

ROAD SAFETY AUDIT

Route 134 at the Route 6 Ramps

Town of Dennis

August 2009

Prepared for:
Massachusetts Highway Department



Prepared by:
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Table of Contents

Background	2
Project Data	2
Project Location Description	3
Road Safety Audit Observations	5
Safety Issue #1. Interchange Geometry	6
Safety Issue #2. Pavement Markings	7
Safety Issue #3. Sign Improvements	7
Safety Issue #4. Maintenance	8
Safety Issue #5. Pedestrian Accommodations	8
Safety Issue #6. Bicycle Accommodations	9
Recommendations	10

List of Appendices

Appendix A. RSA Meeting Agenda	
Appendix B. RSA Audit Team Contact List	
Appendix C. Detailed Crash Data	
Appendix D. Additional Information	

List of Figures

Figure 1. Locus Map	4
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List of Tables

Table 1. Participating Audit Team Members	2
Table 2. Proposed Safety Enhancement Summary	11

Background

The intersections of Route 134 with the Route 6 Ramps in Dennis are in the Top 5% of High Crash Locations on Cape Cod. These intersections and three others that meet initial criteria for eligibility of the Highway Safety Improvement Program (HSIP) funding were selected by the Cape Cod Joint Transportation Committee (CCJTC) for potential future redesign to improve safety. To this end, a Road Safety Audit (RSA) was conducted to identify the safety issues and potential safety enhancements. Based on the results of this and several other RSAs within the Cape Cod region, the MassHighway Safety Management Unit and CCJTC will prioritize the locations to receive HSIP funding for design improvements.

The Route 134/Route 6 interchange was reconstructed to a full cloverleaf interchange in Spring 2004 due to a high number of severe crashes. Prior to the reconstruction, the interchange was a half-cloverleaf interchange that required vehicles exiting Route 6 to take a right or left turn onto Route 134. More recently, the Route 134 Bridge over Route 6 was reconstructed between January 2008 and July 2009.

Project Data

The audit team conducted an RSA for the intersections of Route 134 and the Route 6 Ramps in Dennis, Massachusetts, on August 4, 2009. The RSA agenda is provided in **Appendix A. Table 1** lists the audit team members and their affiliations. **Appendix B** provides contact information for all team members.

Table 1. Participating Audit Team Members

Audit Team Member	Agency/Affiliation
Joe Rodricks	Dennis Town Engineer
David Johansen	Dennis Department of Public Works Superintendent
Peter DiMatteo	Dennis Police Department
Robert Gregory	MassHighway District 5
Edward C. Feeny	MassHighway District 5
Priscilla Leclerc	Cape Cod Commission
Tim White	Federal Highway Administration
Lisa Schletzbaum	MassHighway Safety
Bonnie Polin	MassHighway Safety
Austin Feula	MassHighway Safety
Carrie Lavallee	MassHighway Projects
Kelly Shanahan	MassHighway Projects
Keri Pyke	Howard/Stein-Hudson Associates
Michelle Langone	Howard/Stein-Hudson Associates
Sarah Kurpiel	Howard/Stein-Hudson Associates

Project Location Description

The intersections of Route 134 and the Route 6 Ramps are located in the Town of Dennis, as shown in the aerial provided in **Figure 1**. Along Route 134, south of Route 6, there are several commercial uses, including a shopping plaza, Patriots Square Mall, on the east side of Route 134. Southwest of the interchange, the land use is a mix of residential and commercial properties. Along Route 134, north of Route 6, the area is mostly forest, with a few commercial or residential uses.

Prior to the RSA, the team reviewed collision diagrams and a crash detail summary based on the crash records supplied by the Dennis Police Department in order to begin assessing the possible safety issues. Of the 83 crashes related to the ramp intersections from 2006 through 2009, 90% were rear-end crashes. Crashes typically occurred on dry pavement (87%) and during daylight hours (90%). Crashes most commonly occurred from vehicles exiting Route 6 onto Route 134 northbound or southbound. Most of the crashes occurred on the exit ramps from Route 6 eastbound onto Route 134.

Due to the reconstruction occurring at the Route 6 bridge, MassHighway performed a speed study on Route 134 north of the Route 6 ramps. The posted speed limit is 40 miles per hour in both the northbound and the southbound directions where the speed study was conducted. The 85th percentile speed was 42 miles per hour in both directions.

The detailed intersection crash data from 2006 through 2009 are provided in **Appendix C**. Other intersection data such as traffic volumes are presented in **Appendix D**.

The four intersections formed by the cloverleaf interchange are the junction of the following roadways, which are categorized according to Massachusetts Executive Office of Transportation Office of Transportation Planning functional classifications:

Route 134 is an urban principal arterial roadway. MassHighway owns Route 134 from Hemlock Lane south to 200 feet north of Enterprise Drive. Route 134 runs north–south and connects Route 28 and Route 6A in Dennis. Route 134 over Route 6 has one southbound travel lane and two northbound travel lanes and crosses Route 6 on a bridge. Within the study area, Route 134 has a raised median separating the northbound and the southbound directions. Per the speed regulations, the speed limit on Route 134 at the interchange with Route 6 is 40 miles per hour in both directions. However, no speed limit signs are posted within the study area.

Route 6 On- and Off-ramps are classified as urban principal arterials and are owned by the Massachusetts Highway Department. All of the ramps provide one travel lane for vehicles entering or exiting Route 6. The Route 6 off-ramps are yield-controlled at the junction of Route 134.

Figure 1. Locus Map



Not to scale.

Road Safety Audit Observations

The safety issues and possible enhancements determined in the RSA conducted on August 4, 2009, include:

- Complexity of the interchange geometry;
- Access management;
- Faded pavement markings;
- Unclear signage;
- Overgrown shrubbery;
- Lack of pedestrian accommodations; and
- Lack of bicycle accommodations.

Several of these issues require further study and engineering judgment in order to determine the feasibility of implementing enhancements to address them.

The following sections describe in more detail the safety issues determined during the RSA. In the table following the descriptions, each issue is listed with possible enhancements, estimated safety payoff, time frame, and cost. Safety payoff estimates are based on the approximate percent of crashes reduced by enhancement and are categorized as low (<30%), medium (31% to 70%), and high (>71%). The time frame is categorized as short-term (<1 year), mid-term (1 to 3 years), or long-term (>3 years). The costs are categorized as low (<\$10,000), medium (\$10,001 to \$50,000), or high (>\$50,001).

Safety Issue #1. Interchange Geometry

Observation:

As stated above, 90% of the crashes at the Route 134/Route 6 interchange were rear-end crashes. Police noted that most crashes here occur when the second or third driver in the queue does not verify that the first driver completed his/her maneuver onto Route 134 before proceeding. Field observations indicated that uncertainty about the configuration of the merge lanes may result in driver confusion about how to maneuver from Route 6 to Route 134. Additionally, the steady flow of vehicles on Route 134 that reduces the number of available gaps, combined with the lack of a clear message regarding the merge condition, may lead a driver to take advantage of a smaller gap than is safe to enter Route 134.



Looking northbound on Route 134 toward Route 6 interchange.



Looking southbound on Route 134 toward Patriots Square Mall.

Field observations indicated that the lengths of several of the acceleration and deceleration lanes are inadequate. Route 6 eastbound to Route 134 northbound ramp has no acceleration lane. Similarly, several of the Route 6 off-ramps provide inadequate radii for larger trucks. Larger trucks (semi-tractor trailers) were observed utilizing both travel lanes to complete turning maneuvers from the Route 6 eastbound off-ramp onto Route 134 northbound or southbound.

Additionally, the geometry of the Route 6 eastbound to Route 134 southbound ramp is complicated by the lack of clear direction as to whether there is an additional

lane. The perceived short distance to weave to access the retail areas and Main Street further complicates the travel patterns. The team observed that many motorists exiting from Route 6 eastbound to Route 134 southbound are destined for Patriot's Square Mall, requiring them to weave across two lanes. Motorists on Route 134 southbound who wish to access Main Street, located on the west side of Route 134 south of the Route 6 eastbound off-ramp, must also weave across two lanes in a short distance to access their destination.

Enhancements:

1. Review operations and the feasibility of adding adequate acceleration and deceleration lanes at the interchange of Route 134/Route 6.
2. At the Route 6 eastbound off-ramp to Route 134 southbound, lengthen the solid white channelization line from the end of the delta island to reinforce the separation between the ramp and Route 134 southbound, and to delineate the additional lane. Replace the merge sign with an “add lane” warning sign. In conjunction, review the distance between the Route 6 eastbound ramps and the mall signal for appropriate weave distance.
3. Provide adequate turning radii to accommodate larger vehicles in a single lane on the Route 6 eastbound ramp to Route 134 southbound and on the Route 6 westbound ramp to Route 134 northbound.

Safety Issue #2. Pavement Markings

Observation:

The Route 134/Route 6 interchange has worn or missing pavement markings. However, the pavement markings on the bridge over Route 6 have recently been re-striped in conjunction with the repaving of the bridge deck.

Enhancements:

1. Re-stripe and maintain durable pavement markings at the interchange of Route 134/Route 6.



Worn pavement markings at the interchange of Route 6/Route 134.

Safety Issue #3. Sign Improvements

Observation:

For the Route 6 eastbound ramp to Route 134 northbound, two travel lanes are provided on Route 134. However, north of the bridge, the right travel lane becomes exclusive for accessing Route 6 westbound. This requires vehicles accessing Route 134 northbound from Route 6 to shift to the left lane prior to the bridge. Although there are existing regulatory signs indicating the lane use restriction, the RSA team noted that additional guide signs should be provided to alert drivers of this exclusive right-turn travel lane.

Additionally, several signs should be upgraded to meet the current reflectorized standards.

Enhancements:

1. Provide additional regulatory guide signs on Route 134 northbound prior to the bridge to alert drivers of the “right lane must exit” condition onto Route 6 westbound.
2. Upgrade existing signage with new reflectorized signs.

Safety Issue #4. Maintenance

Observation:

The RSA team noted that the trees and shrubs on several of the ramps at the Route 134/Route 6 interchange are overgrown and blocking signs and/or limiting sight distance.

Enhancements:

1. Trim vegetation to maintain sign visibility and sight lines at the Route 134/Route 6 interchange.

Safety Issue #5. Pedestrian Accommodations

Observation:

The RSA team members noted that several nearby residents walk to the commercial areas. A sidewalk is provided only on the west side of the Route 134 bridge over Route 6. Prior to the bridge, no sidewalks or crosswalks are provided across the on- and off-ramps.

Enhancements:

1. To accommodate pedestrians, a continuous sidewalk should be provided along Route 134. Additionally, crosswalks and appropriate control would be needed at the intersections of Route 134 and the Route 6 ramps.



The sidewalk on the Route 6 bridge.

Safety Issue #6. Bicycle Accommodations

Observation:

During the field visit, the RSA team observed several bicyclists traveling along Route 134. The team noted that bicycle accommodations on Route 134 are limited, with a 6-foot shoulder along Route 134 southbound on the Route 6 bridge. South of the interchange of Route 134/Route 6, a multi-use path is provided (see **Figure 1**). Ideally, the Town of Dennis wants to provide bicycle accommodations along Route 134 so bicyclists can connect to the multi-use path and commercial-use destinations. RSA team members noted that, because Route 134 is one of only two north-south corridors in Dennis, bicycle accommodations are needed.



A bicyclist maneuvers through the Route 134/Route 6 interchange.

Enhancements:

1. Provide bicycle accommodations along Route 134 and bicycle connections to the multi-use path south of Route 6.

Recommendations

Based on its observations and discussions, the RSA team identified the issues and possible enhancements that could improve the safety at the intersections of Route 134 with the Route 6 Ramps in Dennis, Massachusetts. **Table 2** summarizes these safety issues and possible enhancements.

Short-term recommendations include:

- Re-striping and maintaining pavement markings at the interchange of Route 134/Route 6 and re-striping Route 134 south of the interchange as two travel lanes.
- Providing adequate regulatory and warning signs for drivers.
- Upgrading existing signage with new reflectorized signs.
- Trimming vegetation at the interchange of Route 134/Route 6.

To enhance the safety of the interchange of Route 134/Route 6, the *long-term recommendation* is to improve the interchange geometry and manage access. Further study and design work needs to be conducted to determine the feasibility of making improvements to the interchange of Route 134/Route 6.

Table 2. Proposed Safety Enhancement Summary

Safety Issue	Safety Enhancement	Safety Payoff	Time Frame	Cost
Interchange geometry	Review operations and feasibility of adding adequate acceleration and deceleration lanes at interchange of Route 134/Route 6.	Mid	Mid-term	Mid
	At the Route 6 eastbound off-ramp to Route 134 southbound, lengthen the solid white channelization line from the end of the delta island to reinforce the separation between the ramp and Route 134 southbound and to delineate the additional lane. Replace the merge sign to an “add lane” warning sign. In conjunction, review the distance between the Route 6 eastbound ramps and the mall signal for appropriate weave distance.	Mid	Short-term	Mid
	Provide adequate turning radii to accommodate larger vehicles in a single lane on the Route 6 eastbound ramp to Route 134 southbound and on the Route 6 westbound ramp to Route 134 northbound.	High	Mid-term	Mid
Pavement markings	Re-stripe and maintain durable pavement markings at the interchange of Route 134/Route 6.	Low	Short-term	Low
Sign improvements	Provide additional regulatory guide signs on Route 134 northbound prior to the bridge to alert drivers of the “right lane must exit” condition onto Route 6 westbound.	Low	Short-term	Low
	Upgrade existing signage with new reflectorized signs.	Low	Short-term	Low
Maintenance	Trim vegetation to maintain sign visibility and sight lines at the Route 134/Route 6 interchange.	Low	Short-term	Low
Pedestrian accommodations	To accommodate pedestrians, a continuous sidewalk should be provided along Route 134. Additionally, crosswalks and appropriate control would be needed at the intersections of the Route 134/Route 6 ramps.	Low	Long-term	High
Bicycle accommodations	Provide bicycle accommodations along Route 134 and bicycle connections to the multi-use path south of Route 6.	Low	Long-term	Mid

Appendix A. RSA Meeting Agenda

Agenda

Road Safety Audit

Dennis – Route 134 at the Route 6 Ramps

Meeting Location: Dennis DPW Headquarters at
120 Theophilus F. Smith Road, South Dennis

Tuesday, August 4, 2009

10:00 AM – 12:00 noon

Type of meeting: High Crash Location – 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 Review of Site Specific Material

- Crash, Speed & Volume Summaries
- Existing Geometries and Conditions

10:45 AM Visit the Site

- Drive to the interchange of Route 134 and Route 6
- As a group, identify areas for improvement

11:30 AM Completion of RSA

- Finalize all areas for improvement
- Discuss potential improvements with pros and cons and record possible countermeasures

12:00 noon Adjourn for the Day – but the RSA has not ended

Instructions for Participants:

- Before attending the RSA on August 4th, participants are encouraged to drive through the intersections of the Route 6 ramps at Route 134 and complete/consider elements on the RSA Prompt List with a focus on safety.
- 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 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.

Appendix B. RSA Audit Team Contact List

Participating Audit Team Members

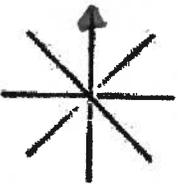
Date: August 4, 2009

Location: DPW Headquarters, 120 Theophilus F. Smith Road, South Dennis

Audit Team Members	Agency/Affiliation	Email Address	Phone Number
Joe Rodricks	Dennis Town Engineer	jrodricks@town.dennis.ma.us	(508) 760-6145
David Johansen	Dennis Department of Public Works Superintendent	djohansen@town.dennis.ma.us	(508) 760-6222
Peter DiMatteo	Dennis Police Department	pdimatteo@town.dennis.ma.us	(774) 352-1435
Robert Gregory	MassHighway District 5	Robert.gregory@mhd.state.ma.us	(508) 884-4245
Edward C. Feeny	MassHighway District 5		(508) 884-4242
Priscilla Leclerc	Cape Cod Commission	pleclerc@capecodcommission.org	(508) 362-3828
Tim White	Federal Highway Administration	Timothy.A.White@fhwa.dot.gov	(617) 494-3290
Lisa Schletzbaum	MassHighway Safety	lisa.schletzbaum@mhd.state.ma.us	(617) 973-7685
Bonnie Polin	MassHighway Safety	bonnie.polin@mhd.state.ma.us	(617) 973-7991
Austin Feula	MassHighway Safety	austin_feula@student.uml.edu	(617) 791-2655
Carrie Lavalley	MassHighway Projects	carrie.lavalle@mhd.state.ma.us	(617) 973-8834
Kelly Shanahan	MassHighway Projects	kmshanah@gmail.com	(617) 973-7440
Keri Pyke	Howard/Stein-Hudson Associates	kpyke@hshassoc.com	(617) 482-7080
Michelle Langone	Howard/Stein-Hudson Associates	mlangone@hshassoc.com	(617) 482-7080
Sarah Kurpiel	Howard/Stein-Hudson Associates	skurpiel@hshassoc.com	(617) 482-7080

Appendix C. Detailed Crash Data

Route 6 EB to Route 134



Indicate North

by Arrow

← on Ramp Rtc 6 EB From 134 SB

COLLISION DIAGRAM

← Off Ramp Rtc 6 EB to Rtc 134 NB

← 12, 5, 7, 12, 16, 24, 31, 32, 34, 38, 40, 46, 49, 60, 62, 65, 69

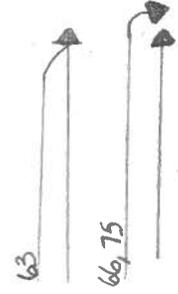
← 17

6, 10, 14, 23, 25, 27, 35, 36

37, 39, 42, 44, 47, 55, 59, 73, 77, 78, 80, 82

off Ramp Rtc 6 EB to Rtc 134 SB

Name



On Ramp Rtc 6 EB from Rtc 134 NB

Name

SYMBOLS	TYPES OF COLLISIONS	SHOW FOR EACH ACCIDENT
<p>← Moving Vehicle</p> <p>←>>>> Backing Vehicle</p> <p>--- Non-involved Vehicle</p> <p>X --- Pedestrian</p> <p>▣ Parked Vehicle</p> <p>□ Fixed Object</p> <p>● Fatal Accident</p> <p>○ Injury Accident</p>	<p>←< Rear-End</p> <p>→> Head On</p> <p>←> Side Swipe</p> <p>←> (curved) Out of Control</p> <p>←> (angled) Left Turn</p> <p>⊥ Right Angle</p>	<ol style="list-style-type: none"> 1. Approximate location of accident 2. Type of collision and vehicles involved. 3. Time, Day, Date 4. Any other pertinent factors mentioned on the report (i.e. presence of oil on road, ruts, etc.)

INTERSECTION Route 6

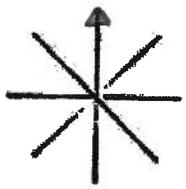
PERIOD FROM: 2/5/06

and

Route 134

to 2/25/09

Route 6 WB to Route 134



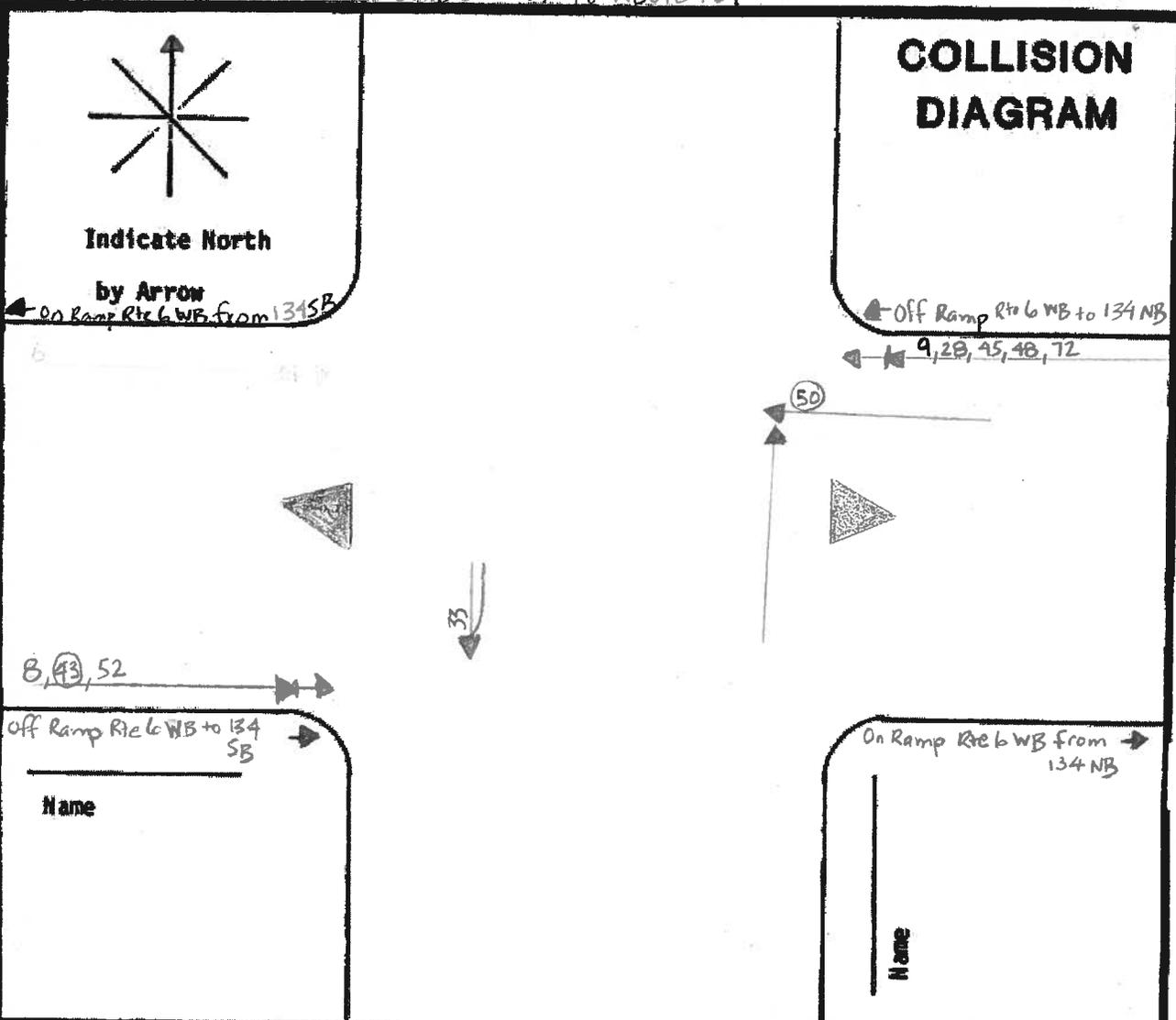
Indicate North
by Arrow

← On Ramp Rte 6 WB from 134 SB

COLLISION DIAGRAM

← Off Ramp Rte 6 WB to 134 NB

9, 28, 45, 48, 72



Name _____

Name _____

SYMBOLS	TYPES OF COLLISIONS	SHOW FOR EACH ACCIDENT
<ul style="list-style-type: none"> ← Moving Vehicle ←>>>> Backing Vehicle - - - Non-Involved Vehicle X - - - Pedestrian ▣ Parked Vehicle □ Fixed Object ● Fatal Accident ○ Injury Accident 	<ul style="list-style-type: none"> ←> Rear-End →> Head On ←> Side Swipe ←> Out of Control ←> Left Turn ⊥ Right Angle 	<ol style="list-style-type: none"> 1. Approximate location of accident 2. Type of collision and vehicles involved. 3. Time, Day, Date 4. Any other pertinent factors mentioned on the report (i.e. presence of oil on road, ruts, etc.)

INTERSECTION Route 6 and Route 134

PERIOD FROM: 2/5/06 to 2/25/09

Crash Summary for the intersections of Route 134 and the Route 6 Ramps

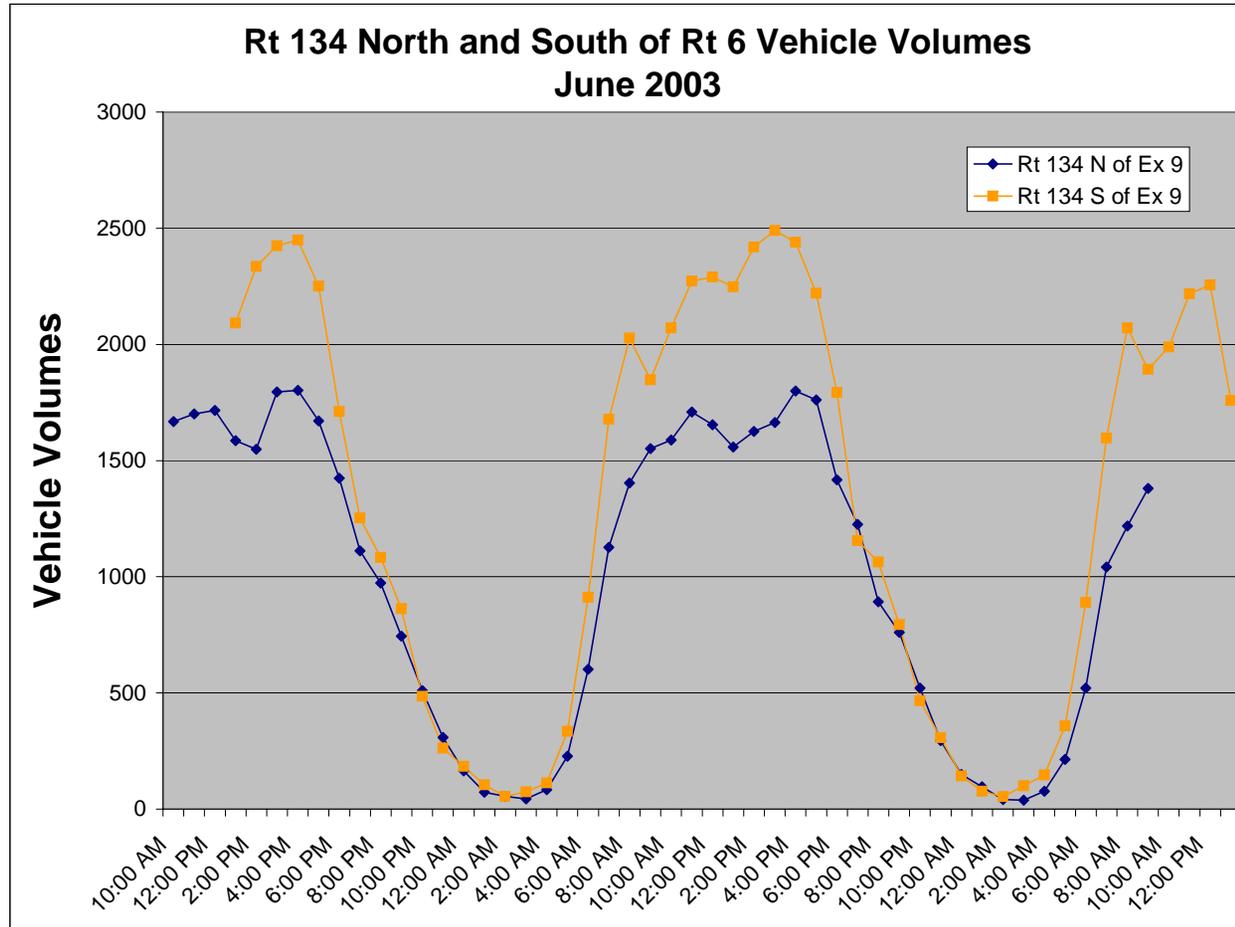
Crash Number	Crash Day	Crash Date	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	Comments
1	Sunday	February 5, 2006	2:38 PM	Rear-end	Daylight	Clear	Dry	Inattention	
2	Friday	March 24, 2006	9:35 AM	Rear-end	Daylight	Clear	Dry	Inattention	
3	Thursday	April 6, 2006	2:22 AM	Angle	Dark - Roadway not light	Clear	Dry	Failure to keep in proper lane or running off road	Out of Area
4	Monday	May 15, 2006	10:50 AM	Rear-end	Daylight	Cloudy	Wet	Followed too closely	Exiting Rte 6 onto 134 SB
5	Wednesday	May 31, 2006	3:15 PM	Rear-end	Daylight	Clear	Dry	Inattention	
6	Monday	June 26, 2006	4:32 PM	Rear-end	Daylight	Clear	Dry	Inattention	
7	Friday	June 30, 2006	2:25 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	
8	Wednesday	July 5, 2006	4:47 PM	Rear-end	Daylight	Clear	Dry	Inattention	
9	Saturday	July 29, 2006	4:49 PM	Rear-end	Daylight	Clear	Dry	Inattention	
10	Monday	July 31, 2006	3:26 PM	Rear-end	Daylight	Clear	Dry	Inattention	
11	Thursday	August 3, 2006	11:15 AM	Rear-end	Daylight	Clear	Dry	Inattention	Exiting Rte 6 onto 134 SB
12	Thursday	August 3, 2006	11:18 AM	Rear-end	Daylight	Clear	Dry	Inattention	
13	Saturday	August 5, 2006	11:48 AM	Rear-end	Daylight	Clear	Dry	Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner	Exiting Rte 6 onto 134 NB
14	Saturday	August 12, 2006	1:11 PM	Rear-end	Daylight	Clear	Dry	Inattention	
15	Saturday	August 26, 2006	6:07 PM	Rear-end	Daylight	Clear	Dry	Inattention	Exiting Rte 6 onto 134 SB
16	Saturday	September 2, 2006	1:45 PM	Rear-end	Daylight	Clear	Dry	Inattention	
17	Friday	September 22, 2006	4:25 PM	Rear-end	Daylight	Clear	Dry	Inattention	
18	Friday	September 22, 2006	5:35 PM	Rear-end	Daylight	Clear	Dry	Inattention	Exiting Rte 6 onto 134 NB
19	Tuesday	October 10, 2006	7:48 AM	Rear-end	Daylight	Clear	Dry	Followed too closely	Exiting Rte 6 onto 134 SB
20	Sunday	October 22, 2006	3:17 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	Exiting Rte 6 onto 134 SB
21	Thursday	November 9, 2006	2:54 PM	Rear-end	Daylight	Clear	Dry	Illness	Out of Area - Driver has a medical condition
22	Thursday	November 16, 2006	9:11 AM	Rear-end	Daylight	Clear	Dry	Inattention	Exiting Rte 6 onto 134 NB
23	Sunday	December 31, 2006	1:59 PM	Rear-end	Daylight	Clear	Dry	Inattention	
24	Friday	January 5, 2007	4:53 PM	Rear-end	Dark - Roadway not light	Rain	Wet	Inattention	
25	Monday	March 12, 2007	2:30 PM	Rear-end	Daylight	Clear	Dry	Inattention	
26	Wednesday	March 14, 2007	6:09 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	Exiting Rte 6 onto 134 NB
27	Saturday	March 31, 2007	1:20 PM	Rear-end	Daylight	Clear	Dry	Inattention	
28	Monday	April 9, 2007	4:29 PM	Rear-end	Daylight	Clear	Dry	Inattention	
29	Friday	April 13, 2007	8:54 AM	Rear-end	Daylight	Clear	Dry	Followed too closely	Exiting Rte 6 onto 134 NB
30	Friday	April 13, 2007	8:46 PM	Rear-end	Dark - Roadway not light	Cloudy	Dry	Inattention	Out of Area
31	Monday	April 23, 2007	12:45 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	
32	Thursday	April 26, 2007	2:45 PM	Rear-end	Daylight	Clear	Dry	Inattention	
33	Monday	May 21, 2007	10:45 AM	Sideswipe, same direction	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings	
34	Sunday	June 3, 2007	5:53 PM	Rear-end	Daylight	Clear	Dry	Inattention	
35	Sunday	June 17, 2007	2:11 PM	Rear-end	Daylight	Clear	Dry	Inattention	
36	Tuesday	June 19, 2007	1:25 PM	Rear-end	Daylight	Clear	Dry	Inattention	
37	Saturday	June 23, 2007	5:27 PM	Rear-end	Daylight	Clear	Dry	Inattention	
38	Tuesday	June 19, 2007	6:17 PM	Rear-end	Daylight	Clear	Dry	Inattention	
39	Tuesday	July 3, 2007	7:19 PM	Rear-end	Daylight	Clear	Dry	Inattention	
40	Friday	July 6, 2007	12:21 PM	Rear-end	Daylight	Clear	Dry	Inattention	
41	Friday	July 6, 2007	12:46 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	Exiting Rte 6 onto 134 SB
42	Friday	July 27, 2007	10:46 PM	Rear-end	Dark - Roadway not light	Clear	Dry	Inattention	
43	Sunday	July 29, 2007	6:11 PM	Rear-end	Daylight	Clear	Dry	Inattention	
44	Tuesday	August 7, 2007	11:04 AM	Rear-end	Daylight	Cloudy	Dry	Inattention	
45	Wednesday	August 15, 2007	12:39 PM	Rear-end	Daylight	Clear	Dry	Inattention	
46	Thursday	August 16, 2007	4:19 PM	Rear-end	Daylight	Cloudy	Dry	Inattention	
47	Friday	August 17, 2007	1:24 PM	Rear-end	Daylight	Clear	Dry	Inattention	
48	Friday	August 17, 2007	3:57 PM	Rear-end	Daylight	Clear	Dry	Inattention	
49	Friday	September 14, 2007	3:32 PM	Rear-end	Daylight	Clear	Dry	Inattention	
50	Saturday	September 29, 2007	6:06 PM	Angle	Daylight	Clear	Dry	Made an improper turn	Driver attempted U-turn on Route 134
51	Tuesday	October 9, 2007	1:43 PM	Single Vehicle Crash	Daylight	Clear	Dry	NA/Can't Read	Out of Area
52	Monday	October 15, 2007	8:55 AM	Rear-end	Daylight	Clear	Dry	Other improper action	
53	Wednesday	October 31, 2007	3:33 PM	Rear-end	Daylight	Clear	Dry	Inattention	Exiting Rte 6 onto 134 NB
54	Tuesday	November 6, 2007	7:46 AM	Rear-end	Daylight	Clear	Dry	No Improper Driving	On Route 134 by Exit 9 - Not sure of which Exit 9 though
55	Saturday	November 17, 2007	2:13 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	
56	Thursday	December 6, 2007	2:25 PM	Rear-end	Daylight	Clear	Dry	Inattention	Exiting Rte 6 onto 134 NB
57	Sunday	January 27, 2008	6:58 PM	Rear-end	Dark - Lighted Roadway	Snow	Snow	Driving too fast for conditions	Courtesy to snow plow in construction zone

Crash Number	Crash Day	Crash Date	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	Comments
58	Sunday	February 10, 2008	2:26 PM	Sideswipe, same direction	Daylight	Clear	Dry	Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner	Construction related?
59	Saturday	February 16, 2008	5:04 PM	Rear-end	Dusk	Clear	Dry	Inattention	
60	Thursday	February 21, 2008	3:05 PM	Rear-end	Daylight	Clear	Dry	Inattention	
61	Sunday	February 24, 2008	12:45 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	
62	Saturday	March 1, 2008	3:03 PM	Rear-end	Daylight	Cloudy	Wet	Inattention	
63	Wednesday	March 12, 2008	4:06 PM	Sideswipe, same direction	Daylight	Cloudy	Wet	Inattention	Construction related?
64	Thursday	March 27, 2008	5:34 PM	Rear-end	Daylight	Cloudy	Dry	Inattention	Exiting Rte 6 onto 134 NB
65	Thursday	April 3, 2008	9:41 AM	Rear-end	Daylight	Clear	Dry	Inattention	
66	Tuesday	April 8, 2008	1:53 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Construction related?
67	Saturday	May 31, 2008	12:06 PM	Rear-end	Daylight	Cloudy	Dry	Inattention	Exiting Rte 6 onto 134 SB
68	Friday	June 20, 2008	4:50 PM	Single Vehicle Crash	Daylight	Clear	Dry	Inattention	
69	Friday	August 1, 2008	10:30 AM	Rear-end	Daylight	Clear	Dry	Inattention	
70	Saturday	August 2, 2008	12:44 PM	Rear-end	Daylight	Clear	Dry	Inattention	Exiting Rte 6 onto 134 NB
71	Friday	August 15, 2008	4:03 PM	Rear-end	Daylight	Clear	Dry	Inattention	Exiting Rte 6 onto 134 SB
72	Saturday	August 16, 2008	5:21 PM	Rear-end	Daylight	Clear	Dry	NA/Hit & Run	
73	Friday	August 29, 2008	10:31 AM	Rear-end	Daylight	Clear	Dry	Inattention	
74	Friday	September 12, 2008	2:43 PM	Rear-end	Daylight	Clear	Dry	Inattention	Exiting Rte 6 onto 134 SB
75	Tuesday	November 4, 2008	7:38 AM	Angle	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	
76	Saturday	November 22, 2008	5:04 PM	Rear-end	Dark - Lighted Roadway	Clear	Dry	Followed too closely	Construction related?
77	Thursday	November 27, 2008	11:37 AM	Rear-end	Daylight	Cloudy	Dry	Inattention	
78	Wednesday	December 3, 2008	4:39 PM	Rear-end	Dark - Lighted Roadway	Clear	Dry	No Improper Driving	
79	Friday	December 12, 2008	10:13 AM	Single Vehicle Crash	Daylight	Clear	Wet	No Improper Driving	Construction debris fell on car
80	Wednesday	December 17, 2008	9:51 AM	Rear-end	Daylight	Rain	Wet	Inattention	
81	Friday	December 19, 2008	5:31 PM	Rear-end	Dark - Lighted Roadway	Snow	Snow	No Improper Driving	Courtesy to snow plow in construction zone
82	Monday	January 5, 2009	9:53 AM	Rear-end	Daylight	Cloudy	Wet	Inattention	
83	Wednesday	February 25, 2009	7:42 AM	Rear-end	Daylight	Clear	Dry	Followed too closely	Exiting Rte 6 onto 134 NB/Construction related?
Not intersection related			Not mapped						
Of the 83 crashes submitted to us, 30 crashes were not mapped. 4 of these were outside of the area of interest.									
9 of the 29 crashes occurred exiting Route 6 onto 134 SB but not enough information to tell if driver was coming from Route 6 NB or SB.									
10 of the 29 crashes occurred exiting Route 6 onto 134 NB but not enough information to tell if driver was coming from Route 6 NB or SB.									
8 crashes from 1/27/2008 - 2/25/2009 are potentially related to the construction on Route 134.									
Summary									
79	Total Crashes								
Manner of Collision				Time of Day					
Angle	Rear-End	Single Vehicle Crash	Sideswipe, same direction	6:00am-10:00am	10:00am-2:00pm	2:00pm-6:00pm	6:00pm-10:00pm	10:00-2:00am	2:00am-6:00am
3	71	2	3	11	24	36	7	1	0
3.8%	89.9%	2.5%	3.8%	13.9%	30.4%	45.6%	8.9%	1.3%	0.0%
Road Surface			Lighting						
Dry	Wet	Snow	Daylight	Dusk	Dark-lighted	Dark - not lighted			
70	7	2	71	1	6	1			
88.6%	8.9%	2.5%	89.9%	1.3%	7.6%	1.3%			
Day of Week									
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday			
9	8	9	10	19	15	9			
11.4%	10.1%	11.4%	12.7%	24.1%	19.0%	11.4%			
Source: Dennis Police Department									

Appendix D. Additional Information

Route 134 Vehicle Volumes

Time	20766	20448
10:00 AM	1668	
11:00 AM	1701	
12:00 PM	1716	
1:00 PM	1585	2092
2:00 PM	1548	2335
3:00 PM	1795	2425
4:00 PM	1802	2449
5:00 PM	1670	2250
6:00 PM	1424	1710
7:00 PM	1112	1252
8:00 PM	973	1083
9:00 PM	744	862
10:00 PM	510	485
11:00 PM	309	262
12:00 AM	165	184
1:00 AM	72	104
2:00 AM	55	55
3:00 AM	44	74
4:00 AM	84	113
5:00 AM	227	335
6:00 AM	601	911
7:00 AM	1127	1677
8:00 AM	1404	2027
9:00 AM	1552	1848
10:00 AM	1588	2071
11:00 AM	1709	2272
12:00 PM	1654	2290
1:00 PM	1558	2247
2:00 PM	1625	2419
3:00 PM	1664	2490
4:00 PM	1800	2440
5:00 PM	1761	2220
6:00 PM	1417	1792
7:00 PM	1225	1156
8:00 PM	892	1063
9:00 PM	761	793
10:00 PM	521	466
11:00 PM	294	307
12:00 AM	150	142
1:00 AM	96	77
2:00 AM	41	54
3:00 AM	39	100
4:00 AM	77	146
5:00 AM	214	358
6:00 AM	521	889
7:00 AM	1042	1596
8:00 AM	1218	2071
9:00 AM	1380	1893
10:00 AM		1988
11:00 AM		2217
12:00 PM		2256
1:00 PM		1758



THE COMMONWEALTH OF MASSACHUSETTS

MASSACHUSETTS HIGHWAY DEPARTMENT

INTEROFFICE MEMORANDUM

TO: Rick Wilson, Traffic Regulations Engineer

FROM: Joseph Amato, Civil Engineer II

DATE: April 8, 2009

RE: Route 134 @ Route 6 –Town of Dennis
Bearses Way – Barnstable Town, near Hyannis

On Tuesday, April 7, Thao Tran and I conducted a speed study on Route 134 in the Town of Dennis at the Route 6 ramps, a location on the list of HSIP Projects for Cape Cod, 2009. While driving on Route 134 we observed that the two northbound lanes within the ramp system were under reconstruction and the north and south traffic were detoured onto the two southbound lanes. We stationed ourselves and recorded radar readings of vehicles at approximately 1000' north of the work zone area near the intersection of Bob Crowell Road.

A second location, Bearses Way in Barnstable Town near Hyannis, was selected for a speed study using radar readings. We stationed ourselves on this busy 4-lane road located between Route 132 and Route 28. Bearses Way is also on the MassHighway Top 58 High Crash Locations on Cape Cod.

The following 85th and 50th percentiles were observed and calculated at:

<u>Location</u>	<u>Direction</u>	<u>85th %</u>	<u>50th%</u>
Route 134	NB	42	40
Route 134	SB	42	38
Bearses Way	NB	43	38
Bearses Way	SB	43	38

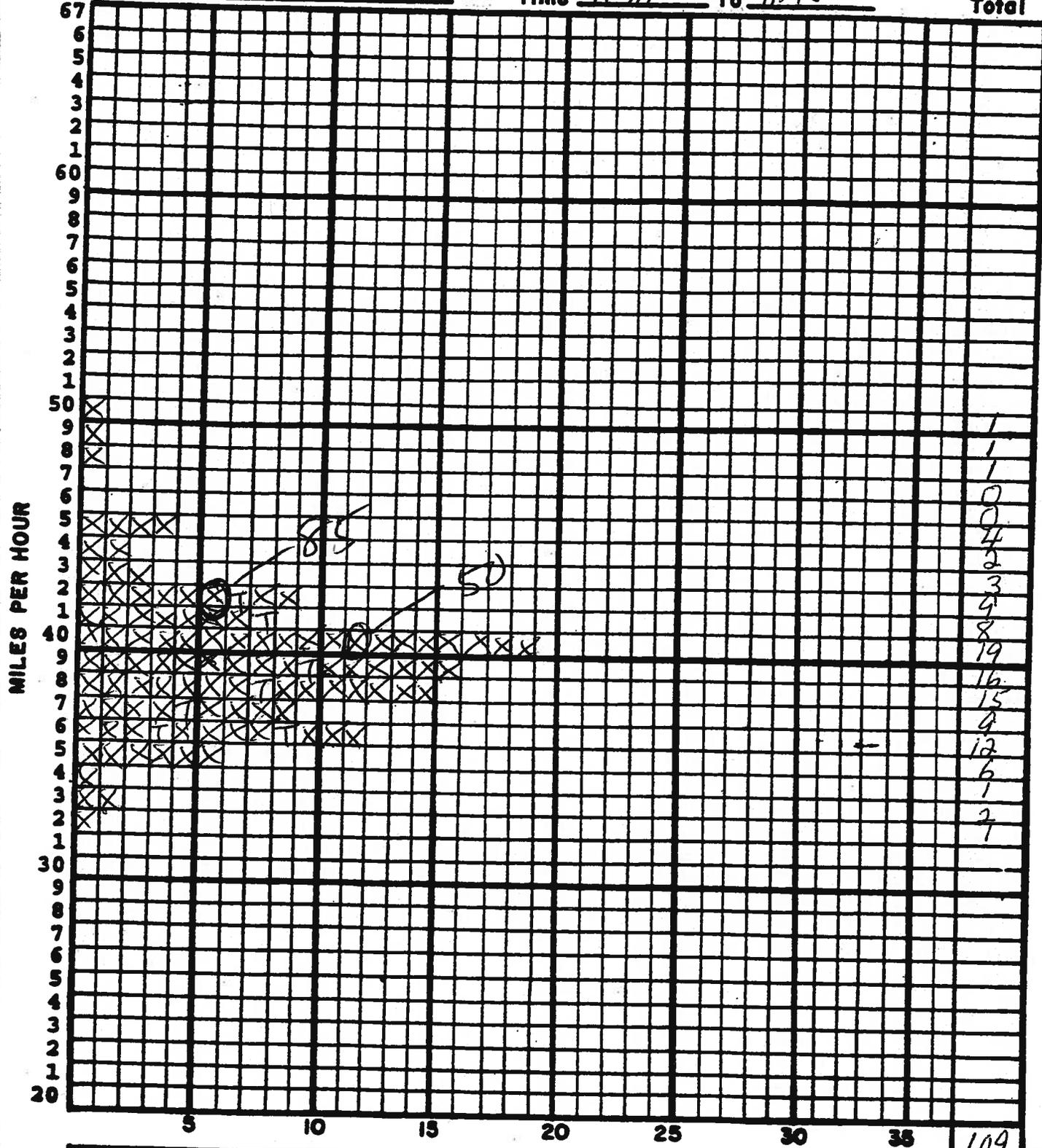
The Speed Distribution Sheets are attached for your inspection. If you have any questions or comments on this matter please contact Joseph Amato at ext 7337 or Thao Tran at ext 7457.

Massachusetts Highway Department

SPEED DISTRIBUTION

Location: Route 134 Town Dennis
 Direction of Travel NB Station @ Bob Crowell Rd
 Date 4-27-09 Time 11:10 To 11:45

Interval
Total



109 TOTAL
 95% Speed _____ M.P.H.
 85% Speed 42 M.P.H.
 50% Speed 40 M.P.H.
 Mode _____ M.P.H.

LEGEND: X=Pass. Car
 T=Truck
 S=Semi Trailer
 B=Bus

NUMBER OF VEHICLES
 Surface Type _____
 Weather Dry cloudy
 Existing Posted Speed _____ M.P.H.

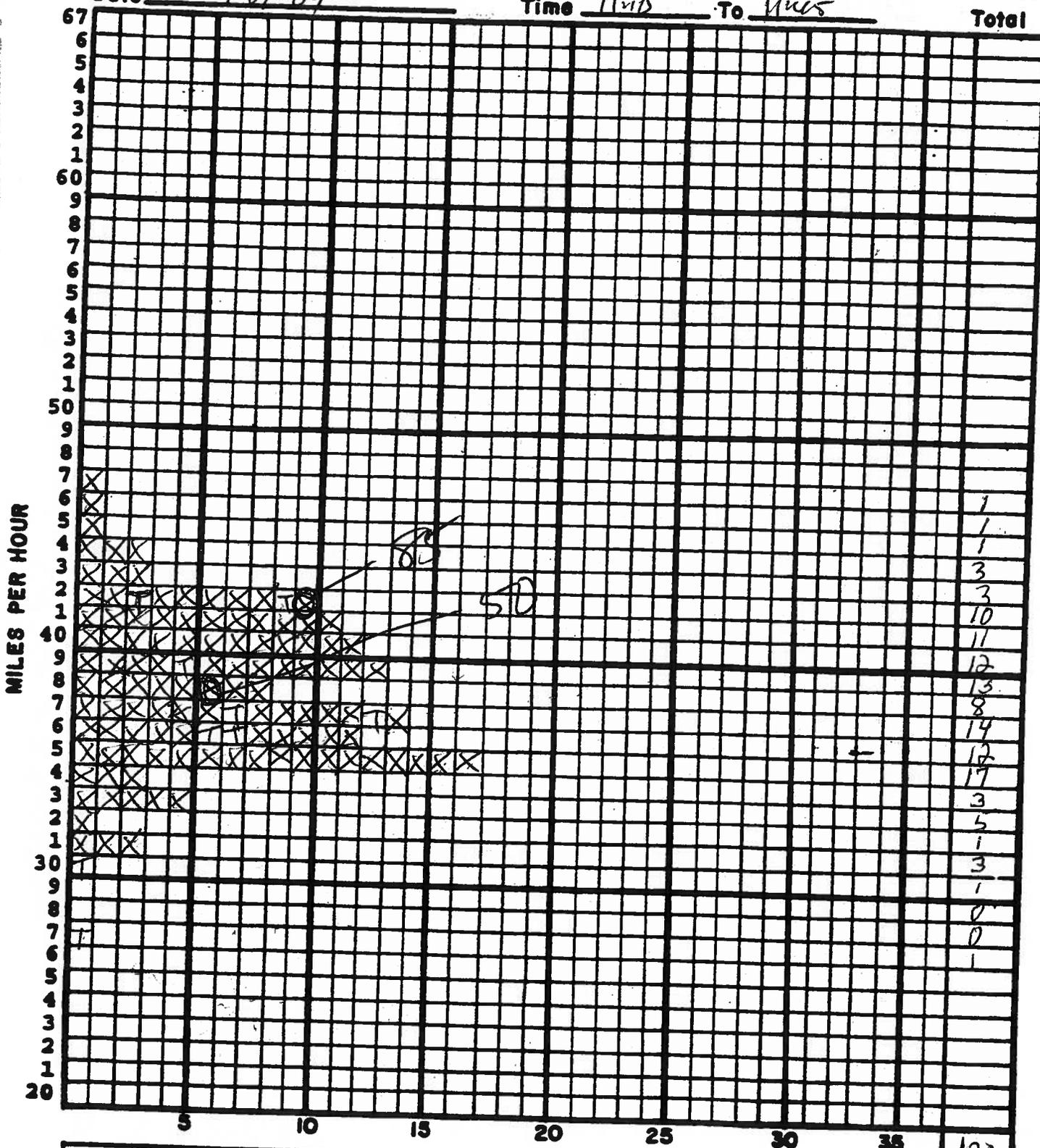
OBSERVER _____

Massachusetts Highway Department

SPEED DISTRIBUTION

Location: Route 134 Town Dennis
 Direction of Travel SB Station C Bob Crowell Rd.
 Date 4-27-09 Time 11:10 To 11:45

Interval
Total



TOTAL 120
 95% Speed M.P.H.
 85% Speed 42 M.P.H.
 50% Speed 38 M.P.H.
 Mode M.P.H.

LEGEND: X=Pass. Car
 T=Truck
 S=Semi Trailer
 B=Bus

NUMBER OF VEHICLES
 Surface Type
 Weather Dry cloudy
 Existing Posted Speed MPH.

OBSERVER

GEOMETRIC DESIGN	
Issue	Comment
A. Speed – (Design Speed; Speed Limit & Zoning; Sight Distance; Overtaking)	
<p>Are there speed-related issues along the corridor? Please consider the following elements:</p> <ul style="list-style-type: none"> • Horizontal and vertical alignment; • Posted and advisory speeds • Driver compliance with speed limits • Approximate sight distance • Safe passing opportunities 	
B. Road alignment and cross section	
<p>With respect to the roadway alignment and cross-section please consider the appropriateness of the following elements:</p> <ul style="list-style-type: none"> • 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	
<p>For intersections along the corridor please consider all potential safety issues. Some specific considerations should include the following:</p> <ul style="list-style-type: none"> • 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	
<ul style="list-style-type: none"> • Do auxiliary lanes appear to be adequate? • Could the taper locations and alignments be causing safety deficiencies? • Are shoulder widths at merges causing safety deficiencies? 	

E. Clear zones and crash barriers	
<p>For the roadside the major considerations are clear zone issues and crash barriers. Consider the following:</p> <ul style="list-style-type: none"> • Do there appear to be clear zones issues? <ul style="list-style-type: none"> — 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)	
<p>Are there specific issues related to bridges and culverts that may result in safety concerns?</p>	
G. Pavement – (Defects, Skid Resistance, and Flooding)	
<ul style="list-style-type: none"> • 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, steep 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)	
<p>It is important to consider to the impacts of lighting. Some specifics include the following:</p> <ul style="list-style-type: none"> • 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	
<p>Signage is a critical element in providing a safe roadway environment. Please consider the following:</p> <ul style="list-style-type: none">• Are all current signs visible (consider both night and day)? Are they conspicuous and clear? Are the correct signs used for each situation?• Does the retroreflectivity or illumination appear satisfactory?• Are there any concerns regarding sign supports?	
J. Traffic signals	
<ul style="list-style-type: none">• If present, do the traffic signals appear to be designed, installed, and operating correctly?• Is the signal processing the traffic efficiently?• 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	
<ul style="list-style-type: none">• Is the line marking and delineation:<ul style="list-style-type: none">— 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
<p>With respect to roadway activity please consider safety elements related to the following:</p> <ul style="list-style-type: none">• Pedestrians• Bicycles• Public transportation vehicles and riders• Emergency vehicles• Commercial vehicles• Slow moving vehicles	

ENVIRONMENTAL CONSIDERATIONS

Issue	Comment
Weather & Animals	
<p>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:</p> <ul style="list-style-type: none">• 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?	