

# **AN EVALUATION OF RATIONALLY IMPLEMENTED SPEED LIMITS ON COLLECTOR ROADWAYS**

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## **ABSTRACT**

To address speed-related safety issues the U.S. Department of Transportation established a Speed Management Team which, in turn established an experimental projects related to the implementation and evaluation of rationally established speed limits. By definition, a rationally established speed limit is one that is based upon formal review and engineering study and is reflective of realistic roadway speeds, which are reasonable under normal travel conditions. An additional benefit expected with rationally determined speed limits is the establishment of a reasonable enforcement threshold for law enforcement personnel, and allows for strict, yet fair, enforcement of the speed limit. The specific goal of this project was to evaluate the Massachusetts rational speed limit demonstration project, which in addition to the rational speed limits included a rigorous enforcement campaign as well as an intense public information and education (PI &E) campaign. For six project roadways implementation of the rational speed limit meant an increase of five mph along each roadway. Data from almost 1.5 million free flow vehicles was collected over a 20-month time frame and provided 85<sup>th</sup>, 95<sup>th</sup>, and mean speeds for each of 12 data collection locations. In general, the speed parameters tended to reduce by one to two mph during the enforcement period, and later increased during the post enforcement period. During the post-enforcement period, the 85<sup>th</sup> percentile speed increased, on average, 0.3mph. In some instances the speed remained constant throughout all stages of the project, and in fewer instances, the speeds in the post enforcement period exceeded the initial baseline speed parameters. Based upon the information collected in pre and post opinion surveys, the community residents were aware of the project, the rational speed concept, and more importantly, they supported both the increase in speed and enforcement. Overall the project was considered to be a success by those involved based upon several of the documented findings and lessons learned:

## **INTRODUCTION**

According to documented crash statistics, speed is frequently cited as a significant factor in roadway crashes as the National Highway Traffic Safety Administration (NHTSA) reports that is a factor in 31 percent of all crash fatalities along U.S. roadways (1). In Massachusetts, speed was reported as a contributing factor in 34 percent of all roadway fatalities, and 4,193 speed-related citations were issued where a crash occurred in 2003. By definition, speeding is considered to be traveling at a rate of speed in excess of the posted legal limit or at a rate of speed that is too fast for the prevailing conditions (1). To address speed-related safety issues the U.S. Department of Transportation established a Speed Management Team with the mission of the Speed Management Team, which includes representatives from the Federal Highway Administration (FHWA), Federal Motor Carrier Safety Administration, and NHTSA, is to promote speed management and aid in the reduction of speeding-related injuries and deaths along U.S. roadways (2). Established goals resulting from the defined mission include the following: the development of strategies to effectively manage speed; the development of rational criteria for setting speed limits; and innovative and effective speed enforcement methods, strategies, and programs.

In accordance with both the mission and goals, the Speed Management Team initiated a series of demonstration projects related to the implementation and evaluation of rationally established speed limits. By definition, a rationally established speed limit is one that is based upon formal review and engineering study and is reflective of realistic roadway speeds, which are reasonable under normal travel conditions. An additional benefit expected with rationally determined speed limits is the establishment of a reasonable enforcement threshold for law enforcement personnel, and allows for strict, yet fair, enforcement of the speed limit. The specific goal of this project was to evaluate the Massachusetts rational speed limit demonstration project, which in addition to the rational speed limits included a rigorous enforcement campaign as well as an intense public information and education (PI &E) campaign. The conceptual idea behind the demonstration effort was to determine the impact of such a program on speeds, safety, public opinion, and overall feasibility of implementation. As a result a multi-faceted project evaluation was developed to include components such as speed data collection and analysis, crash and citation analyses, public opinion surveys, and testimonials of those tasked with implementing the project. The following sections detail the various stages of project implementation and the evaluation methodology.

## **PROJECT IMPLEMENTATION**

Following the establishment of selection criteria for candidate communities and completion of a request-for-response process, the Massachusetts demonstration project was conducted in Natick, Massachusetts in concert with the GHSB's Speedwatch programming effort. Natick, with a population of approximately 32,170, is located 18 miles southwest of Boston, and from a traffic safety perspective was well-suited for the demonstration project based upon the following:

- Traffic safety frequently ranks among priority issues in town polls;
- The police department has a dedicated traffic safety unit and internal policies regarding enforcement, which were consistent with the project goals; and

- An existing Traffic Safety Committee, chaired by the Chief of Police, which could provide town level project support, and more importantly, had the authority for posting advisory signage.

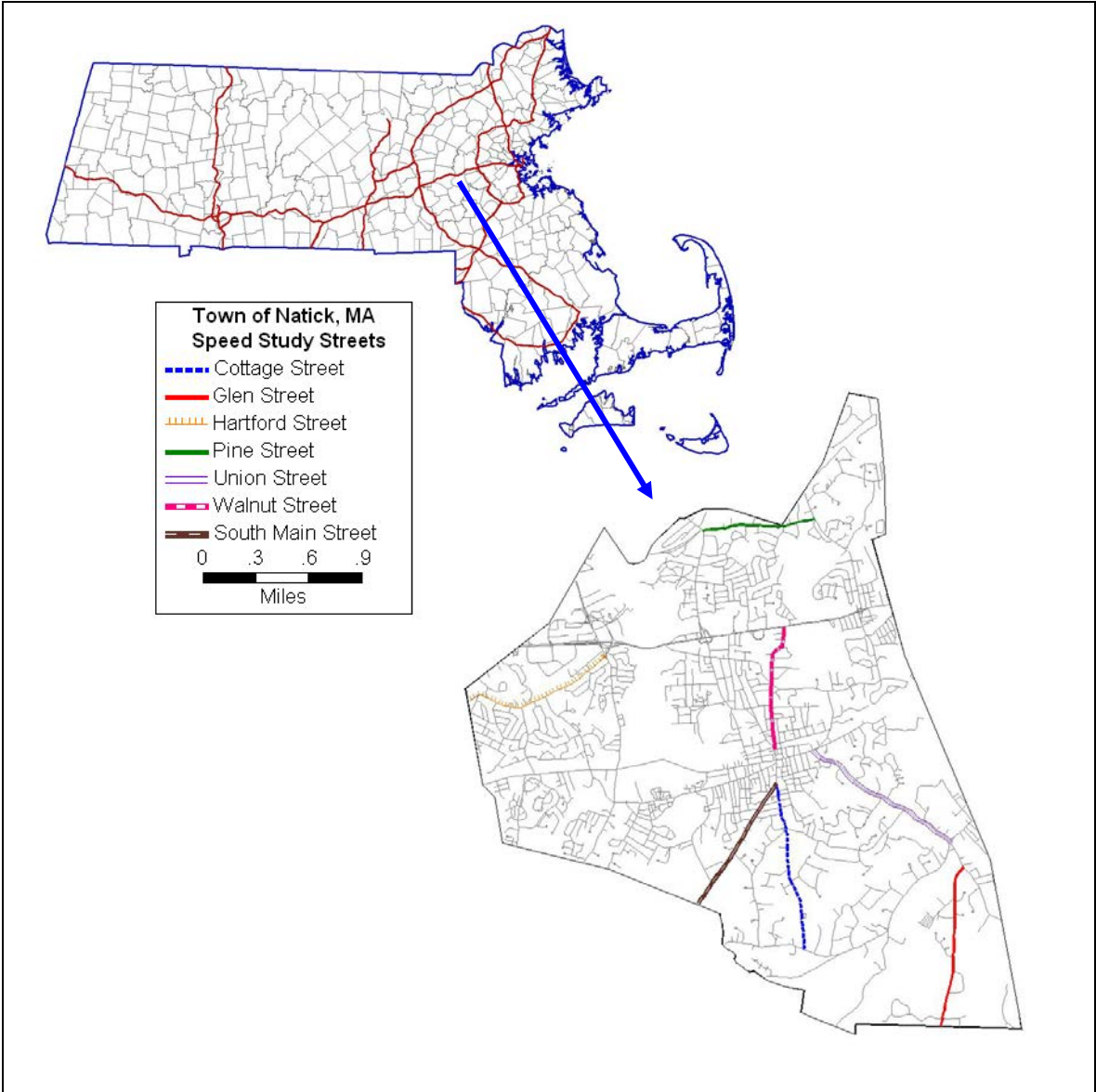
In conjunction with the Natick Police Department six candidate roadways were selected for inclusion in the demonstration project in the fall of 2002, pending an initial evaluation of roadway speeds, crash history and review of roadway features. Figure 1 presents an overall project locus and layout of the project roadways within the Town of Natick. The selected roadways were each functionally classified collector roadways that were predominantly residential in land use; typical cross-sections are presented in Figure 2. Additionally, each of the existing roadways are approximately one mile in length with limited horizontal and vertical changes in alignment.

All selected roadways were initially unposted (i.e., no regulatory speed limit signs) with established 30 mile per hour prima facie speed limits in accordance with Massachusetts General Law (MGL) Chapter 90 Section 17 which states (3):

*No person operating a motor vehicle on any way shall run it at a rate of speed greater than is reasonable and proper, having regard to traffic and the use of the way and the safety of the public. Unless a way is otherwise posted in accordance with the provisions of section eighteen, it shall be prima facie evidence of a rate of speed greater than is reasonable and proper as aforesaid ... (3) inside a thickly settled or business district at a rate of speed exceeding thirty miles per hour for a distance of one-eighth of a mile.*

In the context of Massachusetts General Law, “thickly settled or business district” is defined as follows (4):

*The territory contiguous to any way which is built up with structures devoted to business, or the territory contiguous to any way where the dwelling houses are situated at such distances as will average less than two hundred feet between them for a distance of a quarter of a mile or over.*



**Figure 1 Project Locus and Roadway Location.**



**Figure 2 Typical Project Roadway Cross-Section and Land Use.**

Following completion of the initial engineering study, baseline data collection, and overall roadway assessment, all materials were presented to the Natick Traffic Safety Committee, who in accordance with the project recommendations agreed to post advisory speed signage reflecting the 85<sup>th</sup> percentile speed rounded down to the nearest five mile per hour increment. For project roadways, the revision resulted in an increase of 5 miles per hour from the existing 30 miles per hour prima facie limit. In reality, the speed limit on record had not been changed, in that the speed limit remained 30 miles per hour in accordance with the prima facie limit; however the posted advisory signage was symbolic of the newly adopted enforcement threshold to be publicized on both the signage and in PI & E campaigns. The rationale for accepting this policy was based upon the lack of perceived understanding related to prima facie laws. It is imperative to note that the advisory nature of the signs was necessary for two reasons: 1) it is within the purview of the Natick Traffic Committee to post such signage (MassHighway is the state agency responsible for establishing all speed zones MGL Chapter 90 Section 18) and 2) it is reflective of the experimental nature of the project and could easily be removed following project completion.

The date at which the revised speed limits were posted varied across the six project roadways. Specifically, three roads were posted in May 2003, while the remaining three streets were posted in July of 2003. The staggered posting date was directly related to requirements associated with pre- and post opinion surveys, which were part of the project evaluation and discussed in further detail later in this paper. In addition to the revision of speed limits, other essential elements of the project implementation included the following:

- Educational meetings were held with judicial branch responsible for contested citations written under the auspices of the demonstration project;
- Rigorous enforcement campaign, which featured approximately 200 hours of enforcement per project roadway was undertaken. The enforcement period for each street was initiated shortly after each roadway was posted with the revised speed limit and lasted seven months for the initially posted streets and four months for the second group of roadways with all enforcement ending in November 2003;
- The PI&E campaign remained ongoing during enforcement campaign and included educational materials (hand cards), press releases and articles, variable message signs, banners, speed trailers, and community meetings (residents of each project roadway were invited to a community meeting to discuss project details).

## **EVALUATION METHODOLOGY**

To adequately evaluate all facets of the demonstration project, a comprehensive evaluation plan was developed. The Massachusetts Traffic Safety Research Program (MassSAFE), a program of the GHSB at the University of Massachusetts Amherst, was subcontracted by the GHSB to conduct all components of the project evaluation which included the following elements:

- Baseline data collection and safety review;
- Speed data analysis;
- Citation data analysis;
- Crash data analysis; and
- Pre and post opinion survey.

In addition to the data collection efforts along project roadways in Natick, similar data were compiled in nearby Auburn, MA by Westat to serve as a comparison location, where no such treatment was enacted. A finalized project evaluation currently underway will document and compare the findings in both the demonstration (Natick) and comparison (Auburn) communities.

### **Baseline Data Collection and Safety Review**

As previously noted, the identification of project roadways was completed in cooperation with the Natick Police Department. Following an initial site review more formal reviews of each roadway's characteristics were undertaken. Specifically, a roadway safety review (e.g. a formalized checklist evaluation for any roadway features, which may impact project results), a sign inventory, crash analysis, and speed data collection study were completed. The results of the review, inventory, and initial crash analysis were compiled and sent to the entire project team for consideration.

For the collection of speed data, Jamar pneumatic tubes were used in *basic* format, which allows for the recording of each passing axle and provides individualized vehicle data, including the essential parameters of travel direction, time, speed, gap, and vehicle classification. Data were collected in each direction at two different locations on each project roadway, resulting in 12 total data collection locations, which remained consistent throughout the duration of the project. The data collection locations were near end points of the concerned segment, so as to capture speeds for vehicles entering and exiting the project location. All efforts were made to avoid areas that may adversely impact data collection efforts, including roadway junctions, curves, traffic signals, etc. The initial, or early baseline, data collection was completed in November 2002. Baseline speed data collection was completed following the winter months. At this time one initial roadway was replaced due to significant damage from the previous winter conditions.

### **Speed Data Analysis**

Speed data collection remained ongoing throughout the duration of the project, consistent with the procedure described in the previous section (e.g., pneumatic road tubes, two locations per roadway). Table 1 summarizes the number of complete 24-hour weekday periods of data at each data collection location; there were some instances during which portions of data were available, but did not complete a 24-hour period. Additionally, data collection was not completed at each location during each data collection period for an assortment of possible reasons. Scenarios under which data was not collected, included, but were not limited to, scheduling, tube failures, road conditions, or vandalism, and these scenarios are characterized by a "0" in Table 1. Nevertheless speed data were collected in excess of the initially established goal of once per quarter.

The analysis of speed data was centered on evaluating customary speed values throughout the various project stages. Specifically, the following speed parameters were recorded:

- 85<sup>th</sup> and 95<sup>th</sup> percentile speeds;
- Median speeds;
- Mean speeds; and
- Speed variance.

**Table 1 Complete 24-hour Periods of Data for each Data Collection Location**

Road	Sign Date <sup>a</sup>	Loc. No. & Abbr <sup>b</sup>	Data Collection Year											
			2002	2003						2004				
			Nov	Apr	Jun	Jul	Aug	Sep	Oct	Nov	Jan	Mar	May	Jun
South Main	May 2003	1 SMN	0	3	2	7	3	4	3	0	2	5	2	2
		2 SMS	0	3	7	7	3	4	3	4	2	5	2	2
Cottage	July 2003	3 CN	0	0	5	0	3	4	3	1	0	5	4	2
		4 CS	0	0	5	7	3	4	3	3	0	5	4	3
Walnut	May 2003	5 WN	5	0	7	6	3	3	3	0	0	5	4	3
		6 WS	5	0	10	5	3	3	3	5	0	5	4	3
Pine	July 2003	7 PW	5	0	2	3	3	4	2	2	0	5	3	3
		8 PE	5	0	5	8	3	4	0	3	0	5	2	2
Hartford	May 2003	9 HW	0	3	6	5	3	4	3	2	0	5	4	3
		10 HE	0	3	2	8	3	4	3	0	0	3	3	0
Union	June 2003	11 UNW	2	0	0	4	3	3	2	1	1	5	0	2
		12 USE	5	0	0	2	3	3	2	1	0	5	0	2

<sup>a</sup> Date revised advisory speed signage was posted and shading corresponds to enforcement period;

<sup>b</sup> Location number and abbreviated name (by geography) by which each data collection location is referenced (e.g. South Main Street's northern location is referenced as count location 1 SMN)

Speed data were only considered from complete 24-hour periods in order to account for potential variations by time of day. Additionally, the speed analysis was focused on free flow vehicles, which were identified by vehicle gaps greater than or equal to 6 seconds; note that all speed data, including non-free flow vehicles, were recorded for use in a potential analysis to determine the effect of gaps and free flow definitions on observed vehicle speeds.

### Crash and Citation Data Analysis

In addition to the speed data collected in the field, crash and citation data were collected throughout the project. A citation database was made available by the Natick Police Department. All issued citations and warnings were collected for each of the six project roadways. From a speed enforcement perspective, all issued citations were in accordance with MGL Chapter 90 Section 17 because the roadways were covered under prima facie speed limits.

### Pre and Post Opinion Survey

In addition to the analyses of driver speed behavior, vehicle crash, citation and related observable data, MassSAFE engaged the University of Massachusetts Donahue Institute to collect pre- and post-intervention public opinion data through a survey of Natick residents. Survey content focused on respondents' personal attributes, views on speeding and enforcement in Natick, and self-reported driving behaviors on intervention roadways. In addition, the post-intervention survey measured perceived changes in speed limits, enforcement, and driving behaviors over the course of the program. Both the pre- and post-intervention surveys were administered to residents of Natick and its immediate environs through a telephone interview process. All respondents were informed of the confidentiality of their responses and cooperated voluntarily.

Community residents who live on one of the intervention roadways were targeted for inclusion in the survey sample through the use of listed sample provided by the Natick Police Department. All other respondents were contacted through a random digit dial process.



Among respondents, 162 (41%) resided within an area defined by MassSAFE as an “intervention neighborhood.” Using the listed sample information and respondent address data obtained through a reverse-directory lookup, intervention neighborhood status was assigned to survey participants living on one of the selected intervention roadways or on a street directly adjacent to one of these roadways. Additionally, if a series of residential streets are connected and the only community exit is an intervention roadway, the street is considered part of the intervention neighborhood. The only exceptions to these coding rules are major roadways such as routes 27 and 16 that may border an intervention roadway. These major roads were uniformly designated non-neighborhood. All other survey respondents were considered to be “non-neighborhood”, and as a result were assumed to have less direct exposure to components of the demonstration project.

## **DATA ANALYSIS AND RESULTS**

The multifaceted project evaluation yielded an abundant amount of data. The general approach throughout the various analyses was to track and quantify changes over time, with a focus on the following project stages:

- Baseline – prior to the revision of speeds;
- Enforcement – during the rigorous enforcement and public information and education period campaign which was initiated with the revised speed limit signage. Note that for three project roadways this stage was initiated in May (2003), and the remaining three roadways were revised in July (2003);
- Post-enforcement – period following the end of rigorous enforcement period, which for all roadways ended in October (2003). Data collection continued through June (2004), such that the revised signage had been posted for one calendar year on all six roadways.

The baseline data collection elements, such as the review, inventory, and initial crash analysis were used in the project implementation stages and discussed previously. The remaining data analysis and results are discussed in the following sections.

### **Speed Data Analysis**

In accordance, with the data collection periods highlighted in Table 1, a total of 406 24-hour periods over a 20-month time frame, including approximately 1.5 million free flow vehicles were observed. An initial review of the collected data yielded variations in speed characteristics across locations on a given roadway. As a result, the data at each data collection location (two per project roadway) were analyzed separately. For each data collection location, a table describing all speed parameters for each grouped (combined 24-hour periods) collection period is included. These elements are presented for each roadway (and subsequently each data collection location) in Tables 2 through 7, respectively.

As shown in Table 2 at the South Main Street North data collection location, the baseline 85<sup>th</sup>, 95<sup>th</sup>, and means speeds of 40, 38 and 33.5 mph, respectively were higher than the all equivalent values during the enforcement and public information and education campaigns. During the post enforcement periods four of the 11 24-hour periods had 95<sup>th</sup> percentile speeds equal to the baseline value and one 24-hour period in excess. Nevertheless, the 85<sup>th</sup> and mean speeds remained lower than original baseline levels during the post enforcement period. Similar

trends were observed at the southern data collection location on South Main Street (Table 2) where all values recorded after the initial baseline period (85<sup>th</sup>, 95<sup>th</sup>, and mean) were lower than the initial baseline values.

**Table 2 Speed Parameters for Grouped Data on South Main Street**

<b>South Main Street – North Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
4/15-4/18	2003	14,716	38	40	33.53	34	12.79
Sign revision, enforcement and PI and E campaigns begin							
6/6-6/19	2003	9,694	36	38	31.90	32	12.87
6/30- 7/3		14,383	36	39	32.06	32	12.76
7/7-7/10		14,058	36	39	32.17	32	12.50
7/14-7/17		9,694	36	39	32.46	32	12.45
8/27 to 8/29		14,373	35	38	31.36	31	12.85
9/15 to 9/19		18,859	36	38	31.81	32	12.82
10/20 to 10/24		13,999	36	39	31.88	32	12.78
Enforcement and PI and E campaigns end							
3/22 to 3/26	2004	23,872	36	39	31.51	32	18.38
5/17 to 5/20		10,039	36	39	31.21	32	17.92
6/29 to 7/1		6,551	38	40	32.75	33	17.67
<b>South Main Street – South Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
4/15 to 4/18	2003	13,495	42	45	37.65	38	12.40
Sign revision, enforcement and PI and E campaigns begin							
6/05 to 6/06	2003	10,826	40	42	35.27	35	12.41
6/09 to 6/10		9,094	39	42	35.06	35	12.46
6/16 to 6/19		13,193	40	43	35.59	36	12.58
6/23 to 6/26		8,932	40	42	35.30	35	12.65
6/30 to 7/03		13,625	40	42	35.47	36	12.03
7/07 to 7/10		13,063	40	42	35.31	35	12.30
7/14 to 7/17		9,069	40	42	35.69	36	11.80
8/27 to 8/29		13,353	39	42	34.89	35	12.13
9/15 to 9/19		16,961	39	42	34.80	35	12.30
10/20 to 10/24		12,887	39	41	35.19	35	12.13
Enforcement and PI and E campaigns end							
11/10 to 11/14	2003	3,862	37	40	32.74	33	13.94
3/22 to 3/26	2004	22,337	40	43	34.86	36	16.71
5/17 to 5/20		9,122	40	43	34.82	36	17.20
6/29 to 7/1		8,296	38	40	34.79	35	17.16

The speed sign revision, and subsequent enforcement period, was initiated in July of 2003 along Cottage Street resulting in a four-month enforcement and public information and education campaign. For both data collection locations the speed parameters remained fairly constant from the baseline through the enforcement period. At the North location, as shown in Table 3, the speed parameters increased slightly in the post enforcement period, with much higher values during the final data collection effort one year following the sign revision. At the South location along Cottage Street, post enforcement values were consistent with previous values, with the exception of two 24-hour periods; however, considering the grouped data (Table 3) the trends are approximately equal throughout the duration of data collection.

**Table 3 Speed Parameters for Grouped Data on Cottage Street**

<b>Cottage Street – North Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
6/16 to 6/19	2003	10,416	35	37	30.89	31	12.34
6/23 to 6/26		6,827	35	37	30.63	31	12.80
<b>Sign revision, enforcement and PI and E campaigns begin</b>							
8/27 to 8/29	2003	8,988	35	37	30.69	31	13.54
9/15 to 9/19		11,845	35	37	30.50	31	14.58
10/20 to 10/24		8,983	36	38	31.27	32	14.33
<b>Enforcement and PI and E campaigns end</b>							
11/10 to 11/14	2003	2,329	36	39	31.92	32	13.54
3/22 to 3/26	2004	15,496	37	40	31.45	32	17.82
5/17 to 5/20		14,806	35	38	30.00	31	18.02
6/29 to 7/1		5,301	43	47	37.27	37	15.18
<b>Cottage Street – South Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
6/16 to 6/19	2003	4,463	41	44	36.37	36	13.07
6/23 to 6/26		2,933	41	44	36.14	36	13.30
6/30 to 7/03		4,171	41	45	36.80	36	13.42
7/07 to 7/10		1,327	41	44	36.30	36	12.76
<b>Sign revision, enforcement and PI and E campaigns begin</b>							
7/14 to 7/17	2003	2,889	41	44	36.31	36	12.85
8/27 to 8/29		3,919	40	43	35.60	36	12.28
9/15 to 9/19		5,025	40	43	35.86	36	12.01
10/20 to 10/24		4,231	40	44	36.09	36	12.67
<b>Enforcement and PI and E campaigns end</b>							
11/10 to 11/14	2003	3,930	41	44	36.38	36	12.20
3/22 to 3/26	2004	6,383	41	44	36.37	36	13.36
5/17 to 5/20		6,367	43	47	37.68	38	14.61
6/29 to 7/1		4,284	41	44	36.28	36	13.68

Walnut Street was among the first streets to implement the revised speed signage. As shown in Table 4, following the baseline data collection, the 85<sup>th</sup>, 95<sup>th</sup> percentile, and mean speeds at the Walnut Street North location tended to decrease by approximately one to two miles per hour during the seven month enforcement period. At this location, speeds in the post enforcement location were similar to the original baseline conditions. At the Walnut Street South location the three speed parameters remained nearly constant across all data collection periods, with a slight decrease in speed values in July and August of 2003.

**Table 4 Speed Parameters for Grouped Data on Walnut Street North**

<b>Walnut Street – North Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
11/19 to 11/27	2002	9,599	37	40	32.26	32	14.56
Sign revision, enforcement and PI and E campaigns begin							
6/05 to 6/06	2003	3,830	36	39	31.54	32	13.55
6/16 to 6/19		3,382	35	38	31.03	31	14.16
6/23 to 6/26		5,003	35	39	31.05	31	14.14
6/30 to 7/03		3,275	35	39	30.96	31	14.66
7/07 to 7/10		3,463	35	38	30.9	31	14.03
7/14 to 7/17		3,378	35	38	31.005	31	13.97
8/27 to 8/29		5,325	35	38	30.98	31	13.91
9/15 to 9/19		5,191	35	38	30.66	31	13.81
10/20 to 10/24		5,704	36	38	31.22	31	13.57
Enforcement and PI and E campaigns end							
11/10 to 11/14	2003	2,835	33	35	29.07	29	12.72
3/22 to 3/26	2004	8,847	37	40	32.32	32	15.52
5/17 to 5/20		7,862	35	38	30.49	31	16.31
6/29 to 7/1		5,582	37	40	31.80	32	15.72
<b>Walnut Street – South Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
11/19 to 11/27	2002	10,227	34	37	28.86	29	16.56
Sign revision, enforcement and PI and E campaigns begin							
6/05 to 6/06	2003	4,298	34	37	29.00	29	16.99
6/09 to 6/10		3,826	34	37	29.11	29	17.12
6/12 to 6/13		3,963	34	37	29.11	29	16.35
6/16 to 6/19		3,581	34	37	29.24	29	16.81
6/23 to 6/26		3,534	35	37	29.44	29	16.68
7/07 to 7/10		5,506	34	37	29.21	29	15.74
7/14 to 7/17		3,634	34	36	28.73	29	16.16
8/27 to 8/29		6,581	32	35	28.06	28	15.15
9/15 to 9/19		6,902	34	36	29.19	29	14.88
10/20 to 10/24		7,082	34	37	29.63	30	15.54
Enforcement and PI and E campaigns end							
11/10 to 11/14	2003	10,679	34	37	29.28	29	15.56
3/22 to 3/26	2004	9,718	34	37	28.75	29	18.87
5/17 to 5/20		8,744	33	36	27.32	28	20.33
6/29 to 7/1		5,916	33	36	27.69	28	20.40

Speed trends along Pine Street varied by location (see Table 5). Specifically, at the Pine Street West location the observed speed parameters during the baseline periods were higher than during both the enforcement and post enforcement periods. Between those two project stages, speeds increased in the post enforcement period as compared to the enforcement period. At the Pine Street East location, the observed difference in speeds was less pronounced. Trends in the baseline and post enforcement periods were nearly identical, and slightly lower during the enforcement period.

**Table 5 Speed Parameters for Grouped Data on Pine Street**

<b>Pine Street – West Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
11/19 to 11/27	2002	20,444	42	46	36.91	37	14.62
6/23 to 6/26	2003	13,044	37	39	32.81	33	12.25
6/30 to 7/03		12,405	39	41	34.79	35	11.88
<b>Sign revision, enforcement and PI and E campaigns begin</b>							
8/27 to 8/29	2003	11,935	37	40	33.62	33	11.71
9/15 to 9/19		11,820	37	40	33.33	33	12.01
10/20 to 10/24		8,305	35	38	31.61	32	12.32
<b>Enforcement and PI and E campaigns end</b>							
11/10 to 11/14	2003	7,779	35	38	31.64	32	12.19
3/22 to 3/26	2004	18,355	39	41	35.23	35	11.21
5/17 to 5/20		12,123	39	41	34.73	35	12.06
6/29 to 7/1		12,020	39	41	34.69	35	12.30
<b>Pine Street – East Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
11/19 to 11/27	2002	20,159	36	39	32.07	32	12.69
6/12 to 6/13	2003	8,731	36	39	32.33	32	12.38
6/16 to 6/19		12,826	37	39	32.61	31	11.82
6/30 to 7/03		12,534	37	39	32.72	33	12.42
7/07 to 7/10		12,261	37	39	32.76	33	12.39
<b>Sign revision, enforcement and PI and E campaigns begin</b>							
7/14 to 7/17	2003	4,854	35	38	31.47	31	12.25
8/27 to 8/29		11,989	35	37	31.20	31	12.27
9/15 to 9/19		11,945	35	37	31.09	31	12.56
10/20 to 10/24		3,501	38	41	34.94	35	10.70
<b>Enforcement and PI and E campaigns end</b>							
11/10 to 11/14	2003	11,806	35	38	31.65	32	12.27
3/22 to 3/26	2004	19,645	36	39	32.04	32	14.67
5/17 to 5/20		8,293	36	39	31.71	32	16.38
6/29 to 7/1		8,410	36	39	32.11	32	13.63

For the first three months of the enforcement periods, the speeds were consistent with the baseline conditions, at which time the 85<sup>th</sup>, 95<sup>th</sup> percentile, and mean speeds decreased by one mile per hour at the Hartford Street West location as shown in Table 6. The speed values varied in the post enforcement period, with high speeds in March (10 months after sign revision and 4 months following enforcement) and low speeds in May. Also shown Table 6, Hartford Street West speeds remained constant through all stages of the project.

**Table 6 Speed Parameters for Grouped Data on Hartford Street**

<b>Hartford Street – West Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
4/15 to 4/18	2003	19,147	39	42	35.06	35	11.95
Sign revision, enforcement and PI and E campaigns begin							
6/12 to 6/13	2003	13,220	39	42	34.87	35	11.60
6/16 to 6/19		12,725	39	41	34.65	35	12.07
6/23 to 6/26		12,288	39	42	34.43	35	13.11
6/30 to 7/03		6,523	39	42	35.34	35	11.33
7/07 to 7/10		12,864	39	42	34.95	35	11.45
8/27 to 8/29		24,169	38	41	34.23	34	12.00
9/15 to 9/19		12,077	38	41	34.03	34	11.35
10/20 to 10/24		18,714	38	41	34.42	34	11.77
Enforcement and PI and E campaigns end							
11/10 to 11/14	2003	12,167	39	42	35.17	35	11.79
3/22 to 3/26	2004	30,579	40	43	35.65	36	12.28
5/17 to 5/20		10,903	37	40	32.87	33	15.44
6/29 to 7/1		6,219	39	41	34.25	34	13.46
<b>Hartford Street – East Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
4/15 to 4/18	2003	17,990	38	40	33.38	33	13.41
Sign revision, enforcement and PI and E campaigns begin							
6/23 to 6/26	2003	12,619	38	41	33.91	34	12.58
6/30 to 7/03		6,105	37	40	33.32	33	13.07
7/07 to 7/10		12,373	37	40	32.94	33	11.95
7/14 to 7/17		12,161	38	40	33.58	33	11.99
8/27 to 8/29		17,380	38	41	33.93	34	12.53
9/15 to 9/19		21,345	38	41	33.83	34	12.85
10/20 to 10/24		11,111	38	41	33.57	34	13.82
Enforcement and PI and E campaigns end							
11/10 to 11/14	2003	2,685	39	41	34.33	34	12.60
3/22 to 3/26	2004	17,923	38	41	34.00	34	14.89
5/17 to 5/20		19,511	38	41	34.46	34	11.75

The observed speed values along Union Street are presented in Figures 14 and 15 along with Table 12 and 13. At the Northwest location the speeds were relatively constant throughout with approximately five 24-hour periods with slight reduced speeds during the enforcement stage. At the Southeast location, the speed parameters were generally one mile per hour lower during the enforcement period than in both the baseline and post enforcement periods.

**Table 7 Speed Parameters for Grouped Data on Union Street**

<b>Union Street – Northwest Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
11/15 to 11/18	2002	9,361	37	40	33.406	33	11.81
7/07 to 7/10	2003	10,451	37	39	33.07	33	11.79
Sign revision, enforcement and PI and E campaigns begin							
7/14 to 7/17	2003	11,245	36	39	32.66	33	11.43
8/27 to 8/29		8,551	36	39	32.23	32	11.66
9/15 to 9/19		13,845	37	40	33.23	33	11.66
10/20 to 10/24		10,565	37	39	32.92	33	11.35
Enforcement and PI and E campaigns end							
11/10 to 11/14	2003	4,991	36	38	32.25	32	11.68
3/22 to 3/26	2004	27,834	37	39	33.08	33	12.55
6/29 to 7/1		6,186	37	40	32.83	33	13.81
<b>Union Street – Southeast Location</b>							
<b>Collection Period Dates</b>		<b>Vehicles</b>	<b>85<sup>th</sup> %tile</b>	<b>95<sup>th</sup> %tile</b>	<b>Mean Speed</b>	<b>Median</b>	<b>Coefficient of Variation</b>
11/19 to 11/27	2002	21,912	37	40	32.91	33	12.97
7/07 to 7/10	2003	9,046	37	39	32.78	33	12.41
Sign revision, enforcement and PI and E campaigns begin							
8/27 to 8/29	2003	13,405	36	38	32.08	32	11.92
9/15 to 9/19		13,055	36	38	31.70	32	12.69
10/20 to 10/24		8,813	36	38	32.09	32	12.10
Enforcement and PI and E campaigns end							
11/10 to 11/14	2003	4,237	37	40	32.93	33	12.69
3/22 to 3/26	2004	13,068	36	39	32.04	33	15.43
6/29 to 7/1		9,619	36	38	31.96	32	13.36

## Crash and Citation Data Analyses

In addition to the speed data collected in the field, crash and citation data were collected throughout the project. Table 8 presents a summary of all reported crashes along project roadways for three years prior to project implementation as well as the year in which the project components were initiated. Note that this includes all crashes, some of which may have occurred at intersections on either end of the roadway segment. Additionally, it should be noted that a new crash reporting form was introduced in Massachusetts late in 2001, which may potentially impact crash reporting. One of the major changes to the MA crash form was injury severity definitions, which make an analysis of injury crashes and crash severity across these years, inappropriate. Nevertheless, an attempt was made to summarize the data, filtering for project time constraints, which resulted in the findings outlined in Table 8.

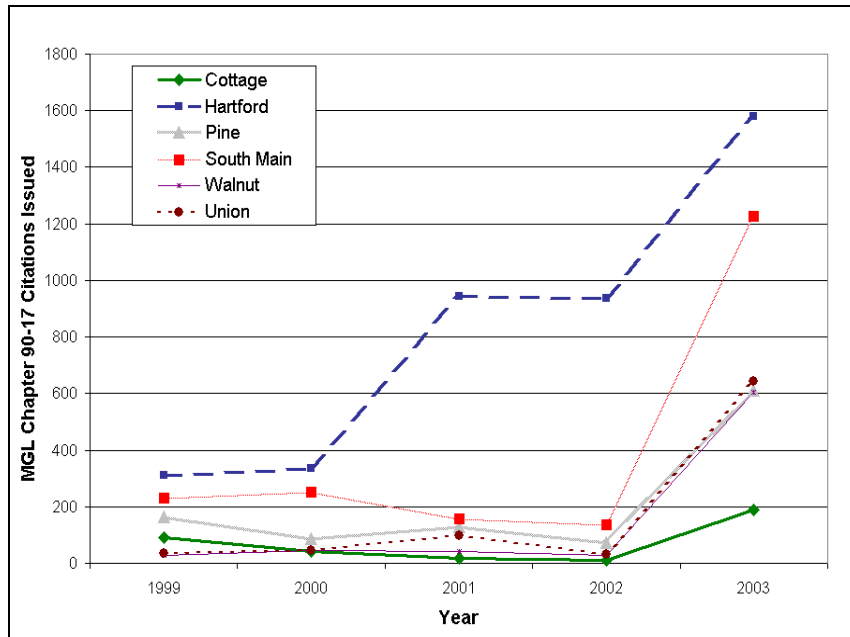
**Table 8 Crash Frequencies for Periods Before and After Sign Revisions**

Street	Before			After Sign Revision
Pine	5 12 months prior to sign revision			0 July-Dec 2003
South Main	7 May-Dec 2002	21 All 2002	19 All 2003	16 May-Dec 2003
Walnut	10 May-Dec 2000	10 May-Dec 2001	6 May-Dec 2002	10 May-Dec 2003
Union	11 July-Dec 2000	13 July-Dec 2001	12 July-Dec 2002	6 June-Dec 2003
Hartford <sup>a</sup>	33 May-Dec 2000	40 May-Dec 2001	47 May-Dec 2002	31 May-Dec 2003
Cottage	4 July-Dec 2002			2 May-Dec 2003

<sup>a</sup> From May through December of 2003 there were 31 reported crashes, however, 13 of these occurred at the segment end at a major intersection (Speen Street). This is a lower frequency than for the same time period for each of the three preceding year, during which time there were 33, 40 and 37 crashes (with 10, five, and 10 crashes at the Speen Street intersection).

Figure 3 presents the total number of MGL Chapter 90-17 citations issued along the project roadway between 1999 and 2003. As expected, the number of citations in 2003 is significantly greater as a result of the demonstration project and Speedwatch campaign. It is worth noting that Hartford Street had previously been a project roadway in both 2001 and 2002 Speedwatch campaigns, which partially explains the increased number of citations in comparison to the other roadways. A direct correlation of enforcement activity (in terms of citations issued) and observed speed values was completed to identify the impact of enforcement on the overall speed parameters.

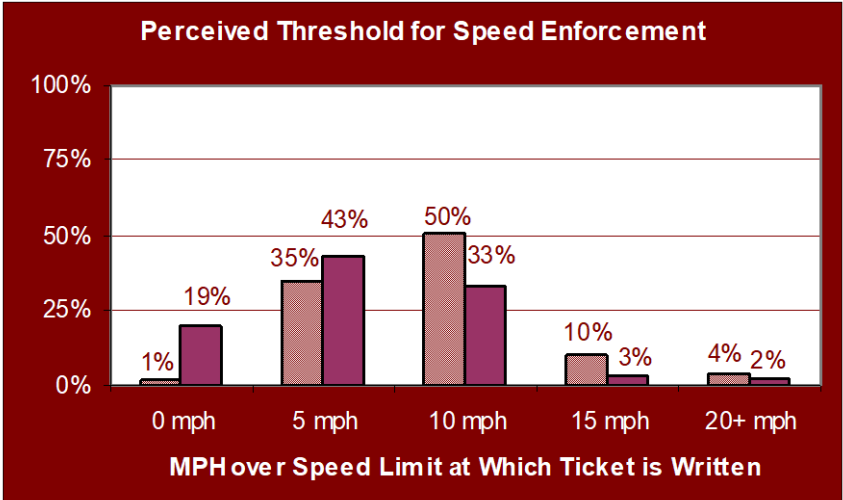
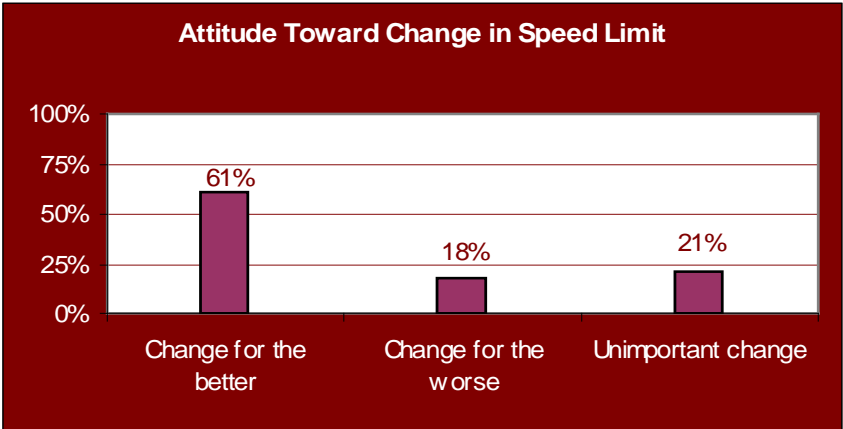
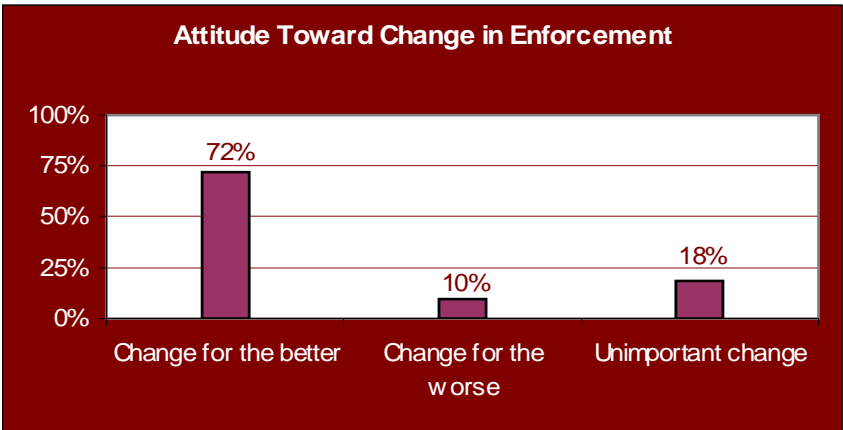




**Figure 3 MGL Chapter 90-17 Citation Issued along Project Roadways from 1999-2003.**

### **Pre and Post Opinion Surveys**

Another significant component of the project was completed by the Donahue Institute at UMass and included pre and post opinion surveys. Statistically significant differences in pre- and post-survey comparisons, as well as sub-group responses were determined through chi square analyses. As previously noted, 162 (41%) respondents resided within an area defined as an “intervention neighborhood.” All other survey respondents were considered to be “non-neighborhood”, and as a result were assumed to have less direct exposure to components of the demonstration project. Figure 4 presents the result of the opinion surveys. As shown in Figure 4, drivers opinions regarding the enforcement threshold had been reduced after the project had been initiated. Additionally, as shown, drivers were supportive of both the increased speed limit and intensified enforcement associated with the project.

Opinion Survey Question	Breakdown of Responses																		
<p data-bbox="212 285 488 533"><i>“On residential commuter roads, at how many miles over the posted speed limit do the Natick police typically issue a ticket?”</i></p> <p data-bbox="212 579 488 716"><i>(shaded bar is before intervention and solid bar is after intervention)</i></p>	 <p data-bbox="716 285 1284 317"><b>Perceived Threshold for Speed Enforcement</b></p> <table border="1" data-bbox="607 344 1393 743"> <thead> <tr> <th>MPH over Speed Limit</th> <th>Before Intervention (%)</th> <th>After Intervention (%)</th> </tr> </thead> <tbody> <tr> <td>0 mph</td> <td>1%</td> <td>19%</td> </tr> <tr> <td>5 mph</td> <td>35%</td> <td>43%</td> </tr> <tr> <td>10 mph</td> <td>50%</td> <td>33%</td> </tr> <tr> <td>15 mph</td> <td>10%</td> <td>3%</td> </tr> <tr> <td>20+ mph</td> <td>4%</td> <td>2%</td> </tr> </tbody> </table> <p data-bbox="743 716 1338 743"><b>MPH over Speed Limit at Which Ticket is Written</b></p>	MPH over Speed Limit	Before Intervention (%)	After Intervention (%)	0 mph	1%	19%	5 mph	35%	43%	10 mph	50%	33%	15 mph	10%	3%	20+ mph	4%	2%
MPH over Speed Limit	Before Intervention (%)	After Intervention (%)																	
0 mph	1%	19%																	
5 mph	35%	43%																	
10 mph	50%	33%																	
15 mph	10%	3%																	
20+ mph	4%	2%																	
<p data-bbox="204 898 532 1146"><i>“On the whole, do you consider this increase in the posted limit to have been... a change for the worse, a change for the better, or an unimportant change?”</i></p>	 <p data-bbox="756 844 1243 875"><b>Attitude Toward Change in Speed Limit</b></p> <table border="1" data-bbox="607 926 1393 1226"> <thead> <tr> <th>Attitude</th> <th>Percentage (%)</th> </tr> </thead> <tbody> <tr> <td>Change for the better</td> <td>61%</td> </tr> <tr> <td>Change for the worse</td> <td>18%</td> </tr> <tr> <td>Unimportant change</td> <td>21%</td> </tr> </tbody> </table>	Attitude	Percentage (%)	Change for the better	61%	Change for the worse	18%	Unimportant change	21%										
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<p data-bbox="204 1415 532 1663"><i>“On the whole, do you consider this increase in enforcement to have been... a change for the worse, a change for the better, or an unimportant change?”</i></p>	 <p data-bbox="756 1356 1243 1388"><b>Attitude Toward Change in Enforcement</b></p> <table border="1" data-bbox="607 1436 1393 1736"> <thead> <tr> <th>Attitude</th> <th>Percentage (%)</th> </tr> </thead> <tbody> <tr> <td>Change for the better</td> <td>72%</td> </tr> <tr> <td>Change for the worse</td> <td>10%</td> </tr> <tr> <td>Unimportant change</td> <td>18%</td> </tr> </tbody> </table>	Attitude	Percentage (%)	Change for the better	72%	Change for the worse	10%	Unimportant change	18%										
Attitude	Percentage (%)																		
Change for the better	72%																		
Change for the worse	10%																		
Unimportant change	18%																		

**Figure 4 Highlighted Breakdown of Driver Opinion Surveys.**

## CONCLUSIONS AND RECOMMENDATIONS

The cooperative agreement between the FHWA and the Massachusetts GHSB was initiated to evaluate the effectiveness of a rational speed limit setting project (using advisory signage) in Natick, MA, which was accompanied by a rigorous enforcement campaign as well as an intense public information and education campaign. Specifically, the overarching project goal was to evaluate the Massachusetts rational speed limit demonstration project and identify the impact on travel speeds, roadway safety, public opinion, and overall feasibility of implementation. Collectively, the evaluation resulted in the following summary points:

- Using baseline data collection and engineering study, a rational speed limit was established for each of six project roadways. This revision resulted in an increase of five miles per hour and was reflective of the 85<sup>th</sup> percentile speed rounded down to the nearest five mph increment. There was an initial level of apprehension among residents, the judicial branch, and some Natick Officials, fearing that increased speed limits would simply result in increased speeds and crashes. In general, the initially feared opposition never surfaced during the project.
- Data from almost 1.5 million free flow vehicles was collected over a 20-month time frame and provided 85<sup>th</sup>, 95<sup>th</sup>, and mean speeds for each of 12 data collection locations. Because speeds varied, even between locations on a given roadway, each data collection was analyzed independently. In general, the speed parameters tended to reduce by one to two mph during the enforcement period, and later increased during the post enforcement period. During the post-enforcement period, the 85<sup>th</sup> percentile speed increased, on average, 0.3mph. In some instances the speed remained constant throughout all stages of the project, and in fewer instances, the speeds in the post enforcement period exceeded the initial baseline speed parameters.
- Crashes did not change following the implementation of the revised speed limit; however it is important to note the change in Massachusetts crash report form in 2001 which makes expanded comparisons across years inappropriate.
- A direct analysis of the citation and speed data was completed to assess any impacts resulting from motorist exposure to enforcement. As was initially expected, the number of speed citations (MGL Chapter 90-17) were significantly higher in 2003, and in the project enforcement months as well.
- Based upon the information collected in the pre and post opinion surveys, it is clear that Natick residents were aware of the project, the rational speed concept, and more importantly, they supported both the increase in speed and enforcement.
- Although the demonstration project was an overall success, additional questions remain and should be addressed in future efforts. Most notably, the potential impact if the project were completed using regulatory speed signage enforced under MGL Chapter 90-18 should be quantified. Additionally, a more direct comparison of speed data and police presence would be recommended to quantify the exact impact of enforcement on speed parameters (e.g. coordinate exact enforcement times with speed data collection) and identify any temporal effects. Lastly, periodic review of the speed parameters on the project roadways is recommended to determine long term effects of the rational speed process, such as potential increases in speed as drivers adapt to new limits.

In conclusion, the project was successful in showing that rationally setting speeds did not adversely impact safety on the demonstration roadways as crash frequencies did not increase after posting the increased speed limits; in fact, speed parameters were reduced in most cases or at the very least, remained constant. Nevertheless the revised speed limit provided a realistic for both drivers and enforcement personnel. Further evaluation of other aspects of this project, as outlined above, would provide more detailed insight into the impact of rational speed limits on speed and safety measures.

## LESSONS LEARNED

Overall the project was considered to be a success by those involved based upon several of the interesting findings and lessons learned:

- Speeds were in effect reduced during the enforcement period; however this was not necessarily an overall goal of the project. Some had hypothesized a increase in speeds consistent with the revision of the speed limit which was not the case;
- Officers were effectively able to enforce a zero tolerance policy while maintaining a level;
- An integral part of the project success was based upon the buy-in from the community residents. This was completed with a comprehensive PI&E campaign;
- Another effective component of the project, which would likely be necessary for a successful duplication was the judicial education; judicial stakeholder were briefed on the project as a whole and learned why citations would be issued at near zero tolerance levels.

## REFERENCES

- (1) *Traffic Safety Facts 2003: Speeding*. National Center for Statistics and Analysis. U.S. Department of Transportation, Washington D.C., 2003.
- (2) US DOT Speed Management Team Charter. United State Department of Transportation. [http://safety.fhwa.dot.gov/speed\\_manage/docs/speedmgt\\_team.pdf](http://safety.fhwa.dot.gov/speed_manage/docs/speedmgt_team.pdf). Accessed January 26, 2005.
- (3) General Laws of Massachusetts, Chapter 90 Motor Vehicles and Aircraft. Section 17 Speed Limits. <http://www.mass.gov/legis/laws/mgl/90-17.htm>. Accessed January 25, 2005.
- (4) General Laws of Massachusetts, Chapter 90 Motor Vehicles and Aircraft. Section 1 Definitions Limits. <http://www.mass.gov/legis/laws/mgl/90-1.htm>. Accessed January 25, 2005.
- (5) *Natick Speedwatch Research Project: Post-intervention Survey Results, Technical Report*. Donahue Institute for the Massachusetts Traffic Safety Research Program and the Governor's Highway Safety Bureau. December 2003.