Montachusett Regional Planning Commission

Traffic Study of Selected Intersections for the Town of Lancaster, Massachusetts

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October, 2006

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(Insert MRPC Region Map here)

EXECUTIVE SUMMARY

The ***Traffic Study of Selected Intersections*** is being presented to the Town of Lancaster to be used for possible traffic flow improvements to the intersections of:

Lunenburg Road (Route 70) & Old Union Turnpike
Lunenburg Road (Route 70) & Main Street (Route 117/70)
Main Street/Seven Bridge Road (Route 117/70) & Main St (Route 70)/Shirley Rd
Main Street (Route 70) & Sterling Road/Bennett Lane
Main Street (Route 70) & Mill Street
High Street (Route 110) & Mill Street
“Five Corners”: (High Street (Route 110), Center Bridge Road, Old Common Road, Bolton Road (Route 110), Bolton Road)

This study is intended to address the concerns that local representatives and officials in Lancaster expressed about the intersections. This study identifies traffic flow and safety problems, and provides improvement alternatives and recommendations to improve these conditions. The identified problems, alternatives, and recommendations of four of the intersections are summarized below:

- The Old Union minor street approaches at the intersection of Lunenburg Road & Old Union Turnpike currently suffer significant delay during the PM peak hour that is predicted to increase by the year 2015. This problem will become significantly worse if Wal-Mart is constructed. One improvement alternative would be to install a traffic signal with a left-turn lane on the northbound Lunenburg Road approach to accommodate the increase in left-turn traffic.
- The Lunenburg Road minor street approach at the intersection of Lunenburg Road & Main Street currently suffers significant delay during the PM peak hour that is predicted to increase by the year 2015. One improvement alternative would be to install a traffic signal with a left-turn lane on the Lunenburg Road approach.
- The Main Street minor street approach at the intersection of Main Street & Main Street/Seven Bridge Road currently suffers significant delay during the PM peak hour that is predicted to increase by the year 2015. One improvement alternative would be to install a traffic signal.
- Although traffic operations at the “Five Corners” intersection appear to be operate without much delay, improvement alternatives are recommended due to the many conflict points that have the potential of creating driver confusion and safety problems. Two alternatives would be to change this five-way intersection into a four-way intersection or a roundabout.

In this study you will find the details on these identified traffic and safety problems, improvement alternatives, and recommendations. The Montachusett Regional Planning Commission is available to assist the Town as the Town determines alternatives and recommendations for implementation.

If the Town has any questions about this study, please contact George Snow at 978-345-7376 ext 2267 or by e-mail at gsnow@mrpc.org.

Introduction

This report evaluates the current traffic and safety conditions at selected intersections in the Town of Lancaster and discusses possible improvements. The intersections on which the report focuses are:

1. Lunenburg Road (Route 70) & Old Union Turnpike
2. Lunenburg Road (Route 70) & Main Street (Route 117/70)
3. Main Street/Seven Bridge Road (Route 117/70) & Main St (Route 70)/Shirley Rd
4. Main Street (Route 70) & Sterling Road/Bennett Lane
5. Main Street (Route 70) & Mill Street
6. High Street (Route 110) & Mill Street
7. "Five Corners": (High Street (Route 110), Center Bridge Road, Old Common Road, Bolton Road (Route 110), Bolton Road)

Figure 2 shows the selected intersections.

Overview of Analyses

Operational Analyses

Operational conditions at each intersection were assessed based on the traffic flow that occurs during the afternoon peak (i.e., highest-volume) hour of a typical weekday. Analyses of current conditions were based on traffic data collected in 2003-2006. For analyses of future conditions, the MRPC's current urban traffic growth factor of 1.67% per year was used to predict traffic volumes in 2015.

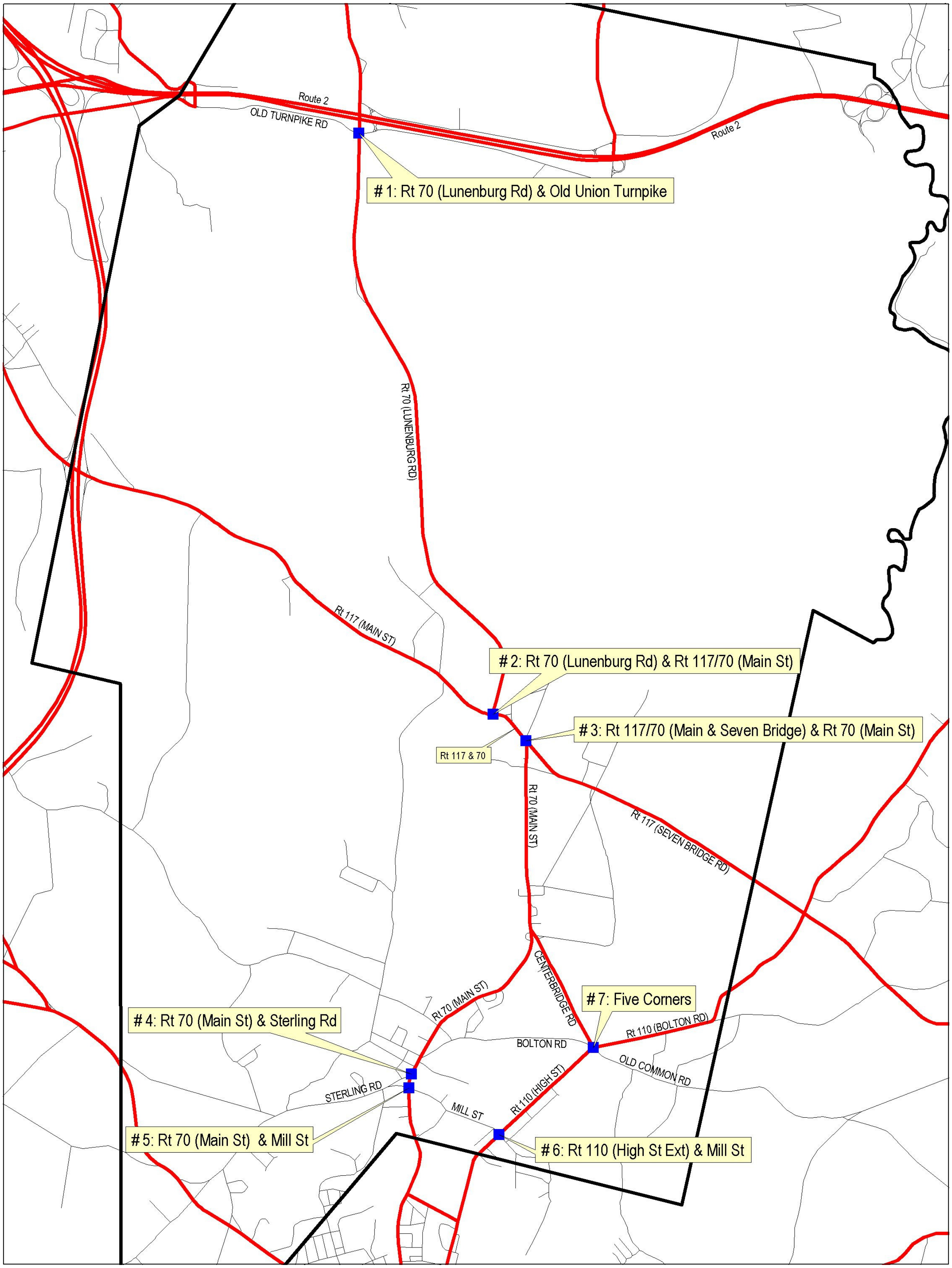
The level of service (LOS) of an intersection or road segment represents the quality of traffic flow and is used to assess the operation of that facility. LOS analyses are based on the methods in the *Highway Capacity Manual (2000)*. LOS is defined differently for each type of facility, such as an unsignalized intersection, signalized intersection, two-lane road, or multi-lane road. For intersections, the LOS is defined by the average amount of delay experienced by a vehicle at the intersection due to the traffic controls (i.e., signs or signals). Usually each approach is assessed independently, since the LOS of the major and minor approaches may differ greatly. Table 1 summarizes the LOS definitions for intersections controlled by STOP signs and those controlled by traffic signals.

Table 1. LOS definitions for intersections.

LOS	*Average Control Delay (seconds per vehicle)*	
	Stop-Controlled	*Signalized*
A	0 - 10.0	0 - 10.0
B	10.1 – 15.0	10.1 – 20.0
C	15.1 – 25.0	20.1 – 35.0
D	25.1 – 35.0	35.1 – 55.0
E	35.1 – 50.0	55.1 – 80.0
F	>50.0	>80.0

When evaluating alternatives, LOS values and average control delay were estimated for each alternative and compared.

Figure 2: Selected Intersections for Study



***Overview of Analyses* (continued)**

Signal Warrant Analyses

Since most of the intersections had at least one approach with high delay, they were also evaluated for possible signalization. The *Manual of Uniform Traffic Control Devices* contains warrants for installation of traffic signals (see Appendix F). If an intersection meets the criteria of at least one of the warrants, installation of a signal may be appropriate. These warrants include criteria such as minimum volumes, peak hour delay, and crashes. Recent data were compared to the warrants to assess the appropriateness of a traffic signal under current conditions.

Safety Conditions

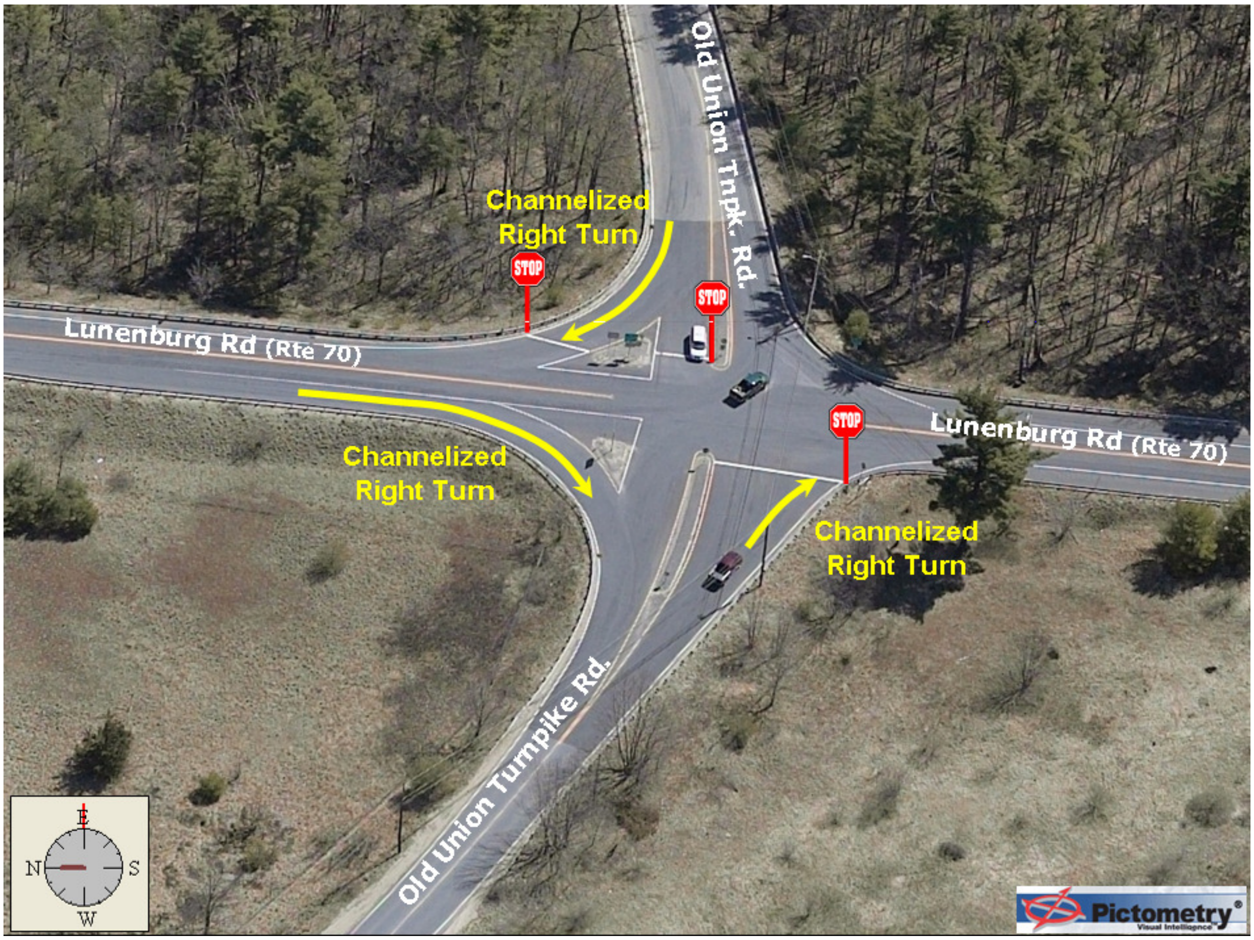
An intersection may also be improved to address poor safety conditions. Safety conditions at intersections were assessed based on crash data from the Massachusetts Highway Department (MHD) for years 2002 through 2004 (see Appendix C). A subset that covers a twelve-month period of the crash data was used to evaluate Signal Warrant 7: Crash Experience. The three-year crash data were used to calculate a crash rate for each applicable intersection. The crash rate was then compared to the MHD District 3 Average Crash Rate for unsignalized intersections of 0.79 crashes per million entering vehicles. If the intersection crash rate is above the District 3 Crash Rate, it may indicate a safety problem and further study of the safety conditions at the intersection should be undertaken.

An applicable intersection is one that has is deemed to have sufficient crash data to calculate a crash rate and/or meets the Signal Warrant 7 minimum crash requirement (see Appendix F). An examination of Lancaster Police Department crash data may need to be considered at non-applicable intersections if the Town of Lancaster deems it necessary.

1) Intersection of Lunenburg Road and Old Union Turnpike

Lunenburg Road (Route 70) is the major road at this intersection, a two-lane rural major collector running north and south. Old Union Turnpike is a two-lane local road running east and west that is used to access Route 2 eastbound. The two approaches of Old Union Turnpike are stop-controlled, and the approaches of Lunenburg Road are uncontrolled. The eastbound, westbound and southbound approaches have channelized right turns. Figure 3 shows the intersection.

Figure 3: Lunenburg Road and Old Union Turnpike



In a traffic impact assessment[1] prepared in 2004 for a proposed Massachusetts Youth Soccer Association (MYSA) soccer facility at the corner of Lunenburg Road and Old Union Turnpike, the traffic conditions and impacts at this intersection were examined and mitigation measures proposed. The MYSA project has been approved and is expected to be completed within the next few years. According to a more recent traffic impact study for Wal-Mart[2] (May 2006), as part of the MYSA project, "the intersection will be re-striped to provide exclusive turning lanes and an exclusive through lane for the Old Union Turnpike eastbound and westbound approaches." The minor approaches will then each have three lanes. These changes

[1] MYSA Soccer Facility, Lancaster, Massachusetts; *Traffic Impact Assessment*; Vanasse & Associates, Inc.; November 2004.
[2] Environmental Notification Form, Proposed Wal-Mart Store, 438 Old Union Turnpike, Lancaster, MA; Bohler Engineering, P.C.; May 26, 2006.

as well as the additional traffic predicted to be generated by the MYSA facility are included in the future (2015) analyses.

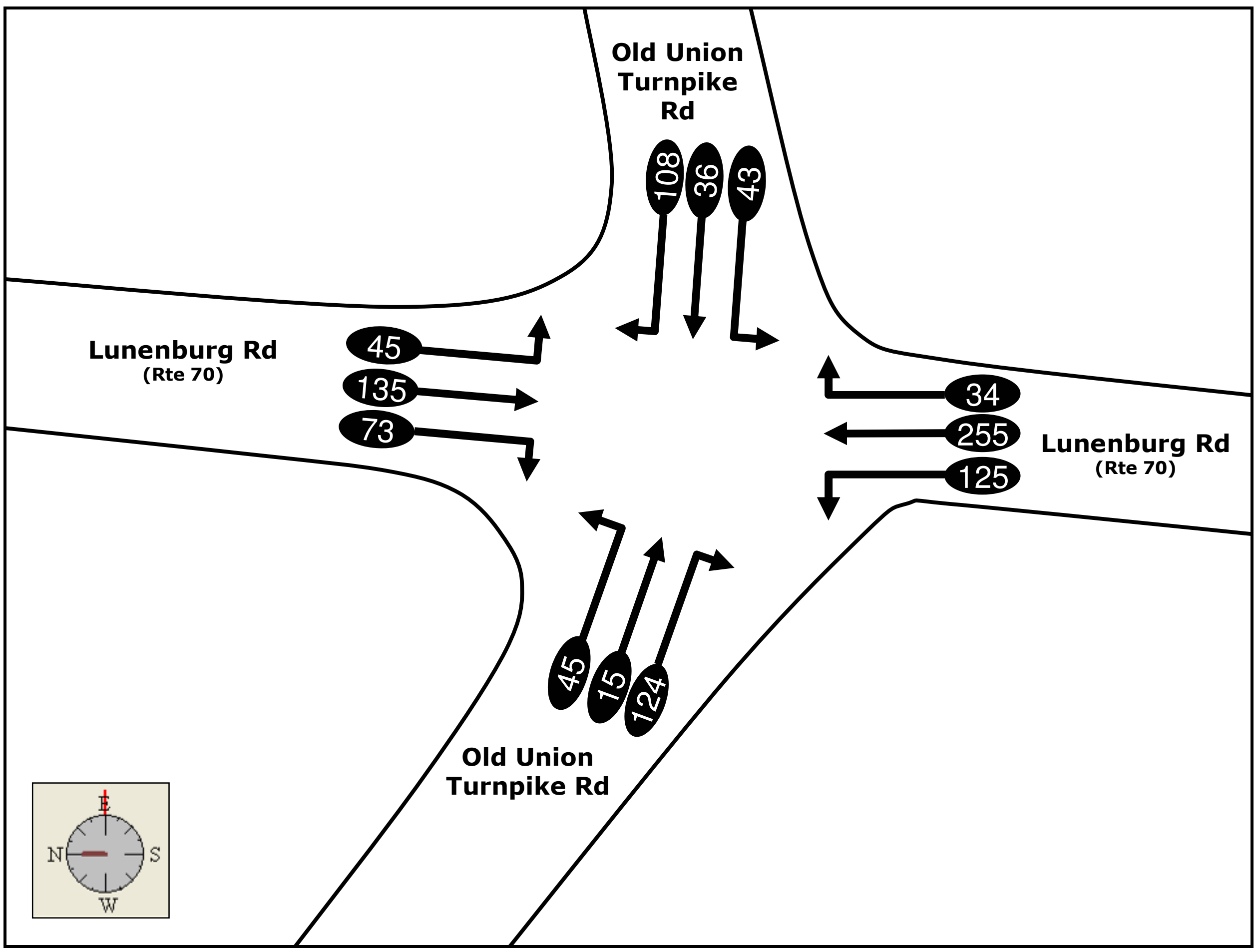
Operational Conditions

Turning movement volumes (see Appendix A) collected during the afternoon peak hour (4:15-5:15 PM) in 2003 are shown in Table 2 and Figure 4. These volumes were recorded in November and have been adjusted by a seasonal factor of 1.02 and axle correction factor of 0.97 for all approaches.

Table 2. 2003 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (Route 70)	125	255	34	414
Southbound (Route 70)	45	135	73	253
Eastbound (Old Union)	45	15	124	184
Westbound (Old Union)	43	36	108	187

Figure 4: 2003 PM peak turning movement volumes



Several development projects are underway or proposed in this area. By 2007, one housing development (Lancaster Woods) should be completed nearby. This 30-unit development is only expected to add eleven exiting vehicles and twenty entering vehicles in the afternoon peak hour, so it has not been included in the analyses of this intersection.

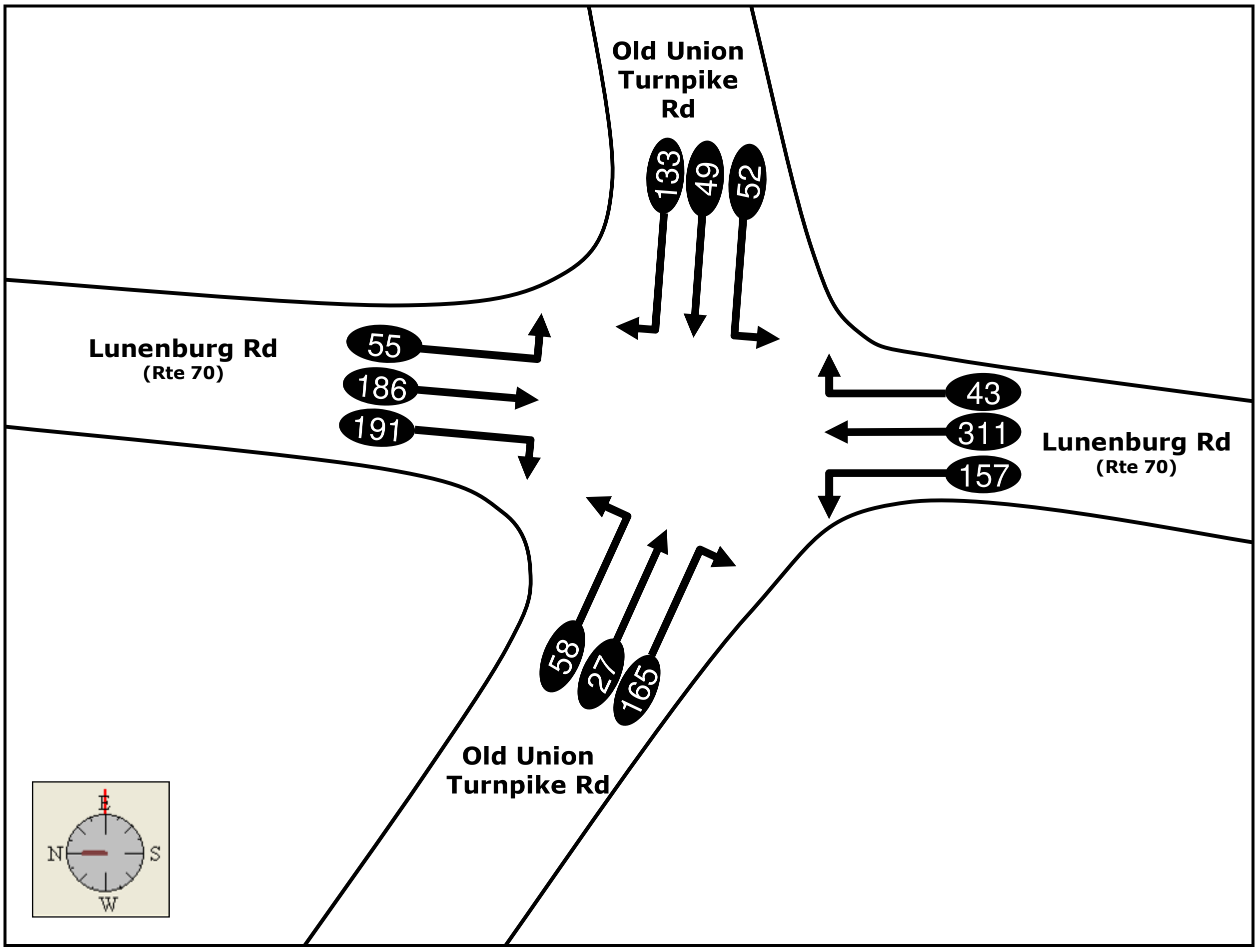
In 2015, the soccer facility discussed above is expected to add to the turning movement volumes at this intersection, with a significant increase in southbound right turns.

Based on expected traffic growth and the addition of the soccer facility traffic, the turning movement volumes predicted for the afternoon peak hour in 2015 are shown in Table 3 and Figure 5.

Table 3. Predicted 2015 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (Route 70)	157	311	43	511
Southbound (Route 70)	55	186	191	432
Eastbound (Old Union)	58	27	165	250
Westbound (Old Union)	52	49	133	234

Figure 5: Predicted 2015 PM peak turning movement volumes



A Wal-Mart shopping center has also been proposed for completion in 2009, to be located on Old Union Turnpike west of this intersection. If this facility is approved and constructed, it will also add to the intersection volumes. The Wal-Mart traffic impact study[3] predicted that in 2011, the site would add 21 southbound right turns, 42 northbound left turns, 23 eastbound left turns, and 46 eastbound right turns at this intersection. Since the Wal-Mart

[3] Environmental Notification Form, Proposed Wal-Mart Store, 438 Old Union Turnpike, Lancaster, MA; Bohler Engineering, P.C.; May 26, 2006

development has not yet been approved, its effects have not been included in the 2015 analyses but are considered in a separate analysis.

During the afternoon peak hour in 2003, given the volumes shown in Table 2, both major approaches had an LOS of A; both minor approaches had an LOS of D. The minor-street delays seem to be primarily a result of left-turning traffic. For the predicted traffic flow in 2015, the LOS for the major approaches would still be A, and the LOS on the minor approaches would drop to F. The traffic impact study completed for Wal-Mart[4] predicted similar LOS for 2011 (without a Wal-Mart). If the Wal-Mart store were constructed, the 2015 LOS would remain the same for all approaches, but the Old Union Turnpike approaches would have significantly increased delays. Table 4 summarizes the results of the operational analyses. See Appendix B for full LOS analyses.

Table 4. 2003 and 2015 PM peak LOS and control delay.

Approach	*LOS*			*Delay (seconds per vehicle)*		
	2003	*2015*	*2015 w/WalMart*	*2003*	*2015*	*2015 w/WalMart*
Northbound (Route 70)	A	A	A	7.8	8.1	8.2
Southbound (Route 70)	A	A	A	8.0	8.3	8.3
Eastbound (Old Union)	D	F	F	29.5	53.6	144.1
Westbound (Old Union)	D	F	F	27.1	68.0	126.0

Safety Conditions

According to MHD crash data, the average number of crashes at this intersection during 2002-2004 was 4.67 per year, occurring at a rate of 1.10 crashes per million entering vehicles. This rate exceeds the MHD District 3 average unsignalized intersection crash rate of 0.79 crashes per million entering vehicles, which may indicate a safety problem. Further study of the safety conditions at this intersection should be undertaken. Six of the crashes occurred in a twelve-month period and are considered correctible by installation of a traffic signal. Of the three-year total of fourteen crashes, eight were angle crashes. See Appendix C for crash data and full crash rate analyses.

Signal Warrant Analysis Results

Based on 2005 traffic data, this intersection meets at least three signal warrants: Warrant 1, Eight-Hour Vehicular Volume; Warrant 2, Four-Hour Vehicular Volume; and Warrant 3, Peak Hour. If “adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency,” then Warrant 7, Crash Experience, is also met. Since only one satisfied warrant is required to warrant the installation of a traffic signal, a signal is warranted at this intersection. See Appendix D for traffic data; see Appendix E for Signal Warrant Analysis results.

Improvement Alternatives

The minor approaches are predicted to suffer significant delays in 2015, even with the added turning lanes. Two alternatives were examined to improve the intersection operation, and the analysis results are summarized in Table 5. The effects of the proposed Wal-Mart traffic are

[4] Environmental Notification Form, Proposed Wal-Mart Store, 438 Old Union Turnpike, Lancaster, MA; Bohler Engineering, P.C.; May 26, 2006.

shown in Table 6. See Appendix B for full LOS and control delay results for improvement alternatives.

Alternative 1 is to install a traffic signal at the intersection. A three-phase signal plan (i.e., northbound, north-south, and east-west traffic) could result in reduced minor-approach delays and an overall intersection LOS of C. A traffic signal would also be likely to improve the safety of the intersection.

Alternative 2 is to install the traffic signal and also add a left-turn lane on the northbound approach. This would decrease delays on the northbound approach and result in an overall intersection LOS of B.

The Wal-Mart traffic would primarily affect the northbound approach, since it adds to the volume of northbound left-turns. It would not affect the overall intersection LOS.

Table 5. 2015 PM peak LOS and control delay for improvement alternatives.

Approach	*LOS*			*Delay (seconds per vehicle)*		
	2015	*2015 Alt 1*	*2015 Alt 2*	*2015*	*2015 Alt 1*	*2015 Alt 2*
Northbound (Route 70)	A	C	A	8.1	23.7	7.2
Southbound (Route 70)	A	C	C	8.3	23.6	22.7
Eastbound (Old Union)	F	C	C	53.6	21.0	21.0
Westbound (Old Union)	F	B	B	68.0	19.5	19.5

Table 6. Effects of Wal-Mart on 2015 PM peak LOS and delay for improvement alternatives.

Approach	*LOS*			*Delay (seconds per vehicle)*		
	2015 w/ WalMart	*2015 Alt 1 w/WalMart*	*2015 Alt 2 w/WalMart*	*2015 w/ WalMart*	*2015 Alt 1 w/WalMart*	*2015 Alt 2 w/WalMart*
Northbound (Route 70)	A	D	A	8.2	45.4	8.0
Southbound (Route 70)	A	C	C	8.3	28.5	26.7
Eastbound (Old Union)	F	C	C	144.1	22.3	22.3
Westbound (Old Union)	F	B	B	126.0	18.5	18.5

2) <u>Intersection of Lunenburg Road and Main Street</u>

Main Street (Route 117/70) is the major road at this "T" intersection, a two-lane urban arterial running east and west. Lunenburg Road (Route 70) is a two-lane rural major collector. The Lunenburg Road (southbound) approach is stop-controlled and wide enough to allow for a short right-turn lane, and the Main Street approaches are uncontrolled. Figure 6 shows the intersection.

Figure 6: Lunenburg Road and Main Street

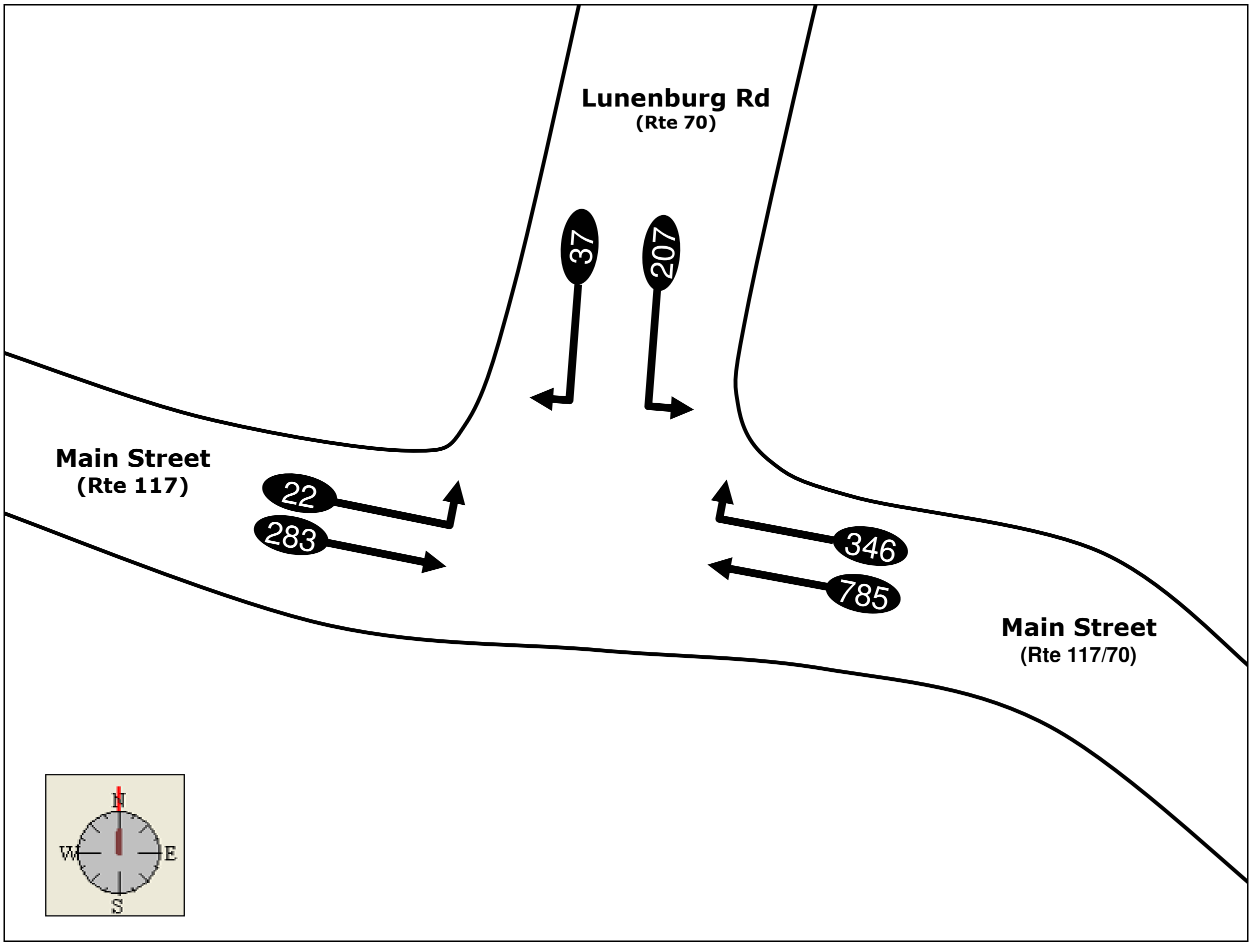
Operational Conditions

Turning movement volumes (see Appendix A) collected during the afternoon peak hour (4:30-5:30 PM) in 2005 are shown in Table 7 and Figure 7. These volumes were recorded in November and have been adjusted by seasonal factors of 1.02 and 0.98 for the minor and major approaches respectively, and by an axle correction factor of 0.97 for all approaches.

Table 7. 2005 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Southbound (Lunenburg Rd)	207	n/a	37	244
Eastbound (Main St)	22	283	n/a	305
Westbound (Main St)	n/a	785	346	1131

Figure 7: 2005 PM peak turning movement volumes

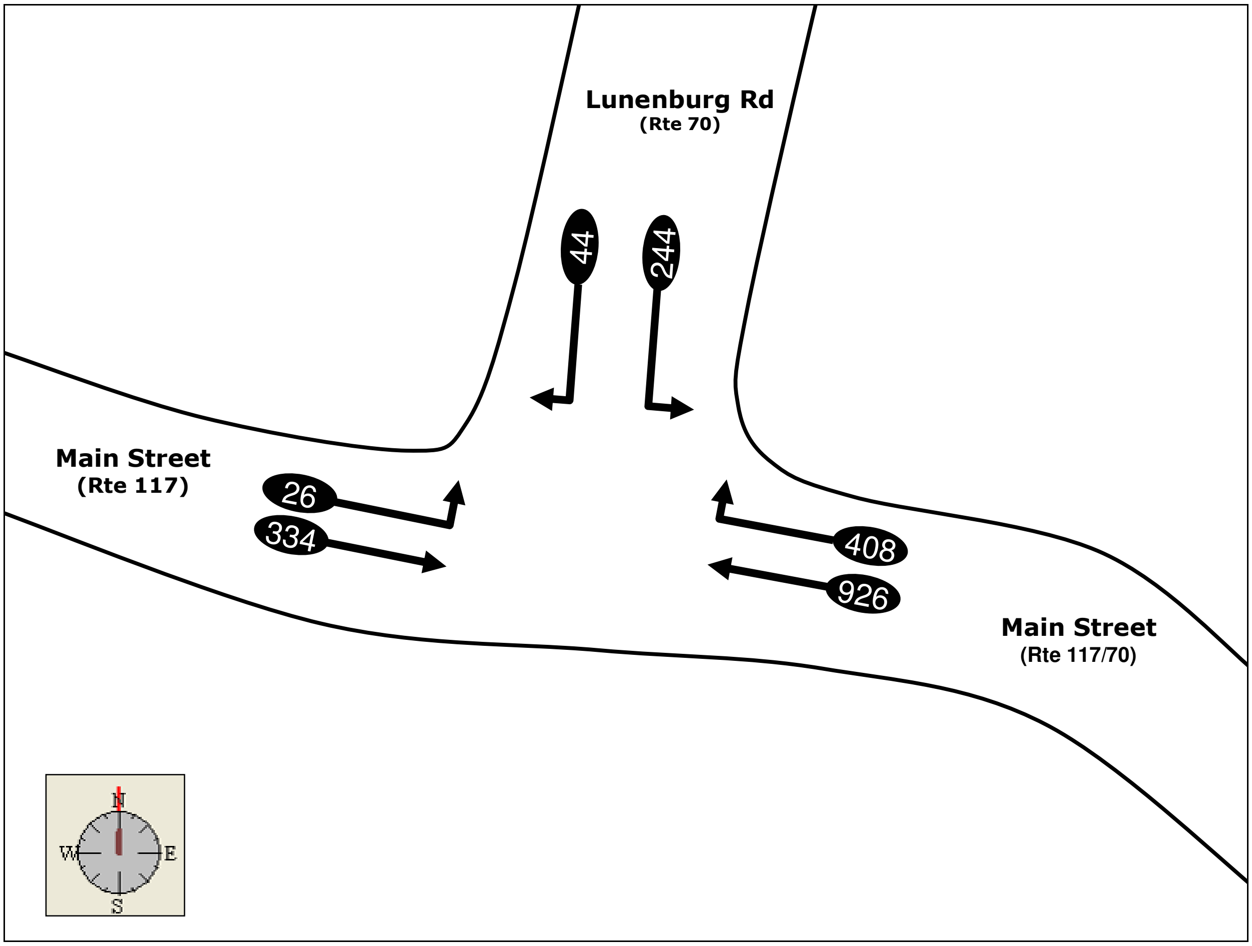


Based on expected traffic growth, the turning movement volumes predicted for the afternoon peak hour in 2015 are shown in Table 8 and Figure 8.

Table 8. Predicted 2015 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Southbound (Lunenburg Rd)	244	n/a	44	288
Eastbound (Main St)	26	334	n/a	360
Westbound (Main St)	n/a	926	408	1334

Figure 8: Predicted 2015 PM peak turning movement volumes



During the afternoon peak hour, given the volumes shown in Table 7, eastbound left-turning traffic has an LOS of B; the southbound approach has an LOS of F, which indicates high delay. The traffic on the other approaches is unopposed. For the predicted traffic flow in 2015, the LOS for all the approaches would remain the same, with higher delays. Table 9 summarizes the operational analysis results. See Appendix B for full LOS analyses.

Table 9. 2005 and 2015 PM peak LOS and control delay.

Approach	*LOS*		*Delay (seconds per vehicle)*	
	2005	*2015*	*2005*	*2015*
Southbound (Lunenburg Rd)	F	F	422.4	981.7
Eastbound (Main St)	B	B	11.3	12.7
Westbound (Main St)	n/a	n/a	n/a	n/a

Safety Conditions

According to MHD crash data, the average number of crashes at this intersection during 2002-2004 was 4.67 per year, occurring at a rate of .65 crashes per million entering vehicles. This rate does not exceed the MHD District 3 average unsignalized intersection crash rate of 0.79 crashes per million entering vehicles, which indicates a safety problem may not exist. However, a detailed review of the Lancaster Police Department crash data should be considered because the MHD crash data for this location may be underreported. See Appendix C for crash data and full crash rate analyses.

Signal Warrant Analysis Results

Based on 2003 traffic data, this intersection meets four signal warrants: Warrant 1, Eight-Hour Vehicular Volume; Warrant 2, Four-Hour Vehicular Volume; Warrant 3, Peak Hour; and Warrant 8, Roadway Network. Warrant 7, Crash Experience, was not addressed due to insufficient crash data. Since only one satisfied warrant is required to warrant the installation of a traffic signal, a signal is warranted at this intersection. See Appendix D for traffic data; see Appendix E for Signal Warrant Analysis results.

Improvement Alternatives

The minor (southbound) approach is predicted to suffer significant delays in 2015. Three alternatives to improve the traffic conditions were examined, and the analysis results are summarized in Table 10. See Appendix B for full LOS and control delay results for improvement alternatives.

Alternative 1 is to add a left-turn lane on this approach. This would reduce the approach delay somewhat but remain at LOS F.

Alternative 2 is to install a traffic signal at the intersection. A simple two-phase signal plan (i.e., southbound and east-west traffic) could result in reduced delays on the southbound and eastbound approaches and an overall intersection LOS of D. This would dramatically reduce the delay to the southbound traffic, although it would delay the westbound traffic.

Alternative 3 is to install a traffic signal with the same phasing as Alternative 2, but to also add a left-turn lane on the southbound approach. The results would be similar to Alternative 2 except that the southbound delay would drop even more.

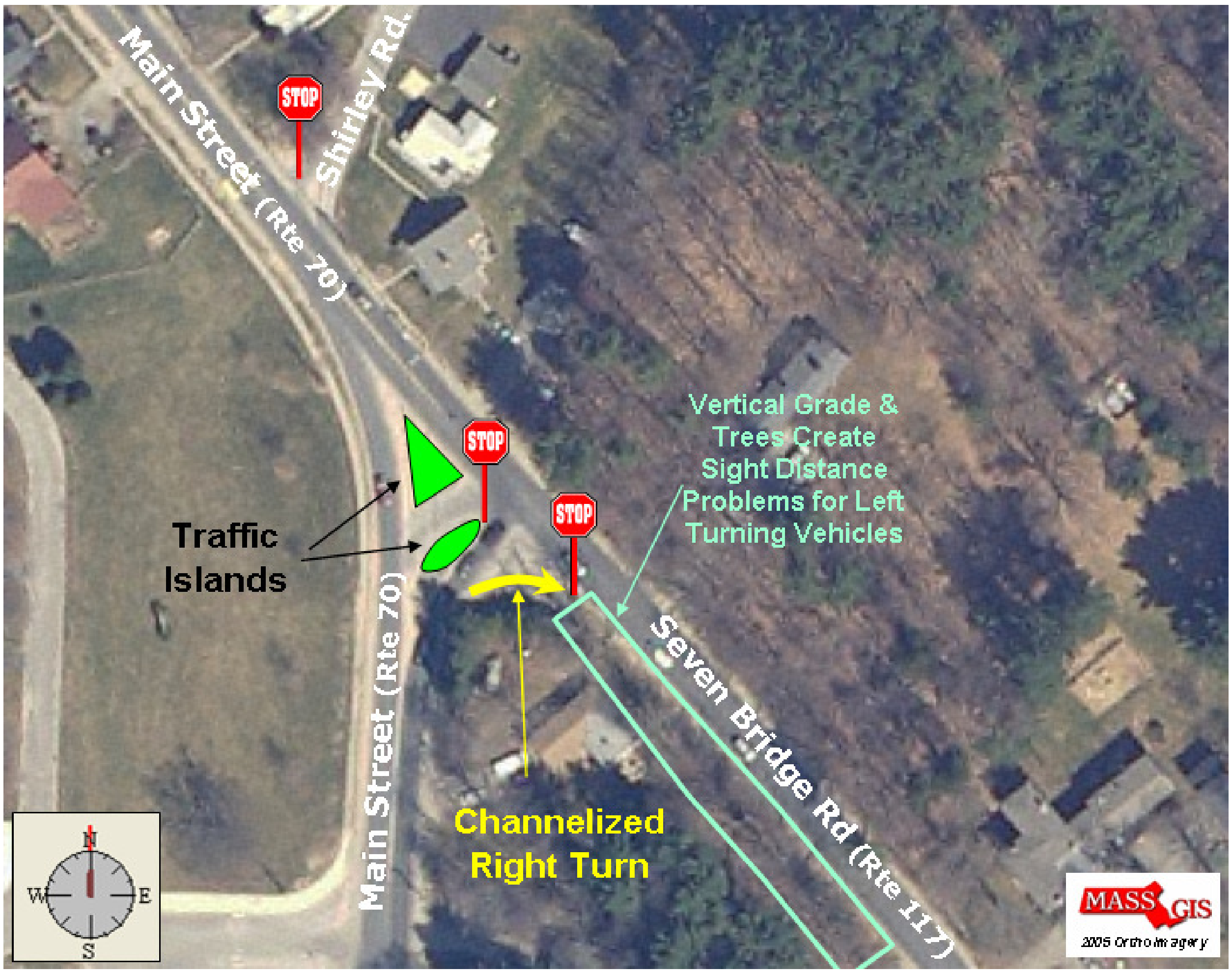
Table 10. 2015 PM peak LOS and control delay for improvement alternatives.

Approach	*LOS*				*Delay (seconds per vehicle)*			
	2015	*2015 Alt 1*	*2015 Alt 2*	*2015 Alt 3*	*2015*	*2015 Alt 1*	*2015 Alt 2*	*2015 Alt 3*
Southbound (Lunenburg Rd)	F	F	F	F	981.7	762.8	213.2	108.4
Eastbound (Main St)	B	B	A	A	12.7	12.7	3.7	3.9
Westbound (Main St)	n/a	n/a	C	C	n/a	n/a	31.7	33.9

3) <u>Intersection of Main Street/Seven Bridge Rd (Route 117/70) and Main Street (Route 70) / Shirley Road</u>

Main Street/Seven Bridge Road (Route 117/70) is the major road at this skewed intersection, a two-lane urban arterial running east and west. Main Street (Route 70) northbound is a two-lane urban collector. Shirley Road southbound is a stop-controlled, dead-end, two-lane local road offset from Main Street (Route 70) with very low traffic volumes. It forms a separate intersection but is located close enough to be included in the analyses. The northbound approach is stop-controlled with a flashing red light and a channelized right-turn, and the east and westbound approaches are uncontrolled except for a flashing yellow light, with a channelized eastbound right-turn. Figure 8 shows the intersection.

Figure 9: Main Street/Seven Bridge Road and Main Street/Shirley Road



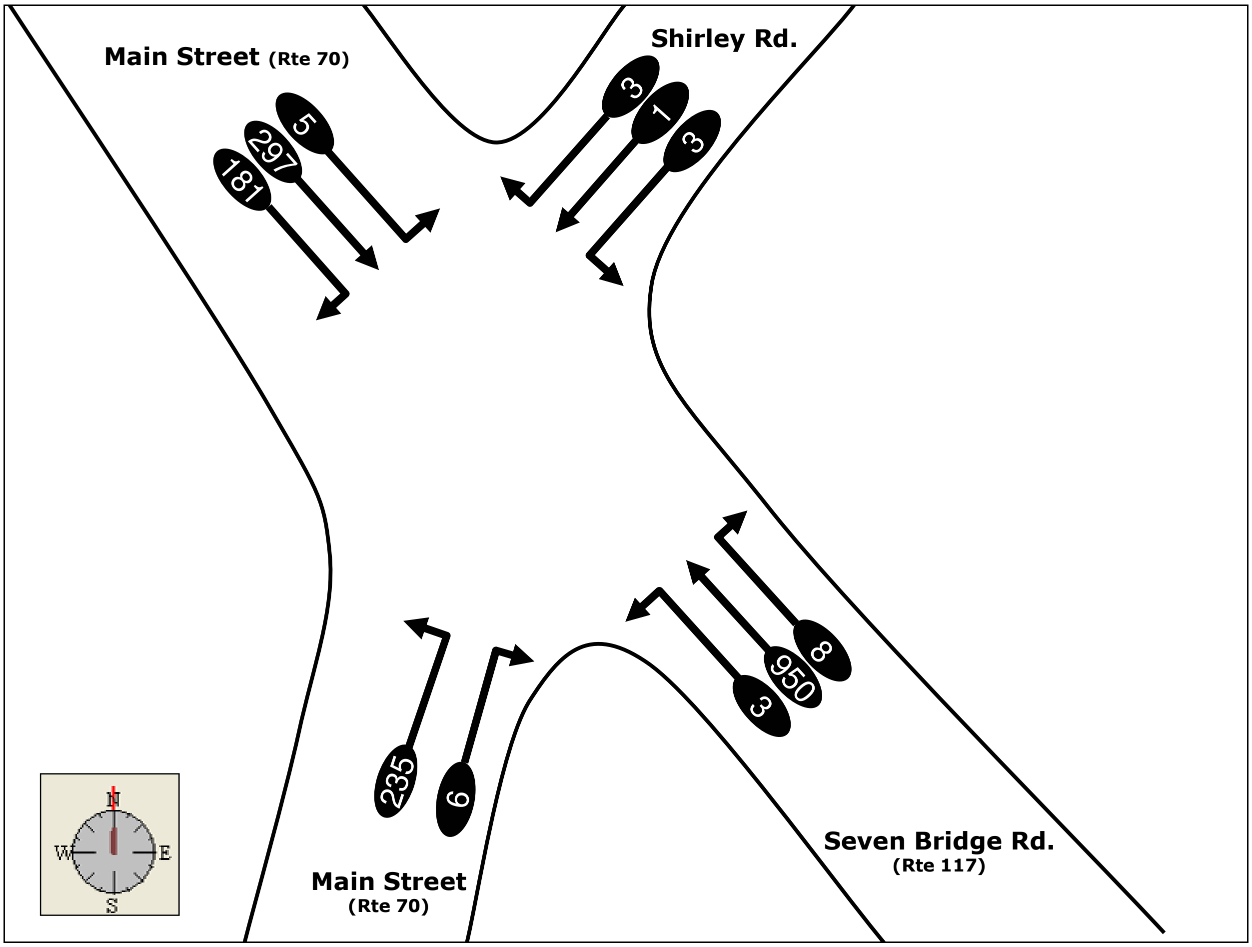
Operational Conditions

Turning movement volumes (see Appendix A) collected during the afternoon peak hour (4:45-5:45 PM) in 2005 are shown in Table 11 and Figure 10. These volumes were recorded in November and have been adjusted by a seasonal factor of 0.98 for all approaches and an axle correction factor of 0.97 and 0.99 for the major and minor approaches, respectively.

Table 11. 2005 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (Main St)	235	0	6	241
Southbound (Shirley Rd)	3	1	3	7
Eastbound (Main St)	5	297	181	483
Westbound (Seven Bridge Rd)	3	950	8	961

Figure 10: 2005 PM peak turning movement volumes

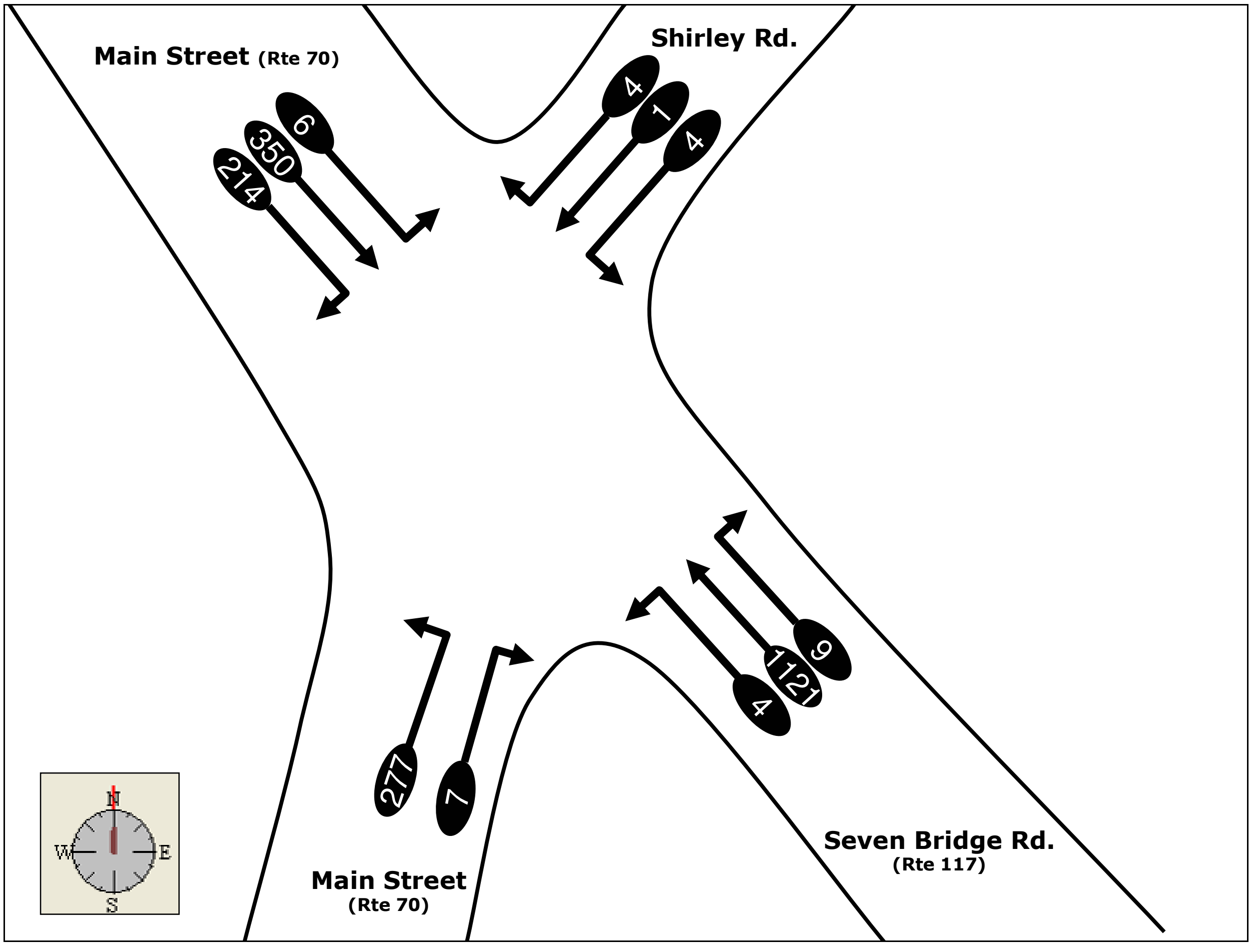


Based on expected traffic growth, the turning movement volumes predicted for the afternoon peak hour in 2015 are shown in Table 12 and Figure 11.

Table 12. Predicted 2015 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (Main St)	277	0	7	284
Southbound (Shirley Rd)	4	1	4	9
Eastbound (Main St)	6	350	214	570
Westbound (Seven Bridge Rd)	4	1121	9	1134

Figure 11: Predicted 2015 PM peak turning movement volumes



During the afternoon peak hour, given the volumes shown in Table 11, eastbound and westbound left-turning traffic have LOS of B and A, respectively; the southbound approach has an LOS of E; and the northbound approach has an LOS of F, which indicates high delay, due to delays to left-turning traffic. For the predicted traffic flow in 2015, the LOS for all approaches would remain the same, with higher delays, except for the southbound approach, which would drop to LOS F. The operational analysis results are summarized in Table 13. See Appendix B for full LOS analyses.

Table 13. 2005 and 2015 PM peak LOS and control delay.

Approach	*LOS*		*Delay (seconds per vehicle)*	
	2005	*2015*	*2005*	*2015*
Northbound (Main St)	F	F	1580.0	3570.0
Southbound (Shirley Rd)	E	F	43.3	73.7
Eastbound (Main St)	B	B	11.7	13.2
Westbound (Seven Bridge Rd)	A	A	7.8	8.0

Safety Conditions

According to MHD crash data for this location a safety problem may not exist for this intersection. However, a detailed review of the Lancaster Police Department crash data should be considered because the MHD crash data for this location may be underreported. The sight distance from the westbound approach appears to be limited for left turns, due to trees and approach grade. See Appendix C for crash data and full crash rate analyses.

Signal Warrant Analysis Results

Based on 2003 traffic data, this intersection meets at least four signal warrants: Warrant 1, Eight-Hour Vehicular Volume; Warrant 2, Four-Hour Vehicular Volume; Warrant 3, Peak Hour; and Warrant 8, Roadway Network. Warrant 7, Crash Experience, was not addressed due to insufficient crash data. Since only one satisfied warrant is required to warrant the installation of a traffic signal, a signal is warranted at this intersection. See Appendix D for traffic data; see Appendix E for Signal Warrant Analysis results.

Improvement Alternatives

Left-turning traffic on the minor (northbound) approach is predicted to suffer significant delays in both 2005 and 2015 due to the volume of traffic on the major road. One alternative to improve the traffic conditions was examined, and the analysis results are summarized in Table 14. See Appendix B for full LOS and control delay results for improvement alternatives.

Alternative: The alternative is to install a traffic signal at the intersection. A simple two-phase signal plan (i.e., north-south and east-west traffic) could result in significantly reduced delays to northbound traffic and slightly reduced delays to eastbound traffic, with increased delays to westbound and southbound traffic. The overall intersection LOS would be D. The suspected sight distance problem should also be alleviated by traffic signal control.

Table 14. 2015 PM peak LOS and control delay for improvement alternatives.

Approach	*LOS*		*Delay (seconds per vehicle)*	
	2015	*2015 Alt*	*2015*	*2015 Alt.*
Northbound (Main St)	F	E	3570.0	73.7
Southbound (Shirley Rd)	F	F	73.7	939.1
Eastbound (Main St)	B	A	13.2	9.2
Westbound (Seven Bridge Rd)	A	D	8.0	40.5

4) Intersection of Main Street and Sterling Road/Bennett Lane

Main Street (Route 70) is the major road at this skewed intersection, a two-lane urban collector running north and south. Sterling Road is also a two-lane urban collector and Bennett Lane westbound is a two-lane local road offset from this intersection with very low traffic volumes. The Sterling Road (eastbound) approach is stop-controlled, and the north and southbound approaches are uncontrolled. Figure 12 shows the intersection.

Figure 12: Main Street and Sterling Road/Bennett Lane

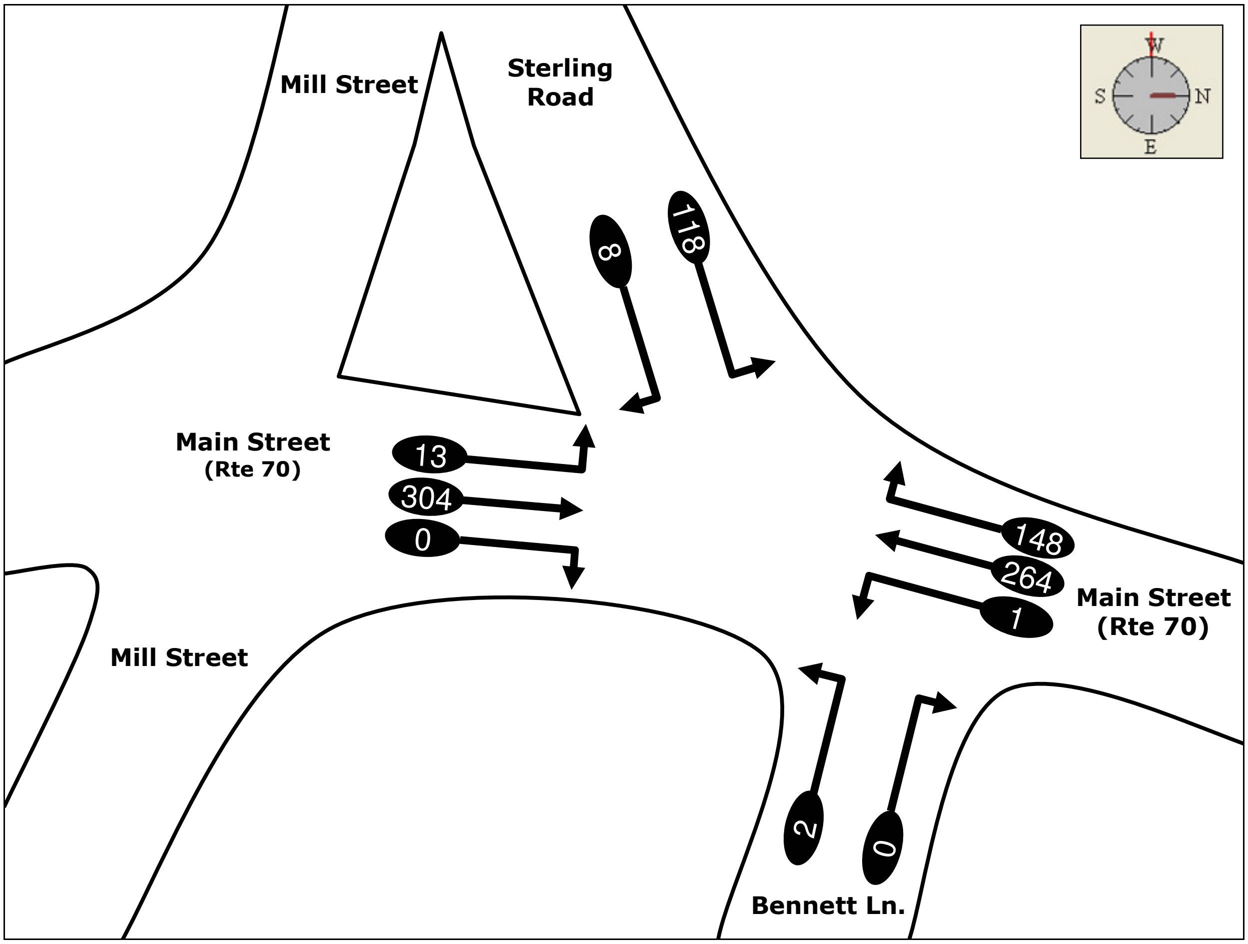
Operational Conditions

Turning movement volumes (see Appendix A) collected during the afternoon peak hour (5:00-6:00 PM) in 2006 are shown in Table 15 and Figure 13. These volumes were recorded in June and have been adjusted by a seasonal factor of 0.89 and an axle correction factor of 0.99 for all approaches.

Table 15. 2006 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (Main St)	13	304	0	317
Southbound (Main St)	1	264	148	413
Eastbound (Sterling Rd)	118	n/a	8	126
Westbound (Bennett Ln)	2	n/a	0	2

Figure 13: 2006 PM peak turning movement volumes

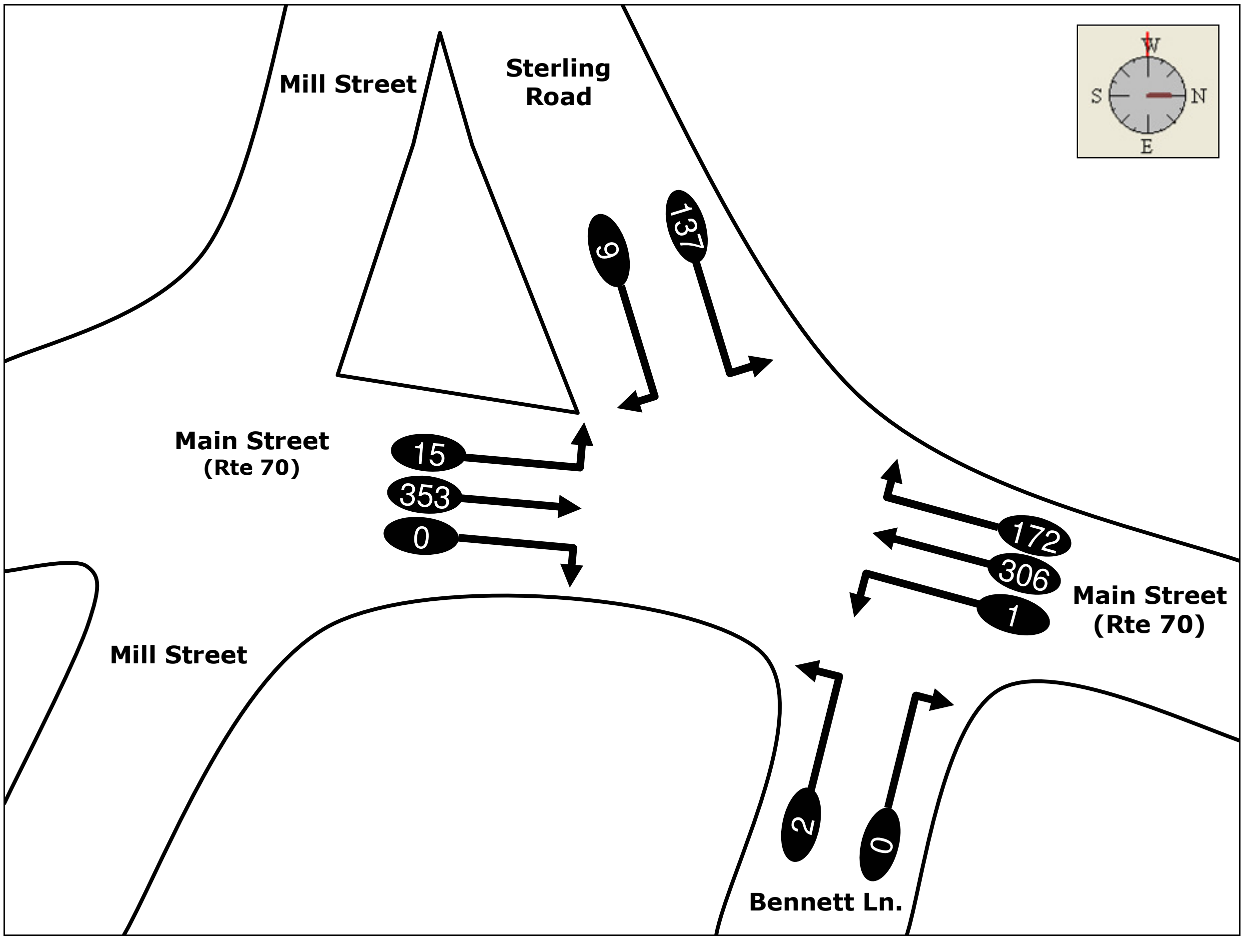


Based on expected traffic growth, the turning movement volumes predicted for the afternoon peak hour in 2015 are shown in Table 16 and Figure 14.

Table 16. Predicted 2015 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (Main St)	15	353	0	368
Southbound (Main St)	1	306	172	479
Eastbound (Sterling Rd)	137	n/a	9	146
Westbound (Bennett Ln)	2	n/a	0	2

Figure 14: Predicted 2015 PM peak turning movement volumes



During the afternoon peak hour, given the volumes shown in Table 15, the Main Street approaches have an LOS of A; the eastbound and westbound approaches have an LOS of C. For the predicted traffic flow in 2015, the LOS would remain the same for all approaches except eastbound, which would drop to D. Table 17 summarizes the operational analysis results. See Appendix B for full LOS analyses.

Table 17. 2006 and 2015 PM peak LOS and control delay.

Approach	*LOS*		*Delay (seconds per vehicle)*	
	2005	*2015*	*2005*	*2015*
Northbound (Main St)	A	A	8.2	8.4
Southbound (Main St)	A	A	7.9	8.0
Eastbound (Sterling Rd)	C	D	22.7	34.2
Westbound (Bennett Ln)	C	C	15.9	18.2

Safety Conditions

According to MHD crash data for this location a safety problem may not exist for this intersection. However, a detailed review of the Lancaster Police Department crash data should be considered because the MHD crash data for this location may be underreported. See Appendix C for crash data and full crash rate analyses.

Signal Warrant Analysis Results

Based on 2005 traffic data, this intersection meets at least three signal warrants: Warrant 1, Eight-Hour Vehicular Volume; Warrant 2, Four-Hour Vehicular Volume; and Warrant 3, Peak Hour. Warrant 7, Crash Experience, was not addressed due to insufficient crash data. Since only one satisfied warrant is required to warrant the installation of a traffic signal, a signal is warranted at this intersection. See Appendix D for traffic data; see Appendix E for Signal Warrant Analysis results.

Improvement Alternatives

This intersection appears to be operating acceptably in 2006 and without significant problems predicted in 2015. The eastbound traffic does have some delay, apparently caused by lack of gaps in the major road traffic to allow the minor road traffic to turn left. Two alternatives to improve the traffic conditions were examined, and the analysis results are summarized in Table 18. See Appendix B for full LOS and control delay results for improvement alternatives.

Alternative 1 is to add a left-turn lane on the eastbound approach. This is predicted to have little effect on delay and no change to the LOS.

Alternative 2 is to install a traffic signal at the intersection. A simple two-phase signal plan (i.e., north-south and east-west traffic) could result in improved LOS on the minor approaches and an overall intersection LOS of A. Note, however, that the delay is only slightly affected; the LOS is improved mostly because drivers' perception of control delay at a signalized intersection differs from that at an unsignalized intersection.

Table 18. 2015 PM peak LOS and control delay for improvement alternatives.

Approach	*LOS*			*Delay (seconds per vehicle)*		
	2015	*2015 Alt.1*	*2015 Alt.2*	*2015*	*2015 Alt.1*	*2015 Alt.2*
Northbound (Main St)	A	A	A	8.4	8.4	5.1
Southbound (Main St)	A	A	A	8.0	8.0	5.7
Eastbound (Sterling Rd)	D	D	C	34.2	32.7	25.9
Westbound (Bennett Ln)	C	C	B	18.2	18.2	19.7

5) Intersection of Main Street and Mill Street

Main Street (Route 70) is the major road at this four-way intersection, a two-lane urban collector running north and south. Mill Street is a two-lane urban collector running east and west. The Mill Street approaches are stop-controlled, and the Main Street approaches are uncontrolled. The westbound approach has a channelized right-turn. Figure 15 shows the intersection.

Figure 15: Main Street and Mill Street

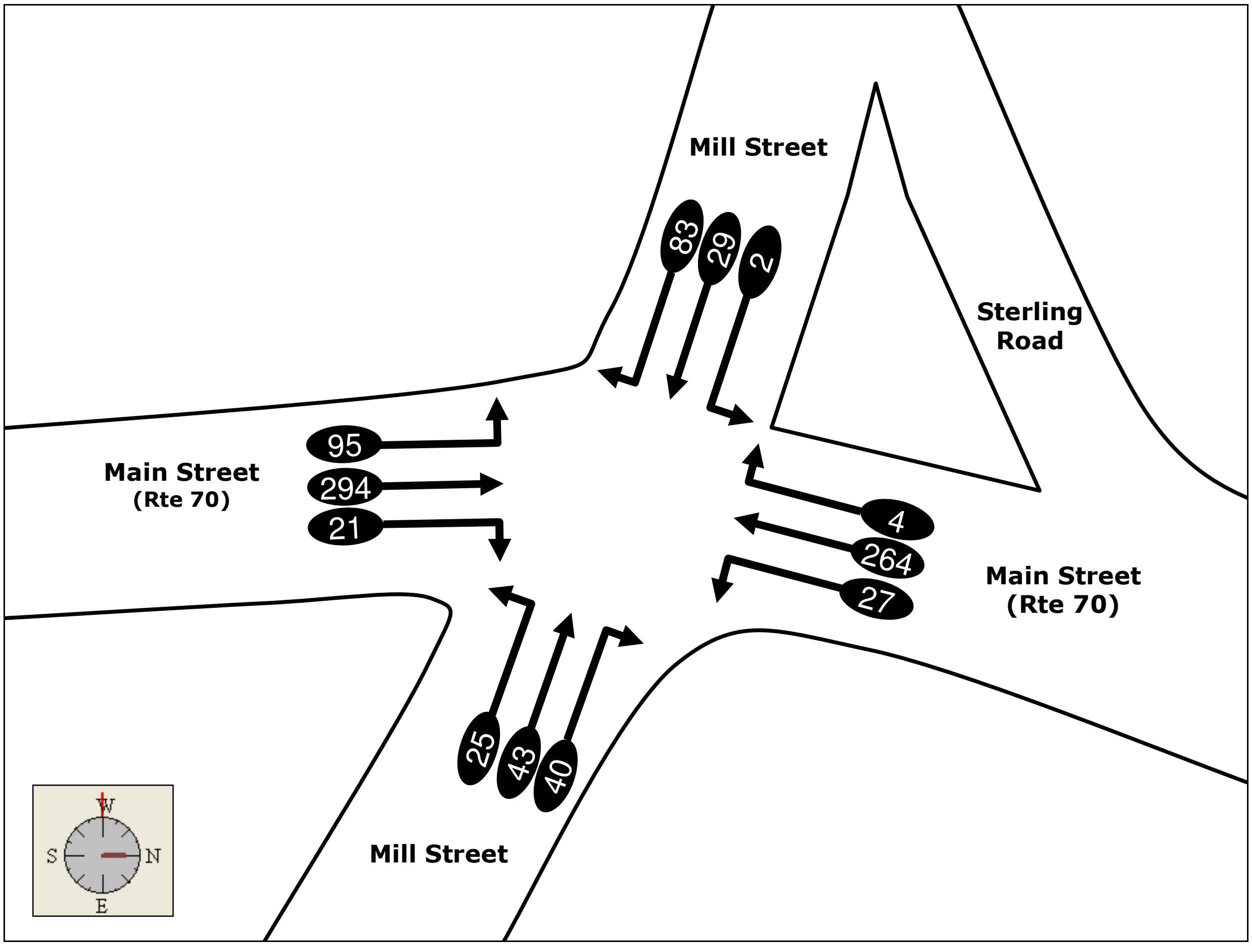
Operational Conditions

Turning movement volumes (see Appendix A) collected during the afternoon peak hour (4:45-5:45 PM) in 2006 are shown in Table 19 and Figure 16. These volumes were recorded in June and have been adjusted by a seasonal factor of 0.89 and an axle correction factor of 0.99 for all approaches.

Table 19. 2006 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (Main St)	95	294	21	410
Southbound (Main St)	27	264	4	295
Eastbound (Mill St)	2	29	83	114
Westbound (Mill St)	25	43	40	108

Figure 16: 2006 PM peak turning movement volumes

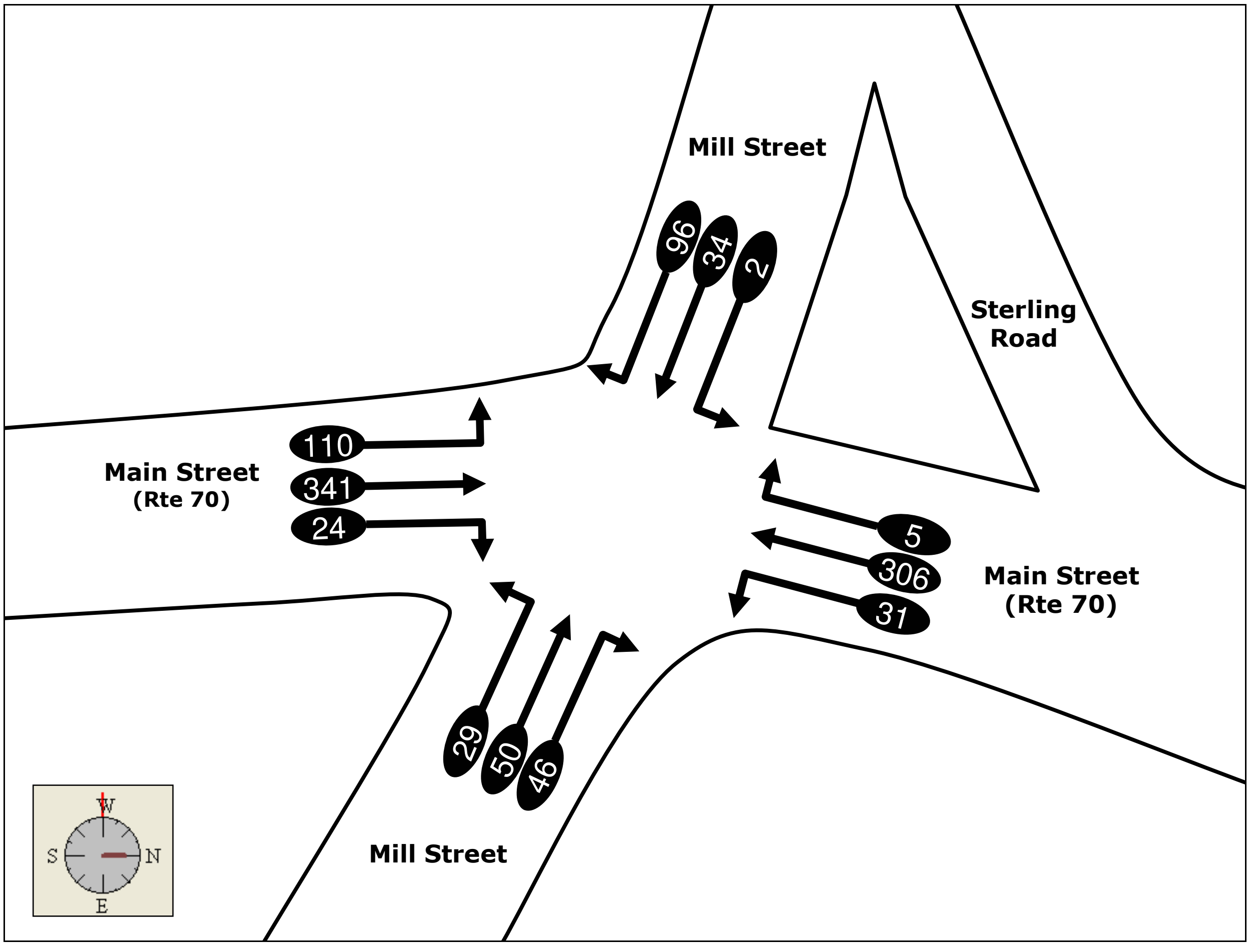


Based on expected traffic growth, the turning movement volumes predicted for the afternoon peak hour in 2015 are shown in Table 20 and Figure 17.

Table 20. Predicted 2015 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (Main St)	110	341	24	475
Southbound (Main St)	31	306	5	342
Eastbound (Mill St)	2	34	96	132
Westbound (Mill St)	29	50	46	125

Figure 17: Predicted 2015 PM peak turning movement volumes



During the afternoon peak hour, given the volumes shown in Table 19, left-turning vehicles on both major approaches have an LOS of A; the eastbound approach has an LOS of C; and the westbound approach has an LOS of D. For the predicted traffic flow in 2015, the LOS for the north, south, and eastbound approaches would remain the same, and the westbound approach would drop to E. Table 21 summarizes the operational analysis results. See Appendix B for full LOS analyses.

Table 21. 2006 and 2015 PM peak LOS and control delay.

Approach	*LOS*		*Delay (seconds per vehicle)*	
	2006	*2015*	*2006*	*2015*
Northbound (Main St)	A	A	8.0	8.2
Southbound (Main St)	A	A	8.0	8.2
Eastbound (Mill St)	C	C	15.3	20.1
Westbound (Mill St)	D	E	23.1	37.1

Safety Conditions

According to MHD crash data for this location a safety problem may not exist for this intersection. However, a detailed review of the Lancaster Police Department crash data should be considered because the MHD crash data for this location may be underreported. Sight distance for vehicles on the westbound approach appears to be limited due to horizontal and vertical alignment issues. See Appendix C for crash data and full crash rate analyses.

Signal Warrant Analysis Results

Based on 2003-05 traffic data, this intersection meets three signal warrants: Warrant 1, Eight-Hour Vehicular Volume; Warrant 2, Four-Hour Vehicular Volume; and Warrant 3, Peak Hour. Since only one satisfied warrant is required to warrant the installation of a traffic signal, a signal is warranted at this intersection. See Appendix D for traffic data; see Appendix E for Signal Warrant Analysis results.

Improvement Alternatives

Traffic on the minor (Mill Street) approaches is predicted to suffer significant delays in 2015 due to the increasing traffic volumes. Two alternatives to improve the traffic conditions were examined, and the analysis results are summarized in Table 22. See Appendix B for full LOS and control delay results for improvement alternatives.

Alternative 1 is to add a left-turn lane to the westbound approach. This would improve the approach LOS to D. Since the eastbound approach had only two left-turning vehicles in the 2006 PM peak hour and four in the AM peak hour, a left-turn lane would not be of much benefit there.

Alternative 2 is to install a traffic signal at the intersection. A simple two-phase signal plan (i.e., north-south and east-west traffic) could result in reduced delays, a westbound LOS of C, and an overall intersection LOS of B. Signal control would also alleviate the suspected sight distance problem.

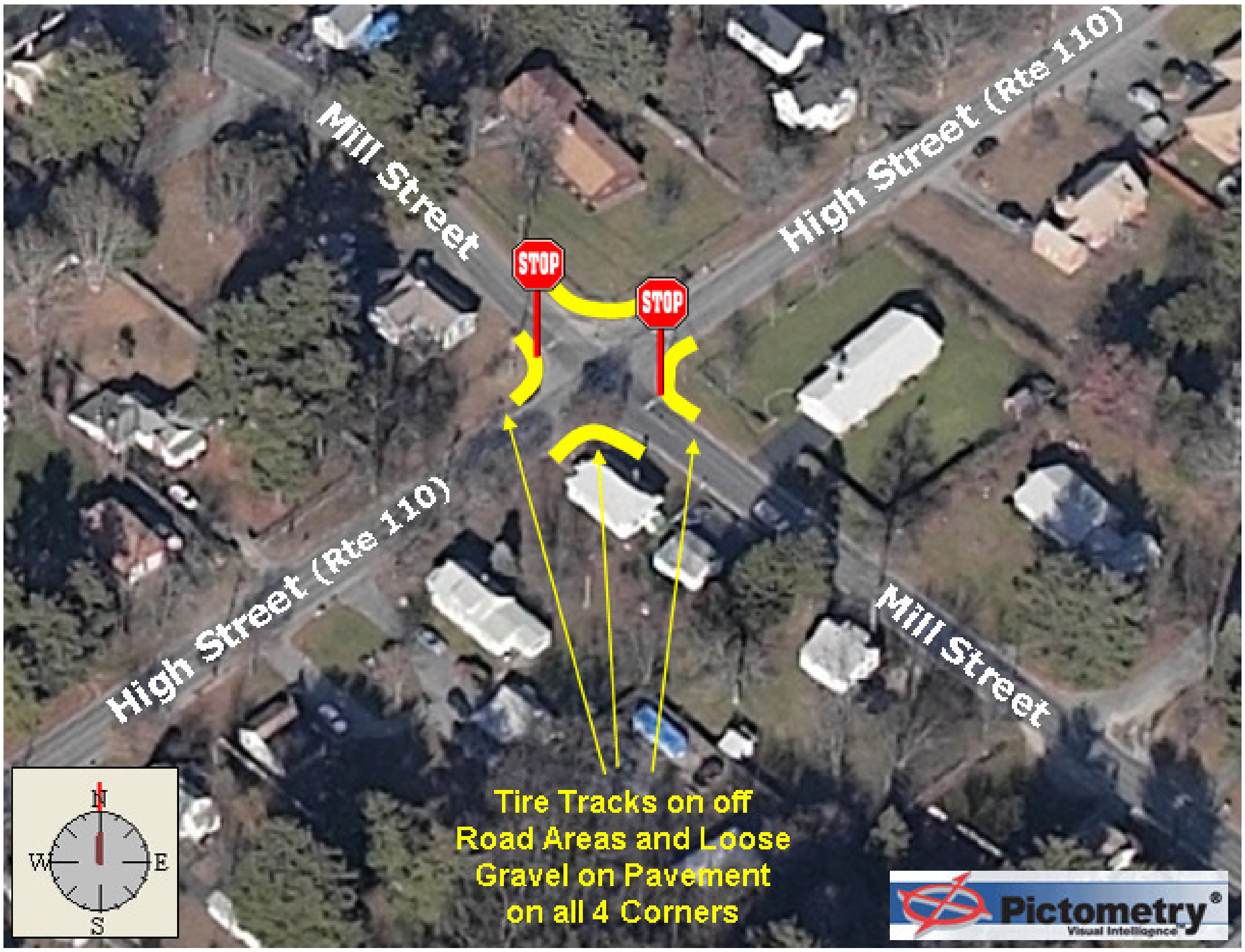
Table 22. 2015 PM peak LOS and control delay for improvement alternatives.

Approach	*LOS*			*Delay (seconds per vehicle)*		
	2015	*2015 Alt.1*	*2015 Alt.2*	*2015*	*2015 Alt.1*	*2015 Alt.2*
Northbound (Main St)	A	A	A	8.2	8.2	4.8
Southbound (Main St)	A	A	A	8.2	8.2	6.7
Eastbound (Mill St)	C	C	C	20.2	19.1	27.3
Westbound (Mill St)	E	D	C	37.1	26.6	22.1

6) Intersection of High Street and Mill Street

High Street (Route 110) is the major road at this four-way intersection, a two-lane urban arterial running northeast and southwest. Mill Street is a two-lane urban collector running northwest and southeast. The Mill Street approaches are stop-controlled, and the Main Street approaches are uncontrolled. Vehicles leave the roadway on all four corners of the intersection as vehicle tire tracks can be seen on the unpaved off-road areas and there is a considerable amount of loose gravel on the pavement. This is most likely the result of a lack of curbing along the corners. Figure 18 shows the intersection.

Figure 18: High Street and Mill Street



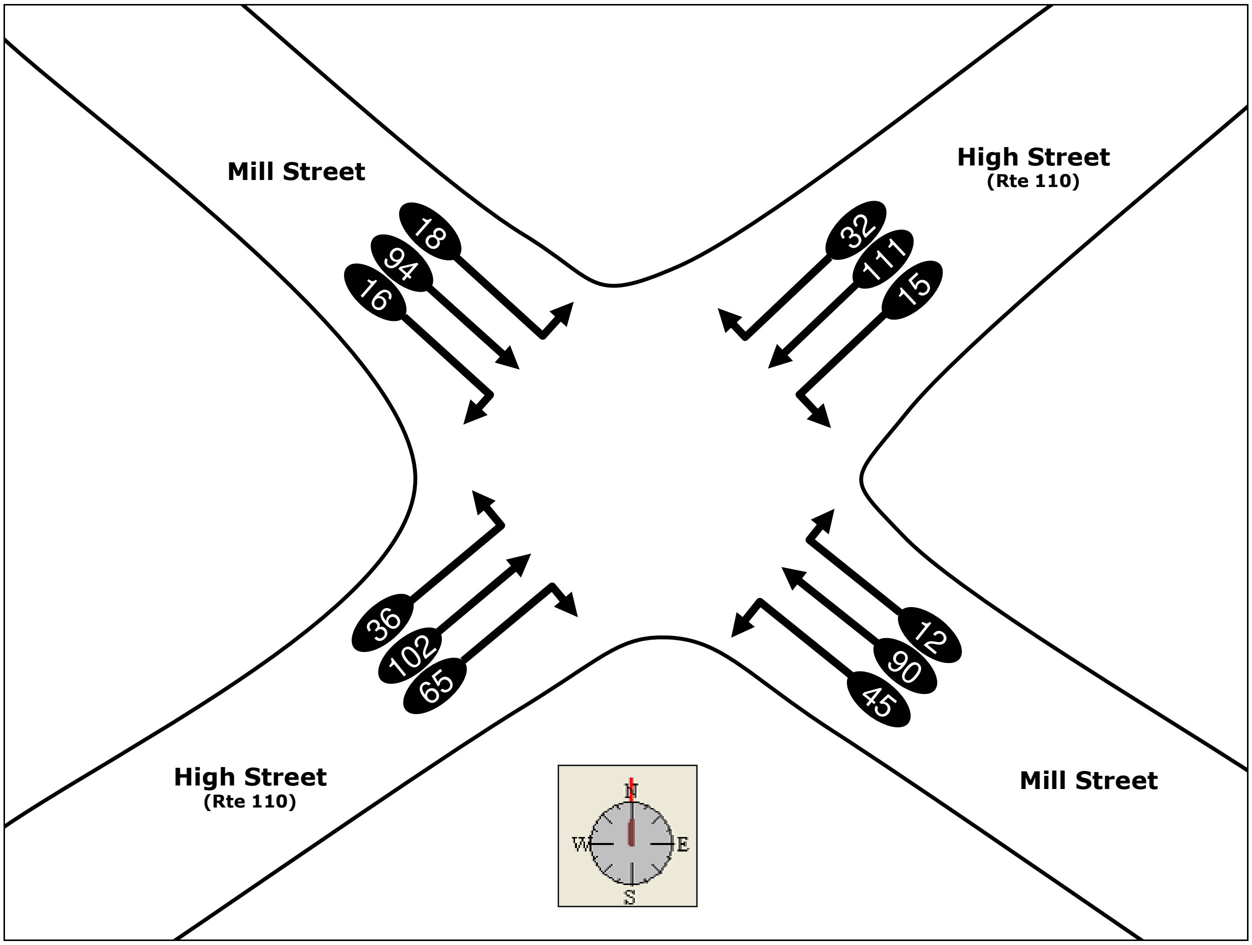
Operational Conditions

Turning movement volumes (see Appendix A) collected during the afternoon peak hour (4:45-5:45 PM) in 2006 are shown in Table 23 and Figure 19. These volumes were recorded in June and have been adjusted by a seasonal factor of 0.89 for all approaches and axle correction factors of 0.97 and 0.99 for the major and minor approaches respectively.

Table 23. 2006 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
NE-bound (High St)	36	102	65	203
SW-bound (High St)	15	111	32	158
NW-bound (Mill St)	45	90	12	147
SE-bound (Mill St)	18	94	16	128

Figure 19: 2006 PM peak turning movement volumes

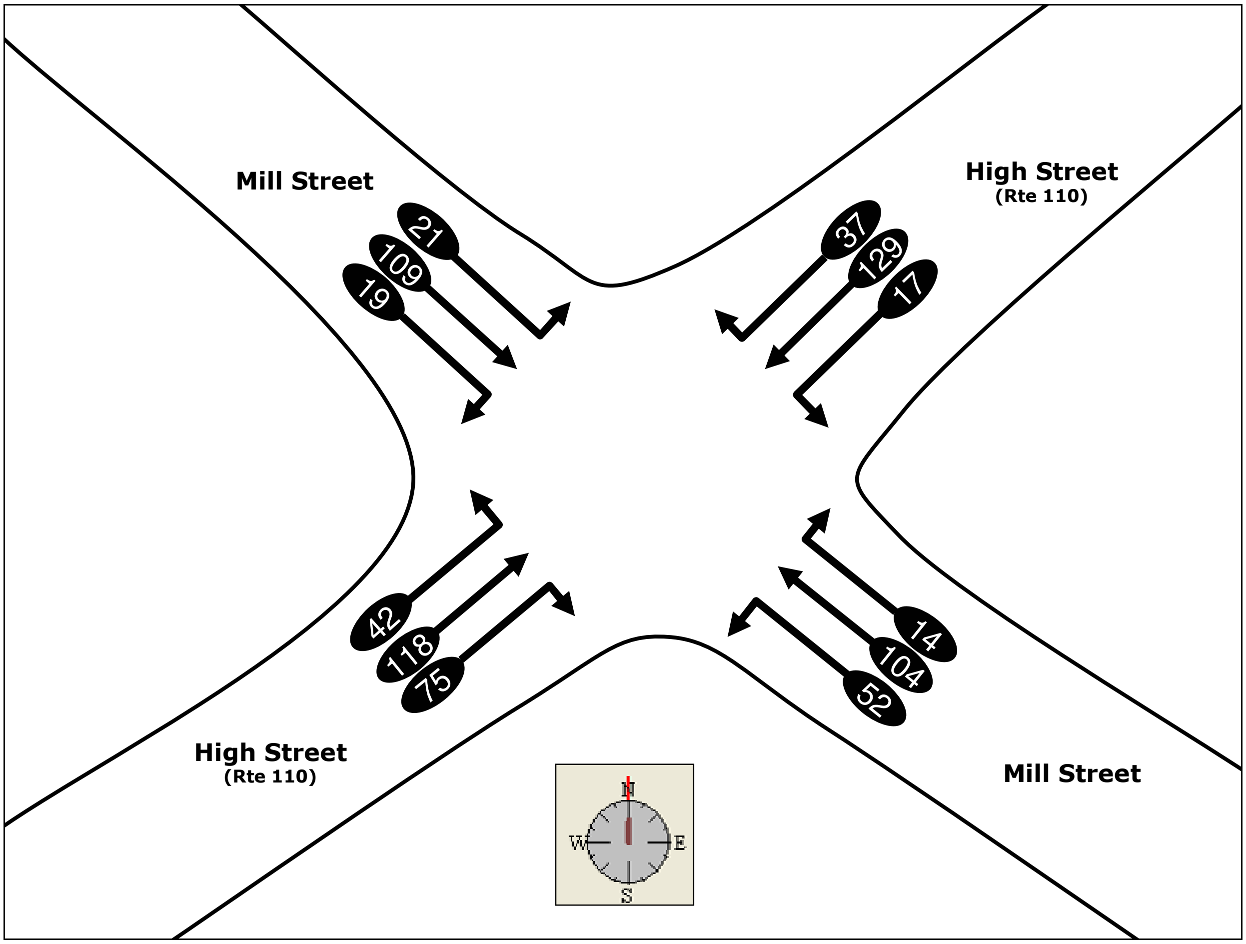


Based on expected traffic growth, the turning movement volumes predicted for the afternoon peak hour in 2015 are shown in Table 24 and Figure 20.

Table 24. Predicted 2015 PM peak turning movement volumes.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
NE-bound (High St)	42	118	75	235
SW-bound (High St)	17	129	37	183
NW-bound (Mill St)	52	104	14	170
SE-bound (Mill St)	21	109	19	149

Figure 20: Predicted 2015 PM peak turning movement volumes



During the afternoon peak hour, given the volumes shown in Table 23, both the major (High Street) approaches have an LOS of A; both the minor (Mill Street) approaches have an LOS of C. For the predicted traffic flow in 2015, the LOS for all approaches would remain the same. The results of the operational analyses are summarized in Table 25. See Appendix B for full LOS analyses.

Table 25. 2006 and 2015 AM peak LOS and control delay.

Approach	*LOS*		*Delay (seconds per vehicle)*	
	2006	*2015*	*2006*	*2015*
NE-bound (High St)	A	A	7.6	7.6
SW-bound (High St)	A	A	7.6	7.7
NW-bound (Mill St)	C	C	15.1	17.8
SE-bound (Mill St)	C	C	17.8	23.8

Safety Conditions

According to MHD crash data, the average number of crashes at this intersection during 2002-2004 was 3.33 per year, occurring at a rate of 1.12 crashes per million entering vehicles. This rate exceeds the MHD District 3 average unsignalized intersection crash rate of 0.79 crashes per million entering vehicles, which may indicate a safety problem. Further study of the safety conditions at this intersection should be undertaken. Five of the crashes occurred in a twelve-month period and are considered correctible by installation of a traffic signal. Of the three year total of ten crashes, seven were angle crashes. See Appendix C for crash data and full crash rate analyses.

Signal Warrant Analysis Results

Based on 2003-05 traffic data, this intersection does not meet any signal warrants. Since at least one satisfied warrant is required to warrant the installation of a traffic signal, a signal is not warranted at this intersection. See Appendix D for traffic data; see Appendix E for Signal Warrant Analysis results.

Improvement Alternatives

Traffic on the minor (Mill Street) approaches is predicted to suffer a slight increase in delay in 2015. See Appendix B for full LOS and control delay results for improvement alternatives.

Alternative: LOS C is usually considered acceptable. However, if an operational improvement is desired, one alternative would be to add a left-turn lane to each minor approach. This would reduce the delay slightly, but not enough to affect the LOS.

The analysis results are summarized in Table 26.

Table 26. 2015 AM peak LOS and control delay for improvement alternatives.

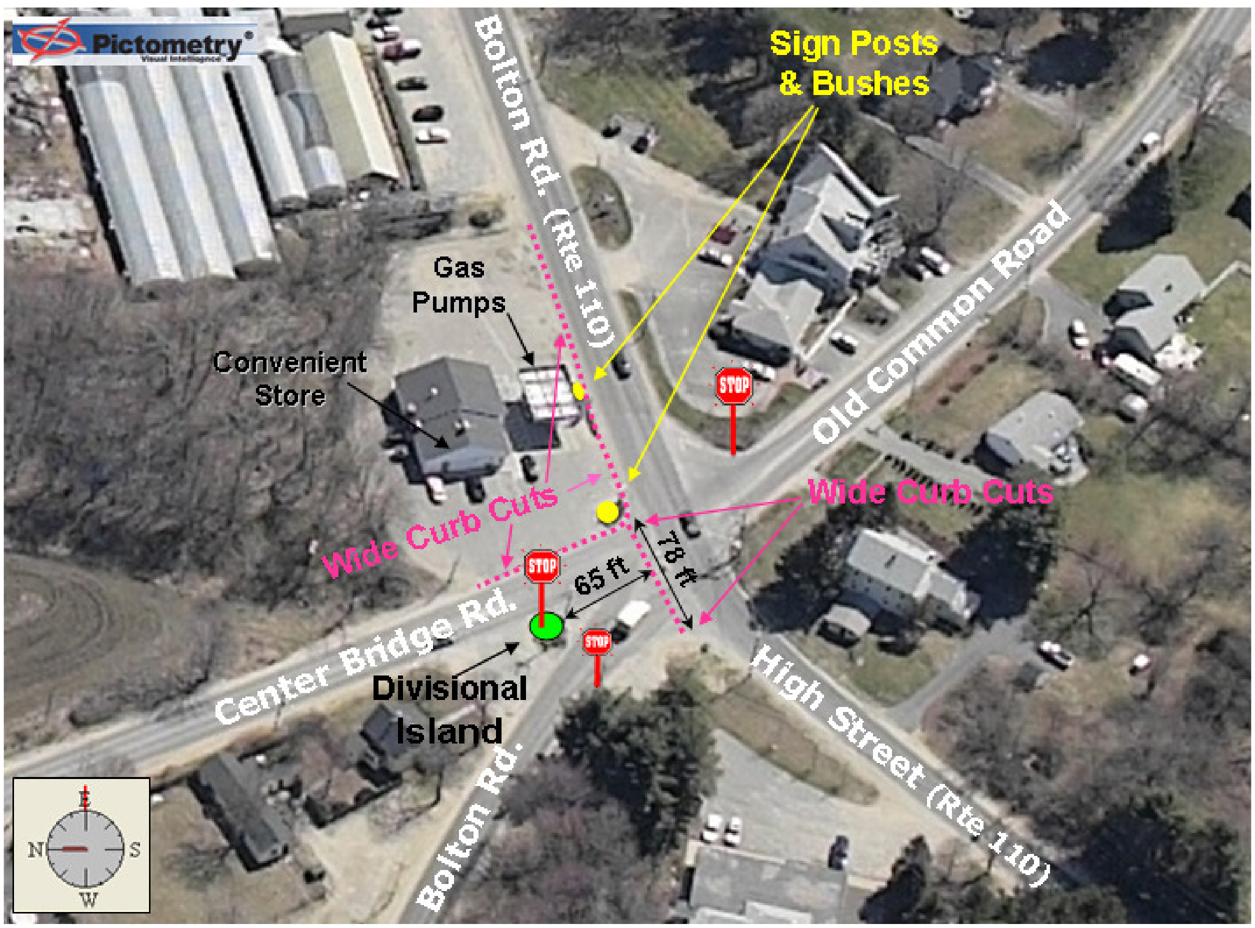
Approach	*LOS*		*Delay (seconds per vehicle)*	
	2015	*2015 Alt.*	*2015*	*2015 Alt.*
NE-bound (High St)	A	A	7.6	7.6
SW-bound (High St)	A	A	7.7	7.7
NW-bound (Mill St)	C	C	17.8	16.0
SE-bound (Mill St)	C	C	23.8	17.1

7) <u>"Five Corners": Intersection of High Street Extension/Bolton Road (Route 110), Bolton Road (minor), Center Bridge Road, and Old Common Road</u>

High Street Extension/Bolton Road (Route 110) is the major road at this five-way intersection, a two-lane urban arterial comprising the northbound and southbound approaches. The minor approaches are Center Bridge Road (southeast-bound), an urban minor arterial; Bolton Road (eastbound), an urban arterial; and Old Common Road (westbound), an urban collector. All the minor streets have two lanes. The three minor approaches are stop-controlled, and the major approaches are uncontrolled.

This five-way intersection has many conflict points, particularly along the east and southeast-bound approaches, that cause considerable driver confusion. The approach width for both approaches is approximately seventy-eight feet, and the STOP signs for each street are set back from Route 110 approximately sixty-five feet. This creates an area of approximately 5,070 square feet in which, according to field observations, vehicles enter, exit, traverse and weave to reach their destination. The wide curb cuts for the convenience store parking lot also contribute to driver confusion. Figure 20 shows the intersection.

Figure 21: Five Corners



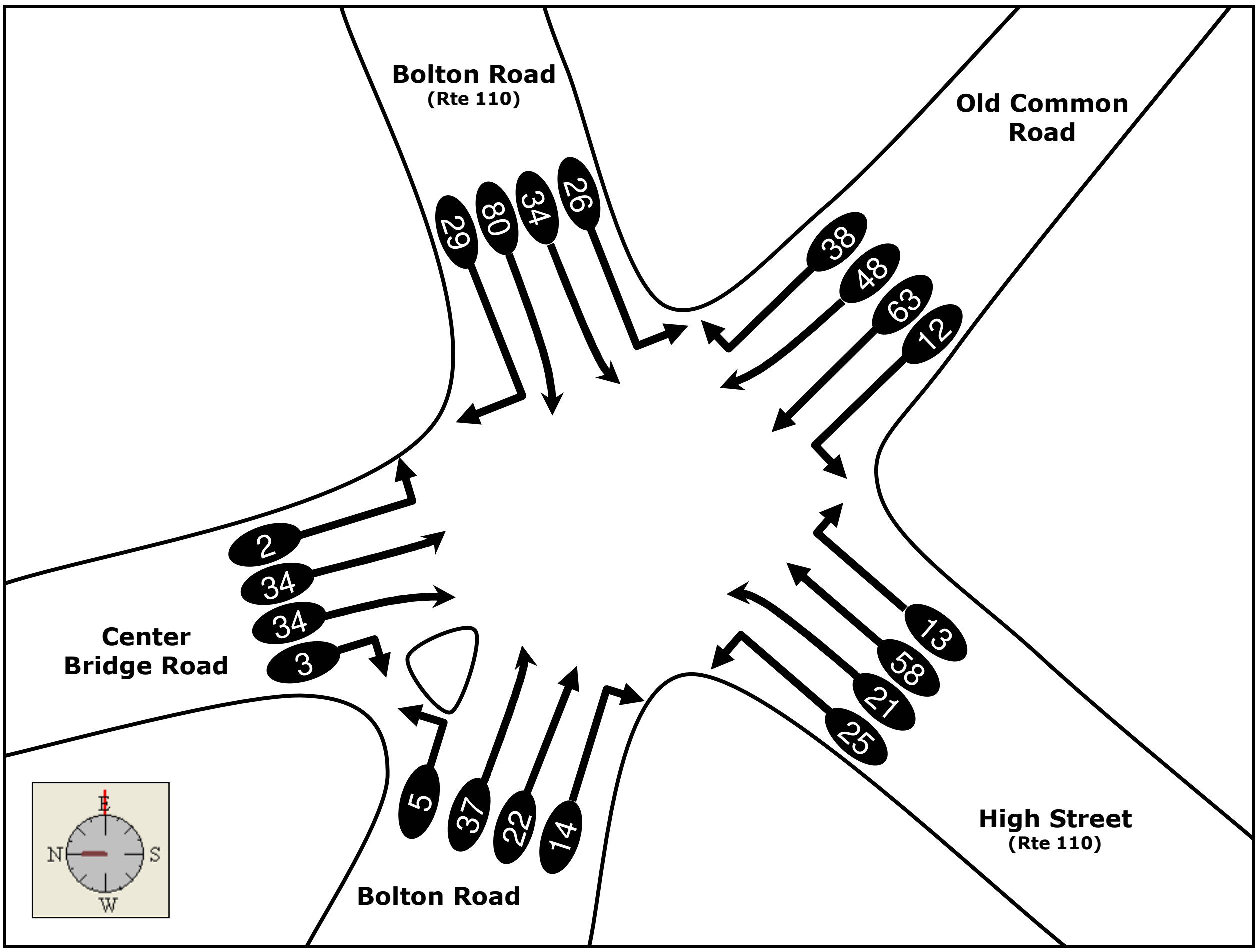
Operational Conditions

Turning movement volumes (see Appendix A) collected during the afternoon peak hour (5:00-6:00 PM) in 2006 are shown in Table 27 and Figure 22. These volumes were recorded in June and have been adjusted by a seasonal factor of 0.89 for all approaches and axle correction factors of 0.99 and 0.97 for the Old Common Road approach and all other approaches respectively.

Table 27. 2006 PM peak turning movement volumes.

Approach	*Hard Left*	*Bear Left*	*Through*	*Bear Right*	*Hard Right*	*Total*
Northbound (High St Ext)	25	21	58	13	n/a	117
Southbound (Bolton Rd)	29	80	n/a	34	26	169
SE-bound (Center Bridge Rd)	2	34	n/a	34	3	73
Eastbound (Bolton Rd)	5	37	22	n/a	14	78
Westbound (Old Common Rd)	n/a	12	63	48	38	161

Figure 22: 2006 PM peak turning movement volumes

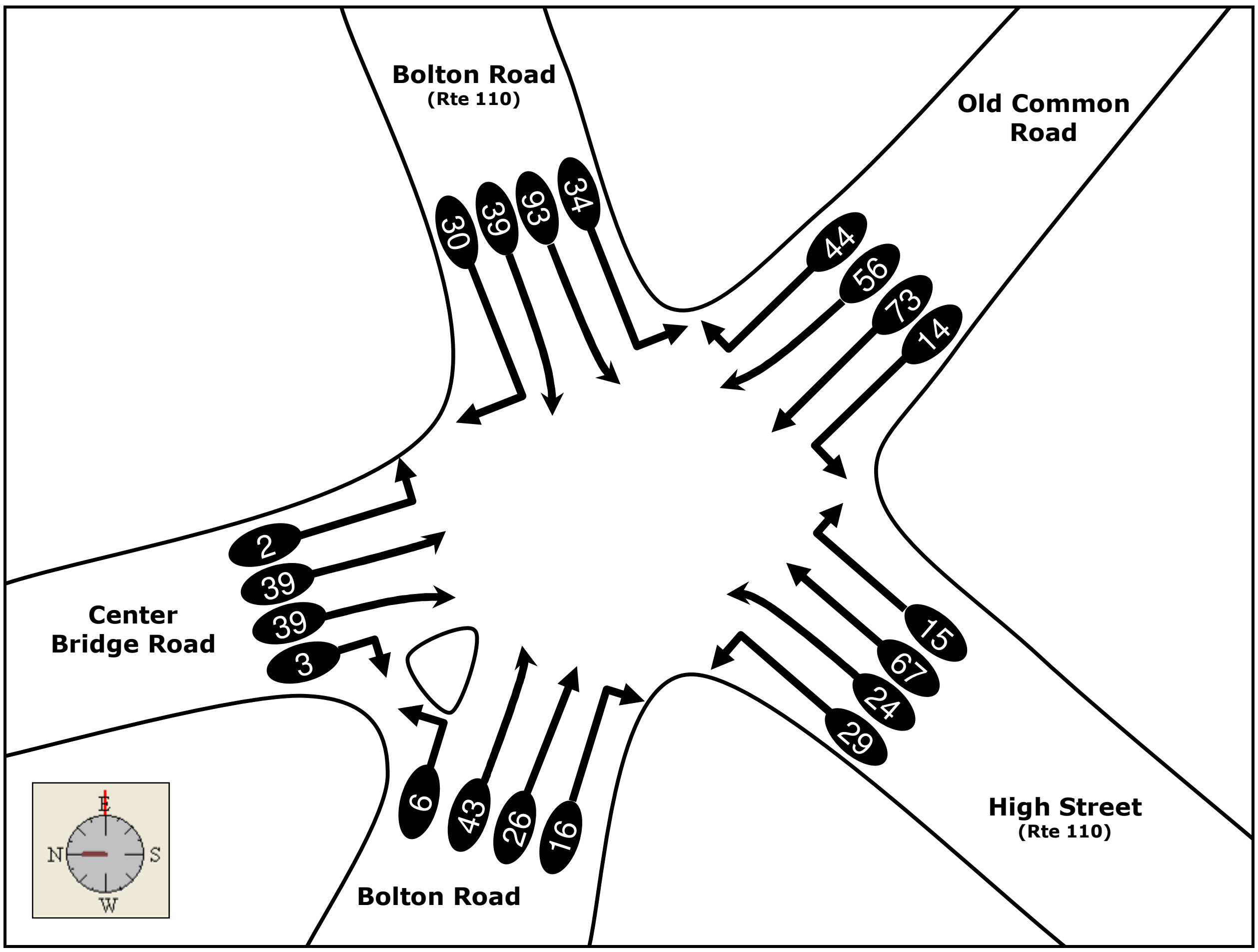


Based on expected traffic growth, the turning movement volumes predicted for the afternoon peak hour in 2015 are shown in Table 28 and Figure 23.

Table 28. Predicted 2015 PM peak turning movement volumes.

Approach	*Hard Left*	*Bear Left*	*Through*	*Bear Right*	*Hard Right*	*Total*
Northbound (High St Ext)	29	24	67	15	n/a	135
Southbound (Bolton Rd)	34	93	n/a	39	30	196
SE-bound (Center Bridge Rd)	2	39	n/a	39	3	83
Eastbound (Bolton Rd)	6	43	26	n/a	16	91
Westbound (Old Common Rd)	n/a	14	73	56	44	187

Figure 23: Predicted 2015 PM peak turning movement volumes



The LOS analysis methodology is not designed for a five-way intersection, so the results obtained may not be an accurate representation of the true conditions. For the purpose of the analyses, the southeast-bound and eastbound approaches were combined into one eastbound approach. This resulted in the turning movement volumes shown in Table 29 and 30 for 2006 and 2015, respectively.

Table 29. 2006 PM peak turning movement volumes for LOS analyses.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (High St Ext)	46	58	13	117
Southbound (Bolton Rd)	26	80	59	165
Eastbound (Center Bridge/Bolton Rds)	39	56	47	142
Westbound (Old Common Rd)	12	112	38	162

Table 30. 2015 PM peak turning movement volumes for LOS analyses.

Approach	*Left Turn*	*Through*	*Right Turn*	*Total*
Northbound (High St Ext)	53	68	15	136
Southbound (Bolton Rd)	30	93	69	192
Eastbound (Center Bridge/Bolton Rds)	45	65	55	165
Westbound (Old Common Rd)	14	129	44	187

As a four-approach, two-way-stop intersection, during the 2006 afternoon peak hour, the left-turning vehicles on both major approaches (Route 110) have an LOS of A; the minor approaches have an LOS of B. For the predicted traffic flow in 2015, the LOS for the major approaches would remain the same, and the LOS for the minor approaches would drop to C due to a slight increase in delay. The LOS analysis results are summarized in Table 31. See Appendix B for full LOS analyses.

Table 31. 2006 and 2015 PM peak LOS and control delay.

Approach	*LOS*		*Delay (seconds per vehicle)*	
	2006	*2015*	*2006*	*2015 & Alt 1*
Northbound (High St Ext)	A	A	7.6	7.6
Southbound (Bolton Rd)	A	A	7.4	7.4
Eastbound (Center Bridge/Bolton Rds)	B	C	14.0	16.5
Westbound (Old Common Rd)	B	C	14.2	16.4

Safety Conditions

According to MHD crash data, the average number of crashes at this intersection during 2002-2004 was 3.67 per year, occurring at a rate of 1.32 crashes per million entering vehicles. This rate well exceeds the MHD District 3 average unsignalized intersection crash rate of 0.79 crashes per million entering vehicles, which may indicate a safety problem. Further study of the safety conditions at this intersection should be undertaken. Five of the crashes occurred in a twelve-month period and are considered correctible by installation of a traffic signal. Of the three-year total of eleven crashes, seven were angle crashes. See Appendix C for crash data and full crash rate analyses. Signposts and bushes in the area in front of the convenient store along Route 110 appear to limit sight distance at the intersection.

Signal Warrant Analysis Results

Based on 2002-05 traffic data, this intersection does not meet any signal warrants. Since at least one satisfied warrant is required to warrant the installation of a traffic signal, a signal is not warranted at this intersection. See Appendix D for traffic data; see Appendix E for Signal Warrant Analysis results.

Improvement Alternatives

Although the analyses do not reveal any operational problems at this intersection, the observed driver behavior on the eastbound and southeast-bound approaches and the high crash rate suggest one or more safety problems. Also, five-way intersections are not recommended due to the many conflict points and potential for driver confusion. Two alternatives are discussed here, both likely to be much safer than a five-way intersection. See Appendix B for full LOS and control delay results for improvement alternatives.

Alternative 1 is to change the five-way intersection to a four-way intersection by realigning the Center Bridge and Bolton Road approaches so that they intersect to the west of this intersection. This alternative is essentially what was analyzed as the current and future no-build scenarios. Figure 24 shows a proposed realignment of the intersection.

Figure 24: Alternative 1 Improvement

Alternative 2 is to change this intersection into a roundabout. A modern roundabout consists of a central island, one or more lanes circulating around the island, and entry/exit points with triangular islands to direct the traffic. Vehicles enter and exit the roundabout by turning right at slow speeds (i.e., 25 mph or less), and entering traffic yields to circulating traffic. Good roundabout design includes deflection, speed reduction and speed consistency, which contribute to safer merging, easier navigation of the intersection, less frequent and less severe collisions, and greater safety for pedestrians. Roundabouts also require less maintenance and longer service life than traffic signals, and they provide an opportunity for attractive landscaping.

At this intersection, a roundabout would reduce the traffic conflicts. LOS criteria have not been established for roundabouts, but another measure is the ratio of existing volume to theoretical capacity, v/c. The v/c values for the approaches range from 0.13 to 0.23, so the roundabout would be well below capacity and probably provide low delay to entering vehicles.

Much more information about the costs and benefits of roundabouts can be found in *Roundabouts: An Informational Guide*, a Federal Highway Administration publication that is available at www.tfhrc.gov/safety/00068.htm.

Conclusions & Recommendations

To improve the traffic flow and safety conditions in the area of interest, the following improvements are recommended:

- Install a traffic signal at the intersection of Lunenburg Road and Old Union Turnpike. The addition of a left-turn lane on the northbound approach would further improve traffic operations.

- Install traffic signals at the intersections of Main Street with Lunenburg Road and Seven Bridge Road, coordinated for best traffic flow along Main Street. The addition of a southbound left-turn lane on Lunenburg Road would further improve the traffic operations. If a traffic signal is not feasible at Lunenburg Road, add a southbound left-turn lane alone.

- At the intersection of Main Street and Mill Street, add a left-turn lane on the westbound approach of Mill Street or install a traffic signal.

- Change the "Five Corners" intersection to either a four-way intersection or a roundabout. Realigning the Center Bridge and Bolton Road approaches so that they intersect west of the subject intersection would make Five Corners a less complex four-way, two-way stop-controlled intersection, reducing the number of conflict points and potential for driver confusion. A roundabout would eliminate most of the conflict points entirely. Either alternative would increase the safety of the intersection and possibly improve its operation.

- For all traffic signals that are installed, consideration should be given to actuation and coordination to improve traffic flow.

At the intersection of High Street and Mill Street, no operational improvements are recommended. No improvement is recommended at the intersection of Main Street and Sterling Road; a traffic signal is warranted and would improve the LOS of the Sterling Road approach, but it would have little effect on control delay.

Next Steps: Project Development

Appendix G: Project Development Process provides the next steps that the Town must take if the Town decides to seek state or federal funds to pay for roadway projects. Please contact the MRPC if you have any questions.

Appendix A

Turning Movement Counts

Appendix B

Level of Service Analysis

Appendix C

Intersection Crash Tables and Crash Rate Analysis

Appendix D

Traffic Volume Counts

Appendix E

Signal Warrants Summaries

Appendix F

MUTCD Traffic Control Signal Needs Studies

<u>Appendix G</u>

Project Development Process