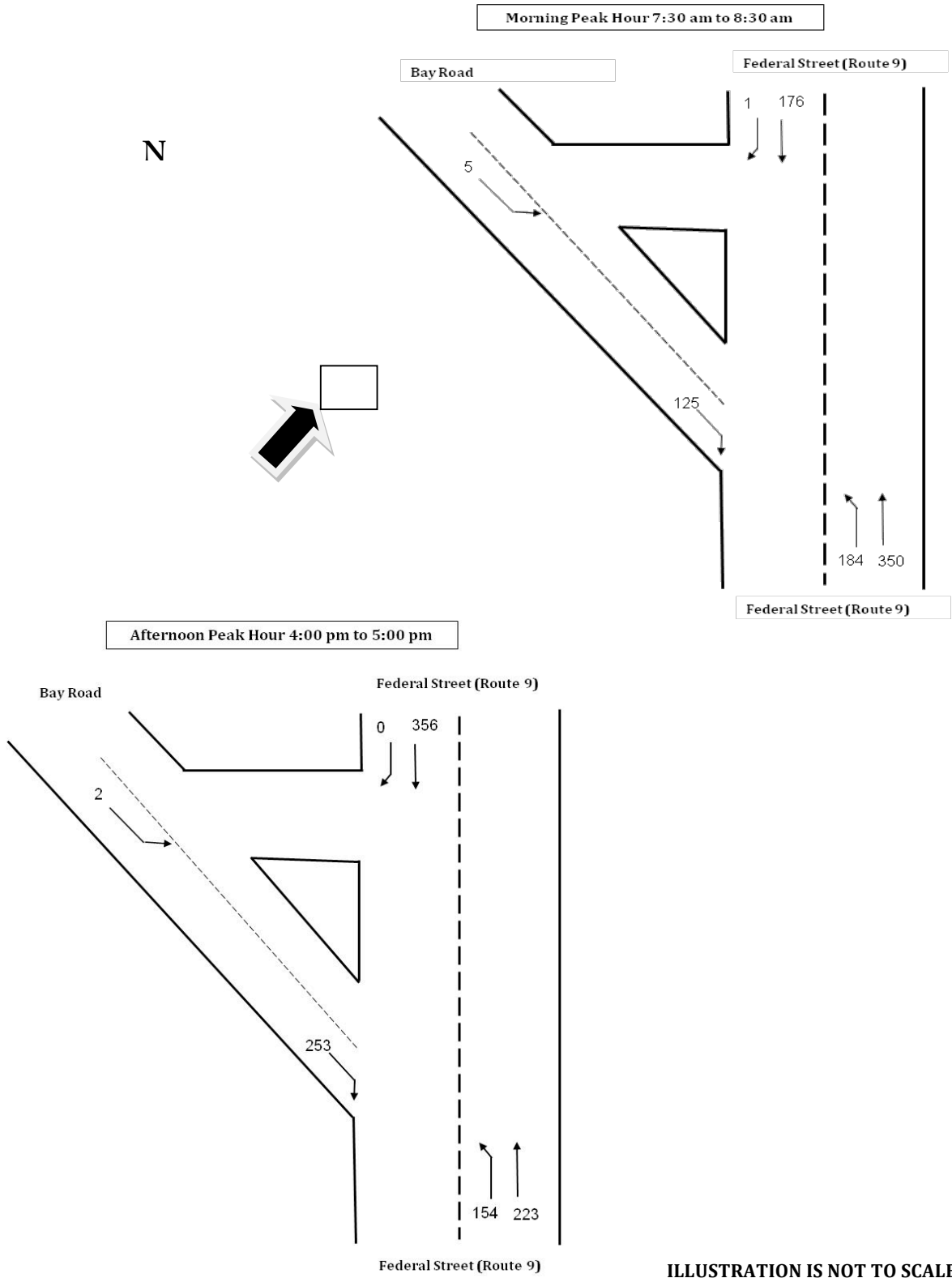


ILLUSTRATION IS NOT TO SCALE

C. SAFETY

To study safety, PVPC obtained the crash history of the intersection from MassDOT and the Belchertown Police Department. Actual crash reports were studied and analyzed to develop a collision diagram of the intersection and identify patterns that could potentially contribute to the crashes in this area.

1. Crash Rate Analysis

A crash rate analysis was performed to compare the value at the intersection to the average value for MassDOT District 2 intersections. The crash rate per million entering vehicles was calculated. In theory, the number of crashes increases 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 MassDOT data, the average crash rate for unsignalized intersections in District 2 is 0.67.

As shown in Table 2, the crash rate at the intersection of Federal Street and Bay Road is 0.8 which is higher than the average value for other similar intersections of similar type in MassDOT District 2. This value indicates that the number of crashes occurring at this intersection is larger than the number of crashes occurring at other similar intersections in the region considering the volume of vehicles entering that intersection.

Table 2: Crash History

Year	Total	Type	Severity	Weather Condition	Road Condition	Crash Rate
2006	1	Angle	0 Property Damage	1 Clear	1 Dry	1
		Rear End	1 Non fatal Injury	0 Cloudy	0 Wet	0
		Single Vehicle	0	0 Rain	0	
2007	4	Angle	1 Property Damage	4 Clear	2 Dry	3
		Rear End	3 Non fatal Injury	0 Cloudy	2 Wet	1
				0 Rain	0	
2008	2	Angle	0 Property Damage	1 Clear	0 Dry	0
		Rear End	2 Non Fatal Injury	1 Cloudy	1 Wet	2
				1 Rain	1 Unknown	0
2009	6	Rear End	6 Property Damage	5 Clear	4 Dry	4
			Non Fatal Injury	1 Cloudy	0 Wet	2
				0 Rain	2 Unknown	0
2010	3	Rear End	3 Property Damage	1 Clear	3 Dry	3
			Non Fatal Injury	2 Cloudy	0 Wet	0
				0 Rain	0 Unknown	0
Total	16					0.80

Source: MassDOT, Belchertown Police Department

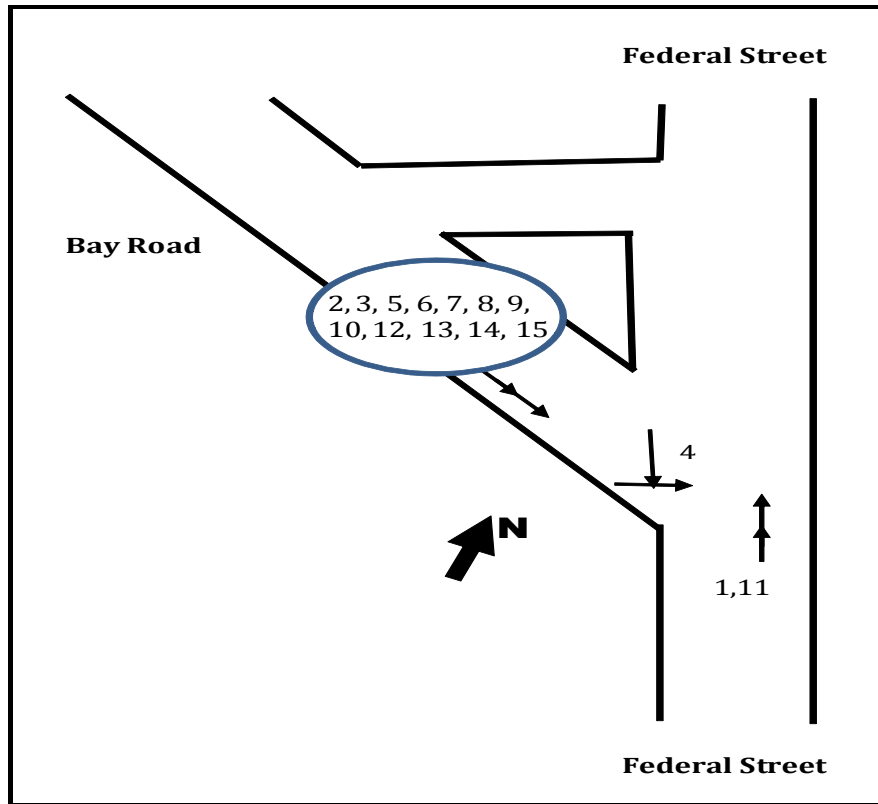
A total of 16 crashes were recorded during the 2006 to 2010 calendar years. Almost all of the crashes were rear end collisions. Most of the crashes occurred during clear weather and dry roadway conditions.

2. Collision Diagram

Based upon the data in the crash reports, each crash has been depicted graphically in a collision diagram and crash patterns have been identified. Figure 5 shows the collision diagram for the intersection. The details of the crashes shown in the figure are summarized in Table 3.

Most of the collisions occurred in the vicinity of the Bay Road approach's 'Stop' line. As discussed in the introduction of this document, Bay Road intersects Federal Street at an acute angle which restricts sight distance to the north. The only reported angle collision was a result of a crash that occurred when a motor vehicle pulled out of Bay Road approach and failed to yield the right of way to another motor vehicle going southbound on federal street. The collision diagram indicates a pattern of rear end collisions indicative of failure of the lagging vehicle to confirm that the lead vehicle has completed its right turn maneuver.

Figure 5: Collision Diagram



LEGEND

Parked Car	→ □	Traffic Flow	••••▶
Angle	→ ↘	Pedestrian	→ ○
Rear End	→ →	Side Swipe	→ →
Backing	→ ←←	Lane Change	→ ↗
Head-on	→ ←		
Bicycle	→		

Table 3: Crashes included in Collision Diagram

No	DATE	TIME	DAY	SEV.	L	R	P
1	08/10/07	10:36 PM	Fri	PD	3	2	5
2	09/28/07	6:05 PM	Fri	PD	1	1	5
3	10/18/07	3:43 PM	Thurs	PD	1	1	5
4	11/23/07	12:49 PM	Fri	PD	1	1	13
5	04/11/08	6:14 PM	Fri	PD	1	2	5
6	06/04/08	6:32 PM	Wed	I	1	2	5
7	05/03/09	4:00 PM	Sun	PD	1	2	5
8	05/20/09	5:49 PM	Wed	PD	1	1	5
9	07/30/09	1:40 PM	Thurs	PD	1	1	5
10	07/31/09	1:36 PM	Fri	PD	1	2	5
11	08/20/09	4:05 PM	Thurs	PD	1	1	5
12	08/22/09	10:28 PM	Sat	I	1	1	5
13	04/19/10	4:29 PM	Mon	I	1	1	5
14	09/20/10	7:21 PM	Mon	PD	3	1	5
15	11/19/10	8:10 AM	Fri	I	1	1	5

Source: Belchertown Police Department

LEGEND

Fatality	F
Personal Injury	I
Property Damage	PD

Light Condition (L)

- 1. Daylight
- 2. Dawn/Dusk
- 3. Darkness
- 4. Unknown

Pattern (P)

- 0. Not Known
- 1. Speed too fast
- 2. Parked Car
- 3. Ran Stop Sign
- 4. Ran Traffic Signal
- 5. Rear End
- 6. Improper Passing
- 7. Wrong side of road
- 8. Improper turning
- 9. Improper backing
- 10. Sideswipe

Road Condition (R)

- 1. Dry
- 2. Wet
- 3. Snow/Ice
- 4. Not Known

- 11. Pedestrian violation
- 12. Human Error
- 13. Angle

D. 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 2010 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 an unsignalized intersection.

Table 4: 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

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. Table 5 depicts the existing level of services at all the three approaches during the AM and PM peak hours.

Table 5: Existing Level of Service

Approach	Movement	AM Peak Hour		PM Peak Hour	
		Delay *	LOS **	Delay *	LOS **
Bay Road Eastbound	Left/Right-Through	12.0	B	16.9	C
Federal Street Northbound	Left/Through	8.2	A	8.8	A
Federal Street Southbound	Through/Right	0.0	A	0.0	A

Source: PVPC

* Delay in seconds ** Level of Service

It can be seen that the intersection does not have major congestion issues. The minor street operates under the LOS 'B' AND LOS 'C' during morning and afternoon peak

hours respectively and there is minimal delay experienced by left turning vehicles from the Federal Street northbound approach.

E. SIGNAL WARRANT ANALYSIS

The intersection of Federal Street and Bay Road was analyzed to determine whether a traffic signal is required. 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 6 presents the results of the signal warrant analysis performed utilizing the Highway Capacity Software (HCS) 2010.

Of the eight total warrants for the installation of a traffic signal, Warrant 1 – 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 require 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 6: Signal Warrant Analysis Results

Warrant	Description	Result
1	Eight Hour Volume	<i>Satisfied</i>
2	Four Hour Volume	<i>Satisfied</i>
3	Peak Hour Volume	Not Applied
4	Pedestrian Volume	Not Satisfied
5	School Crossing	Not Applied
6	Coordinated Signal System	Not Applied
7	Crash Experience	Not Satisfied
8	Roadway Network	Not Applied

Source: PVPC

The above table shows that the intersection fulfills the volume requirements to satisfy warrants 1 and 2 for the installation of a traffic signal assembly. However, as per MUTCD requirements, engineering judgment should also dictate if a traffic signal will improve traffic flow and safety at the intersection. The intersection currently operates at good level of service with very low volumes of left turning traffic from the minor street. In addition rear end collisions are typically not reduced through signalization.

F. LEFT TURN LANE WARRANT

Belchertown Planning Board requested PVPC to include left turn lane warrant analysis for Federal Street northbound approach in the study. According to Massachusetts Highway Department Project Development and Design Guide 2006, (Exhibit 6-23 A) for two lane approaches with 40 mph speed limit at unsignalized intersections, an exclusive left turn lane is warranted if the left turning volume is higher than 30%. More than 34% of vehicles during the morning peak hour and more than 40% of the vehicles during the afternoon peak hour at the northbound approach of Federal Street turn left onto Bay Road. Therefore an exclusive left turn lane is warranted; however MassDOT and the Town need to examine the available right of way to determine the feasibility of installing an additional turn lane at this location.

III. RECOMMENDATIONS

The intersection of Federal Street with Bay Road is characterized by high crash rate and an unusual geometry that contributes to the restricted sight distance. The following short and long term recommendations have been made to improve transportation conditions at the intersection.

A. PAVEMENT

The pavement of the turning lane between Bay Road and Federal Street is in very poor condition and there is drainage issue created because of the higher elevation of the Federal Street pavement. The Town and MassDOT should work together to improve the pavement condition of Bay Road. Pavement markings on Bay Road approach have faded and 'Stop' line is not properly marked or defined. It is recommended that the Town of Belchertown and MassDOT consider repainting the pavement markings, Stop Line and pavement edge lines at this intersection.

B. CURBING AND GEOMETRY

The driveways in the immediate vicinity of the intersection are not well defined by appropriate curbing. It is recommended that the Town cooperates with MassDOT to ensure that any future roadway improvement projects at this location include installation of appropriate curbing.

Bay Road intersects Federal Street at an acute angle which limits sight distance to the north. It is recommended that the Town of Belchertown and MassDOT talk to the property owners to discuss potential measures such as change to the existing landscaping that could improve sight distance in this area. Changing the geometry of the Bay Road approach at the intersection is a long term improvement measure which can improve the intersection sight distance in the northern direction. The existing alignment of Bay Road also creates an illusion of uninterrupted through movement for the drivers who fail to stop at the 'Stop' sign before making the right turn which appears as almost a straight movement. This is reflected in the higher percentage of rear end collisions at this approach. Figure 6 depicts an alternative of changing the geometry of the intersection to a "T" intersection and redefining the movements of the turning vehicles from Bay Road approach. This alternative would also have to take into account required turning radius for tractors trailers and heavy vehicles.

The Town showed interest in exploring the possibility of converting the intersection into a roundabout, however the intersection is located at a downward gradient along the hill and installing a roundabout at such a location may not always be the best alternative. Existing driveways in the vicinity of the intersection also need to be incorporated in roundabout design. It is recommended that the Town of Belchertown and MassDOT consider undertaking an engineering study to determine the feasibility of these alternatives to improve the existing intersection geometry and thereby increase safety.




Figure 6: Concept for 'T' Intersection



Prepared by the Pioneer Valley Planning Commission, December, 2011.

Illustration is not to scale.

FOR CONCEPTUAL PURPOSE ONLY

-  Curbing
-  Pavement Markings
-  Sign

C. REGULATORY AND WARNING SIGNS

As can be seen in the collision diagram, almost all of the crashes at this intersection involved vehicles at Bay Road approach. Majority of these crashes were rear end collisions involving the vehicles that fail to stop in time to avoid colliding with the already stopped vehicles at the stop line. The Town of Belchertown should consider installing advanced 'Stop Ahead' warning signs on Bay Road to alert the drivers about the upcoming intersection and of the possibility of stopping vehicles.

It is also recommended that the vegetation around the advanced intersection ahead warning signs along both approaches of Federal Street is maintained and trimmed at regular intervals to ensure their proper visibility.

Any new alternative for changing the geometry of the intersection should be accompanied by appropriate signs to ensure safe and efficient traffic operations at this location.

D. EXISTING BUS STOPS

Currently the Pioneer Valley Transit Authority (PVTA) Route 45 -Belchertown/UMass bus stop for eastbound buses along this intersection is located adjacent to the traffic island at Bay Road approach. This location is not suitable in case of anticipated geometric improvements at this intersection in future. The Town, MassDOT, PVTA and UMass Transit should cooperate in exploring the possibility of relocating this bus stop to a more suitable location ideally towards southeast of the intersection along Route 9 to avoid any conflicts with the intersection sight distance for vehicles at Bay Road approach.

E. EXCLUSIVE LEFT TURN LANE

The existing traffic conditions on Federal Street satisfy the minimum volume requirements to warrant an exclusive left turn lane for the northbound approach; however MassDOT and the Town need to examine the feasibility of installing an additional turn lane at this location.

F. TRAFFIC SIGNAL

Existing conditions at the intersection satisfy the minimum volume requirements specified in warrants 1 and 2 for the installation of a traffic signal assembly. However the level of service analysis did not depict major congestion or delay issues. It is recommended that the Town and MassDOT undertake an engineering analysis in future to examine the need of traffic signal installation as a long term improvement measure at this location.

G. ZONE CHANGE

New development or zone change proposals for the parcels located in the vicinity of this intersection should be accompanied by appropriate traffic impact study to analyze the effect of the new trips on the existing conditions and traffic operations at

this intersection. The developers, MassDOT and the Town should cooperate with each other in ensuring that proper safety measures like providing appropriate parking facilities, constructing well defined and well marked driveways, and ensuring that the minimum sight distance requirements are adhered to.

H. PEDESTRIAN AMENITIES AND LIVABILITY

The new policy adopted by the Federal Highway and MassDOT advocates the principles of livability for local urban and rural transportation improvement initiatives in an effort to create a well planned multi modal transportation network in long term for sustainable and environment friendly development.

The intersection of Federal Street and Bay Road does not have sidewalks or crosswalks. Existing bus stops at this location have a potential for generating pedestrian traffic. Despite of that it was observed during the field inventory that this intersection did not have considerable bicycle-pedestrian volume. In case of an anticipated change in land use in the vicinity of this location, like a grocery store or any other specialty retail service (besides the existing hair salon); there might be an increase in pedestrian volume at this location. Current strategies adopted in the field of transportation planning aim to encourage multi modal transportation options; as a result there will be an increase in the number of people using transit and eventually pedestrian volumes in the vicinity of this intersection will rise. The residential neighborhoods in the locality of the existing bus stops would make this area an ideal candidate for transit oriented development in future. In light of all these factors it is recommended that the Town and MassDOT keep monitoring the pedestrian volumes at this location and consider developing sidewalks, crosswalks and other warranted pedestrian amenities in future.

I. TRAFFIC FLOW ALONG ROUTE 9

The Town of Belchertown expressed concerns regarding the peak hour congestion along Route 9 especially on Friday afternoons at the intersection of George Hannum Street and Route 9. It is recommended that MassDOT examine the existing signal timing and phasing plan at this location to address these concerns.

The Town also expressed concerns regarding the transportation and safety conditions along the intersection of Route 9 with Allen Street. It was observed that the advance 'Stop' ahead warning sign on the west bound approach of Allen Street was damaged and the 'Stop' sign was lower than the guidelines of MUTCD for post heights. The stop line was also faded and not clearly visible. It is recommended that the Town replace the advance warning sign in accordance with the MUTCD recommendations. It is also recommended that MassDOT consider replacing the 'STOP' sign and repainting the 'Stop' line within their layout to improve the safety and transportation conditions at this location.

MASSACHUSETTS HIGHWAY DEPARTMENT - STATEWIDE TRAFFIC DATA COLLECTION

2011 WEEKDAY SEASONAL FACTORS *

* Note: These are weekday factors. The average of the factors for the year will not equal 1, as weekend data are not considered.

FACTOR GROUP	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
GROUP 1 - WEST INTERSTATE	0.98	0.93	0.90	0.89	0.90	0.88	0.91	0.90	0.89	0.89	0.93	0.95
GROUP 2 - RURAL MAJOR COLLECTOR (R-5)	1.12	1.12	1.07	0.99	0.91	0.90	0.86	0.86	0.92	0.93	1.01	1.05
GROUP 3A - RECREATIONAL ***(1-4) See below	1.26	1.25	1.20	1.06	0.96	0.89	0.76	0.76	0.92	0.99	1.08	1.14
GROUP 3B - RECREATIONAL ****(5) See below	1.22	1.26	1.22	1.06	0.96	0.90	0.72	0.74	0.97	1.02	1.14	1.15
GROUP 4 - I-495 INTERSTATE	1.02	1.00	1.00	0.96	0.92	0.89	0.85	0.83	0.93	0.96	1.01	1.03
GROUP 5 - EAST INTERSTATE	1.04	1.00	0.96	0.93	0.92	0.91	0.91	0.89	0.93	0.93	0.96	1.01
GROUP 6 - URBAN ARTERIALS, COLLECTORS & RURAL ARTERIALS (R-2, R-3)	1.03	1.01	0.96	0.92	0.91	0.90	0.92	0.92	0.93	0.92	0.97	0.97
GROUP 7 - I-84 PROXIMITY (STAS. 17,3921)	1.24	1.24	1.15	1.04	0.99	1.00	0.93	0.89	1.05	1.05	1.05	1.12
GROUP 8 - I-295 PROXIMITY (STA. 6590)	1.00	0.99	0.95	0.92	0.94	0.91	0.93	0.92	0.95	0.94	0.97	0.95
GROUP 9 - I-195 PROXIMITY (STA. 7)	1.13	1.05	1.03	0.95	0.89	0.87	0.86	0.79	0.88	0.91	0.99	1.03

RECREATIONAL: (ALL YEARS)

2011 AXLE CORRECTION FACTORS

ROUND OFF

0 - 999.....10
> 1,000.....100

ROAD INVENTORY FUNCTIONAL CLASSIFICATION CORRECTION FACTOR

RURAL	1	0.95
	2	0.97
	3	0.98
	0.5,6	0.98
URBAN	1	0.96
	2	0.98
	3	0.98
	5	0.98
	0.6	0.99
	I-84	0.90

Apply I-84 factor to stations: 3290,3929

***GROUP 3B:

5. PERMANENTS 2 & 189

- 1066,1067,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,1105,1106,1107,1108,1113,1114,1116,2196,2197,2198

4. NANTUCKET

3. MARTHA'S VINEYARD

- 7014, 7079,7080,7090,7091,7092,7093,7094,7095,7096,7097,7108,7178

2. PLYMOUTH(SOUTH OF RTE.3A)

1. CAPE COD (ALL TOWNS)

**GROUP 3A:

MASSACHUSETTS HIGHWAY DEPARTMENT - STATEWIDE TRAFFIC DATA COLLECTION

2011 WEEKDAY SEASONAL FACTORS *

* Note: These are weekday factors. The average of the factors for the year will not equal 1, as weekend data are not considered.

FACTOR GROUP	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
GROUP 1 - WEST INTERSTATE	0.98	0.93	0.90	0.89	0.90	0.88	0.91	0.90	0.89	0.89	0.93	0.95
GROUP 2 - RURAL MAJOR COLLECTOR (R-5) <i>Use group 2 for R5, R6, & R0</i>	1.12	1.12	1.07	0.99	0.91	0.90	0.86	0.86	0.92	0.93	1.01	1.05
GROUP 3A - RECREATIONAL ** (1-4) See below	1.26	1.25	1.20	1.06	0.96	0.89	0.76	0.76	0.92	0.99	1.08	1.14
GROUP 3B - RECREATIONAL *** (5) See below	1.22	1.26	1.22	1.06	0.96	0.90	0.72	0.74	0.97	1.02	1.14	1.15
GROUP 4 - I-495 INTERSTATE	1.02	1.00	1.00	0.96	0.92	0.89	0.85	0.83	0.93	0.96	1.01	1.03
GROUP 5 - EAST INTERSTATE	1.04	1.00	0.96	0.93	0.92	0.91	0.91	0.89	0.93	0.93	0.96	1.01
GROUP 6: <i>Use group 6 for U2, U3, U5, U6, U0, R2, & R3</i> URBAN ARTERIALS, COLLECTORS & RURAL ARTERIALS (R-2, R-3)	1.03	1.01	0.96	0.92	0.91	0.90	0.92	0.92	0.93	0.92	0.97	0.97
GROUP 7 - I-84 PROXIMITY (STA. 17, 3921)	1.24	1.24	1.15	1.04	0.99	1.00	0.93	0.89	1.05	1.05	1.05	1.12
GROUP 8 - I-295 PROXIMITY (STA. 6590)	1.00	0.99	0.95	0.92	0.94	0.91	0.93	0.92	0.95	0.94	0.97	0.95
GROUP 9 - I-195 PROXIMITY (STA. 7)	1.13	1.05	1.03	0.95	0.89	0.87	0.86	0.79	0.88	0.91	0.99	1.03

RECREATIONAL: (ALL YEARS)

**GROUP 3A:

1. CAPE COD (ALL TOWNS)

2. PLYMOUTH(SOUTH OF RTE 3A)

7014, 7079, 7080, 7090, 7091, 7092, 7093, 7094, 7095, 7096, 7097, 7108, 7178

3. MARTHA'S VINEYARD

4. NANTUCKET

***GROUP 3B:

5. PERMANENTS 2 & 189

1086, 1087, 1083, 1084, 1085, 1086, 1087, 1088, 1089, 1090, 1091, 1092,

1093, 1094, 1095, 1096, 1097, 1098, 1099, 1100, 1101, 1102, 1103, 1104,

1105, 1106, 1107, 1108, 1113, 1114, 1116, 2196, 2197, 2198

2011 AXLE CORRECTION FACTORS

ROAD INVENTORY

FUNCTIONAL CLASSIFICATION

AXLE CORRECTION

FACTOR

ROUND OFF:

0 - 999.....10

> 1,000.....100

FUNCTIONAL CLASSIFICATION	AXLE CORRECTION FACTOR
RURAL	
1	0.95
2	0.97
3	0.98
0,5,6	0.98
URBAN	
1	0.96
2,3	0.98
5	0.98
0,6	0.99
I-84	0.90

Apply I-84 factor to stations:

3290, 3921, 3929

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Belchertown COUNT DATE : Jul-05

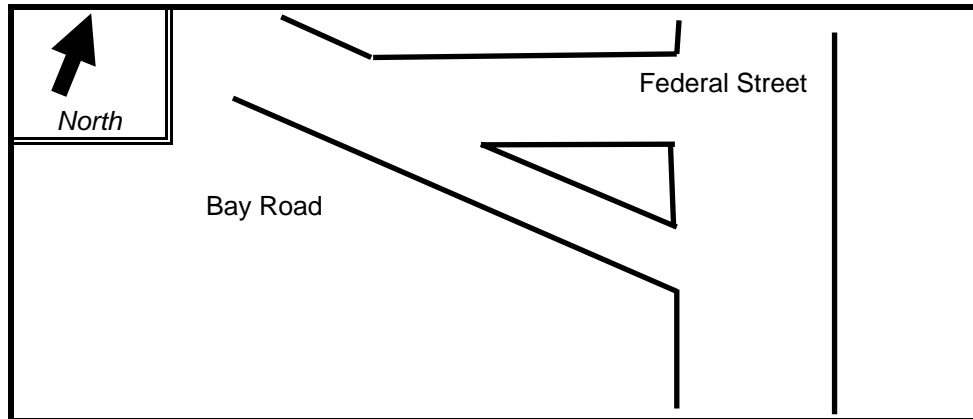
DISTRICT : 2 UNSIGNALIZED : YES SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : Federal Street (Route 9)

MINOR STREET(S) : Bay Road

**INTERSECTION
 DIAGRAM**
 (Label Approaches)



Peak Hour Volumes

APPROACH :	1	2	3	4	5	Total Entering Vehicles
DIRECTION :						
VOLUMES (AM/PM) :	356	154	255	223	0	988

" K " FACTOR : APPROACH ADT : ADT = TOTAL VOL/"K" FACT.

TOTAL # OF ACCIDENTS : # OF YEARS : AVERAGE # OF ACCIDENTS (A) :

CRASH RATE CALCULATION : RATE = $\frac{(A * 1,000,000)}{ADT * 365}$ (

Comments : _____

Project Title & Date: Federal Street (Route 9) and Bay Road Afternoon Peak Hour Volumes