Functional Design Report

Main Street (Rte. 30) at Marlboro/Cordaville Roads (Rte. 85) Transportation Improvements

Southborough,
Massachusetts

Prepared for **Town of Southborough**
147 Cordaville Road
Southborough, MA 01772

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May 2011

Table of Contents

List of Tables

List of Figures

1

Introduction

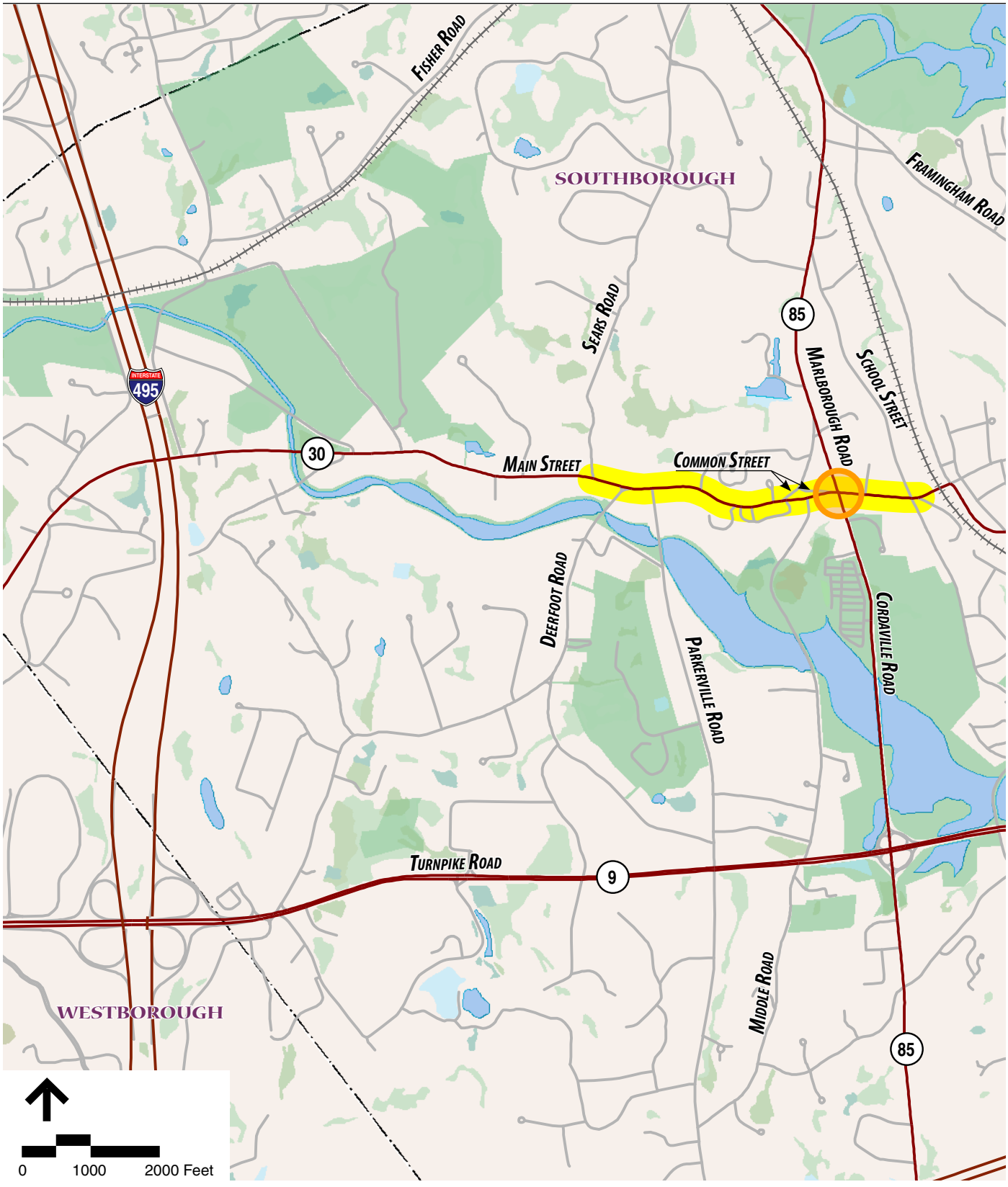
Vanasse Hangen Brustlin, Inc. (VHB) has been retained by the Town of Southborough, Massachusetts to define and prepare plans for roadway and traffic signal improvements along the Main Street (Route 30) corridor in stretching from Sears Road to Park Street. Improvements along the corridor include widening and drainage improvements and intersection improvements at Route 85. The improvements at the intersection include installation of a traffic signal system, geometry improvements, and pedestrian accommodations.

This Functional Design Report (FDR) satisfies part of the 25 percent design stage requirements of the Massachusetts Department of Transportation (MassDOT). It contains a summary of traffic volumes, crash data, roadway geometry, traffic signal warrants, and intersection analyses. Recommendations for roadway and traffic control improvements at the study location are based on the analyses findings. Figure 1-1 identifies the study intersection and project area.

Project Description

To improve traffic operations at the project intersection, roadway and traffic control improvements have progressed to this 25 percent design stage. These improvements include:

- Install fully actuated traffic signal system;
- Widen Main Street (Route 30);
- Realign Common Street at its eastern intersection with Main Street;
- Upgrade pedestrian accommodations to meet current standards; and
- Provide bicycle accommodations.



PROJECT AREA

STUDY INTERSECTION

Vanasse Hangen Brustlin, Inc.

Project Location Map
Transportation Improvements
Main Street (Route 30)
Southborough, Massachusetts

Figure 1 -1

Project Scope

This FDR provides a brief summary and discussion of the needs, benefits, and issues relating to the proposed traffic/roadway control improvements for this intersection. The data profile sections provide a quick reference for existing and proposed intersection characteristics such as geometry and roadway operating conditions. A summary of analyses findings is also provided as a measure of the effectiveness of the proposed improvements. Appendix A provides the methodology used to evaluate traffic flow performance. Appendix B provides complete supporting information relating to the existing conditions data, signal warrant analyses, and capacity analysis worksheets for the study intersection.

Analysis Criteria

MassDOT's review process requires an FDR to be prepared to evaluate the following design conditions:

- 2011 Existing Traffic Volumes with Existing Geometry;
- 2021 Projected Traffic Volumes with Existing Geometry; and
- 2021 Projected Traffic Volumes with Proposed Geometry.

The term "Geometry" represents all traffic control measures including physical roadway geometry and traffic signals. A projected ten-year (2021) design condition is used as a measure of continued effectiveness of the proposed improvements.

Traffic Volumes

Traffic counts were collected at the intersection manually and electronically by Precision Data Industries, Inc., of Berlin, Massachusetts. Manual turning movements counts (TMCs) were collected on April 14, 2009 from 7:00 AM – 9:00 AM and 4:00 PM – 6:00 PM. These hours represent typically weekday peak commuting periods and were used to establish existing and proposed traffic signal operations.

In addition to the TMCs, Automatic Traffic Recorder counts (ATRs) were conducted during the month of April 2009 for a 24-hour period along each of the approaches to the intersection. These counts included volume and speed information and were used to confirm daily traffic volumes along the roadways and to conduct traffic signal warrant analysis for the intersection.

TMCs and ATRs are located in Appendix B.

Seasonal Variation

The 2007 MassDOT Weekday Seasonal Factors indicate traffic volumes in April are above average annual traffic for Urban Minor Arterials. A review of the count data available from MassDOT indicates there are no permanent count stations on Route 30 or Route 85. The nearest count station with monthly comparisons, besides those located on interstate highways, is located on Route 9 in Westborough. The data for this count station also indicates that traffic volumes during the month of April are higher than the annual average. To provide a conservative analysis, no seasonal adjustment was made to the traffic counts.

Historic Traffic Growth

Traffic volumes collected in April 2009 were compared to traffic volumes collected in October 2007 at the study intersection. This exercise indicated a slight decrease in the overall traffic volumes at the intersection over those two years. However, there are a number of ongoing or planned projects on Route 9 to the south of the study intersection. The majority of the traffic from the Route 9 sites will use Route 9, Interstate 495 and Interstate 90, but there will be small impacts on the Route 85 corridor. Therefore, to accommodate future general growth and the impacts of projects on Route 9, and to provide a conservative analysis, a growth rate of 1.5% was used to predict future traffic volumes through the study intersection.

2011 Base Year Traffic Volumes

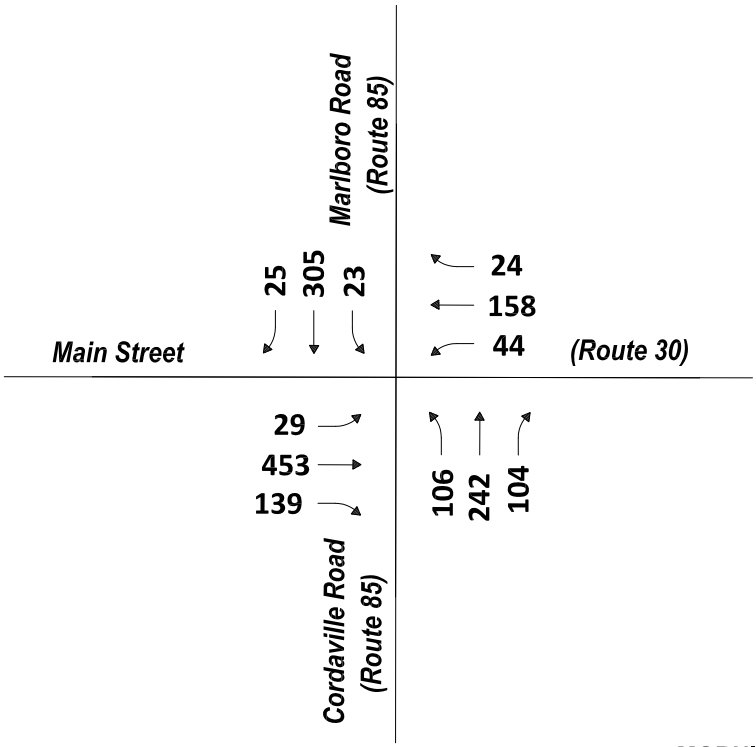
The traffic volume counts collected in April 2009 were increase by 1.5% per year to reflect current 2011 conditions. 2011 existing volumes are shown in Figure 1-2 for the weekday morning and weekday evening peak periods.

Project Generated Trips

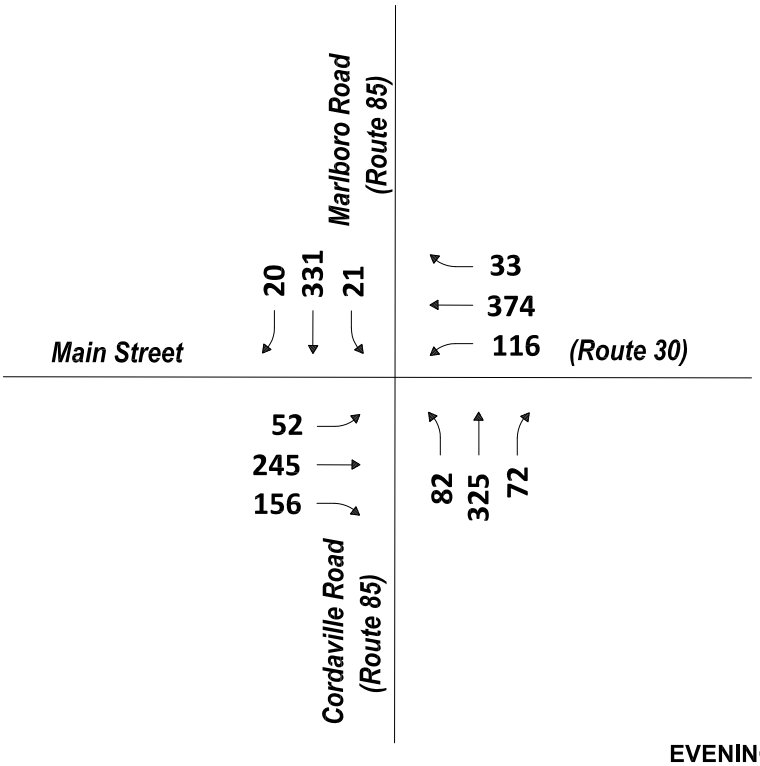
This is a traffic operations and roadway improvement project. There are no project-specific generated trips.

Design Year Traffic Volumes

The 2011 based year volumes were increased by 1.5% per year for ten years to determine the 2021 design year volumes. This growth rate is based on the Historic Traffic Growth discussed above. The 2021 volumes are shown in Figure 1-3 for the weekday morning and weekday evening peak periods.



MORNING PEAK HOUR



EVENING PEAK HOUR

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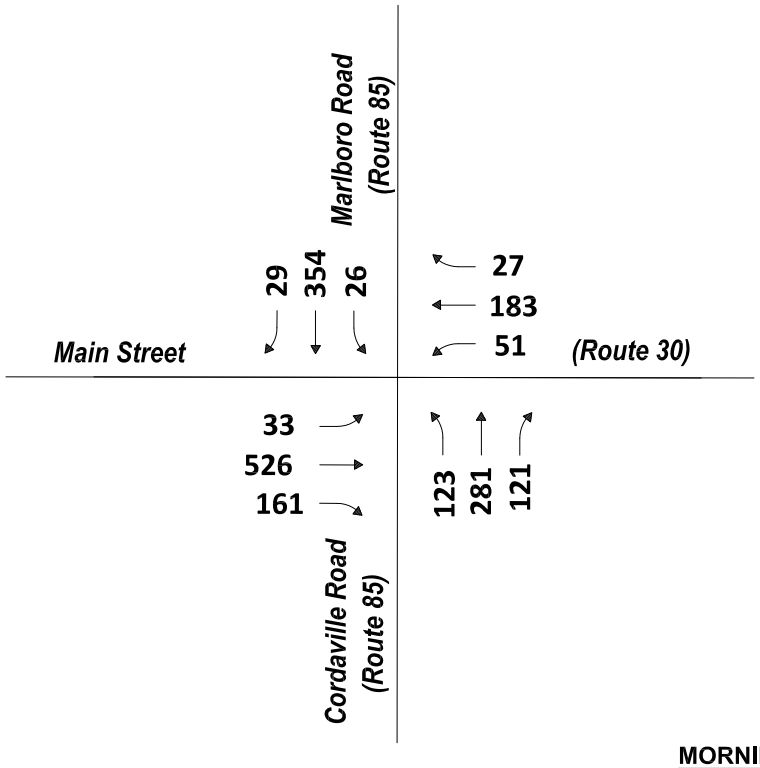
2011 Existing Conditions
Weekday Morning & Evening
Peak Hour Traffic Volumes

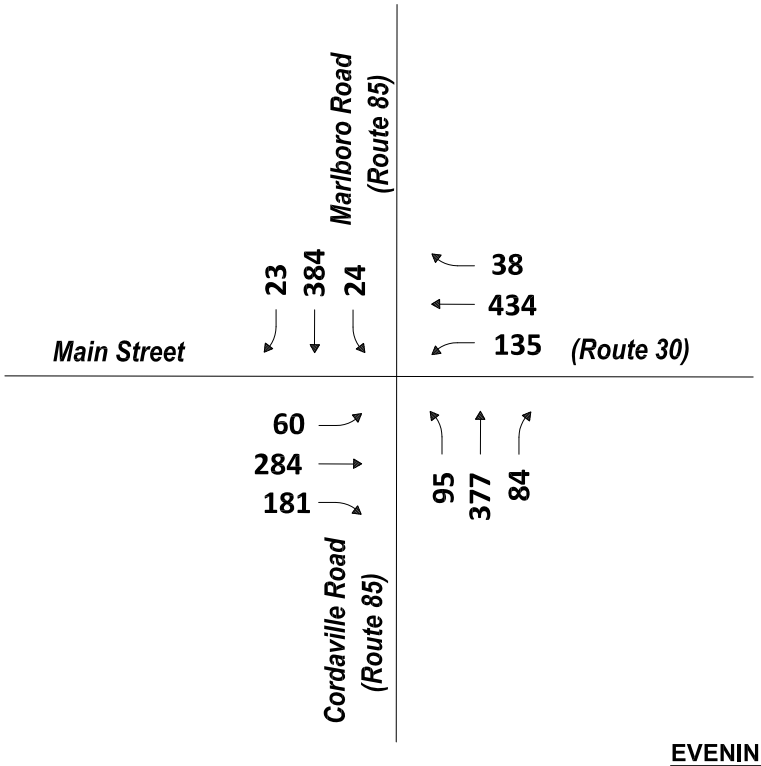
Figure 1-2

Not to Scale

Main Street at Marlboro Road/Cordaville Road
Southborough, Massachusetts



MORNING PEAK HOUR



EVENING PEAK HOUR

Vanasse Hangen Brustlin, Inc.

2021 Future Conditions
Weekday Morning & Evening
Peak Hour Traffic Volumes

Figure 1-3

Not to Scale

Main Street at Marlboro Road/Cordaville Road
Southborough, Massachusetts

Crash Data

To identify crash trends, VHB reviewed the most current crash data for the study area intersections utilizing data obtained from MassDOT files for the years 2006 through 2008. MassDOT receives crash information from the Massachusetts Registry of Motor Vehicles (RMV). Drivers must report crashes to the RMV that result in personal injury or more than $1,000 in property damage (including the vehicle(s) involved). Many minor motor vehicle crashes ("fender benders") do not cause substantial property damage, and therefore may not be reported. Table 1-2 summarizes the reported crashes. Raw crash data can be found in Appendix B.

It is worth noting that the study intersection is not included on the 2008 Top 200 Crash Locations list.

As the data in Table 1-2 indicates, rear-end collisions were the most common (6 of 12) type of vehicle crashes at this intersection. Rear-end collisions at signalized intersections are often caused by improper vehicle clearance intervals. Although only four of the twelve total crashes occurred during wet pavement conditions, three of those were also rear-end collisions. Half of the crashes occurred during weekday peak hours, while the other half occurred during the weekday off peak hours or the weekend. No fatalities were reported during the three-year study period, though five of the twelve accidents reported personal injury. There were no reported crashes that involved pedestrians or bicyclists.

The current official statewide crash rate is 0.82 for signalized intersections. District 3 (The MassDOT District designation for Southborough) average crash rate for signalized intersections is 0.93.

Using standard MassDOT formulas, a crash rate of 0.68, in the unit of crashes per million entering vehicles, calculated for the study intersection. This location is below both the State and District rates for signalized intersections. See Appendix B for calculations.

Table 1-1:
Study Intersection Crash Summary - 2006 through 2008

	Route 30 at Route 85
Year	
2006	4
2007	3
2008	5
Total	12
Collision Type	
Angle	1
Head-on	3
Rear-end	6
Sideswipe, opposite direction	1
Not reported	1
Total	12
Crash Severity	
Non-fatal injury	5
Property damage only (none injured)	5
Not Reported	1
Unknown	1
Total	12
Time of Day	
Weekday, 7:00 AM - 9:00 AM	5
Weekday, 4:00 PM - 6:00 PM	1
Saturday, 11:00 AM - 2:00 PM	1
Weekday, other time	4
Weekend, other time	1
Total	12
Pavement Conditions	
Dry	8
Wet	4
Total	12
Non Motorist (Bike, Pedestrian)	
Total	0
MassDOT Crash Rate	0.68

Source: MassDOT, compiled by VHB

Corridor Improvements

This project includes improvements beyond the signalized intersection. The improvements consist of pavement widening and profile adjustments on Main Street (Route 30) from Sears Road to the west of the intersection to just past Park Street to the east of the intersection. The project will include widening to accommodate a minimum 30-foot cross section (11-foot travel lanes with 4-foot shoulders). New sidewalks are proposed along the south side of Route 30 between the existing sidewalk (which ends in the vicinity of the Fay School) and Sears Road. New sidewalks are also proposed along the east side of Cordaville Road between Route 30 and the project limits (approximately 300 feet south of the signalized intersection).

Significant consideration was given to the proposed alignment of Main Street, particularly in the area adjacent to the Town Common. The project is expected to result in the relocation/rebuilding of between 700 and 800 linear feet of existing stonewalls including the historic wall along the Town Common. Widening in the vicinity of the common is to accommodate on-street parking and improve accessibility for emergency response vehicles. The wall along the Town Common is proposed to be relocated approximately 2-feet to the north for its entire length to accommodate the necessary widening.

The roadway improvements will not result in any impact to wetland resource areas or open space. Construction near the intersection of Main Street and Parkerville Road is located within wetland buffer zones. The improvements are intended to enhance pedestrian safety and provide for a safer environment for bicyclists. While this project will result in a uniform roadway and therefore increase pavement widths, reset catch basins will be equipped with hoods and sediment sumps to provide for improved stormwater quality overall. The Project will not result in adverse impact to the environment.

Improving the streetscape and landscape quality along the Main Street corridor has included substantial outreach with the Town and coordination with the private landowners lining both sides of the Main Street right-of-way. Working with abutters can help the city to provide landscape strips to establish mature shade trees and other plantings.

Traffic Performance Measures

Level of service (LOS) is the term used to denote the different operating conditions that occur on a given roadway segment under various traffic volume loading. It is a qualitative measurement of the effect of a number of factors, including roadway geometry, speed, travel delay, freedom to maneuver, and safety. LOS provides an index to the operational qualities of a roadway segment or an intersection with letter designations ranging from A to F. LOS A represents the best operating condition, and LOS F represents the worst operating condition.

The level-of-service designation is reported slightly differently for signalized and unsignalized intersections. For signalized intersections, the analysis considers the operations of all traffic entering the intersection and the LOS designation is for the overall operations at the intersection. For unsignalized intersections, the analysis assumes that the traffic on the mainline is not affected by traffic on the side streets. Therefore, LOS designations are determined for the critical movements at the intersection, which are typically the turning movements. The evaluation criteria used to analyze the study intersection are based on the Highway Capacity Manual[1] and described more fully in Appendix A of this report.

1 Highway Capacity Manual 2000: Transportation Research Board, Washington, D.C., 2000.

2

Main Street (Route 30) at Marlboro Road/Cordaville Road (Route 85)

Route 85 intersects Main Street (Route 30) from the north and the south. Route 85 is known as Marlboro Road to the north of Route 30, and as Cordaville Road to the south of Route 30. Within the study area, all roadways are classified as Urban Minor Arterials and are under Town of Southborough jurisdiction.

Each approach to the intersection provides one general purpose lane. Also, each approach is posted at 25 MPH approaching the intersection.

The existing traffic signal system at the intersection operates pre-timed with two vehicle phases and an exclusive pedestrian phase.

Sidewalks are present on both sides of Main Street and on the west side of Cordaville Road. There are no sidewalks on Marlboro Road. Crosswalks are provided across each approach, except for the Main Street westbound approach.

There are a variety of land uses in the area of the intersection. The Town of Southborough Fire Station and Police Station are located approximately 300 feet to the east on Main Street and the Town of Southborough Public Library is located on the northwest corner of the intersection. Saint Marks Church is located to the west of the intersection on Main Street, and Saint Mark's School is located on Marlboro Road approximately 900 feet to the north of the intersection. Saint Mark's School is a private boarding and day school for grades nine through twelve. The Fay School is located on Main Street, approximately 700 feet to the west of the intersection. The Fay School is a private boarding and day school for pre-kindergarten through grade nine. The Town Common is also located just to the west of the intersection. The Albert S. Woodward Memorial School, a public elementary school, is located approximately 400 feet south of the intersection on Cordaville Road. There are also residential and commercial uses in the area.

Common Street borders the Town Common on two sides and therefore intersects Main Street from the northwest approximately 120 feet to the west of the study intersection and again an additional 500 feet west of the intersection. Common Street provides two-way travel and is unsignalized.

Summary of Proposed Improvements

In order to better accommodate existing and future traffic volumes through the study intersection, and to provide efficient traffic operation, roadway and traffic control improvements will be necessary. Under 2011 existing conditions, the intersection experiences a LOS C (v/c = 0.87) during the morning peak period, and LOS C (v/c = 0.89) during the evening peak period. In the absence of any improvements, the intersection delay is expected to further increase, especially during peak hours as traffic volumes increase at this intersection.

In addition, this intersection continues to satisfy the 2003 Manual on Uniform Traffic Control Devices (MUTCD) criteria for warranting a traffic signal.

Proposed Geometric Changes

Proposed improvements at this intersection are detailed in the 25 percent design plans prepared with this FDR. These geometric improvements are as follows:

- Widen each approach to provide a dedicated left turn lane and a shared through-right lane;
- Reconstruct stone walls were necessary;
- Realign Common Street to intersect Main Street approximately 80 feet further to the west. Also, restrict Common Street to one-way operation, in the westbound direction.

Proposed Traffic Control Improvements

Improvements to traffic control will be necessary to accommodate future traffic volumes, and to provide efficient traffic operation at this intersection. These traffic control improvements are as follows:

- Install a fully actuated traffic signal system with appropriate timing and phasing for peak hour volume requirements to control all movements;
- Provide a protected lead phases for Main Street westbound and Cordaville Road northbound;
- Provide an exclusive pedestrian phase with countdown pedestrian timers and audible pedestrian devices;
- Provide vehicle and bicycle detection on all approaches;
- Provide emergency vehicle pre-emption on all approaches;

- Upgrade existing signs and pavement markings to meet with the proposed design;
- Retain existing right turn on red restriction on Cordaville Road northbound;
- Provide emergency traffic signal control at the Public Safety Complex Driveway with hardwire pre-emption to the fire station and the intersection of Route 30 and Route 85.

Environmental

There are no environmental impacts related to the construction of the signalized intersection. The project area is located within the Historic District and the proposed cross section will require the stone retaining walls located in the southeast and southwest corners of the intersection to be removed and reset.

Right-of-Way

Right-of-way alterations will be required on each corner of the intersection to accommodate the proposed lane configuration and provide curb radii that can accommodate fire trucks and tow trucks.

Issues

The Town of Southborough will maintain ownership of the intersection.

Data Profile and Existing/Proposed Comparison

2009 Average Daily Traffic (ADT)

Automatic Traffic Recorder (ATR) counts taken in April 2009 indicate the average daily traffic volumes shown in Table 2-1.

Table 2-1:
Main Street at Marlboro Road/Cordaville Road 2009 ADT

Roadway	Weekday Traffic Volume (vpd)
Main Street (east of Route 85)	8,215
Main Street (west of Route 85)	7,693
Marlboro Road (north of Main Street)	7,245
Cordaville Road (south of Main Street)	11,157

Source: Automatic Traffic Recorder counts collected April 2009.
vpd = vehicles per day

Geometric Conditions

Table 2-2 illustrates the differences between existing and proposed geometric conditions for the intersection of Main Street at Marlboro Road/Cordaville Road;

Table 2-2:
Main Street at Marlboro Road/Cordaville Road Geometric Conditions

	Existing Geometry		Proposed Geometry	
Approach	Movement	Number of Lanes	Movement	Number of Lanes
Main Street (EB)	LT-TH-RT	1	LT TH-RT	1 1
Main Street (WB)	LT-TH-RT	1	LT TH-RT	1 1
Cordaville Road (NB)	LT-TH-RT	1	LT TH-RT	1 1
Marlboro Road (SB)	LT-TH-RT	1	LT TH-RT	1 1

Speed

Main Street is posted at 25 MPH on both the eastbound and westbound approach to the intersection. Marlboro Road and Cordaville Road are both also posted at 25 MPH.

The ATR collected on Main Street to the west of Route 85 also included speed data. The ATR indicates that the 85th percentile speed for traffic in the eastbound direction (approaching Route 85) was 24 MPH and the 85th percentile speed for traffic in the westbound direction (departing the intersection) was 29 MPH.

Special Speed Regulation No. 6037 applies to the sections of Route 30 and Route 85 that are owned by the Town of Southborough, which includes the entire study area for this project. According to the speed regulation, a speed limit of 25 MPH applies to both directions of Route 30 from 0.4 miles to the west of the intersection to 0.2 miles to the east of Route 85 (i.e. from the western most driveway to the Fay School to School Street). To the west of the 25 MPH zone, the speed regulation specifies 30 MPH. To the east of the 25 MPH zone, the speed regulation specifies 20 MPH.

According to the speed regulation, the speed limit of 25 MPH applies to both directions on Route 85 from approximately 500 feet south of Route 30 to approximately 425 feet north of Route 30 (i.e. from just south of the Woodward Memorial School driveway to just north of the northern Town of Southborough Public Library driveway). A speed limit of 40 MPH applies to the north and to the south of the 25 MPH zone outside the limits of this project.

A copy of Special Speed Regulation No 6037 is included in Appendix B.

Recent Crash History

As shown in Table 2-4, 12 crashes were reported at this location over the three-year period. Using standard MassDOT formulas, a crash rate of 0.68 crashes per million entering vehicles was calculated.

Table 2-4:
Main Street at Marlboro Road/Cordaville Road Crash History

Year	Months	Total
2006	(January through December)	4
2007	(January through December)	3
2008	(January through December)	5
	Total:	12

Crash Rate worksheets and raw crash data are included in Appendix B.

Signal Warranting Condition

The intersection is currently signalized. With existing volumes and geometry, thresholds for Warrants #1 (Eight Hour Volume) #2(Four Hour Volume) and #3(Peak Hour Volume) are met. Under proposed conditions, thresholds for Warrants #1 (Eight Hour Volume) #2(Four Hour Volume) and #3(Peak Hour Volume) are also met. The analysis used in the signal warrants evaluation is included in Appendix B.

Capacity Analysis Summary

Table 2-5 summarizes the capacity analysis for the study intersection for the three scenarios described on page 3 of this report. An exclusive pedestrian phase is proposed at the intersection, however the phase was not included in any of the analysis scenarios. A review of the pedestrian volumes collected during the TMC indicates that there is very little pedestrian volume during the morning peak hours. Pedestrian volumes are slightly higher during the evening peak hours, but the pedestrians appear to arrive in groups, thus limiting the number of pedestrian actuations to the traffic signal.

The analysis results indicate that while delays are acceptable under 2011 conditions, as traffic volumes increase there will be a significant increase in delay as the intersection capacity is surpassed. The addition of left turn lanes and vehicle detection allows the intersection to operate with acceptable delays into the future.

Table 2-6 summarizes the queue lengths for the study intersection for the three scenarios described on page 3 of this report. There are long queues in the 2011 condition that will continue to grow in the 2021 scenario with the existing geometry. The table indicates that the proposed improvements will reduce the expected queue lengths.

Capacity analysis worksheets are in Appendix B.

Table 2-5: Capacity Analysis

	2011 Existing Volumes/ Existing Geometry			2021 Future Volumes/ Existing Geometry			2021 Future Volumes/ Proposed Geometry		
	V/C[1]	Delay[2]	LOS[3]	V/C	Delay	LOS	V/C	Delay	LOS
Weekday Morning									
Main Street (EB)									
Left-Through-Right	0.87	29.1	C	1.01	53.5	D	-	-	-
Left	-	-	-	-	-	-	0.08	15.2	B
Through-Right	-	-	-	-	-	-	0.89	34.7	C
Main Street (WB)									
Left-Through-Right	0.37	13.5	B	0.46	14.9	B	-	-	-
Left	-	-	-	-	-	-	0.37	19.0	B
Through-Right	-	-	-	-	-	-	0.24	11.2	B
Cordaville Road (NB)									
Left-Through-Right	0.86	32.8	C	1.09	82.9	F	-	-	-
Left	-	-	-	-	-	-	0.77	39.0	D
Through- Right	-	-	-	-	-	-	0.61	23.1	C
Marlboro Road (SB)									
Left-Through-Right	0.52	16.0	B	0.61	17.6	B	-	-	-
Left	-	-	-	-	-	-	0.18	24.3	C
Through-Right	-	-	-	-	-	-	0.84	40.7	D
Overall	**0.87**	**24.8**	**C**	**1.05**	**47.6**	**D**	**0.79**	**30.3**	**C**
Weekday Evening									
Main Street (EB)									
Left-Through-Right	0.70	20.3	C	0.84	28.4	C	-	-	-
Left	-	-	-	-	-	-	0.34	17.9	B
Through-Right	-	-	-	-	-	-	0.79	27.5	C
Main Street (WB)									
Left-Through-Right	0.94	39.2	D	1.18	114.9	F	-	-	-
Left	-	-	-	-	-	-	0.71	24.0	C
Through-Right	-	-	-	-	-	-	0.62	14.9	B
Cordaville Road (NB)									
Left-Through-Right	0.84	28.9	C	1.02	60.0	E	-	-	-
Left	-	-	-	-	-	-	0.46	15.2	B
Through- Right	-	-	-	-	-	-	0.63	16.2	B
Marlboro Road (SB)									
Left-Through-Right	0.44	14.7	B	0.51	15.8	B	-	-	-
Left	-	-	-	-	-	-	0.13	17.7	B
Through-Right	-	-	-	-	-	-	0.73	25.4	C
Overall	**0.89**	**27.4**	**C**	**1.10**	**61.4**	**E**	**0.72**	**20.4**	**C**

Source: Vanasse Hangen Brustlin, Inc.; based on TMC data collected April 2009

1 V/C -- Volume-to-Capacity ratio.

2 Average delay, expressed in seconds per vehicle.

3 LOS -- Level-of-Service.

Table 2-6: Queue Lengths

	2011 Existing Volumes/ Existing Geometry		2021 Future Volumes/ Existing Geometry		2021 Future Volumes/ Proposed Geometry	
	Average	95th	Average	95th	Average	95th
Weekday Morning						
Main Street (EB)						
Left-Through-Right	218	#421	~293	#526	-	-
Left	-	-	-	-	13	32
Through-Right	-	-	-	-	401	#621
Main Street (WB)						
Left-Through-Right	63	107	77	130	-	-
Left	-	-	-	-	17	34
Through-Right	-	-	-	-	71	108
Cordaville Road (NB)						
Left-Through-Right	169	#341	~261	#437	-	-
Left	-	-	-	-	58	#130
Through- Right	-	-	-	-	226	332
Marlboro Road (SB)						
Left-Through-Right	116	170	142	204	-	-
Left	-	-	-	-	15	38
Through-Right	-	-	-	-	282	#399
Weekday Evening						
Main Street (EB)						
Left-Through-Right	137	246	180	#370	-	-
Left	-	-	-	-	24	57
Through-Right	-	-	-	-	201	318
Main Street (WB)						
Left-Through-Right	230	#366	~368	#481	-	-
Left	-	-	-	-	44	72
Through-Right	-	-	-	-	192	249
Cordaville Road (NB)						
Left-Through-Right	188	#337	~259	#430	-	-
Left	-	-	-	-	30	63
Through- Right	-	-	-	-	189	294
Marlboro Road (SB)						
Left-Through-Right	99	165	120	195	-	-
Left	-	-	-	-	8	30
Through-Right	-	-	-	-	183	#340

Source: Vanasse Hangen Brustlin, Inc.; based on TMC data collected April 2009
Queue length shown in feet
95th percentile volume exceeds Capacity, queue may be longer
~ Volume exceeds capacity, queue is theoretically infinite

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Design Designation Data

Table 2-7 summarizes the average daily roadway usage characteristics of Main Street east of Route 85. These characteristics are:

- Average Daily Traffic (ADT), the total volume of motor vehicle traffic using the roadway on any given day for both existing and design years, expressed in vehicles per day (vpd). Design year is projected 20 years to ensure adequate pavement design;
- Peaking Factor (K), the percentage of daily traffic that occurs during the peak hour travel period;
- Directional Distribution (D), the highest percentage of traffic in a single direction during the peak hour;
- Truck Volume (T), the percentage of heavy vehicles during the peak hour travel period and per-day average;
- Design Hourly Volume (DHV), the bi-directional peak hour volume for the design year, expressed in vehicles per hour (vph); and
- Directional Design Hourly Volume (DDHV), the highest direction volume during the design year peak hour, expressed in vph.

Table 2-7:
Main Street Design Data, east of Route 85

Main Street	
Design Speed:	30 mph
ADT (2009):	8,215 vpd
ADT (2021):	8,986 vpd
K:	10%
D:	72.8 (EB)
T (Peak Hour):	4.3%
T (Average Day):	2% (Assumed)
DHV:	925 vph
DDHV:	674 vph (SB)

Source: Vanasse Hangen Brustlin, Inc.; based on ATRs conducted April 2009.

Calculations are provided in Appendix B.

Appendix A: Capacity Analysis Criteria

Level-of-Service Analysis Procedures

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Signalized Intersection Procedures

In the HCM approach, capacity at intersections is defined for lane groups rather than for approaches or the intersection as a whole. A lane group may be a single movement, a group of movements, or an entire approach and is defined by the geometry of the intersection and the distribution of movements over the various lanes. Capacity of a lane group is calculated as the maximum rate of flow that may pass through the intersection under prevailing traffic, roadway, and signalization conditions. The rate of flow is generally measured or projected for a 15-minute period and capacity is stated in vehicles per hour. Capacity analysis of intersections involves the computation of volume-to-capacity (v/c) ratio for each lane group, from which an overall intersection v/c ratio may be derived.

Generally, when two opposing flows are moving during a signal phase, one of the lane groups will require more green time than another to process all of its volume. This would be defined as the "critical" lane group for the subject signal phase. The concept of a critical v/c ratio is used to evaluate the intersection as a whole, considering only the critical lane groups or those with the greatest demand for green time within each signal phase. This procedure assumes that green time has been appropriately allocated. Thus it is possible to have an overall intersection v/c of less than 1.00 (under capacity), but still have individual movements be over saturated within the signal cycle if the green time has not been appropriately allocated to the various approaches.

The other major concept in signalized intersection analysis is level of service, which is an index used to grade intersection operations. Level of service is defined in terms of delay and ranges from LOS A (free-flow conditions) to LOS F (long delays). Delay represents a measure of driver discomfort and frustration, fuel consumption, and lost time. Specifically, level of service delay criteria are stated in terms of average stopped delay per vehicle for a 15-minute analysis period. The criteria are represented in Table A-1.

Table A-1
Level-of-Service Criteria for Signalized Intersections

Level of Service	Control Delay (sec/veh)
A	≤ 10
B	> 10 - 20
C	> 20 - 35
D	> 35 - 55
E	> 55 - 80
F	>80

Source: Highway Capacity Manual 2000, Transportation Research Board, Washington, DC, 2000.

Delay is a complex measure that depends upon a number of variables such as quality of signal progression, cycle length, allocation of green time, and v/c ratio. Of all the factors cited, v/c ratios have the least effect on delay. Thus, for any given v/c ratio, a range of delay values (and, therefore, level of service) may result. Conversely, for a given level of service, the v/c ratio may lie anywhere within a broad range.

The base saturation flow rate used in the signalized intersection analysis model varies from 1,800 to 1,900 passenger cars per hour of green per lane (pcphgpl). This value is adjusted for prevailing traffic conditions such as lane width, left turns, right turns, heavy vehicles, grades, parking, area type, bus blockage, and left-turn blockage.

Appendix B: Main Street (Route 30) at Marlboro Road/Cordaville Road (Route 85)

- Turning Movement Counts
- Automatic Traffic Recorders
- Crash Data
- Signal Warrant Analysis
- Intersection Capacity Analysis
- Design Designation Data Calculations
- Special Speed Regulation

Turning Movement Counts

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E/W: Main Street (Route 30)
City, State: Southborough, MA
Client: VHB/N. Wilke

File Name : 91857 A
Site Code : 10832.00
Start Date : 4/14/2009
Page No : 1

Groups Printed- Cars - Heavy Vehicles

	Marlboro Road (Route 85) From North			Main Street (Route 30) From East			Cordaville Road (Route 85) From South			Main Street (Route 30) From West			
Start Time	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Int. Total
07:00 AM	1	76	2	3	18	12	19	56	19	29	84	6	325
07:15 AM	3	62	4	4	24	6	10	46	22	39	103	3	326
07:30 AM	15	80	8	0	36	5	25	62	30	33	119	11	424
07:45 AM	6	69	4	6	48	10	25	74	21	33	106	7	409
Total	25	287	18	13	126	33	79	238	92	134	412	27	1484
08:00 AM	1	77	7	13	28	13	15	56	23	34	111	3	381
08:15 AM	2	70	3	4	41	15	36	43	29	35	104	7	389
08:30 AM	2	89	3	4	41	22	35	53	20	36	78	2	385
08:45 AM	4	63	5	4	27	19	31	75	14	33	107	9	391
Total	9	299	18	25	137	69	117	227	86	138	400	21	1546
Grand Total	34	586	36	38	263	102	196	465	178	272	812	48	3030
Apprch %	5.2	89.3	5.5	9.4	65.3	25.3	23.4	55.4	21.2	24	71.7	4.2	
Total %	1.1	19.3	1.2	1.3	8.7	3.4	6.5	15.3	5.9	9	26.8	1.6	
Cars	31	563	29	36	249	91	177	438	171	256	796	46	2883
% Cars	91.2	96.1	80.6	94.7	94.7	89.2	90.3	94.2	96.1	94.1	98	95.8	95.1
Heavy Vehicles	3	23	7	2	14	11	19	27	7	16	16	2	147
% Heavy Vehicles	8.8	3.9	19.4	5.3	5.3	10.8	9.7	5.8	3.9	5.9	2	4.2	4.9

	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	**15**	**80**	**8**	**103**	0	36	5	41	25	62	**30**	117	33	**119**	**11**	**163**	**424**
07:45 AM	6	69	4	79	6	**48**	10	**64**	25	**74**	21	**120**	33	106	7	146	409
08:00 AM	1	77	7	85	**13**	28	13	54	15	56	23	94	34	111	3	148	381
08:15 AM	2	70	3	75	4	41	**15**	60	**36**	43	29	108	**35**	104	7	146	389
Total Volume	24	296	22	342	23	153	43	219	101	235	103	439	135	440	28	603	1603
% App. Total	7	86.5	6.4		10.5	69.9	19.6		23	53.5	23.5		22.4	73	4.6		
PHF	.400	.925	.688	.830	.442	.797	.717	.855	.701	.794	.858	.915	.964	.924	.636	.925	.945
Cars	22	284	18	324	22	141	37	200	92	220	98	410	126	434	26	586	1520
% Cars	91.7	95.9	81.8	94.7	95.7	92.2	86.0	91.3	91.1	93.6	95.1	93.4	93.3	98.6	92.9	97.2	94.8
Heavy Vehicles	2	12	4	18	1	12	6	19	9	15	5	29	9	6	2	17	83
% Heavy Vehicles	8.3	4.1	18.2	5.3	4.3	7.8	14.0	8.7	8.9	6.4	4.9	6.6	6.7	1.4	7.1	2.8	5.2

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E/W: Main Street (Route 30)
City, State: Southborough, MA
Client: VHB/N. Wilke

File Name : 91857 A
Site Code : 10832.00
Start Date : 4/14/2009
Page No : 1

Groups Printed- Cars

	Marlboro Road (Route 85) From North			Main Street (Route 30) From East			Cordaville Road (Route 85) From South			Main Street (Route 30) From West			
Start Time	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Int. Total
07:00 AM	1	75	2	3	18	11	19	54	17	29	81	6	316
07:15 AM	3	61	3	4	24	6	10	41	22	36	102	3	315
07:30 AM	15	77	8	0	33	4	20	58	27	33	117	10	402
07:45 AM	6	65	3	6	44	8	24	68	21	29	103	7	384
Total	25	278	16	13	119	29	73	221	87	127	403	26	1417
08:00 AM	0	73	5	13	26	12	14	51	22	32	110	2	360
08:15 AM	1	69	2	3	38	13	34	43	28	32	104	7	374
08:30 AM	1	82	2	3	40	20	30	50	20	33	73	2	356
08:45 AM	4	61	4	4	26	17	26	73	14	32	106	9	376
Total	6	285	13	23	130	62	104	217	84	129	393	20	1466
Grand Total	31	563	29	36	249	91	177	438	171	256	796	46	2883
Apprch %	5	90.4	4.7	9.6	66.2	24.2	22.5	55.7	21.8	23.3	72.5	4.2	
Total %	1.1	19.5	1	1.2	8.6	3.2	6.1	15.2	5.9	8.9	27.6	1.6	

	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	**15**	**77**	**8**	**100**	0	33	4	37	20	58	27	105	**33**	**117**	**10**	**160**	**402**
07:45 AM	6	65	3	74	6	**44**	8	**58**	24	**68**	21	**113**	29	103	7	139	384
08:00 AM	0	73	5	78	**13**	26	12	51	14	51	22	87	32	110	2	144	360
08:15 AM	1	69	2	72	3	38	**13**	54	**34**	43	**28**	105	32	104	7	143	374
Total Volume	22	284	18	324	22	141	37	200	92	220	98	410	126	434	26	586	1520
% App. Total	6.8	87.7	5.6		11	70.5	18.5		22.4	53.7	23.9		21.5	74.1	4.4		
PHF	.367	.922	.563	.810	.423	.801	.712	.862	.676	.809	.875	.907	.955	.927	.650	.916	.945

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Site Code : 10832.00
Start Date : 4/14/2009
Page No : 1

Groups Printed- Heavy Vehicles

	Marlboro Road (Route 85) From North			Main Street (Route 30) From East			Cordaville Road (Route 85) From South			Main Street (Route 30) From West			
Start Time	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Int. Total
07:00 AM	0	1	0	0	0	1	0	2	2	0	3	0	9
07:15 AM	0	1	1	0	0	0	0	5	0	3	1	0	11
07:30 AM	0	3	0	0	3	1	5	4	3	0	2	1	22
07:45 AM	0	4	1	0	4	2	1	6	0	4	3	0	25
Total	0	9	2	0	7	4	6	17	5	7	9	1	67
08:00 AM	1	4	2	0	2	1	1	5	1	2	1	1	21
08:15 AM	1	1	1	1	3	2	2	0	1	3	0	0	15
08:30 AM	1	7	1	1	1	2	5	3	0	3	5	0	29
08:45 AM	0	2	1	0	1	2	5	2	0	1	1	0	15
Total	3	14	5	2	7	7	13	10	2	9	7	1	80
Grand Total	3	23	7	2	14	11	19	27	7	16	16	2	147
Apprch %	9.1	69.7	21.2	7.4	51.9	40.7	35.8	50.9	13.2	47.1	47.1	5.9	
Total %	2	15.6	4.8	1.4	9.5	7.5	12.9	18.4	4.8	10.9	10.9	1.4	

	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:45 AM																	
07:45 AM	0	4	1	5	0	**4**	**2**	**6**	1	**6**	0	7	**4**	3	0	7	25
08:00 AM	**1**	4	**2**	7	0	2	1	3	1	5	**1**	7	2	1	**1**	4	21
08:15 AM	1	1	1	3	**1**	3	2	6	2	0	1	3	3	0	0	3	15
08:30 AM	1	**7**	1	**9**	1	1	2	4	**5**	3	0	**8**	3	**5**	0	**8**	**29**
Total Volume	3	16	5	24	2	10	7	19	9	14	2	25	12	9	1	22	90
% App. Total	12.5	66.7	20.8		10.5	52.6	36.8		36	56	8		54.5	40.9	4.5		
PHF	.750	.571	.625	.667	.500	.625	.875	.792	.450	.583	.500	.781	.750	.450	.250	.688	.776

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Site Code : 10832.00
Start Date : 4/14/2009
Page No : 1

Groups Printed- Peds and Bicycles

	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
07:00 AM	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Total	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	3
08:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
08:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 AM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	2
Grand Total	0	0	0	1	0	0	0	2	0	1	0	0	0	1	0	0	5
Apprch %	0	0	0	100	0	0	0	100	0	100	0	0	0	100	0	0	
Total %	0	0	0	20	0	0	0	40	0	20	0	0	0	20	0	0	

	Marlboro Road (Route 85) From North					Main Street (Route 30) From East					Cordaville Road (Route 85) From South					Main Street (Route 30) From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	0	0	0	**2**	**2**	0	0	0	0	0	0	0	0	0	0	**2**
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	**1**			**1**	0	0	0	0	0	1
Total Volume	0	0	0	0	0	0	0	0	2	2	0	1	0	0	1	0	0	0	0	0	3
% App. Total	0	0	0	0		0	0	0	100		0	100	0	0		0	0	0	0		
PHF	.000	.000	.000	.000	.000	.000	.000	.000	.250	.250	.000	.250	.000	.000	.250	.000	.000	.000	.000	.000	.375

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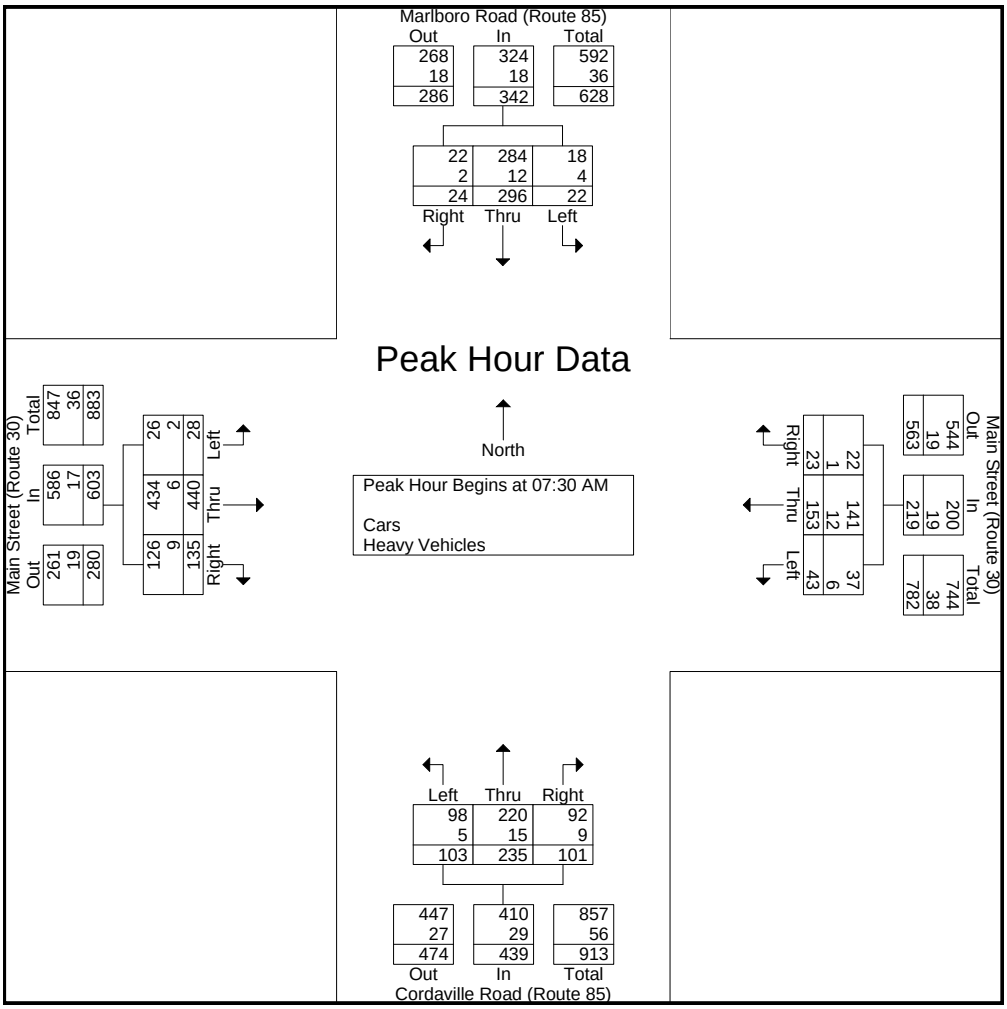
	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:30 AM																	
07:30 AM	**15**	**80**	**8**	**103**	0	36	5	41	25	62	**30**	117	33	**119**	**11**	**163**	**424**
07:45 AM	6	69	4	79	6	**48**	10	**64**	25	**74**	21	**120**	33	106	7	146	409
08:00 AM	1	77	7	85	**13**	28	13	54	15	56	23	94	34	111	3	148	381
08:15 AM	2	70	3	75	4	41	**15**	60	**36**	43	29	108	**35**	104	7	146	389
Total Volume	24	296	22	342	23	153	43	219	101	235	103	439	135	440	28	603	1603
% App. Total	7	86.5	6.4		10.5	69.9	19.6		23	53.5	23.5		22.4	73	4.6		
PHF	.400	.925	.688	.830	.442	.797	.717	.855	.701	.794	.858	.915	.964	.924	.636	.925	.945
Cars	22	284	18	324	22	141	37	200	92	220	98	410	126	434	26	586	1520
% Cars	91.7	95.9	81.8	94.7	95.7	92.2	86.0	91.3	91.1	93.6	95.1	93.4	93.3	98.6	92.9	97.2	94.8
Heavy Vehicles	2	12	4	18	1	12	6	19	9	15	5	29	9	6	2	17	83
% Heavy Vehicles	8.3	4.1	18.2	5.3	4.3	7.8	14.0	8.7	8.9	6.4	4.9	6.6	6.7	1.4	7.1	2.8	5.2



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Groups Printed- Cars - Heavy Vehicles

	Marlboro Road (Route 85) From North			Main Street (Route 30) From East			Cordaville Road (Route 85) From South			Main Street (Route 30) From West			
Start Time	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Int. Total
04:00 PM	5	58	1	6	52	22	16	64	22	32	34	5	317
04:15 PM	11	60	4	4	52	26	12	57	14	25	31	6	302
04:30 PM	12	67	3	11	77	23	13	59	20	37	36	5	363
04:45 PM	6	75	6	13	61	22	15	70	17	37	47	9	378
Total	34	260	14	34	242	93	56	250	73	131	148	25	1360
05:00 PM	5	79	5	3	63	33	15	83	21	34	56	16	413
05:15 PM	5	77	10	8	99	35	16	71	13	44	59	15	452
05:30 PM	4	84	3	6	81	23	22	88	25	44	67	11	458
05:45 PM	5	81	2	15	120	22	17	73	21	29	56	8	449
Total	19	321	20	32	363	113	70	315	80	151	238	50	1772
Grand Total	53	581	34	66	605	206	126	565	153	282	386	75	3132
Apprch %	7.9	87	5.1	7.5	69	23.5	14.9	66.9	18.1	38	52	10.1	
Total %	1.7	18.6	1.1	2.1	19.3	6.6	4	18	4.9	9	12.3	2.4	
Cars	53	572	31	64	599	205	126	553	151	277	379	75	3085
% Cars	100	98.5	91.2	97	99	99.5	100	97.9	98.7	98.2	98.2	100	98.5
Heavy Vehicles	0	9	3	2	6	1	0	12	2	5	7	0	47
% Heavy Vehicles	0	1.5	8.8	3	1	0.5	0	2.1	1.3	1.8	1.8	0	1.5

	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	**5**	79	5	89	3	63	33	99	15	83	21	119	34	56	**16**	106	413
05:15 PM	5	77	**10**	**92**	8	99	**35**	142	16	71	13	100	**44**	59	15	118	452
05:30 PM	4	**84**	3	91	6	81	23	110	**22**	**88**	**25**	**135**	44	**67**	11	**122**	**458**
05:45 PM	5	81	2	88	**15**	**120**	22	**157**	17	73	21	111	29	56	8	93	449
Total Volume	19	321	20	360	32	363	113	508	70	315	80	465	151	238	50	439	1772
% App. Total	5.3	89.2	5.6		6.3	71.5	22.2		15.1	67.7	17.2		34.4	54.2	11.4		
PHF	.950	.955	.500	.978	.533	.756	.807	.809	.795	.895	.800	.861	.858	.888	.781	.900	.967
Cars	19	319	20	358	31	359	112	502	70	307	79	456	150	234	50	434	1750
% Cars	100	99.4	100	99.4	96.9	98.9	99.1	98.8	100	97.5	98.8	98.1	99.3	98.3	100	98.9	98.8
Heavy Vehicles	0	2	0	2	1	4	1	6	0	8	1	9	1	4	0	5	22
% Heavy Vehicles	0	0.6	0	0.6	3.1	1.1	0.9	1.2	0	2.5	1.3	1.9	0.7	1.7	0	1.1	1.2

PRECISION
D A T A
INDUSTRIES, LLC
P.O.Box 301 Berlin, MA 01503
Office: 508.481.3999 Fax: 508.545.1234
Email: datarequests@pdillc.com

N/S: Marlboro Rd/Cordaville Rd (Rte 85)
E/W: Main Street (Route 30)
City, State: Southborough, MA
Client: VHB/N. Wilke

File Name : 91857 AA
Site Code : 10832.00
Start Date : 4/14/2009
Page No : 1

Groups Printed- Cars

	Marlboro Road (Route 85) From North			Main Street (Route 30) From East			Cordaville Road (Route 85) From South			Main Street (Route 30) From West			
Start Time	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Int. Total
04:00 PM	5	57	0	5	52	22	16	62	21	30	33	5	308
04:15 PM	11	58	4	4	50	26	12	57	14	24	31	6	297
04:30 PM	12	67	3	11	77	23	13	58	20	37	35	5	361
04:45 PM	6	71	4	13	61	22	15	69	17	36	46	9	369
Total	34	253	11	33	240	93	56	246	72	127	145	25	1335
05:00 PM	5	78	5	3	63	32	15	80	20	34	56	16	407
05:15 PM	5	76	10	7	97	35	16	70	13	44	58	15	446
05:30 PM	4	84	3	6	80	23	22	84	25	43	66	11	451
05:45 PM	5	81	2	15	119	22	17	73	21	29	54	8	446
Total	19	319	20	31	359	112	70	307	79	150	234	50	1750
Grand Total	53	572	31	64	599	205	126	553	151	277	379	75	3085
Apprch %	8.1	87.2	4.7	7.4	69	23.6	15.2	66.6	18.2	37.9	51.8	10.3	
Total %	1.7	18.5	1	2.1	19.4	6.6	4.1	17.9	4.9	9	12.3	2.4	

	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	**5**	78	5	88	3	63	32	98	15	80	20	115	34	56	**16**	106	407
05:15 PM	5	76	**10**	**91**	7	97	**35**	139	16	70	13	99	**44**	58	15	117	446
05:30 PM	4	**84**	3	91	6	80	23	109	**22**	**84**	**25**	**131**	43	**66**	11	**120**	**451**
05:45 PM	5	81	2	88	**15**	**119**	22	**156**	17	73	21	111	29	54	8	91	446
Total Volume	19	319	20	358	31	359	112	502	70	307	79	456	150	234	50	434	1750
% App. Total	5.3	89.1	5.6		6.2	71.5	22.3		15.4	67.3	17.3		34.6	53.9	11.5		
PHF	.950	.949	.500	.984	.517	.754	.800	.804	.795	.914	.790	.870	.852	.886	.781	.904	.970

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N/S: Marlboro Rd/Cordaville Rd (Rte 85)
E/W: Main Street (Route 30)
City, State: Southborough, MA
Client: VHB/N. Wilke

File Name : 91857 AA
Site Code : 10832.00
Start Date : 4/14/2009
Page No : 1

Groups Printed- Heavy Vehicles

	Marlboro Road (Route 85) From North			Main Street (Route 30) From East			Cordaville Road (Route 85) From South			Main Street (Route 30) From West			
Start Time	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Int. Total
04:00 PM	0	1	1	1	0	0	0	2	1	2	1	0	9
04:15 PM	0	2	0	0	2	0	0	0	0	1	0	0	5
04:30 PM	0	0	0	0	0	0	0	1	0	0	1	0	2
04:45 PM	0	4	2	0	0	0	0	1	0	1	1	0	9
Total	0	7	3	1	2	0	0	4	1	4	3	0	25
05:00 PM	0	1	0	0	0	1	0	3	1	0	0	0	6
05:15 PM	0	1	0	1	2	0	0	1	0	0	1	0	6
05:30 PM	0	0	0	0	1	0	0	4	0	1	1	0	7
05:45 PM	0	0	0	0	1	0	0	0	0	0	2	0	3
Total	0	2	0	1	4	1	0	8	1	1	4	0	22
Grand Total	0	9	3	2	6	1	0	12	2	5	7	0	47
Apprch %	0	75	25	22.2	66.7	11.1	0	85.7	14.3	41.7	58.3	0	
Total %	0	19.1	6.4	4.3	12.8	2.1	0	25.5	4.3	10.6	14.9	0	

	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:45 PM																	
04:45 PM	0	**4**	**2**	**6**	0	0	0	0	0	1	0	1	**1**	**1**	0	**2**	**9**
05:00 PM	0	1	0	1	0	0	**1**	1	0	3	**1**	**4**	0	0	0	0	6
05:15 PM	0	1	0	1	**1**	**2**	0	**3**	0	1	0	1	0	1	0	1	6
05:30 PM	0	0	0	0	0	1	0	1	0	**4**	0	4	1	1	0	2	7
Total Volume	0	6	2	8	1	3	1	5	0	9	1	10	2	3	0	5	28
% App. Total	0	75	25		20	60	20		0	90	10		40	60	0		
PHF	.000	.375	.250	.333	.250	.375	.250	.417	.000	.563	.250	.625	.500	.750	.000	.625	.778

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N/S: Marlboro Rd/Cordaville Rd (Rte 85)
E/W: Main Street (Route 30)
City, State: Southborough, MA
Client: VHB/N. Wilke

File Name : 91857 AA
Site Code : 10832.00
Start Date : 4/14/2009
Page No : 1

Groups Printed- Peds and Bicycles

	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
04:00 PM	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	2
04:15 PM	0	0	0	0	0	0	0	2	0	2	0	0	0	1	0	0	5
04:30 PM	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	9
04:45 PM	0	0	0	0	0	0	0	6	0	0	0	0	0	1	0	6	13
Total	0	0	0	0	0	0	1	17	0	2	0	0	1	2	0	6	29
05:00 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
05:15 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
05:30 PM	2	0	0	1	0	6	0	0	0	0	0	6	0	1	0	0	16
05:45 PM	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Total	3	3	0	1	0	7	0	0	0	0	0	6	0	1	0	1	22
Grand Total	3	3	0	1	0	7	1	17	0	2	0	6	1	3	0	7	51
Apprch %	42.9	42.9	0	14.3	0	28	4	68	0	25	0	75	9.1	27.3	0	63.6	
Total %	5.9	5.9	0	2	0	13.7	2	33.3	0	3.9	0	11.8	2	5.9	0	13.7	

	Marlboro Road (Route 85) From North					Main Street (Route 30) From East					Cordaville Road (Route 85) From South					Main Street (Route 30) From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:45 PM																					
04:45 PM	0	0	0	0	0	0	0	0	**6**	**6**	0	0	0	0	0	0	**1**	0	**6**	**7**	13
05:00 PM	0	**1**	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
05:15 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
05:30 PM	**2**			**1**	**3**	0	**6**							**6**	**6**	0	1	0	0	1	**16**
Total Volume	2	1	0	1	4	0	7	0	6	13	0	0	0	6	6	0	2	0	6	8	31
% App. Total	50	25	0	25		0	53.8	0	46.2		0	0	0	100		0	25	0	75		
PHF	.250	.250	.000	.250	.333	.000	.292	.000	.250	.542	.000	.000	.000	.250	.250	.000	.500	.000	.250	.286	.484

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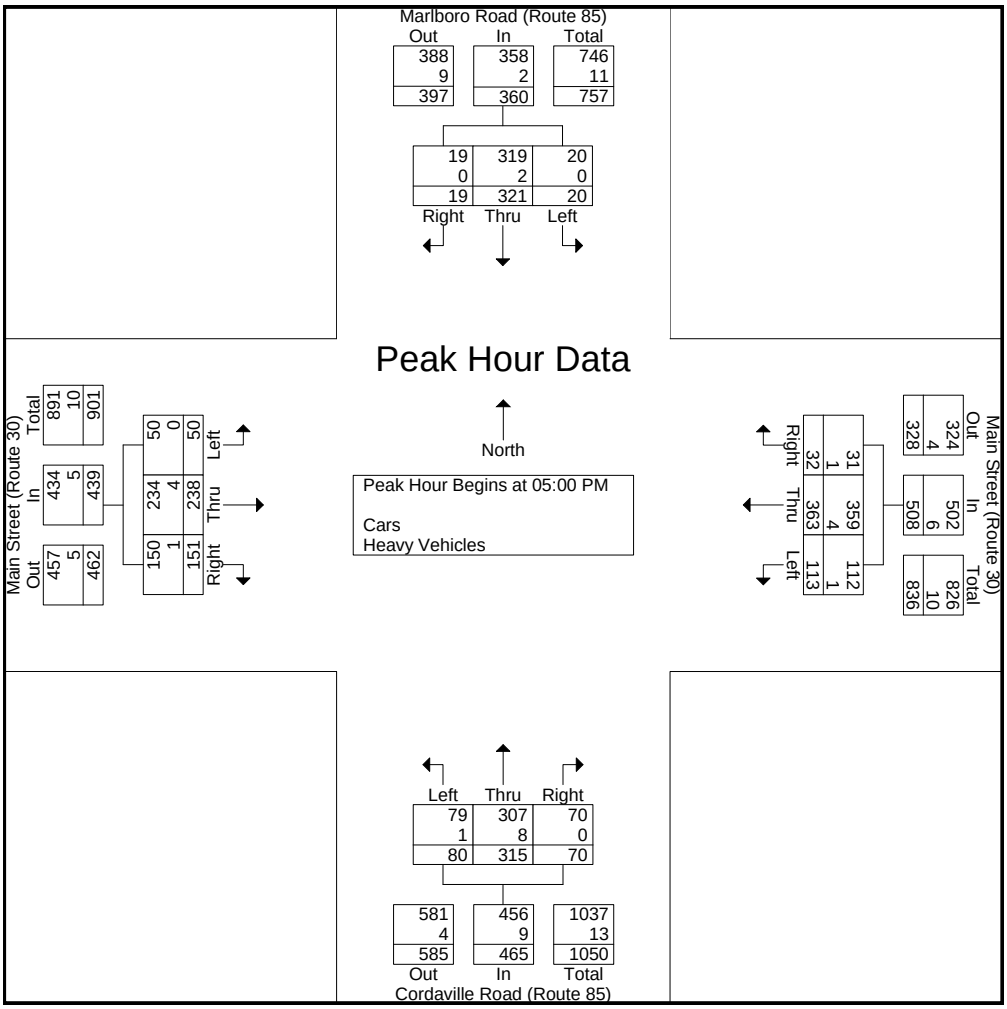
N/S: Marlboro Rd/Cordaville Rd (Rte 85)
E/W: Main Street (Route 30)
City, State: Southborough, MA
Client: VHB/N. Wilke

File Name : 91857 AA
Site Code : 10832.00
Start Date : 4/14/2009
Page No : 1

	Marlboro Road (Route 85) From North				Main Street (Route 30) From East				Cordaville Road (Route 85) From South				Main Street (Route 30) From West				
Start Time	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Right	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	**5**	79	5	89	3	63	33	99	15	83	21	119	34	56	**16**	106	413
05:15 PM	5	77	**10**	**92**	8	99	**35**	142	16	71	13	100	**44**	59	15	118	452
05:30 PM	4	**84**	3	91	6	81	23	110	**22**	**88**	**25**	**135**	44	**67**	11	**122**	**458**
05:45 PM	5	81	2	88	**15**	**120**	22	**157**	17	73	21	111	29	56	8	93	449
Total Volume	19	321	20	360	32	363	113	508	70	315	80	465	151	238	50	439	1772
% App. Total	5.3	89.2	5.6		6.3	71.5	22.2		15.1	67.7	17.2		34.4	54.2	11.4		
PHF	.950	.955	.500	.978	.533	.756	.807	.809	.795	.895	.800	.861	.858	.888	.781	.900	.967
Cars	19	319	20	358	31	359	112	502	70	307	79	456	150	234	50	434	1750
% Cars	100	99.4	100	99.4	96.9	98.9	99.1	98.8	100	97.5	98.8	98.1	99.3	98.3	100	98.9	98.8
Heavy Vehicles	0	2	0	2	1	4	1	6	0	8	1	9	1	4	0	5	22
% Heavy Vehicles	0	0.6	0	0.6	3.1	1.1	0.9	1.2	0	2.5	1.3	1.9	0.7	1.7	0	1.1	1.2



Automatic Traffic Recorders

PRECISION
D A T A
INDUSTRIES, LLC
P.O. Box 301 Berlin, MA 01503
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Email: datarequests@pdillc.com

Marlboro Road (Route 85)
north of Main Street (Route 30)
City, State: Southborough, MA
Client: VHB/N. Wilke

91857 A volume
Site Code: 10832.00

Start	NB				SB				Combined				14-Apr-09
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Tue
12:00	4		62		2		48		6		110		
12:15	1		54		2		46		3		100		
12:30	2		48		1		40		3		88		
12:45	1	8	42	206	0	5	56	190	1	13	98	396	
01:00	0		42		0		56		0		98		
01:15	3		46		0		59		3		105		
01:30	1		46		0		66		1		112		
01:45	2	6	46	180	0	0	62	243	2	6	108	423	
02:00	2		39		0		54		2		93		
02:15	1		47		2		46		3		93		
02:30	0		52		0		62		0		114		
02:45	0	3	76	214	0	2	57	219	0	5	133	433	
03:00	2		62		0		72		2		134		
03:15	0		58		2		48		2		106		
03:30	1		50		1		72		2		122		
03:45	0	3	72	242	1	4	84	276	1	7	156	518	
04:00	2		71		1		64		3		135		
04:15	0		68		0		72		0		140		
04:30	1		71		2		81		3		152		
04:45	5	8	88	298	2	5	86	303	7	13	174	601	
05:00	6		106		4		88		10		194		
05:15	5		94		4		94		9		188		
05:30	11		104		21		88		32		192		
05:45	16	38	86	390	26	55	81	351	42	93	167	741	
06:00	24		90		23		76		47		166		
06:15	26		58		34		68		60		126		
06:30	48		56		44		80		92		136		
06:45	38	136	55	259	56	157	60	284	94	293	115	543	
07:00	67		47		85		43		152		90		
07:15	54		48		70		46		124		94		
07:30	70		41		102		48		172		89		
07:45	88	279	30	166	104	361	36	173	192	640	66	339	
08:00	79		28		84		28		163		56		
08:15	53		30		74		28		127		58		
08:30	62		21		96		23		158		44		
08:45	82	276	22	101	74	328	15	94	156	604	37	195	
09:00	70		15		56		24		126		39		
09:15	56		26		62		10		118		36		
09:30	58		18		44		12		102		30		
09:45	54	238	14	73	35	197	14	60	89	435	28	133	
10:00	42		9		42		10		84		19		
10:15	45		8		38		7		83		15		
10:30	46		5		52		5		98		10		
10:45	36	169	5	27	62	194	5	27	98	363	10	54	
11:00	38		2		43		5		81		7		
11:15	54		8		49		3		103		11		
11:30	46		1		36		6		82		7		
11:45	46	184	4	15	53	181	3	17	99	365	7	32	
Total	1348		2171		1489		2237		2837		4408		
Percent	47.5%		49.3%		52.5%		50.7%						
Day Total		3519				3726				7245			
Peak	07:15		04:45		07:30		04:45		07:30		04:45		
Vol.	291		392		364		356		654		748		
P.H.F.	0.827		0.925		0.875		0.947		0.852		0.964		

Main Street (Route 30)
east of Marlboro Road (Route 85)
City, State: Southborough, MA
Client: VHB/N. Wilke

PRECISION DATA INDUSTRIES, LLC
P.O. Box 301 Berlin, MA 01503
Office: 508.481.3999 Fax: 508.545.1234
Email: datarequests@pdillc.com

91857 B volume
Site Code: 10832.00

Start	EB				WB				Combined				14-Apr-09
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Tue
12:00	2		73		7		92		9		165		
12:15	0		62		1		56		1		118		
12:30	1		51		0		59		1		110		
12:45	1	4	65	251	2	10	51	258	3	14	116	509	
01:00	1		68		1		54		2		122		
01:15	0		59		2		70		2		129		
01:30	2		62		0		47		2		109		
01:45	0	3	65	254	1	4	56	227	1	7	121	481	
02:00	1		58		0		78		1		136		
02:15	0		68		0		72		0		140		
02:30	1		76		0		72		1		148		
02:45	1	3	78	280	0	0	71	293	1	3	149	573	
03:00	0		80		0		64		0		144		
03:15	2		66		0		81		2		147		
03:30	0		76		1		95		1		171		
03:45	2	4	58	280	0	1	80	320	2	5	138	600	
04:00	3		55		2		77		5		132		
04:15	1		47		2		80		3		127		
04:30	4		50		1		114		5		164		
04:45	0	8	69	221	0	5	96	367	0	13	165	588	
05:00	6		80		4		106		10		186		
05:15	7		90		1		138		8		228		
05:30	9		89		6		106		15		195		
05:45	6	28	76	335	4	15	143	493	10	43	219	828	
06:00	15		78		4		97		19		175		
06:15	34		55		16		60		50		115		
06:30	49		41		20		62		69		103		
06:45	80	178	60	234	41	81	83	302	121	259	143	536	
07:00	111		48		34		62		145		110		
07:15	119		53		35		56		154		109		
07:30	156		49		44		49		200		98		
07:45	162	548	22	172	62	175	41	208	224	723	63	380	
08:00	152		17		62		26		214		43		
08:15	146		16		62		25		208		41		
08:30	118		17		66		25		184		42		
08:45	148	564	17	67	56	246	12	88	204	810	29	155	
09:00	124		9		48		11		172		20		
09:15	86		7		60		14		146		21		
09:30	99		13		38		8		137		21		
09:45	64	373	12	41	52	198	10	43	116	571	22	84	
10:00	56		12		58		13		114		25		
10:15	53		23		46		6		99		29		
10:30	53		16		44		11		97		27		
10:45	48	210	8	59	59	207	4	34	107	417	12	93	
11:00	47		2		61		3		108		5		
11:15	59		2		52		3		111		5		
11:30	68		3		58		2		126		5		
11:45	80	254	3	10	78	249	2	10	158	503	5	20	
Total	2177		2204		1191		2643		3368		4847		
Percent	64.6%		45.5%		35.4%		54.5%						
Day Total		4381				3834				8215			
Peak	07:30		05:00		07:45		05:00		07:30		05:00		
Vol.	616		335		252		493		846		828		
P.H.F.	0.951		0.931		0.955		0.862		0.944		0.908		

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Cordaville Road (Route 85)
south of Main Street (Route 30)
City, State: Southborough, MA
Client: VHB/N. Wilke

91857 C volume
Site Code: 10832.00

Start	SB				NB				Combined				14-Apr-09
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Tue
12:00	6		100		2		109		8		209		
12:15	1		80		1		84		2		164		
12:30	1		66		2		58		3		124		
12:45	1	9	82	328	1	6	78	329	2	15	160	657	
01:00	1		98		0		84		1		182		
01:15	1		100		3		72		4		172		
01:30	1		96		1		77		2		173		
01:45	1	4	94	388	1	5	66	299	2	9	160	687	
02:00	0		94		2		62		2		156		
02:15	2		96		2		77		4		173		
02:30	0		134		1		79		1		213		
02:45	0	2	104	428	1	6	107	325	1	8	211	753	
03:00	0		108		2		84		2		192		
03:15	2		96		1		100		3		196		
03:30	2		144		1		84		3		228		
03:45	1	5	137	485	1	5	85	353	2	10	222	838	
04:00	2		114		2		100		4		214		
04:15	3		115		1		84		4		199		
04:30	4		130		1		91		5		221		
04:45	3	12	138	497	5	9	104	379	8	21	242	876	
05:00	5		150		7		122		12		272		
05:15	10		158		11		110		21		268		
05:30	27		155		17		118		44		273		
05:45	38	80	132	595	19	54	110	460	57	134	242	1055	
06:00	37		120		34		112		71		232		
06:15	53		93		38		79		91		172		
06:30	52		112		56		74		108		186		
06:45	74	216	85	410	74	202	79	344	148	418	164	754	
07:00	113		73		90		88		203		161		
07:15	110		76		82		84		192		160		
07:30	118		68		117		64		235		132		
07:45	144	485	63	280	122	411	56	292	266	896	119	572	
08:00	128		48		110		30		238		78		
08:15	118		40		119		41		237		81		
08:30	146		40		104		31		250		71		
08:45	118	510	28	156	124	457	20	122	242	967	48	278	
09:00	88		40		122		23		210		63		
09:15	96		19		87		25		183		44		
09:30	50		21		100		28		150		49		
09:45	70	304	23	103	80	389	18	94	150	693	41	197	
10:00	77		21		77		13		154		34		
10:15	60		21		55		10		115		31		
10:30	71		20		77		6		148		26		
10:45	87	295	8	70	60	269	7	36	147	564	15	106	
11:00	78		9		54		4		132		13		
11:15	79		3		69		5		148		8		
11:30	82		5		68		1		150		6		
11:45	106	345	3	20	75	266	8	18	181	611	11	38	
Total	2267		3760		2079		3051		4346		6811		
Percent	52.2%		55.2%		47.8%		44.8%						
Day Total		6027				5130				11157			
Peak	07:45		04:45		08:15		05:00		07:45		04:45		
Vol.	536		601		469		460		991		1055		
P.H.F.	0.918		0.951		0.946		0.943		0.931		0.966		

Main Street (Route 30)
west of Marlboro Road (Route 85)
City, State: Southborough, MA
Client: VHB/N. Wilke

PRECISION DATA INDUSTRIES, LLC
P.O. Box 301 Berlin, MA 01503
Office: 508.481.3999 Fax: 508.545.1234
Email: datarequests@pdillc.com

91857 D volume
Site Code: 10832.00

Start	EB				WB				Combined				14-Apr-09
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Tue
12:00	5		71		4		65		9		136		
12:15	0		64		2		64		2		128		
12:30	1		50		0		42		1		92		
12:45	0	6	63	248	1	7	42	213	1	13	105	461	
01:00	1		62		0		48		1		110		
01:15	0		53		1		48		1		101		
01:30	1		65		0		39		1		104		
01:45	1	3	65	245	0	1	46	181	1	4	111	426	
02:00	1		56		0		63		1		119		
02:15	0		74		1		44		1		118		
02:30	0		101		0		48		0		149		
02:45	1	2	89	320	1	2	58	213	2	4	147	533	
03:00	0		96		0		60		0		156		
03:15	2		98		1		82		3		180		
03:30	0		87		0		59		0		146		
03:45	1	3	69	350	0	1	52	253	1	4	121	603	
04:00	1		81		0		64		1		145		
04:15	1		66		1		71		2		137		
04:30	5		78		0		92		5		170		
04:45	1	8	87	312	0	1	62	289	1	9	149	601	
05:00	5		94		2		61		7		155		
05:15	8		104		2		80		10		184		
05:30	9		87		5		73		14		160		
05:45	17	39	85	370	7	16	127	341	24	55	212	711	
06:00	23		76		8		98		31		174		
06:15	41		76		12		61		53		137		
06:30	50		55		15		54		65		109		
06:45	75	189	58	265	46	81	66	279	121	270	124	544	
07:00	106		55		36		60		142		115		
07:15	138		58		39		68		177		126		
07:30	139		52		58		48		197		100		
07:45	132	515	28	193	54	187	46	222	186	702	74	415	
08:00	141		28		34		20		175		48		
08:15	132		17		54		27		186		44		
08:30	118		13		46		26		164		39		
08:45	123	514	27	85	32	166	9	82	155	680	36	167	
09:00	106		26		35		13		141		39		
09:15	68		15		37		15		105		30		
09:30	61		16		28		12		89		28		
09:45	62	297	15	72	40	140	6	46	102	437	21	118	
10:00	57		12		41		10		98		22		
10:15	48		28		32		4		80		32		
10:30	50		36		40		10		90		46		
10:45	49	204	11	87	45	158	5	29	94	362	16	116	
11:00	52		5		42		6		94		11		
11:15	58		7		43		5		101		12		
11:30	77		3		38		2		115		5		
11:45	77	264	2	17	36	159	5	18	113	423	7	35	
Total	2044		2564		919		2166		2963		4730		
Percent	69.0%		54.2%		31.0%		45.8%						
Day Total		4608				3085				7693			
Peak	07:15		02:30		07:30		05:15		07:30		05:15		
Vol.	550		384		200		378		744		730		
P.H.F.	0.975		0.950		0.862		0.744		0.944		0.861		

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Main Street (Route 30)
west of Marlboro Road (Route 85)
City, State: Southborough, MA
Client: VHB/N. Wilke

91857 D speed
Site Code: 10832.00

EB

Start Time	1 14	15 19	20 24	25 29	30 34	35 39	40 44	45 49	50 54	55 59	60 64	65 69	70 9999	Total	85th % ile	Ave Speed
04/14/0																
9	1	2	3	0	0	0	0	0	0	0	0	0	0	6	21	19
01:00	0	0	2	1	0	0	0	0	0	0	0	0	0	3	25	22
02:00	0	1	1	0	0	0	0	0	0	0	0	0	0	2	20	20
03:00	0	0	2	0	1	0	0	0	0	0	0	0	0	3	30	24
04:00	0	0	6	2	0	0	0	0	0	0	0	0	0	8	25	23
05:00	4	9	20	5	1	0	0	0	0	0	0	0	0	39	24	21
06:00	30	44	79	**27**	**9**	0	0	0	0	0	0	0	0	189	26	20
07:00	**103**	**140**	239	27	5	**1**	0	0	0	0	0	0	0	**515**	24	18
08:00	93	137	**267**	14	3	0	0	0	0	0	0	0	0	514	23	18
09:00	62	65	139	25	6	0	0	0	0	0	0	0	0	297	24	19
10:00	43	57	85	16	3	0	0	0	0	0	0	0	0	204	24	18
11:00	50	52	143	16	**3**	0	0	0	0	0	0	0	0	264	24	19
12 PM	61	54	114	16	3	0	0	0	0	0	0	0	0	248	24	18
13:00	51	40	131	**23**	0	0	0	0	0	0	0	0	0	245	24	19
14:00	**78**	**56**	**175**	9	2	0	0	0	0	0	0	0	0	**320**	23	18
15:00	71	**77**	187	14	1	0	0	0	0	0	0	0	0	350	23	18
16:00	**75**	46	161	28	1	**1**	0	0	0	0	0	0	0	312	24	18
17:00	62	61	**206**	**38**	**3**	0	0	0	0	0	0	0	0	**370**	24	19
18:00	56	50	133	24	2	0	0	0	0	0	0	0	0	265	24	18
19:00	29	40	103	19	2	0	0	0	0	0	0	0	0	193	24	19
20:00	14	32	30	8	0	1	0	0	0	0	0	0	0	85	24	18
21:00	10	21	29	10	2	0	0	0	0	0	0	0	0	72	25	20
22:00	13	27	30	15	1	1	0	0	0	0	0	0	0	87	26	20
23:00	1	1	9	4	2	0	0	0	0	0	0	0	0	17	27	23
Total	907	1012	2294	341	50	4	0	0	0	0	0	0	0	4608		
%	19.7%	22.0%	49.8%	7.4%	1.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
AM Peak	07:00	07:00	08:00	06:00	06:00	07:00								07:00		
Vol.	103	140	267	27	9	1								515		
Midday Peak	14:00	14:00	14:00	13:00	11:00									14:00		
Vol.	78	56	175	23	3									320		
PM Peak	16:00	15:00	17:00	17:00	17:00	16:00								17:00		
Vol.	75	77	206	38	3	1								370		

% iles	15th Percentile :	11 MPH
	50th Percentile :	20 MPH
	85th Percentile :	24 MPH
	95th Percentile :	27 MPH

Stats	10 MPH Pace Speed :	15-24 MPH
	Number in Pace :	3306
	Percent in Pace :	71.7%
	Number of Vehicles > 25 MPH :	326
	Percent of Vehicles > 25 MPH :	7.1%
	Mean Speed(Average) :	19 MPH

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Main Street (Route 30)
west of Marlboro Road (Route 85)
City, State: Southborough, MA
Client: VHB/N. Wilke

91857 D speed
Site Code: 10832.00

WB

Start Time	1 14	15 19	20 24	25 29	30 34	35 39	40 44	45 49	50 54	55 59	60 64	65 69	70 9999	Total	85th % ile	Ave Speed
04/14/0																
9	0	0	2	4	1	0	0	0	0	0	0	0	0	7	28	26
01:00	0	0	0	0	1	0	0	0	0	0	0	0	0	1	30	30
02:00	0	1	1	0	0	0	0	0	0	0	0	0	0	2	20	20
03:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1	20	20
04:00	0	0	1	0	0	0	0	0	0	0	0	0	0	1	20	20
05:00	0	1	7	5	1	2	0	0	0	0	0	0	0	16	34	26
06:00	0	15	39	17	8	2	0	0	0	0	0	0	0	81	29	23
07:00	**1**	**26**	**131**	25	4	0	0	0	0	0	0	0	0	**187**	25	22
08:00	1	19	108	35	3	0	0	0	0	0	0	0	0	166	26	23
09:00	0	13	64	**42**	**17**	**4**	0	0	0	0	0	0	0	140	29	25
10:00	2	24	64	52	11	4	1	0	0	0	0	0	0	158	29	24
11:00	0	16	87	40	13	**3**	0	0	0	0	0	0	0	159	28	24
12 PM	1	**28**	87	**73**	21	3	0	0	0	0	0	0	0	**213**	29	24
13:00	1	16	73	60	**29**	2	0	0	0	0	0	0	0	181	30	25
14:00	**5**	28	**100**	58	21	1	0	0	0	0	0	0	0	213	29	24
15:00	5	**34**	133	67	13	1	0	0	0	0	0	0	0	253	28	23
16:00	1	31	119	98	**38**	2	0	0	0	0	0	0	0	289	29	25
17:00	0	19	**172**	**130**	19	1	0	0	0	0	0	0	0	**341**	28	24
18:00	4	19	111	106	33	**5**	**1**	0	0	0	0	0	0	279	29	25
19:00	**6**	28	93	79	13	3	0	0	0	0	0	0	0	222	28	24
20:00	1	3	39	31	7	1	0	0	0	0	0	0	0	82	29	25
21:00	0	3	20	16	6	1	0	0	0	0	0	0	0	46	29	25
22:00	0	0	10	13	4	1	0	**1**	0	0	0	0	0	29	31	27
23:00	1	0	7	7	2	1	0	0	0	0	0	0	0	18	29	24
Total	29	324	1469	958	265	37	2	1	0	0	0	0	0	3085		
%	0.9%	10.5%	47.6%	31.1%	8.6%	1.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
AM Peak	07:00	07:00	07:00	09:00	09:00	09:00								07:00		
Vol.	1	26	131	42	17	4								187		
Midday Peak	14:00	12:00	14:00	12:00	13:00	11:00								12:00		
Vol.	5	28	100	73	29	3								213		
PM Peak	19:00	15:00	17:00	17:00	16:00	18:00	18:00	22:00						17:00		
Vol.	6	34	172	130	38	5	1	1						341		

% iles		
	15th Percentile :	20 MPH
	50th Percentile :	24 MPH
	85th Percentile :	29 MPH
	95th Percentile :	32 MPH

Stats		
	10 MPH Pace Speed :	20-29 MPH
	Number in Pace :	2427
	Percent in Pace :	78.7%
	Number of Vehicles > 25 MPH :	1071
	Percent of Vehicles > 25 MPH :	34.7%
	Mean Speed(Average) :	24 MPH

Crash Data

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Southborough | COUNT DATE : April 2009

DISTRICT : 3 | UNSIGNALIZED : | SIGNALIZED : x

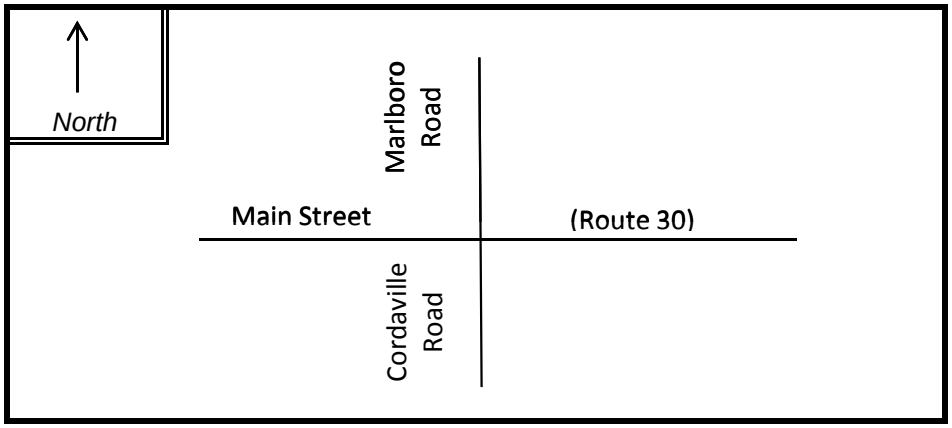
~ INTERSECTION DATA ~

MAJOR STREET : Main Street (Route 30)

MINOR STREET(S) : Marlborough Road (Route 85)

Cordaville Road (Route 85)

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB	SB		
PEAK HOURLY VOLUMES (AM) :	603	219	439	342		**1,603**

" K " FACTOR : **0.100**

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **16,030**

TOTAL # OF CRASHES : 12 | # OF YEARS : 3 | AVERAGE # OF CRASHES PER YEAR (**A**) : **4.00**

CRASH RATE CALCULATION : 0.68

$$\text{RATE} = \frac{(A * 1{,}000{,}000)}{(V * 365)}$$

Comments :

Project Title & Date:

Crash ID	Town	Year	Crash Date	Crash Time	Crash Severity	Total Vehicles	Total Injured	Total Fatals	Collision manner	Road Surface	Lighting	Weather	Street	Intersection	Distance From Nearest Intersection	Vehicles Travel Directions	Most Harmful Events	Vehicle Action Prior to Crash	Vehicle Configuration
2155414	SOUTHBOROUGH	2006	8/12/2006	1:10 PM	Unknown	2	0	0	Rear-end	Dry	Daylight	Clear	Rte 85	Rte 30		V1:Northbound / V2:Southbound	V1: Not reported / V2: Not reported		
2126674	SOUTHBOROUGH	2006	6/14/2006	6:00 PM	Property damage only (none	2	0	0	Rear-end	Wet	Daylight	Rain			19 MAIN STREET Rte 30	V1:Westbound / V2:Westbound	V1: Not reported / V2: Not reported		
2141040	SOUTHBOROUGH	2006	10/25/2006	6:48 AM	Non-fatal injury	2	3	0	Head-on	Dry	Daylight	Clear/Clear	MAIN STREET	CORDAVILLE ROAD		V1:Westbound / V2:Not reported	V1: Collision with motor vehicle in traffic / V2: Collision with motor		
2177596	SOUTHBOROUGH	2006	10/25/2006	8:05 AM	Not Reported	2	0	0	Head-on	Dry	Daylight	Clear			CORDAVILLE ROAD Rte 85 / MAIN STREET Rte	V1:Northbound / V2:Southbound	V1: Not reported / V2: Not reported		
2252970	SOUTHBOROUGH	2007	10/10/2007	8:30 AM	Non-fatal injury	2	2	0	Sideswipe, opposite direction	Wet	Daylight	Cloudy/Rain			1 CORDAVILLE ROAD	V1:Southbound / V2:Not reported	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic		
2165415	SOUTHBOROUGH	2007	2/11/2007	8:08 PM	Non-fatal injury	2	1	0	Head-on	Dry	Dark - lighted roadway	Clear/Clear	CORDAVILLE ROAD Rte 85 N / MAIN STREET Rte 30 W	CORDAVILLE ROAD Rte 85 N / MAIN STREET Rte 30 W		V1:Northbound / V2:Southbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic		
2277719	SOUTHBOROUGH	2007	2/15/2007	7:20 AM	Non-fatal injury	2	2	0	Not reported	Dry	Daylight	Clear	Rte 85 / Rte 30	Rte 85 / Rte 30		V1:Not reported / V2:Not reported	V1: Not reported / V2: Not reported		
2288953	SOUTHBOROUGH	2008	1/15/2008	6:53 AM	Property damage only (none injured)	2	0	0	Rear-end	Wet	Daylight	Cloudy/Cloudy	CORDAVILLE ROAD Rte 85 N / MAIN STREET Rte 30 E	CORDAVILLE ROAD Rte 85 N / MAIN STREET Rte 30 E		V1:Northbound / V2:Eastbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Travelling straight ahead / V2:Turning right	V1: Passenger car / V2:Passenger car
2476796	SOUTHBOROUGH	2008	5/8/2008	7:00 AM	Property damage only (none injured)	2	0	0	Rear-end	Wet	Daylight	Clear/Clear	CORDAVILLE ROAD Rte 85 N / MAIN STREET Rte 30 E	CORDAVILLE ROAD Rte 85 N / MAIN STREET Rte 30 E		V1:Northbound / V2:Northbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Travelling straight ahead / V2:Slowing or stopped in traffic	V1: Passenger car / V2:Light truck(van, mini-van, panel, pickup, sport utility) with only four tires
2455726	SOUTHBOROUGH	2008	5/9/2008	7:45 AM	Property damage only (none injured)	2	0	0	Rear-end	Dry	Daylight	Cloudy			200 feet S from Intersection Rte 85 / Rte 30	V1:Northbound / V2:Northbound	V1: Not reported / V2: Not reported	V1: Slowing or stopped in traffic / V2:Travelling straight ahead	V1: Passenger car / V2:Not reported
2394841	SOUTHBOROUGH	2008	6/19/2008	3:30 PM	Property damage only (none	2	0	0	Angle	Dry	Daylight	Clear/Clear	MAIN STREET / CORDAVILLE ROAD	MAIN STREET / CORDAVILLE ROAD		V1:Southbound / V2:Southbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor	V1: Turning right / V2:Travelling straight ahead	V1: Light truck(van, mini-van, panel, pickup, sport utility)
2395241	SOUTHBOROUGH	2008	9/19/2008	8:59 PM	Non-fatal injury	2	1	0	Rear-end	Dry	Daylight	Clear/Clear	CORDAVILLE ROAD / MAIN STREET Rte 30	CORDAVILLE ROAD / MAIN STREET Rte 30		V1:Northbound / V2:Not reported	V1: Collision with motor vehicle in traffic / V2: Collision with motor	V1: Travelling straight ahead / V2:Travelling straight ahead	V1: Passenger car / V2:Passenger car

Signal Warrant Analysis

2003 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Main Street at Marlboro Street

Major Street Direction: Eastbound-Westbound

Year: 2009 **Condition:** Existing

Operating speed on major roadway: 25 MPH - 30 MPH

Number of approaches: 4

Warrant 1 EIGHT-HOUR VEHICULAR VOLUME		Required approach volumes: Minimum*	Adjusted Minimum**
Warrant 1A	MINIMUM VEHICULAR VOLUME (8 hours of day)		
	Major Street : 1 Lane(s) on each approach	500	500
	Minor Street : 1 Lane(s) on each approach	150	150
Warrant 1B	INTERRUPTION OF CONTINUOUS TRAFFIC (8 hours of day)		
	Major Street : 1 Lane(s) on each approach	750	750
	Minor Street : 1 Lane(s) on each approach	75	75
80 PERCENT SATISFACTION OF WARRANT 1A **AND** WARRANT 1B		Warrant 1A	Warrant 1B
	Major Street : 1 Lane(s) on each approach	400	600
	Minor Street : 1 Lane(s) on each approach	120	60

Warrant 2 FOUR HOUR VEHICULAR VOLUME

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-1 or 4C-2.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Warrant 3 PEAK HOUR VOLUME

Major Street : 1 Lane(s) on each approach — If "verify" indicated, see Figure 4C-3 or 4C-4.

Minor Street : 1 Lane(s) on each approach — 25 = accuracy of regression equations

Hour	Entering Vol. Minor Road+	Entering Vol. on Major Road: Eastbound	Entering Vol. on Major Road: Westbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	202	81	189	270	No	No	No	No	No
7:00 - 8:00 AM	411	175	515	690	Yes	No	Yes	Yes	Yes
8:00 - 9:00 AM	457	246	514	760	Yes	Yes	Yes	Yes	Yes
9:00 - 10:00 AM	389	198	297	495	No	No	No	Yes	No
10:00 - 11:00 AM	269	207	204	411	No	No	No	No	No
11:00 - 12:00 AM	266	249	264	513	Yes	No	No	No	No
12:00 - 1:00 PM	329	258	248	506	Yes	No	No	Yes	No
1:00 - 2:00 PM	299	227	245	472	No	No	No	Yes	No
2:00 - 3:00 PM	325	293	320	613	Yes	No	Yes	Yes	No
3:00 - 4:00 PM	353	320	350	670	Yes	No	Yes	Yes	Yes
4:00 - 5:00 PM	379	367	312	679	Yes	No	Yes	Yes	Yes
5:00 - 6:00 PM	460	493	370	863	Yes	Yes	Yes	Yes	Yes
6:00 - 7:00 PM	344	302	265	567	Yes	No	No	Yes	No
					Yes	**No**	**No**	**Yes**	**Yes**
			Warrants Met?		**1**			**2**	**3**
					Yes			**Yes**	**Yes**

*From the criteria described for the warrant in the MUTCD.

**If the operating speed is higher than 40mph then the volumes can be adjusted to 70%. (If no adjusted minimum, the minimum from the previous column is shown)

+If more than one approach, report the approach that has the higher volume.

NON-VOLUME-BASED WARRANTS

Warrant 4, Minimum Pedestrian Volume: No

Peak Four Hour Pedestrian Volumes: 0

(non-concurrent) 0

0

0

Warrant 5, School Crossing:

See MUTCD for details.

Warrant 6, Coordinated Signal System:

See MUTCD for details.

Warrant 7, Crash Experience: No

# of accidents "correctable by signalization" occuring in the last 12 months: 0

Warrant 8, Roadway Network:

See MUTCD for details.

Source: *Manual on Uniform Traffic Control Devices* (MUTCD); 2003 Edition [2003]

last updated: 08/05/05 [version]

2003 MUTCD

TRAFFIC SIGNAL WARRANT ANALYSIS (VOLUME BASED)

Intersection: Main Street at Marlboro Street

Major Street Direction: Eastbound-Westbound

Year: 2021 **Condition:** Proposed

Operating speed on major roadway: 25 MPH - 30 MPH

Number of approaches: 4

Warrant 1 EIGHT-HOUR VEHICULAR VOLUME		Required approach volumes: Minimum*	Adjusted Minimum**
Warrant 1A MINIMUM VEHICULAR VOLUME (8 hours of day)			
Major Street :	2 Lane(s) on each approach	600	600
Minor Street :	2 Lane(s) on each approach	200	200
Warrant 1B INTERRUPTION OF CONTINUOUS TRAFFIC (8 hours of day)			
Major Street :	2 Lane(s) on each approach	900	900
Minor Street :	2 Lane(s) on each approach	100	100
80 PERCENT SATISFACTION OF WARRANT 1A **AND** WARRANT 1B		Warrant 1A	Warrant 1B
Major Street :	2 Lane(s) on each approach	480	720
Minor Street :	2 Lane(s) on each approach	160	80

Warrant 2 FOUR HOUR VEHICULAR VOLUME

Major Street : 2 Lane(s) on each approach — If "verify" indicated, see Figure 4C-1 or 4C-2.

Minor Street : 2 Lane(s) on each approach — 25 = accuracy of regression equations

Warrant 3 PEAK HOUR VOLUME

Major Street : 2 Lane(s) on each approach — If "verify" indicated, see Figure 4C-3 or 4C-4.

Minor Street : 2 Lane(s) on each approach — 25 = accuracy of regression equations

Hour	Entering Vol. Minor Road+	Entering Vol. on Major Road: Eastbound	Entering Vol. on Major Road: Westbound	Tot. Ent. Vol. On Major Rd	Meets the following volume-based warrants? 1A	1B	80%(1A&1B)	2	3
6:00 - 7:00 AM	242	97	226	323	No	No	No	No	No
7:00 - 8:00 AM	491	209	616	825	Yes	No	Yes	Yes	Yes
8:00 - 9:00 AM	546	294	615	909	Yes	Yes	Yes	Yes	Yes
9:00 - 10:00 AM	465	237	355	592	No	No	No	Yes	No
10:00 - 11:00 AM	441	247	244	491	No	No	No	No	No
11:00 - 12:00 AM	438	298	316	614	Yes	No	No	Yes	No
12:00 - 1:00 PM	393	308	297	605	Yes	No	No	Yes	No
1:00 - 2:00 PM	357	271	293	564	No	No	No	No	No
2:00 - 3:00 PM	389	350	383	733	Yes	No	Yes	Yes	No
3:00 - 4:00 PM	422	383	418	801	Yes	No	Yes	Yes	No
4:00 - 5:00 PM	453	439	373	812	Yes	No	Yes	Yes	No
5:00 - 6:00 PM	550	489	442	931	Yes	Yes	Yes	Yes	Yes
6:00 - 7:00 PM	411	361	317	678	Yes	No	No	Yes	No
					Yes	**No**	**No**	**Yes**	**Yes**
			Warrants Met?		**1**			**2**	**3**
					Yes			**Yes**	**Yes**

*From the criteria described for the warrant in the MUTCD.

**If the operating speed is higher than 40mph then the volumes can be adjusted to 70%. (If no adjusted minimum, the minimum from the previous column is shown)

+If more than one approach, report the approach that has the higher volume.

NON-VOLUME-BASED WARRANTS

Warrant 4, Minimum Pedestrian Volume: No

Peak Four Hour Pedestrian Volumes: 0

(non-concurrent) 0

0

0

Warrant 5, School Crossing:

See MUTCD for details.

Warrant 6, Coordinated Signal System:

See MUTCD for details.

Warrant 7, Crash Experience: No

# of accidents "correctable by signalization" occuring in the last 12 months: 0

Warrant 8, Roadway Network:

See MUTCD for details.

Source: *Manual on Uniform Traffic Control Devices* (MUTCD); 2003 Edition [2003]

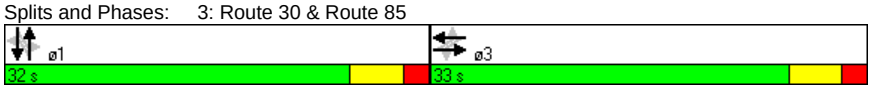
last updated: 08/05/05 [version]

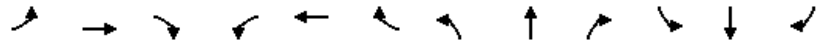
Intersection Capacity Analysis

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	11	12	10	15	12	10	11	12	10	15	12
Storage Length (ft)	100		0	100		0	100		0	100		0
Storage Lanes	0		0	0		0	0		0	0		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.970			0.986			0.969			0.990	
Flt Protected		0.998			0.990			0.988			0.997	
Satd. Flow (prot)	0	1720	0	0	1876	0	0	1652	0	0	1961	0
Flt Permitted		0.977			0.819			0.789			0.952	
Satd. Flow (perm)	0	1684	0	0	1552	0	0	1319	0	0	1872	0
Right Turn on Red			Yes			Yes			No			Yes
Satd. Flow (RTOR)		29			12						7	
Headway Factor	1.09	1.04	1.00	1.09	0.88	1.00	1.09	1.04	1.00	1.09	0.88	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		1687			1881			940			1108	
Travel Time (s)		38.3			42.8			21.4			25.2	
Volume (vph)	29	453	139	44	158	24	106	242	104	23	305	25
Peak Hour Factor	0.93	0.93	0.93	0.86	0.86	0.86	0.92	0.92	0.92	0.83	0.83	0.83
Heavy Vehicles (%)	7%	2%	7%	14%	8%	4%	5%	6%	9%	18%	4%	8%
Adj. Flow (vph)	31	487	149	51	184	28	115	263	113	28	367	30
Lane Group Flow (vph)	0	667	0	0	263	0	0	491	0	0	425	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		3			3			1			1	
Permitted Phases	3			3			1			1		
Minimum Split (s)	33.0	33.0		33.0	33.0		32.0	32.0		32.0	32.0	
Total Split (s)	33.0	33.0	0.0	33.0	33.0	0.0	32.0	32.0	0.0	32.0	32.0	0.0
Total Split (%)	50.8%	50.8%	0.0%	50.8%	50.8%	0.0%	49.2%	49.2%	0.0%	49.2%	49.2%	0.0%
Maximum Green (s)	27.0	27.0		27.0	27.0		26.0	26.0		26.0	26.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
v/c Ratio		0.87			0.38			0.86			0.52	
Control Delay		30.4			13.4			35.4			16.3	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		30.4			13.4			35.4			16.3	
Queue Length 50th (ft)		218			63			169			116	
Queue Length 95th (ft)		#421			107			#341			170	
Internal Link Dist (ft)		1607			1801			860			1028	
Turn Bay Length (ft)												
Base Capacity (vph)		767			699			568			810	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		0.87			0.38			0.86			0.52	

Intersection Summary	
Area Type:	Other
Cycle Length: 65	
Actuated Cycle Length: 65	
Offset: 0 (0%), Referenced to phase 0:NBEB, Start of Green	
Natural Cycle: 65	
Control Type: Pretimed	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 3: Route 30 & Route 85





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	10	15	12	10	11	12	10	15	12
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.97			0.99			0.97			0.99	
Flt Protected		1.00			0.99			0.99			1.00	
Satd. Flow (prot)		1720			1876			1652			1961	
Flt Permitted		0.98			0.82			0.79			0.95	
Satd. Flow (perm)		1684			1552			1319			1874	
Volume (vph)	29	453	139	44	158	24	106	242	104	23	305	25
Peak-hour factor, PHF	0.93	0.93	0.93	0.86	0.86	0.86	0.92	0.92	0.92	0.83	0.83	0.83
Adj. Flow (vph)	31	487	149	51	184	28	115	263	113	28	367	30
RTOR Reduction (vph)	0	16	0	0	7	0	0	0	0	0	4	0
Lane Group Flow (vph)	0	651	0	0	256	0	0	491	0	0	421	0
Heavy Vehicles (%)	7%	2%	7%	14%	8%	4%	5%	6%	9%	18%	4%	8%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		3			3			1			1	
Permitted Phases	3			3			1			1		
Actuated Green, G (s)		27.0			27.0			26.0			26.0	
Effective Green, g (s)		29.0			29.0			28.0			28.0	
Actuated g/C Ratio		0.45			0.45			0.43			0.43	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Lane Grp Cap (vph)		751			692			568			807	
v/s Ratio Prot												
v/s Ratio Perm		c0.39			0.17			c0.37			0.22	
v/c Ratio		0.87			0.37			0.86			0.52	
Uniform Delay, d1		16.3			11.9			16.8			13.6	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		12.8			1.5			16.0			2.4	
Delay (s)		29.1			13.5			32.8			16.0	
Level of Service		C			B			C			B	
Approach Delay (s)		29.1			13.5			32.8			16.0	
Approach LOS		C			B			C			B	

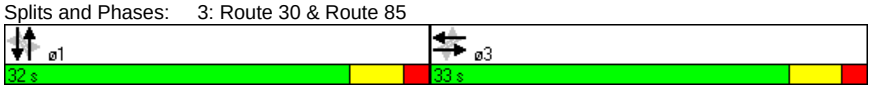
Intersection Summary			
HCM Average Control Delay	24.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	89.8%	ICU Level of Service	E
Analysis Period (min)	15		

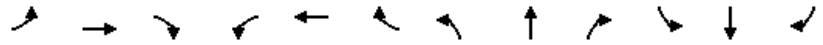
c Critical Lane Group

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	11	12	10	15	12	10	11	12	10	15	12
Storage Length (ft)	100		0	100		0	100		0	100		0
Storage Lanes	0		0	0		0	0		0	0		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.954			0.991			0.980			0.993	
Flt Protected		0.994			0.989			0.992			0.997	
Satd. Flow (prot)	0	1717	0	0	2026	0	0	1747	0	0	2051	0
Flt Permitted		0.884			0.749			0.872			0.959	
Satd. Flow (perm)	0	1527	0	0	1534	0	0	1536	0	0	1973	0
Right Turn on Red			Yes			Yes			No			Yes
Satd. Flow (RTOR)		52			7						5	
Headway Factor	1.09	1.04	1.00	1.09	0.88	1.00	1.09	1.04	1.00	1.09	0.88	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		1687			1881			940			1108	
Travel Time (s)		38.3			42.8			21.4			25.2	
Volume (vph)	52	245	156	116	374	33	82	325	72	21	331	20
Peak Hour Factor	0.90	0.90	0.90	0.81	0.81	0.81	0.86	0.86	0.86	0.98	0.98	0.98
Heavy Vehicles (%)	0%	2%	1%	1%	1%	3%	1%	3%	0%	0%	1%	0%
Adj. Flow (vph)	58	272	173	143	462	41	95	378	84	21	338	20
Lane Group Flow (vph)	0	503	0	0	646	0	0	557	0	0	379	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		3			3			1			1	
Permitted Phases	3			3			1			1		
Minimum Split (s)	33.0	33.0		33.0	33.0		32.0	32.0		32.0	32.0	
Total Split (s)	33.0	33.0	0.0	33.0	33.0	0.0	32.0	32.0	0.0	32.0	32.0	0.0
Total Split (%)	50.8%	50.8%	0.0%	50.8%	50.8%	0.0%	49.2%	49.2%	0.0%	49.2%	49.2%	0.0%
Maximum Green (s)	27.0	27.0		27.0	27.0		26.0	26.0		26.0	26.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
v/c Ratio		0.71			0.94			0.84			0.44	
Control Delay		19.7			42.2			31.0			14.9	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		19.7			42.2			31.0			14.9	
Queue Length 50th (ft)		137			230			188			99	
Queue Length 95th (ft)		246			#366			#337			165	
Internal Link Dist (ft)		1607			1801			860			1028	
Turn Bay Length (ft)												
Base Capacity (vph)		710			688			662			853	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		0.71			0.94			0.84			0.44	

Intersection Summary	
Area Type:	Other
Cycle Length: 65	
Actuated Cycle Length: 65	
Offset: 0 (0%), Referenced to phase 0:NBEB, Start of Green	
Natural Cycle: 70	
Control Type: Pretimed	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 3: Route 30 & Route 85





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	10	15	12	10	11	12	10	15	12
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.95			0.99			0.98			0.99	
Flt Protected		0.99			0.99			0.99			1.00	
Satd. Flow (prot)		1717			2027			1746			2051	
Flt Permitted		0.88			0.75			0.87			0.96	
Satd. Flow (perm)		1526			1535			1534			1972	
Volume (vph)	52	245	156	116	374	33	82	325	72	21	331	20
Peak-hour factor, PHF	0.90	0.90	0.90	0.81	0.81	0.81	0.86	0.86	0.86	0.98	0.98	0.98
Adj. Flow (vph)	58	272	173	143	462	41	95	378	84	21	338	20
RTOR Reduction (vph)	0	29	0	0	4	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	474	0	0	642	0	0	557	0	0	376	0
Heavy Vehicles (%)	0%	2%	1%	1%	1%	3%	1%	3%	0%	0%	1%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		3			3			1			1	
Permitted Phases	3			3			1			1		
Actuated Green, G (s)		27.0			27.0			26.0			26.0	
Effective Green, g (s)		29.0			29.0			28.0			28.0	
Actuated g/C Ratio		0.45			0.45			0.43			0.43	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Lane Grp Cap (vph)		681			685			661			849	
v/s Ratio Prot												
v/s Ratio Perm		0.31			c0.42			c0.36			0.19	
v/c Ratio		0.70			0.94			0.84			0.44	
Uniform Delay, d1		14.5			17.1			16.5			13.0	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		5.8			22.1			12.4			1.7	
Delay (s)		20.3			39.2			28.9			14.7	
Level of Service		C			D			C			B	
Approach Delay (s)		20.3			39.2			28.9			14.7	
Approach LOS		C			D			C			B	

Intersection Summary			
HCM Average Control Delay	27.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	104.2%	ICU Level of Service	G
Analysis Period (min)	15		

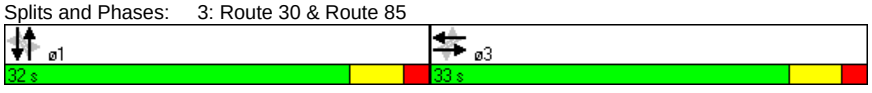
c Critical Lane Group

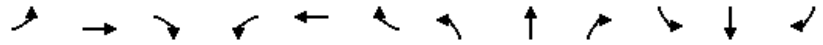
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	11	12	10	15	12	10	11	12	10	15	12
Storage Length (ft)	100		0	100		0	100		0	100		0
Storage Lanes	0		0	0		0	0		0	0		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.970			0.986			0.969			0.990	
Flt Protected		0.998			0.990			0.988			0.997	
Satd. Flow (prot)	0	1720	0	0	1876	0	0	1652	0	0	1962	0
Flt Permitted		0.975			0.761			0.731			0.952	
Satd. Flow (perm)	0	1681	0	0	1442	0	0	1222	0	0	1873	0
Right Turn on Red			Yes			Yes			No			Yes
Satd. Flow (RTOR)		29			11						7	
Headway Factor	1.09	1.04	1.00	1.09	0.88	1.00	1.09	1.04	1.00	1.09	0.88	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		1687			1881			940			1108	
Travel Time (s)		38.3			42.8			21.4			25.2	
Volume (vph)	33	526	161	51	183	27	123	281	121	26	354	29
Peak Hour Factor	0.93	0.93	0.93	0.86	0.86	0.86	0.92	0.92	0.92	0.83	0.83	0.83
Heavy Vehicles (%)	7%	2%	7%	14%	8%	4%	5%	6%	9%	18%	4%	8%
Adj. Flow (vph)	35	566	173	59	213	31	134	305	132	31	427	35
Lane Group Flow (vph)	0	774	0	0	303	0	0	571	0	0	493	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		3			3			1			1	
Permitted Phases	3			3			1			1		
Minimum Split (s)	33.0	33.0		33.0	33.0		32.0	32.0		32.0	32.0	
Total Split (s)	33.0	33.0	0.0	33.0	33.0	0.0	32.0	32.0	0.0	32.0	32.0	0.0
Total Split (%)	50.8%	50.8%	0.0%	50.8%	50.8%	0.0%	49.2%	49.2%	0.0%	49.2%	49.2%	0.0%
Maximum Green (s)	27.0	27.0		27.0	27.0		26.0	26.0		26.0	26.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
v/c Ratio		1.01			0.47			1.09			0.61	
Control Delay		55.7			15.1			87.0			18.0	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		55.7			15.1			87.0			18.0	
Queue Length 50th (ft)		~293			77			~261			142	
Queue Length 95th (ft)		#526			130			#437			204	
Internal Link Dist (ft)		1607			1801			860			1028	
Turn Bay Length (ft)												
Base Capacity (vph)		766			649			526			811	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		1.01			0.47			1.09			0.61	

Intersection Summary

Area Type: Other
Cycle Length: 65
Actuated Cycle Length: 65
Offset: 0 (0%), Referenced to phase 0:NBEB, Start of Green
Natural Cycle: 75
Control Type: Pretimed
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Route 30 & Route 85





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	10	15	12	10	11	12	10	15	12
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.97			0.99			0.97			0.99	
Flt Protected		1.00			0.99			0.99			1.00	
Satd. Flow (prot)		1720			1877			1652			1962	
Flt Permitted		0.97			0.76			0.73			0.95	
Satd. Flow (perm)		1680			1441			1222			1875	
Volume (vph)	33	526	161	51	183	27	123	281	121	26	354	29
Peak-hour factor, PHF	0.93	0.93	0.93	0.86	0.86	0.86	0.92	0.92	0.92	0.83	0.83	0.83
Adj. Flow (vph)	35	566	173	59	213	31	134	305	132	31	427	35
RTOR Reduction (vph)	0	16	0	0	6	0	0	0	0	0	4	0
Lane Group Flow (vph)	0	758	0	0	297	0	0	571	0	0	489	0
Heavy Vehicles (%)	7%	2%	7%	14%	8%	4%	5%	6%	9%	18%	4%	8%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		3			3			1			1	
Permitted Phases	3			3			1			1		
Actuated Green, G (s)		27.0			27.0			26.0			26.0	
Effective Green, g (s)		29.0			29.0			28.0			28.0	
Actuated g/C Ratio		0.45			0.45			0.43			0.43	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Lane Grp Cap (vph)		750			643			526			808	
v/s Ratio Prot												
v/s Ratio Perm		c0.45			0.21			c0.47			0.26	
v/c Ratio		1.01			0.46			1.09			0.61	
Uniform Delay, d1		18.0			12.6			18.5			14.2	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		35.5			2.4			64.4			3.4	
Delay (s)		53.5			14.9			82.9			17.6	
Level of Service		D			B			F			B	
Approach Delay (s)		53.5			14.9			82.9			17.6	
Approach LOS		D			B			F			B	

Intersection Summary			
HCM Average Control Delay	47.6	HCM Level of Service	D
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		

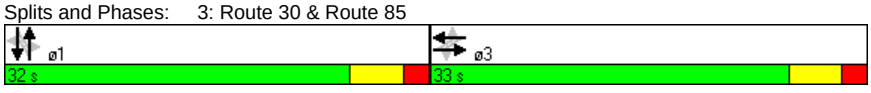
c Critical Lane Group

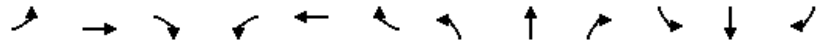
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	11	12	10	15	12	10	11	12	10	15	12
Storage Length (ft)	100		0	100		0	100		0	100		0
Storage Lanes	0		0	0		0	0		0	0		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.954			0.992			0.980			0.993	
Flt Protected		0.994			0.989			0.992			0.997	
Satd. Flow (prot)	0	1717	0	0	2028	0	0	1747	0	0	2051	0
Flt Permitted		0.855			0.691			0.833			0.958	
Satd. Flow (perm)	0	1477	0	0	1417	0	0	1467	0	0	1971	0
Right Turn on Red			Yes			Yes			No			Yes
Satd. Flow (RTOR)		52			7						5	
Headway Factor	1.09	1.04	1.00	1.09	0.88	1.00	1.09	1.04	1.00	1.09	0.88	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		1687			1881			940			1108	
Travel Time (s)		38.3			42.8			21.4			25.2	
Volume (vph)	60	284	181	135	434	38	95	377	84	24	384	23
Peak Hour Factor	0.90	0.90	0.90	0.81	0.81	0.81	0.86	0.86	0.86	0.98	0.98	0.98
Heavy Vehicles (%)	0%	2%	1%	1%	1%	3%	1%	3%	0%	0%	1%	0%
Adj. Flow (vph)	67	316	201	167	536	47	110	438	98	24	392	23
Lane Group Flow (vph)	0	584	0	0	750	0	0	646	0	0	439	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		3			3			1			1	
Permitted Phases	3			3			1			1		
Minimum Split (s)	33.0	33.0		33.0	33.0		32.0	32.0		32.0	32.0	
Total Split (s)	33.0	33.0	0.0	33.0	33.0	0.0	32.0	32.0	0.0	32.0	32.0	0.0
Total Split (%)	50.8%	50.8%	0.0%	50.8%	50.8%	0.0%	49.2%	49.2%	0.0%	49.2%	49.2%	0.0%
Maximum Green (s)	27.0	27.0		27.0	27.0		26.0	26.0		26.0	26.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag												
Lead-Lag Optimize?												
v/c Ratio		0.85			1.18			1.02			0.52	
Control Delay		29.1			117.9			63.7			16.1	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		29.1			117.9			63.7			16.1	
Queue Length 50th (ft)		180			~368			~259			120	
Queue Length 95th (ft)		#370			#481			#430			195	
Internal Link Dist (ft)		1607			1801			860			1028	
Turn Bay Length (ft)												
Base Capacity (vph)		688			636			632			852	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		0.85			1.18			1.02			0.52	

Intersection Summary

Area Type: Other
Cycle Length: 65
Actuated Cycle Length: 65
Offset: 0 (0%), Referenced to phase 0:NBEB, Start of Green
Natural Cycle: 70
Control Type: Pretimed
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Route 30 & Route 85





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	10	15	12	10	11	12	10	15	12
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frt		0.95			0.99			0.98			0.99	
Flt Protected		0.99			0.99			0.99			1.00	
Satd. Flow (prot)		1717			2027			1745			2051	
Flt Permitted		0.85			0.69			0.83			0.96	
Satd. Flow (perm)		1476			1417			1467			1969	
Volume (vph)	60	284	181	135	434	38	95	377	84	24	384	23
Peak-hour factor, PHF	0.90	0.90	0.90	0.81	0.81	0.81	0.86	0.86	0.86	0.98	0.98	0.98
Adj. Flow (vph)	67	316	201	167	536	47	110	438	98	24	392	23
RTOR Reduction (vph)	0	29	0	0	4	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	555	0	0	746	0	0	646	0	0	436	0
Heavy Vehicles (%)	0%	2%	1%	1%	1%	3%	1%	3%	0%	0%	1%	0%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		3			3			1			1	
Permitted Phases	3			3			1			1		
Actuated Green, G (s)		27.0			27.0			26.0			26.0	
Effective Green, g (s)		29.0			29.0			28.0			28.0	
Actuated g/C Ratio		0.45			0.45			0.43			0.43	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Lane Grp Cap (vph)		659			632			632			848	
v/s Ratio Prot												
v/s Ratio Perm		0.38			c0.53			c0.44			0.22	
v/c Ratio		0.84			1.18			1.02			0.51	
Uniform Delay, d1		16.0			18.0			18.5			13.5	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		12.4			96.9			41.5			2.2	
Delay (s)		28.4			114.9			60.0			15.8	
Level of Service		C			F			E			B	
Approach Delay (s)		28.4			114.9			60.0			15.8	
Approach LOS		C			F			E			B	

Intersection Summary			
HCM Average Control Delay	61.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.10		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	119.5%	ICU Level of Service	H
Analysis Period (min)	15		

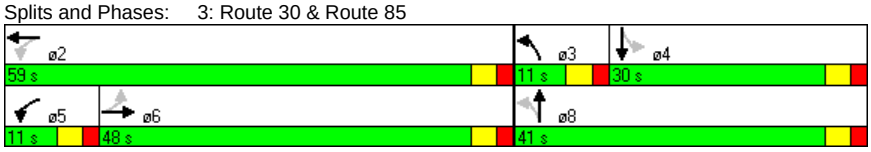
c Critical Lane Group

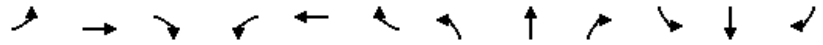
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	15	12	10	15	12	10	15	12	10	15	12
Storage Length (ft)	100		0	100		0	100		0	100		0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50		50	50		50	50		50	50	
Trailing Detector (ft)	0	0		0	0		0	0		0	0	
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.965			0.981			0.955			0.989	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1574	1955	0	1478	1907	0	1604	1867	0	1428	1982	0
Flt Permitted	0.607			0.083			0.133			0.407		
Satd. Flow (perm)	1006	1955	0	129	1907	0	225	1867	0	612	1982	0
Right Turn on Red			Yes			Yes			No			Yes
Satd. Flow (RTOR)		20			12						4	
Headway Factor	1.09	0.88	1.00	1.09	0.88	1.00	1.09	0.88	1.00	1.09	0.88	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		1687			1881			940			1108	
Travel Time (s)		38.3			42.8			21.4			25.2	
Volume (vph)	33	526	161	51	183	27	123	281	121	26	354	29
Peak Hour Factor	0.93	0.93	0.93	0.86	0.86	0.86	0.92	0.92	0.92	0.83	0.83	0.83
Heavy Vehicles (%)	7%	2%	7%	14%	8%	4%	5%	6%	9%	18%	4%	8%
Adj. Flow (vph)	35	566	173	59	213	31	134	305	132	31	427	35
Lane Group Flow (vph)	35	739	0	59	244	0	134	437	0	31	462	0
Turn Type	Perm			pm+pt			pm+pt			Perm		
Protected Phases		6		5	2		3	8			4	
Permitted Phases	6			2			8			4		
Detector Phases	6	6		5	2		3	8		4	4	
Minimum Initial (s)	10.0	10.0		6.0	10.0		6.0	6.0		6.0	6.0	
Minimum Split (s)	15.0	15.0		11.0	15.0		11.0	15.0		15.0	15.0	
Total Split (s)	48.0	48.0	0.0	11.0	59.0	0.0	11.0	41.0	0.0	30.0	30.0	0.0
Total Split (%)	48.0%	48.0%	0.0%	11.0%	59.0%	0.0%	11.0%	41.0%	0.0%	30.0%	30.0%	0.0%
Maximum Green (s)	43.0	43.0		6.0	54.0		6.0	36.0		25.0	25.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lag	Lag		Lead			Lead			Lag	Lag	
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	Min	Min		None	Min		None	Min		Min	Min	
v/c Ratio	0.08	0.87		0.32	0.25		0.66	0.63		0.18	0.82	
Control Delay	17.1	36.3		15.4	11.7		40.5	29.1		32.1	46.9	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	17.1	36.3		15.4	11.7		40.5	29.1		32.1	46.9	
Queue Length 50th (ft)	13	401		17	71		58	226		15	282	
Queue Length 95th (ft)	32	#621		34	108		#130	332		38	#399	
Internal Link Dist (ft)		1607			1801			860			1028	
Turn Bay Length (ft)	100			100			100			100		
Base Capacity (vph)	494	969		183	1125		202	797		196	638	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.07	0.76		0.32	0.22		0.66	0.55		0.16	0.72	

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 85.4
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Route 30 & Route 85





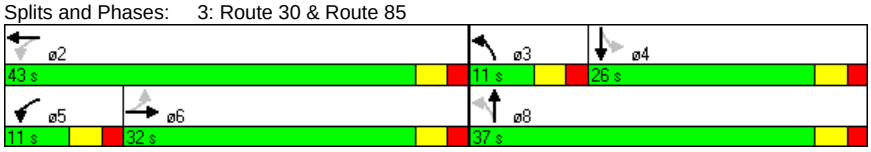
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	15	12	10	15	12	10	15	12	10	15	12
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.96		1.00	0.98		1.00	0.95		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1574	1955		1478	1907		1604	1866		1428	1981	
Flt Permitted	0.61	1.00		0.10	1.00		0.14	1.00		0.43	1.00	
Satd. Flow (perm)	1007	1955		155	1907		243	1866		639	1981	
Volume (vph)	33	526	161	51	183	27	123	281	121	26	354	29
Peak-hour factor, PHF	0.93	0.93	0.93	0.86	0.86	0.86	0.92	0.92	0.92	0.83	0.83	0.83
Adj. Flow (vph)	35	566	173	59	213	31	134	305	132	31	427	35
RTOR Reduction (vph)	0	12	0	0	6	0	0	0	0	0	3	0
Lane Group Flow (vph)	35	727	0	59	238	0	134	437	0	31	459	0
Heavy Vehicles (%)	7%	2%	7%	14%	8%	4%	5%	6%	9%	18%	4%	8%
Turn Type	Perm			pm+pt			pm+pt			Perm		
Protected Phases		6		5	2		3	8			4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	35.2	35.2		44.4	44.4		32.0	32.0		22.8	22.8	
Effective Green, g (s)	36.2	36.2		45.4	45.4		33.0	33.0		23.8	23.8	
Actuated g/C Ratio	0.42	0.42		0.53	0.53		0.38	0.38		0.28	0.28	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	422	819		161	1002		175	713		176	546	
v/s Ratio Prot		c0.37		c0.02	0.12		c0.05	0.23			0.23	
v/s Ratio Perm	0.03			0.17			c0.25			0.05		
v/c Ratio	0.08	0.89		0.37	0.24		0.77	0.61		0.18	0.84	
Uniform Delay, d1	15.1	23.2		17.6	11.1		21.1	21.5		23.8	29.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.1	11.5		1.4	0.1		17.9	1.6		0.5	11.2	
Delay (s)	15.2	34.7		19.0	11.2		39.0	23.1		24.3	40.7	
Level of Service	B	C		B	B		D	C		C	D	
Approach Delay (s)		33.8			12.8			26.8			39.7	
Approach LOS		C			B			C			D	

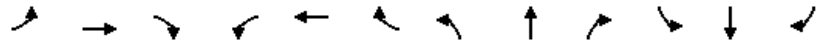
Intersection Summary			
HCM Average Control Delay	30.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	86.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	79.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	10	15	12	10	15	12	10	15	12	10	15	12
Storage Length (ft)	100		0	100		0	100		0	100		0
Storage Lanes	1		0	1		0	1		0	1		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (ft)	50	50		50	50		50	50		50	50	
Trailing Detector (ft)	0	0		0	0		0	0		0	0	
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00
Frt		0.942			0.988			0.973			0.992	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1685	1938	0	1668	2041	0	1668	1985	0	1600	1951	0
Flt Permitted	0.371			0.163			0.154			0.360		
Satd. Flow (perm)	658	1938	0	286	2041	0	270	1985	0	606	1951	0
Right Turn on Red			Yes			Yes			No			Yes
Satd. Flow (RTOR)		44			8						4	
Headway Factor	1.09	0.88	1.00	1.09	0.88	1.00	1.09	0.88	1.00	1.09	0.88	1.00
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		1687			1881			940			1108	
Travel Time (s)		38.3			42.8			21.4			25.2	
Volume (vph)	60	284	181	135	434	38	95	377	84	24	384	23
Peak Hour Factor	0.90	0.90	0.90	0.81	0.81	0.81	0.86	0.86	0.86	0.98	0.98	0.98
Heavy Vehicles (%)	0%	2%	1%	1%	1%	3%	1%	3%	0%	0%	1%	0%
Adj. Flow (vph)	67	316	201	167	536	47	110	438	98	24	392	23
Lane Group Flow (vph)	67	517	0	167	583	0	110	536	0	24	415	0
Turn Type	Perm			pm+pt			pm+pt			Perm		
Protected Phases		6		5	2		3	8			4	
Permitted Phases	6			2			8			4		
Detector Phases	6	6		5	2		3	8		4	4	
Minimum Initial (s)	6.0	6.0		6.0	6.0		6.0	10.0		10.0	10.0	
Minimum Split (s)	11.0	11.0		11.0	11.0		11.0	15.0		15.0	15.0	
Total Split (s)	32.0	32.0	0.0	11.0	43.0	0.0	11.0	37.0	0.0	26.0	26.0	0.0
Total Split (%)	40.0%	40.0%	0.0%	13.8%	53.8%	0.0%	13.8%	46.3%	0.0%	32.5%	32.5%	0.0%
Maximum Green (s)	27.0	27.0		6.0	38.0		6.0	32.0		21.0	21.0	
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lead/Lag	Lag	Lag		Lead			Lead			Lag	Lag	
Lead-Lag Optimize?												
Vehicle Extension (s)	2.0	2.0		3.0	2.0		3.0	2.0		2.0	2.0	
Recall Mode	Min	Min		None	Min		None	Min		Min	Min	
v/c Ratio	0.31	0.78		0.61	0.64		0.42	0.65		0.13	0.71	
Control Delay	24.0	29.6		22.9	17.9		19.3	21.4		24.0	32.5	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	24.0	29.6		22.9	17.9		19.3	21.4		24.0	32.5	
Queue Length 50th (ft)	24	201		44	192		30	189		8	183	
Queue Length 95th (ft)	57	318		72	249		63	294		30	#340	
Internal Link Dist (ft)		1607			1801			860			1028	
Turn Bay Length (ft)	100			100			100			100		
Base Capacity (vph)	266	810		274	1089		261	947		208	671	
Starvation Cap Reductn	0	0		0	0		0	0		0	0	
Spillback Cap Reductn	0	0		0	0		0	0		0	0	
Storage Cap Reductn	0	0		0	0		0	0		0	0	
Reduced v/c Ratio	0.25	0.64		0.61	0.54		0.42	0.57		0.12	0.62	

Intersection Summary	
Area Type:	Other
Cycle Length: 80	
Actuated Cycle Length: 65.8	
Natural Cycle: 65	
Control Type: Actuated-Uncoordinated	
#	95th percentile volume exceeds capacity, queue may be longer.
	Queue shown is maximum after two cycles.

Splits and Phases: 3: Route 30 & Route 85





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	15	12	10	15	12	10	15	12	10	15	12
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		0.95	0.95	
Frt	1.00	0.94		1.00	0.99		1.00	0.97		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1685	1937		1668	2041		1668	1984		1600	1951	
Flt Permitted	0.35	1.00		0.16	1.00		0.18	1.00		0.39	1.00	
Satd. Flow (perm)	627	1937		279	2041		311	1984		658	1951	
Volume (vph)	60	284	181	135	434	38	95	377	84	24	384	23
Peak-hour factor, PHF	0.90	0.90	0.90	0.81	0.81	0.81	0.86	0.86	0.86	0.98	0.98	0.98
Adj. Flow (vph)	67	316	201	167	536	47	110	438	98	24	392	23
RTOR Reduction (vph)	0	30	0	0	4	0	0	0	0	0	3	0
Lane Group Flow (vph)	67	487	0	167	579	0	110	536	0	24	412	0
Heavy Vehicles (%)	0%	2%	1%	1%	1%	3%	1%	3%	0%	0%	1%	0%
Turn Type	Perm			pm+pt			pm+pt			Perm		
Protected Phases		6		5	2		3	8			4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	20.2	20.2		29.4	29.4		27.6	27.6		18.4	18.4	
Effective Green, g (s)	21.2	21.2		30.4	30.4		28.6	28.6		19.4	19.4	
Actuated g/C Ratio	0.32	0.32		0.45	0.45		0.43	0.43		0.29	0.29	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	2.0		3.0	2.0		3.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	198	613		234	926		238	847		191	565	
v/s Ratio Prot		0.25		0.06	c0.28		0.04	c0.27				
v/s Ratio Perm	0.11			c0.27			0.16			0.04	0.21	
v/c Ratio	0.34	0.79		0.71	0.62		0.46	0.63		0.13	0.73	
Uniform Delay, d1	17.5	20.9		14.1	14.0		13.8	15.1		17.5	21.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.4	6.6		9.9	1.0		1.4	1.1		0.1	4.0	
Delay (s)	17.9	27.5		24.0	14.9		15.2	16.2		17.7	25.4	
Level of Service	B	C		C	B		B	B		B	C	
Approach Delay (s)		26.4			16.9			16.0			25.0	
Approach LOS		C			B			B			C	

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	67.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	92.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Design Designation Data Calculations

Vanasse Hangen Brustlin, Inc.

Project:	Route 30 at Route 85	Project #:	10832
Location:	Southborough, MA	Sheet:	1 of 1
Calculated by:	AEB	Date:	2/18/2011
Checked by:	PTN	Date:	2/18/2011
Title:	Design Designation Data - Main Street (Route 30) east of Route 85		

2009 Average Daily Traffic (ADT) =	4,381	+	3,834	=	8,215 vpd Tue 4-14-09	
Seasonally Adjusted ADT =	8,215	*	0.00%	=	8,215 vpd	
K Factor =	616 / 8,215	+	230	=	0.10 7:30 AM	
D =	616 / (616 + 230)			=	72.8% EB	
Peak Hour % Trucks =	17 / 846	+	19	=	4.3%	
Daily % Trucks =					2.0% (Assumed)	
2021 Design Year ADT = Background:	8,215	*	(1+.0075)^22	=	8,986	
Project:						
Other Specific Projects:						
			Total:		8,986 vpd	
DHV =	8,986	*	0.10	=	925 vph	
DDHV =	925	*	72.8%	=	674 vph	

Special Speed Regulation

Mr. Sullivan

APR 29 1981

TOWN OF SOUTHBOROUGH
SPECIAL SPEED REGULATION NO. 6037

Highway Location: SOUTHBOROUGH

Authority In Control: TOWN OF SOUTHBOROUGH

Name of Highway: JERICHO HILL ROAD JOHNSON ROAD
FISHER ROAD FRAMINGHAM RD.
NORTHBORO ROAD RTES. 30 & 85

In accordance with the provisions of Chapter 90, Section 18, of the General Laws (Ter. Ed.) as amended, the following Special Speed Regulation is

hereby Adopted

by the Board of Selectmen

of the Town of Southborough

That the following speed limits are established at which motor vehicles may be operated in the areas described:

JERICHO HILL ROAD-NORTHBOUND

Beginning at Fisher Road
Thence northerly on Jericho Hill Road
0.45 miles at 35 miles per hour ending at Marlboro City Line; the total distance being 0.45 miles.

JERICHO HILL ROAD-SOUTHBOUND

Beginning at the Marlboro City Line
Thence southerly on Jericho Hill Road
0.40 miles at 35 miles per hour
0.05 " " 20 " " " ending at Fisher Road; the total distance being 0.45 miles.

FISHER ROAD-EASTBOUND

Beginning at a point 100 feet east of Jericho Hill Road
Thence easterly on Fisher Road
0.78 miles at 40 miles per hour
0.48 " " 35 " " " ending at the Marlboro City Line; the total distance being 1.26 miles.

FISHER ROAD-WESTBOUND

Beginning at the Marlboro City Line
Thence westerly on Fisher Road
0.48 miles at 35 miles per hour
0.75 " " 40 " " "
0.05 " " 20 " " " ending at Jericho Hill Road; the total distance being 1.28 miles.

NORTHBORO ROAD-EASTBOUND

Beginning at Marlboro City Line
Thence easterly on Northboro Road
0.79 miles at 35 miles per hour
0.50 " " 20 " " "
0.48 " " 30 " " "
0.06 " " 20 " " " ending at Main Street (Route 30); the total distance being 1.83 miles.

NORTHBORO ROAD-WESTBOUND

Beginning at a point 300 feet west of Main Street (Route 30)
Thence westerly on Northboro Road
0.48 miles at 30 miles per hour
0.50 " " 20 " " "
0.79 " " 35 " " " ending at the Marlboro City Line; the total distance being 1.77 miles.

JOHNSON ROAD-NORTHBOUND

Beginning at Main Street (Route 30)
Thence northerly on Johnson Road
0.27 miles at 35 miles per hour
0.05 " " 20 " " " ending at Northboro Road; the total distance being 0.32 miles.

JOHNSON ROAD-SOUTHBOUND

Beginning at Northboro Road
Thence southerly on Johnson Road
0.27 miles at 35 miles per hour
0.05 " " 20 " " " ending at Main Street (Route 30); the total distance being 0.32 miles.

FRAMINGHAM ROAD-NORTHBOUND

Beginning at Route 30
Thence northerly on Framingham Road
0.20 miles at 30 miles per hour
1.25 " " 40 " " "
0.04 " " 30 " " " ending at Route 85; the total distance being 1.49 miles.

FRAMINGHAM ROAD-SOUTHBOUND

Beginning at a point 200 feet south of Route 85
Thence southerly on Framingham Road
1.25 miles at 40 miles per hour
0.20 " " 30 " " " ending at Route 30; the total distance being 1.45 miles.

ROUTE 30-EASTBOUND

Beginning at the end of State Highway
Thence easterly on Route 30
0.30 miles at 30 miles per hour
0.60 " " 25 " " "
0.17 " " 20 " " "
0.48 " " 30 " " "
0.32 " " 40 " " " ending at the beginning of State Highway; the total distance being 1.87 miles.

ROUTE 30-WESTBOUND

Beginning at the end of State Highway
Thence westerly on Route 30
0.32 miles at 40 miles per hour
0.48 " " 30 " " "
0.17 " " 20 " " "
0.60 " " 25 " " "
0.30 " " 30 " " " ending at the beginning of State Highway the total distance being 1.87 miles.

ROUTE 85-NORTHBOUND

Beginning at the Hookington Town Line
Thence northerly on Route 85
0.38 miles at 30 miles per hour
1.32 " " 40 " " " ending at the beginning of State Highway south of Route 9

And beginning again at the end of State Highway north of Route 9
Thence northerly on Route 85
0.81 miles at 40 miles per hour
0.19 " " 25 " " "
0.79 " " 40 " " "
0.26 " " 30 " " "
0.55 " " 40 " " " ending at the Marlboro City Line; the total distance being 4.30 miles.

ROUTE 85-SOUTHBOUND

Beginning at the Marlborough City Line
Thence southerly on Route 85
0.55 miles at 40 miles per hour
0.26 " " 30 " " "
0.79 " " 40 " " "
0.19 " " 25 " " "
0.81 " " 40 " " " ending at the beginning of State Highway north of Route 9

ROUTE 85-SOUTHBOUND (Cont.'d)

And beginning again at the end of State Highway south of Route 9 Thence southerly on Route 85

1.32 miles at 40 miles per hour
0.38 " " 30 " " " ending at the Hookington Town Line; the total distance being 4.30 miles.

Operation of a motor vehicle at a rate of speed in excess of these limits shall be prima facie evidence that such speed is greater than is reasonable and proper.

The provisions of this regulation shall not, however, abrogate in any sense Chapter 90, Section 14, of the general Laws (Ter. Ed.)

Date of Passage April 7, 1981

Board of Selectmen

Attest Paul J. Berry
Town Clerk

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS

SPECIAL SPEED REGULATION NO. 6037

The Department of Public Works and the Registrar of Motor Vehicles, acting jointly, do hereby certify that this regulation is consistent with the public interests.

Standard signs must be erected at the beginning of each zone.

DATE: APR 29 1981

FOR THE DEPARTMENT OF PUBLIC WORKS

BY: Traffic Engineer

Robert A. Pasma
Chief Deputy Registrar