Lane Departure Road Safety Audit for Route 24 through Old Colony Planning Council

Prepared by

Old Colony Planning Council
and
University of Massachusetts Traffic Safety Research Program

Prepared for

Massachusetts Highway Department

Federal Highway Administration

May 2008

1.0 Introduction to Road Safety Audits & Lane Departure Crashes in Massachusetts

The Federal Highway Administration defines a Road Safety Audit (RSA) as *the formal safety examination* of an existing or future road or intersection by an *independent, multidisciplinary team*. The purpose of an RSA is to *identify potential safety issues and possible opportunities for safety improvements* considering all roadway users. Specific objectives of an RSA include, but are not limited to the following:

- Minimizing the risk and severity of road crashes that may be affected by the existing or future roadway at a specific location or nearby network;
- Improving the awareness of safe design practices which are likely to result in safety benefits based upon potential safety concerns.

Although RSA's have been employed in other countries for some time, they are being fully embraced across the United States as a low cost opportunity to make significant safety improvements at any number of stages ranging from project development and planning through existing operation. Furthermore, RSA's have proven to be effective on projects of all shapes and sizes. The RSA program here in the Commonwealth presents a unique and exciting opportunity for improvements in roadway safety.

The RSA program in Massachusetts is being implemented in accordance with the Commonwealth's role as a lead state in preventing run-off the road (lane departure) crashes and in conjunction with the Strategic Highway Safety Plan (SHSP). Lane departure crashes are a notable problem area for Massachusetts, especially for crashes with high injury severities. Between 2002 and 2004, lane departure crashes accounted for nearly 20 percent of all crashes in Massachusetts and approximately one-quarter of crashes involving an incapacitating injury. Almost one-half of fatal crashes between 2002 and 2004 were lane departure crashes. As the crash severity increases, so too does the percent of crashes that is lane departures, as shown in Figure 1.

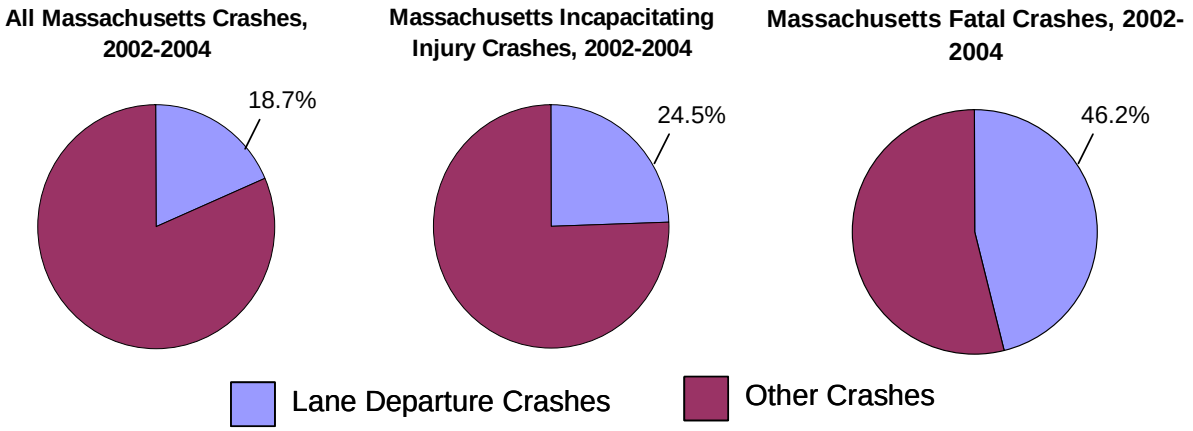

Figure 1 Relationship Between Lane Departure Crashes and Injury Severity

In an effort to combat the lane departure problem, a strategy was developed for the SHSP to identify hot spot lane departure locations, perform road safety audits, and implement low-cost comprehensive countermeasures. The following report summarizes the findings of a RSA focused on lane departure crashes (LD-RSA) along Route 24 through the Old Colony Planning Council.

2.0 Background Material for Route 24

Route 24 is a vital link in the Massachusetts roadway infrastructure in eastern Massachusetts. Through Massachusetts, Route 24 extends north and south for approximately 50 miles connecting Interstate 93 to the north with Interstate 495 and Interstate 195 before continuing in to Rhode Island. In many ways, Route 24 operates as an extension of the Interstate system, in that it is high speed (primarily posted at 65 mph), high capacity (primarily 3 lanes per direction), and limited access (median divided with designated interchange style ramps). Geographically, Route 24 passes through both the Old Colony Planning Council (OCPC) and the Southeast Regional Planning & Economic Development District (SRPEDD) planning organizations. The primary focus of this LD-RSA is the approximately 18 miles of Route 24 between Interstate 93/Route 128 and Interstate 495 that pass through OCPC. The OCPC is the designated regional planning agency for 15 communities with a total population of 321,515 as of the 2000 U.S. Census. Some of the major characteristics, including crash clusters, for Route 24 are summarized in Figure 2.

The LD-RSA for Route 24 was held on November 29, 2007 at the OCPC offices in Brockton, Massachusetts. In total, 20 team members participated in the road safety audit as listed in Table 1. As indicated in Table 1, representatives were present from Federal, State, Regional and Local agencies and included a cross-section of engineering/planning, education, and enforcement expertise. Members of the lane departure road safety audit team were asked to visit the stretch of Route 24 through OCPC in both the northbound and southbound directions in advance of the meeting to familiarize themselves with the roadway attributes and characteristics.

Table 1 Participating Audit Team Members

Audit Team Members	Agency/Affiliation
Bonnie Polin	Massachusetts Highway Department – Safety Management Unit
Neil Boudreau	Massachusetts Highway Department – Traffic Engineering Section
Carrie Lavallee	Massachusetts Highway Department – Highway Design
Lisa Schletzbaum	Massachusetts Highway Department – Safety Management Unit
Kyle Alspach	Enterprise
Tim White	Federal Highway Administration
Ray Guarino	Old Colony Planning Council
Pat Ciaramella	Old Colony Planning Council
Dan Mulkern	Massachusetts State Police
Ken LeGrice	City of Brockton Police Department
George Gurley	Town of Bridgewater Police Department
Donald Pettey	Massachusetts Highway Department – District 5 Maintenance
Robert Wood	Town of Bridgewater
Warren Phillips	Town of Avon Police Department
Frank Hegarty	Town of Avon
Bruce Hughes	Old Colony Planning Council
Jim Noyes	Greenman-Pedersen
Mike Thoreson	City of Brockton
Charles Kilmer	Old Colony Planning Council
Michael Knodler	University of Massachusetts - Amherst

Figure 2 Major Characteristics for Route 24 through OCPC

A copy of the meeting agenda and instructions, as well as a packet of pertinent information, was distributed to RSA meeting invitees prior to the meeting (this information is included in the Appendix of this report). Specifically, the additional information provided was pertinent to the LD-RSA safety initiative and included traffic volumes, a summary of predominant crashes as well as relevant projections for Route 24 as summarized below.

- Massachusetts Highway Department (MassHighway) traffic count data was provided for both the northbound and southbound directions from three different studies, which are summarized in Table 2. As shown, the ADT exceeds 50,000 in each direction and during the most recent count (10/06) the total roadway volume was 114,012, with nearly equivalent directional splits. Related to the increasing volumes are the projected volumes that were provided by both OCPC and SRPEDD. Specifically, OCPC projections indicate a 2010 ADT of 153,890 between Route 139 and I-93, and that number increases to 184,729 by 2020. Coupled with similar SRPEDD projections, all indications are that Route 24 in its current state is at or nearing capacity.

Table 2 Summary of Observed Traffic Volumes along Route 24

Interval	ATR Location #3 Route 24 – South of Pond Street in Avon (10/06)			ATR Location #2 Route 24 – at West Bridgewater Line (9/06)			ATR Location #1 Route 24 – North of Interstate 495 (8/04)		
Start time	NB	SB	TOTAL	NB	SB	TOTAL	NB	SB	TOTAL
12:00 AM	310	619	929	253	481	734	388	693	1081
1:00 AM	260	325	585	213	275	488	269	404	673
2:00 AM	231	254	485	191	188	379	193	248	441
3:00 AM	391	240	631	327	198	525	350	218	568
4:00 AM	1038	345	1383	951	334	1285	876	339	1215
5:00 AM	3915	888	4803	3525	817	4342	3079	930	4009
6:00 AM	4596	1967	6563	4868	1813	6681	4478	1966	6444
7:00 AM	4180	2855	7035	4680	2752	7432	4787	2673	7460
8:00 AM	3910	2887	6797	4147	2487	6634	4133	2650	6783
9:00 AM	3620	2531	6151	3281	2121	5402	3252	2278	5530
10:00 AM	3125	2599	5724	2698	2300	4998	2866	2558	5424
11:00 AM	2983	2759	5742	2572	2403	4975	2753	2654	5407
12:00 PM	2977	2953	5930	2478	2628	5106	2636	2610	5246
1:00 PM	3054	3196	6250	2523	2769	5292	2721	2855	5576
2:00 PM	3348	3988	7336	2801	3596	6397	3003	3264	6267
3:00 PM	3279	5000	8279	2877	4686	7563	3161	4351	7512
4:00 PM	3316	5242	8558	2736	5073	7809	3366	4816	8182
5:00 PM	3289	5149	8438	2848	4463	7311	3236	4474	7710
6:00 PM	2474	4372	6846	2041	3854	5895	2529	3595	6124
7:00 PM	1872	2965	4837	1524	2595	4119	1867	2575	4442
8:00 PM	1430	2261	3691	1187	1986	3173	1581	2100	3681
9:00 PM	1284	1801	3085	960	1497	2457	1351	1543	2894
10:00 PM	1010	1364	2374	724	1077	1801	1020	1330	2350
11:00 PM	548	1012	1560	424	807	1231	636	1031	1667
Daily Totals	**56440**	**57572**	**114012**	**50829**	**51200**	**102029**	**54531**	**52155**	**106686**

- MassHighway compiled and distributed Route 24 crash data for the 1,309 reported crashes between 2002 through 2007 prior to the meeting. As previously noted, the complete crash summaries are provided in the Appendix; some of the noteworthy observations are included in Table 3.

Table 3 Overview of Crashes along Route 24 through OCPC

Crash Type & Overview	Summary of Observations
Total Crashes There were 1,309 total reported crashes	o 61 percent of crashes occurred during daylight as compared to 33 percent at night. o 44 percent of crashes involved a single vehicle, 31 percent were rear-end, 11 percent were sideswipe same direction, and 5 percent were head on. o 5 percent occurred on snowy, icy or slushy roadways. By comparison, 69 percent occurred on dry roadways, and an additional 24 percent occurred on wet roads. o The reported first harmful events and associated percentages were as follows: motor vehicle in traffic (56 percent), median barrier (14 percent), guard rail (13 percent), and overturn/rollover (4 percent).
Lane Departure Crashes 315 lane departure crashes were reported representing 24 percent of all crashes	o Based upon lighting conditions, day and night crashes were 51 and 41 percent, respectively. o 94 percent of the lane departure crashes involved only a single vehicle. o 11 percent occurred on snowy, icy or slushy roadways. By comparison, 57 percent occurred on dry roadways, and an additional 30 percent occurred on wet roads. o The reported first harmful events and associated percentages were as follows: median barrier (35 percent), guard rail (31 percent), motor vehicle in traffic (14 percent), overturn/rollover (5 percent), and tree (4 percent). o The most common driver contributing code was failure to keep in proper lane (32 percent).
High Speed Crashes 77 lane departure crashes were reported, representing 6 percent of all crashes	o From a lighting condition perspective, 28 percent of these occurred during daylight, while 48 percent occurred at night. o 52 percent of these crashes involved only a single vehicle, 25 percent were rear-end crashes, and 24 percent were either angle or same direction sideswipes. o 71 percent of these crashes occurred on dry pavement. o 55 percent occurred during clear weather.
Deer-Related Crashes 33 lane departure crashes were reported, representing 3 percent of all crashes	o 25 crashes occurred at night. o 8 crashes occurred in June and 7 occurred in each October and November. o 24 crashes were property damage only, and 4 resulted in a non-fatal injury (5 had an unknown or not reported crash injury severity level).

Additional resources made available to the team during the audit meeting included field videos from several drives along Route 24, which were used in aiding discussion of specific roadway elements.

3.0 Characterization of Major Traffic Safety Challenges

Following a brief introduction to the RSA process in general, the meeting participants were asked to summarize and characterize potential safety considerations along Route 24 through OCPC. At the outset, the conversation was centered upon the designation of Route 24. Specifically, there was pointed discussion suggesting that Route 24 be designated an Interstate Highway. Although, much of the discussion and the ultimate decision as to whether or not to redesignate Route 24 as an Interstate is beyond the scope of this particular RSA, there are several key safety-related aspects that warrant further consideration.

- The increasing volumes in conjunction with limited upgrade of safety and/or capacity will continue to result in increased crash frequencies.
- There is an existing cyclical process in that a substandard interchange design given increasing volumes results in increasing levels of congestion and crashes, which in turn cause more congestion and secondary crashes.

A majority of RSA team members present supported the conversion of Route 24 to an Interstate Highway based upon the safety-related benefits.

- Conceptually, the idea for redesignation to an Interstate is supported in the 2007 Regional Transportation Plans for both OCPC and SRPEDD. As cited in the SRPEDD Plan, the estimated cost for converting Route 24 to Interstate standards would be approximately $200 million.

Following this initial discussion, the major safety considerations focused on several key elements.

- The narrow inside shoulder was cited as a concern as it was very unforgiving of motorist mistakes. Also noted was the fact that vehicles striking the inside jersey barrier were deflected back across traffic, and thus increasing the potential severity of any crashes.
- Debris along the roadway was noted as a potential safety concern. The amount of debris present in the narrow inside shoulder was of particular concern.
- The interchanges throughout were cited as major safety concerns. Specifically noted were two elements: 1) vehicles exiting Route 24 often queued back on to Route 24 as the adjacent surface arterial streets could not process the existing vehicles quickly enough and storage was insufficient, and 2) for both entering and exiting vehicles, the amount of space provided for acceleration/deceleration was not sufficient for safe vehicle operation. Near Route 123, there is a perceived increase in rear-end crashes that are often secondary crashes resulting from an initial crash.
- Drainage was reported to be inadequate throughout the corridor. Specifically cited were areas in Avon and Stoughton that regularly flood during weather events. RSA team members mentioned that in the northbound direction, there was frequent rutting throughout. A related issue that was raised was pavement and drainage under a majority of the overpasses where the top layer of pavement is deteriorated (see Figure 3).

Figure 3 Drainage and Pavement Concern at Overpasses

- At the northern end of Route 24, the existing entrance ramps from Interstate 93 were mentioned. Currently, 2 lanes enter to/from each direction and merge together. At this merge location, the center lanes merge and more importantly, the distance over which the merge occurs appears to be shorter than AASHTO standards.

- Some of the existing signage is partially obscured by vegetation. Although this was observed at several locations throughout, it appeared to be most noticeable in the northbound direction through Avon.
- Along the roadside in the northbound direction in Avon, there is a section of ledge in close proximity to the roadway (see Figure 4).
- The existing pavement markings are considerably faded and should be improved to enhance delineation. There are rumble strips along the left and right shoulders along a majority of Route 24 that appear to be in good condition.

Figure 4 Section of Ledge

- At some of the slight horizontal curves (e.g. south of Route 106 or south of Route 27), there were reported concerns with headlight glare from vehicles traveling in the opposing direction.
- A significant portion of the discussion regarding safety concerns was centered upon driving behavior. Some of the attributes cited included appreciable levels of speeding, aggressive driving and road rage, tailgating, and distracted driving. It was mentioned that although these same behaviors are commonly exhibited at other roadway locations, Route 24 was far less forgiving; a specific illustration of this referenced at the meeting was the nearby I-495, which has a consistently level and wide median and roadside.
- Another concern was the increasing levels of development happening in close proximity to Route 24. Recent and proposed developments are continuing to impact Route 24.
- The cobblestone gore area at several of the existing interchange ramps is coming loose and may be a hazard.
- South of Route 106 (near the power lines), there are numerous deer crashes as this is a common path for animals within the corridor.
- The lack of a designated climbing lane for trucks near Route 123 was mentioned as a concern.
- The presence of steep slopes aside of the shoulders was cited as a lane departure hazard for vehicles going beyond the shoulder and overturning.
- Guardrails fastened flat against concrete bridge abutments, which offer no crumple zones, was cited as a lane departure hazard.
- The presence of parked/disabled/abandoned vehicles was mentioned. It was noted that the current penalty for parking along the highway is $20. The State Police noted that the typical protocol was to have any vehicle that was deemed a hazard or obstruction to traffic to be removed immediately. All others would be removed after 24 hours.

4.0 Summary of Short Term Recommendations for Route 24 through OCPC

The formal review of potential safety concerns along Route 24 was completed by the entire audit team. Following identification of potential safety issues, the dialogue subsequently focused on possible countermeasures with some preliminary discussion regarding the feasibility of implementation (timeframe and cost) as well as the potential payoff of safety benefits. Given the potential for an immediate impact, there was an added focus on short term (less than 1 year) and low cost (less than $10,000) improvements that could be implemented quickly resulting in a positive safety impact. Unlike other roadways being evaluated as part of the Massachusetts LD-RSA process, some of the opportunities for Route 24 are limited because of its highway classification. Additionally, it may be expected that associated costs for recommended strategies may be higher, again because of the functional classification. Nevertheless, resulting recommendations for immediate actions along Route 24 are described below.

- Although the conversion to an Interstate is a long term and high cost improvement, it is recommended that conceptual planning and evaluation continue to move forward. The RSA team recommends that in addition to congestion and efficiency related metrics, the safety benefits fully be considered and quantified as part of the ongoing dialogue. However, it should be noted that the safety related improvements should be considered regardless of whether the conversion is formally completed.
- Commence a major clean-up up initiative along the entire corridor along both the roadside and center median. The existing debris has the potential to influence safety.
- Clear trees and vegetation that partially obscures existing signage. This is another corridor wide recommendation; however, the issue was more noticeable in the northbound direction through Avon.
- Evaluate existing drainage facilities. Although some long-term strategies are likely needed, cleaning existing catch basins may reduce some of the ponding that currently exists along Route 24.
- Revisit the formal policy for clearing disabled and/or parked vehicles.
- Work to establish corridor wide education and enforcement campaigns. For example, it is recommended that the Highway Safety Division be contacted to determine what collaborative opportunities exist.
- Suggest the addition of glare paddles around horizontal curves where opposing headlights can be problematic. Candidate locations are south of Route 27 and south of Route 106.
- Repair major pavement deformations and improve pavement markings throughout the corridor.
- Work with existing municipalities to identify opportunities for improvement that exist at each of the interchange exit ramps, where vehicles are often queued back on to Route 24. Although many of these countermeasures may be long-term, it is imperative to identify the appropriate countermeasures that can be woven in as mitigation for development approval. Additionally, it is also likely that many low-cost and easily implemented strategies can be employed at these locations.
- Repair hazardous gore areas as necessary. For example, some of the interchanges currently include cobblestone that has become dislodged and should be repaired and/or removed.
- Install deer warning signs in the area south of Route 106, and consider deer fencing.

5.0 Summary of Additional Route 24 Countermeasures

Although an emphasis was placed upon short term and low cost improvements that could be carried out immediately, the focus of the team was not limited to those constraints. The following section details countermeasures discussed by the team, which are reflective of all costs and timeframes and includes both general (entire corridor) and specific safety opportunities. Please note that with respect to the timeframe, there are some unknown variables that must be further explored. Several definitions exist for low, mid, and high cost as well as for short, mid and long term implementation timeframes. For purposes of this report, low cost improvements will be under $10,000, mid costs will be under $50,000, and high costs will be above $50,000. From a timeframe perspective short term will refer to implementation timeframes less than 1 year, while mid and long term will refer to countermeasures that will take 1 to 3, and greater than 3 years, respectively.

Potential Safety Issue	Possible Countermeasures	Implementation Timeframe & Cost	Potential Safety Payoff	Photos
Interchange improvements	Suggest exploring ways of improving operations at the intersections with Route 123, Route 104, Route 106 and Route 139, that could tie them in with current/proposed developments.	Solutions of all timeframes, costs, and safety payoffs are possible		 
Guard rail opportunities	Upgrade inadequate end treatments as identified and carry out some minor repair work on guard rails.	Mid Term & Mid Cost	Low	 
Markings & delineation	Install highly reflective pavement markings and install roadside reflectors as budget allows.	Mid Term & Mid/High Cost	High	 
Headlight glare	Install glare paddles at horizontal curves to minimize the impacts of headlight glare from opposing vehicles.	Mid Term & Mid Cost	Mid	

Potential Safety Issue	Possible Countermeasures	Implementation Timeframe & Cost	Potential Safety Payoff	Photos
Presence of debris	Sweep debris and sand on inside shoulder and remove litter along road side.	Short Term & Low	Low/Mid	 
Presence of trees and ledge along roadside	Consider guardrail installation near Avon ledge adjacent to roadside.	Mid Term & Mid Cost	Low	 
	Clear brush/tree limbs from roadside that obstructs signage, such as NB between Route 27 and 139.	Short Term & Low Cost	Low	
Expand ITS related activity	Integrate ITS technology such as cameras and variable message signs, which can be employed for monitoring (operations or crashes), driver feedback regarding congestion, and/or weather condition alerts.	Long Term & High Cost	Mid/High	
Driver behavior issues	Explore expanded partnerships with HSD for educational and enforcement support regarding reports of high speed, aggressive driving and road rage, distracted driving, and tailgating.	Short Term & Low/Mid Cost	Mid/High	
Heavy vehicle acceleration lane	Add climbing lane near Route 123 northbound.	Mid Term & Mid Cost	Low	

Potential Safety Issue	Possible Countermeasures	Implementation Timeframe & Cost	Potential Safety Payoff	Photos
Drainage and pavement concerns	Repair poor pavement areas (e.g. NB rutting) in the near future to address degrading pavement condition.	Mid Term & Mid Cost	Mid	 
	Repair pavement and drainage areas beneath overpasses.	Mid Term & Mid/High Cost	Low/Mid	
	Perform catch basin inspection to improve current drainage.	Short Term & Low Cost	Low/Mid	
Disabled/parked vehicles	Reaffirm existing policy regarding treatments for disabled/parked vehicles including the use of CaresVan and Massachusetts State Police.	Short Term & Low Cost	Low	
Concrete medians barriers	Explore possibility for cable barrier restraint system which may be more forgiving for deflecting vehicles.	Short Term & Low Cost	Low	
	Add median barrier reflectors.	Short Term & Low Cost	Low	
Merge from I-93 NB & SB	Consider alternative to eliminate confusing center lane merge, revising existing study.	Short Term & Low Cost	Low	

Potential Safety Issue	Possible Countermeasures	Implementation Timeframe & Cost	Potential Safety Payoff	Photos
Secondary crashes	Develop protocol to help minimize impacts of secondary crashes.	Short Term & Low Cost	Low	
Deer-related crashes	Install deer crossing warning signage (W11-3) south of Route 106.	Short Term & Low Cost	Low	
	Consider installation of deer check fencing in this same area south of Route 106.	Short Term & Low Cost	Low	

6.0 Discussion

As previously noted, the opportunities for safety improvements for Route 24 may be somewhat restrictive or expensive as compared to other roadways. Nevertheless, it is important to note that for the safety improvement opportunities described in the previous sections: 1) many treatments are both low cost and short term; and 2) there is a complimentary nature of many of the safety strategies in that one improvement will aid with multiple safety issues. Please note that although this document provides a series of specific recommendations that warrant short term implementation, the approach towards improved safety is dynamic in nature and warrants revisiting over time.

Several additional topics were discussed at the audit meeting and warrant consideration.

- Development along the corridor appears to be increasing. Opportunities for safety related improvements should be considered at all stages. For example, the development at Route 104 may benefit from a Route 24 SB flyover for left-turns that would improve both safety and efficiency; this strategy would also minimize the impacts of vehicles queuing on to Route 24.
- A slip lane from Interstate 495 SB on to Route 104 was also discussed. This route would help reduce the number of vehicles entering Route 24.
- Impacts of first responders who often come from the nearby communities were discussed. In particular, there was growing concern over the time these responders spent responding to Route 24 incidents and the economic drain it may have on their respective communities. In addition, there was also concern about the increasing response time based upon congestion levels.
- The lack of a quality east-west connector was noted. Specifically, this limitation in mobility encourages motorists to remain on Route 24 for longer durations.
- Concern was raised about the increasing number of vehicles that exit Route 24, due to congestion, and use surface streets. Some RSA team members feared an increase in crashes along these other roadways.
- Lastly, several RSA team members expressed support for added or enhanced exploration of expanding commuter rail lines throughout OCPC as an alternative, which may reduce some of the vehicular demand along Route 24.

7.0 Appendix: Distributed RSA Meeting Materials

Materials provided to RSA team members in advance of the meeting included the following:

1. Agenda
2. RSA and Lane Departure Introduction
3. Crash Data Summary
4. LD-RSA Checklist

Road Safety Audit

Route 24 in Old Colony Planning Council Region

Meeting Location: Old Colony Planning Council
70 School Street, Brockton
Thursday, November 29, 2007
10:00 AM – 12:00 noon

Agenda

Type of meeting:	**Lane Departure – Road Safety Audit**
Attendees:	**Invited Participants to Comprise a Multidisciplinary Team**
Please bring:	**Thoughts and Enthusiasm!!**
10:00 AM	**Welcome and Introductions**
10:15 AM	**Introduction to Road Safety Audits and Lane Departure Crashes**
10:30 AM	**Review of Site Specific Material** • Crash & Volume – provided in advance • Existing Geometries and Conditions • Video and Images
11:00 AM	**Completion of RSA** • Identification of Safety Concerns – using checklists as a guide • Identification of Possible Countermeasures
12:00 noon	**Adjourn for the Day – but the RSA has not ended**

Instructions for Participants:

- **Before attending the RSA on November 29th participants are encouraged to drive Route 24 and complete/consider elements on the RSA advisory checklist with a focus on safety factors affecting roadway departure crashes.**
- **All participants will be actively involved in the process throughout. Participants are encouraged to come with thoughts and ideas, but are reminded that the synergy that develops and respect for others' opinions are key elements to the success of the overall RSA process.**
- **After the initial RSA meeting, participants will be asked to comment and respond to the document materials to assure it is reflective of the RSA completed by the multidisciplinary team.**

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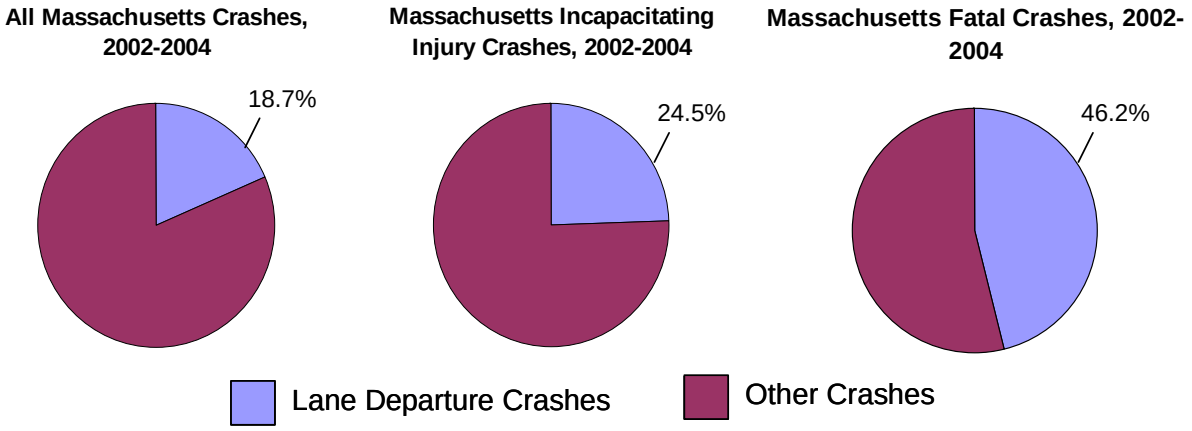

In an effort to combat the lane departure problem, a strategy was developed for the SHSP to identify hot spot lane departure location, perform road safety audits and implement low-cost comprehensive countermeasures.

RT 24 ALL CRASH ANALYSIS
FROM 2002 TO 2007

ALL CRASH TOTAL	LIGHT CONDITION								
	DAYLIGHT	DAWN	DUSK	DARK - ROADWAY LIGHTED	DARK - ROADWAY NOT LIGHTED	DARK ROADWAY UNKNOWN ROADWAY LIGHTING	OTHER	NOT REPORTED	
1,309	802	41	28	71	349	7	2	9	
100 %	61%	3%	2%	5%	27%	1%	0%	1%	
	WEATHER CONDITION								
	CLEAR	CLOUDY	RAIN	SNOW	SLEET, HAIL FREEZING RAIN	FOG, SMOG, SMOKE	SEVERE CROSSWINDS	BLOWING SAND, SNOW	OTHER
	816	295	188	71	11	12	1	1	4
	62%	16%	14%	5%	1%	1%	0%	0%	0%
	ROAD SURFACE								
	DRY	WET	SNOW	ICE	SAND, MUD, DIRT, OIL, GRAVEL	WATER	SLUSH	OTHER	
	902	311	40	17	6	12	18	3	
	69%	24%	3%	1%	0%	1%	1%	0%	
	MANNER OF COLLISION								
	SINGLE VEHICLE CRASH	REAR-END	ANGLE	SIDESWIPE SAME DIRECTION	HEAD - ON	UNKNOWN			
	570	400	181	142	5	11			
	44%	31%	14%	11%	0%	1%			
	FIRST HARMFUL EVENT LOCATION								
	ROADWAY	MEDIAN	ROADSIDE	SHOULDER PAVED	SHOULDER UNPAVED	SHOULDER - TRAVEL LANE	OUTSIDE ROADWAY	UNKNOWN	NOT REPORTED
	983	130	59	38	28	2	53	2	14
	75%	10%	5%	3%	2%	0%	4%	0%	1%
	FIRST HARMFUL EVENT (> 1%)								
	MOTOR VEHICLE IN TRAFFIC	PARKED MOTOR VEHICLE	PEDESTRIAN	ANIMAL DEER	TREE	GUARDRAIL	MEDIAN BARRIER	OVERTURN/ ROLLOVER	TREE
	735	25	1	31	29	164	177	49	29
	56%	2%	0%	2%	2%	13%	14%	4%	2%
DRIVER	DRIVER CONTRIBUTING CODE (WITH IMPROPER DRIVING KNOWN AND >1%)								
	EXCEEDED AUTHORIZED SPEED LIMIT	FAILED TO YIELD RIGHT OF WAY	FOLLOWED TOO CLOSELY	MADE AN IMPROPER TURN	DRIVING TOO FAST FOR CONDITION	FAILURE TO KEEP IN PROPER LANE	OPERATING VEHICLE IN ERRATIC, RECKLESS, CARELESS MANNER	OVER-CORRECTING/ OVER STEERING	INATTENTION
CONTRIBUTING	65	17	177	17	90	257	54	24	71
	5%	2%	15%	2%	7%	21%	4%	2%	6%
	OTHER IMPROPER ACTION	NOT REPORTED	UNKNOWN						
CODE	58	288	44						
	5%	13%	2%						
	CRASH SEVERITY								
	PROPERTY DAMAGE ONLY (NONE INJURED)	NON-FATAL INJURY	FATAL INJURY	NOT REPORTED	UNKNOWN				
	717	508	6	68	10				
	55%	39%	0%	5%	1%				

* 2006 AND 2007 CRASH INFORMATION ARE NOT COMPLETE

FROM 2002 TO 2007

(IDENTIFIED FROM STATE POLICE NARRATIVE)

TOTAL NUMBER OF CRASHES ON RT = 1,309	LIGHT CONDITION							
	DAYLIGHT	DAWN	DUSK	DARK - ROADWAY LIGHTED	DARK - ROADWAY NOT LIGHTED	DARK - ROADWAY UNKNOWN ROADWAY LIGHTING	NOT REPORTED	
TOTAL LANE DEPARTURE CRASHES	161	11	13	12	114	2	2	
	51%	3%	4%	4%	36%	1%	1%	
315	WEATHER CONDITION							
24%	CLEAR	CLOUDY	RAIN	SNOW	SLEET, HAIL FREEZING RAIN	FOG, SMOG, SMOKE		
	163	46	72	29	8	3		
	52%	15%	23%	9%	3%	1%		
	ROAD SURFACE							
	DRY	WET	SNOW	ICE	SAND, MUD, DIRT, OIL, GRAVEL	WATER	SLUSH	NOT REPORTED
	178	95	18	6	1	7	8	1
	57%	30%	6%	2%	0%	2%	3%	0%
	MANNER OF COLLISION							
	SINGLE VEHICLE CRASH	REAR-END	ANGLE	SIDESWIPE SAME DIRECTION	HEAD - ON			
	297	8	7	1	2			
	94%	3%	2%	0%	1%			
	FIRST HARMFUL EVENT LOCATION							
	ROADWAY	MEDIAN	ROADSIDE	SHOULDER PAVED	SHOULDER UNPAVED	SHOULDER - TRAVEL LANE	OUTSIDE ROADWAY	UNKNOWN
	160	75	21	23	10	1	15	2
	51%	25%	7%	7%	3%	0%	5%	1%
	FIRST HARMFUL EVENT (>1%)							
	MOTOR VEHICLE IN TRAFFIC	PARKED MOTOR VEHICLE	TREE	GUARDRAIL	MEDIAN BARRIER	DITCH	EMBANKMENT	OVERTURN/ ROLLOVER
	44	7	12	97	109	5	7	17
	14%	2%	4%	31%	35%	2%	2%	5%
DRIVER	DRIVER CONTRIBUTING CODE (WITH IMPROPER DRIVING KNOWN AND >1%)							
	EXCEEDED AUTHORIZED SPEED LIMIT	FOLLOWED TOO CLOSELY	DRIVING TOO FAST FOR CONDITION	FAILURE TO KEEP IN PROPER LANE	DRIVING TOO FAST FOR CONDITION	OPERATING VEHICLE IN ERRATIC, RECKLESS, CARELESS MANNER	OVER CORRECTING/ OVER-STEERING	INATTENTION
CONTRIBUTING	19	4	38	80	30	12	9	5
	8%	2%	12%	32%	12%	5%	4%	2%
	FATIGUE/ ASLEEP	OTHER IMPROPER ACTION	NOT REPORTED	UNKNOWN				
CODE	5	6	51	16				
	2%	2%	20%	6%				
	CRASH SEVERITY							
	PROPERTY DAMAGE ONLY (NONE INJURED)	NON-FATAL INJURY	FATAL INJURY	NOT REPORTED	UNKNOWN			
	153	131	4	24	3			
	49%	42%	1%	8%	1%			

* 2006 AND 2007 CRASH INFORMATION ARE NOT COMPLETE

RT 24 HIGH SPEED CRASH ANALYSIS
FROM 2002 TO 2007
(IDENTIFIED FROM STATE POLICE NARRATIVE)

TOTAL NUMBER OF CRASHES ON RT = 1,309	LIGHT CONDITION						
	DAYLIGHT	DAWN	DUSK	DARK - ROADWAY LIGHTED	DARK - ROADWAY NOT LIGHTED	NOT REPORTED	
TOTAL HIGH SPEED CRASHES	28	4	6	2	35	2	
77	36%	5%	8%	2%	45%	3%	
6%	**WEATHER CONDITION**						
	CLEAR	CLOUDY	RAIN	SNOW	SLEET, HAIL FREEZING RAIN		
	42	17	11	4	3		
	55%	22%	14%	5%	4%		
	ROAD SURFACE						
	DRY	WET	SNOW	ICE	SLUSH		
	55	16	1	3	2		
	71%	21%	1%	4%	3%		
	MANNER OF COLLISION						
	SINGLE VEHICLE CRASH	REAR END	ANGLE	SIDESWIPE SAME DIRECTION			
	40	19	12	6			
	52%	25%	16%	8%			
	FIRST HARMFUL EVENT LOCATION						
	ROADWAY	MEDIAN	ROADSIDE	SHOULDER PAVED	SHOULDER UNPAVED	REAR TO REAR	UNKNOWN
	52	13	5	1	2	3	1
	68%	17%	6%	1%	3%	4%	1%
	FIRST HARMFUL EVENT (>1%)						
	MOTOR VEHICLE IN TRAFFIC	PARKED MOTOR VEHICLE	GUARDRAIL	MEDIAN BARRIER	EMBANKMENT	OVERTURN/ ROLLOVER	NOT REPORTED
	34	2	12	17	3	5	2
	44%	3%	16%	22%	4%	6%	3%
	DRIVER CONTRIBUTING CODE (WITH IMPROPER DRIVING KNOWN AND >1%)						
	EXCEEDED AUTHORIZED SPEED LIMIT	DRIVING TOO FAST FOR CONDITION	FAILURE TO KEEP IN PROPER LANE	OPERATING VEHICLE IN ERRATIC, RECKLESS, CARELESS MANNER	NOT REPORTED		
	24	14	8	12	24		
	18%	10%	6%	9%	18%		
	CRASH SEVERITY						
	PROPERTY DAMAGE ONLY (NONE INJURED)	NON-FATAL INJURY	FATAL INJURY	NOT REPORTED	UNKNOWN		
	26	43	2	5	1		
	34%	56%	3%	6%	1%		

* 2006 AND 2007 CRASH INFORMATION ARE NOT COMPLETE

RT 24 DEER RELATED CRASH ANALYSIS
FROM 2002 TO 2007
(IDENTIFIED FROM STATE POLICE NARRATIVE)

TOTAL NUMBER OF CRASHES ON RT = 1,309
TOTAL DEER CRASHES
33
3%

LIGHT CONDITION

DAYLIGHT	DAWN	DUSK	DARK - ROADWAY NOT LIGHTED	DARK - ROADWAY UNKNOWN LIGHTING
5	2	1	24	1
15%	6%	3%	73%	3%

WEATHER CONDITION

CLEAR	CLOUDY	RAIN	FOG, SMOG SMOKE
22	8	2	1
67%	24%	6%	3%

ROAD SURFACE

DRY	WET
27	6
82%	18%

LOCATION

WEST BRIDGEWATER NEAR EXIT 16 (RT 106)	BROCTON NEAR EXIT 17 (RT 123	BRIDGEWATER NEAR EXIT 15 (RT 104	WEST BRIDGEWATER NOT REPORTED	WEST BRIDGEWATER NEAR EXIT 17	AVON NEAR EXIT 19A	BRIDGEWATER NEAR EXIT 14B (495	STOUGHTON NOT REPORTED	AVON NOT REPORTED
11	6	5	3	2	2	1	1	2
33%	18%	15%	9%	6%	6%	3%	3%	6%

CRASH DATE

JUNE	OCTOBER	NOVEMBER	JULY	DECEMBER	MAY	JANUARY	FEBRUARY	MARCH
8	7	7	2	2	2	1	1	1
24%	21%	21%	6%	6%	6%	3%	3%	3%

APRIL	SEPTEMBER
1	1
3%	3%

FIRST HARMFUL EVENT LOCATION

ROADWAY	MEDIAN	ROADSIDE	SHOULDER PAVED
28	3	2	1
85%	9%	6%	3%

FIRST HARMFUL EVEN

DEER
33
100%

CRASH SEVERITY

PROPERTY DAMAGE ONLY (NONE INJURED)	NON-FATAL INJURY	NOT REPORTED	UNKNOWN
24	4	3	2
73%	12%	9%	6%

* 2006 AND 2007 CRASH INFORMATION ARE NOT COMPLETE

GEOMETRIC DESIGN –	
Issue	**Comment**
A. Speed – (Design Speed; Speed Limit & Zoning; Sight Distance; Overtaking	
Are there speed-related issues along the corridor? Please consider the following elements: • Horizontal and vertical alignment; • Posted and advisory speeds • Driver compliance with speed limits • Approximate sight distance • Safety passing opportunities	
B. Road alignment and cross section	
With respect to the roadway alignment and cross-section please consider the appropriateness of the following elements: • Functional class (Urban Principal Arterial) • Delineation of alignment; • Widths (lanes, shoulders, medians); • Sight distance for access points; • Cross-slopes • Curbs and gutters Drainage features	
C. Intersections	
For intersections along the corridor please consider all potential safety issues. Some specific considerations should include the following: • Intersections fit alignment (i.e. curvature) • Traffic control devices'' alert motorists as necessary • Sight distance and sight lines seem appropriate • Vehicles can safely slow/stop for turns • Conflict point management • Adequate spacing for various vehicle types Capacity problems that result in safety problems	
D. Auxiliary lanes	
• Do auxiliary lanes appear to be adequate?	
• Could the taper locations and alignments be causing safety deficiencies? • Are should widths at merges causing safety deficiencies?	

E. Clear zones and crash barriers	
For the roadside the major considerations are clear zone issues and crash barriers. Consider the following: • Do there appear to be clear zones issues? — Are hazards located too close the road? — Are side slopes acceptable? • Are suitable crash barriers (i.e, guard rails, curbs, etc.) appropriate for minimizing crash severity? • Barrier features: end treatments, visibility, etc.	
F. Bridges and culverts – (if necessary)	
Are there specific issues related to bridges and culverts that may result in safety concerns?	
G. Pavement – (Defects, Skid Resistance, and Flooding)	
• Is the pavement free of defects including excessive roughness or rutting, potholes, loose material, edge drop-offs, etc.) that could result in safety problems (for example, loss of steering control)? • Does the pavement appear to have adequate skid resistance, particularly on curves, step grades and approaches to intersections? • Is the pavement free of areas where flooding or sheet flow of water could contribute to safety problems? • In general, is the pavement quality sufficient for safe travel of heavy and oversized vehicles?	
H. Lighting (Lighting and Glare)	
It is important to consider to the impacts of lighting. Some specifics include the following: Is lighting required and, if so, has it been adequately provided? Are there glare issues resulting from headlights during night time operations or from sunlight?	

TRAFFIC CONTROL DEVICES	
Issue	**Comment**
I. Signs	
Signage is a critical element in providing a safe roadway environment. Please consider the following: • Are all current signs visible? Are they conspicuous and clear? Are the correct signs used for each situation?	
• Are signs visible (consider both night and day)? • Does the retroreflectivity or illumination appear satisfactory? • Are there any concerns regarding sign supports?	
J. Traffic signals	
Although the focus of this RSA are lane departures, this does present an opportunity for us to consider any traffic signals. Specifically: • If present, do the traffic signals appear to be designed, installed, and operating correctly? • Is the controller located in a safe position? (where it is unlikely to be hit, but maintenance access is safe) • Is there adequate sight distance to the ends of possible vehicle queues?	
K. Marking and delineation	
• Is the line marking and delineation: — appropriate for the function of the road? — consistent along the route? — likely to be effective under all expected conditions? (day, night, wet, dry, fog, rising and setting sun, oncoming headlights, etc.) • Are centerlines, edgelines, and lane lines provided? If not, do drivers have adequate guidance?	

ROADWAY ACTIVITY	
Issue	**Comment**
With respect to roadway activity please consider safety elements related to the following: • Pedestrians • Bicycles • Public transportation vehicles and riders • Emergency vehicles • Commercial vehicles • Slow moving vehicles	

ENVIRONMENTAL CONSIDERATIONS	
Issue	**Comment**
Weather & Animals	
From an environmental perspective it is important to consider any potential impacts. Most notably is likely to be the impacts of weather or animals, including:	
• Possible effects of rain, fog, snow, ice, wind on design features. • Has snow fall accumulation been considered in the design (storage, sight distance around snowbanks, etc.)? • Are there any known animal travel/migration routes in surrounding areas which could affect design?	