A Crash Analysis and Discussion of Off-Premise Commercial Electronic Variable Message Signs (CEVMS) Along New York State Interstate Highways

FINAL REPORT
October 2012

PREPARED BY:
NEW YORK STATE DEPARTEMENT OF TRANSPORTATION

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Overview

Commercial Electronic Variable Message Sign (CEVMS) installations are a relatively new feature along the world's highways. As these off-premise CEVMS billboards become more common along the roadway corridor, the impacts of the installations on road safety are a concern held by the Federal Highway Administration (FHWA), the Department of Transportation, and the general public. Concerns are based on several human factors, concepts, and principles. The placement of large, off-premise CEVMS installations (typically 14 ft by 48 ft) may be directly in the drivers' line of sight and contain illuminated, bright colored and/or "flashing" messages. These factors can divert motorists attentions away from important traffic control devices (signs, signals, and etc.) installed by the Department of Transportation and alerts or warnings made by emergency and other vehicles, particularly at night. The CEVMS is an example of an external stimulus that may cause motorists to become distracted and lose their concentration whilst driving. A human factor called Zeigarnik Effect, suggests road users feel anxious and have a desire to continue looking at changing messages on billboards to see what comes next while they are driving along a roadway. Unlike official traffic signs, billboards do not have to follow design standards with regards to message legibility and readability. This lack of standard may be to make the off-premise CEVMS more visible, force motorists to take more time to read and possibly take multiple glances in order to comprehend the message. The novelty of the CEVMS billboard does not wear off over time since there can be multiple messages played throughout the day and may capture the attention of the road users every time they pass the particular sign. Due to the Moth Effect, the bright light source of off-premise CEVMS may also draw the road users' attention to the side of the roadway and cause crashes.

It is important to monitor the safety impacts of off-premise CEVMS installations. Studies have been conducted nationally and internationally by using crash analysis methodology, field investigations, laboratory simulations, etc. Due to the newness of these installations, the "after" installation data is insufficient to determine what impact these installations have on road users. The results from the studies completed to date are mostly premature and inconclusive.

1.2 New York State Regulations and Background

Along with numerous studies that have been prepared by researchers in other countries and the outdoor advertising industry, a number of states have also completed research about the safety aspects of digital billboards or Commercial Electronic Variable Message Sign (CEVMS) installations, including New York State.

Criteria for Regulating Off-Premise Commercial Electronic Variable Message Signs (CEVMS) in New York State were published by the New York State Department of Transportation on October 28, 2008. To develop these regulations, the New York State Department of Transportation was in consultation with the New York Division of the Federal Highway Administration (FHWA). The criteria were based on rules and regulations governing the Sign Program in Title 17 NYCRR Part 150, including Part 150.8 (b), and all other applicable Federal and State regulations and agreements regarding advertising signs adjacent to highways. Regulations that address the brightness of CEVMS billboards are based on a study performed by the Lighting Research Center of the Rensselaer Polytechnic Institute (RPI), the billboard industry's own literature and numerous municipalities' research. Determination of the criteria for the prohibited locations was based on the research results available which include the studies performed by the University of North Carolina Highway Safety Research Center (UNC-HSRC) and the National Highway Traffic Safety Administration (NHTSA). The purpose of the Criteria is to supplement existing requirements for conventional billboards to consider the unique attributes of CEVMS, and minimize the impacts of the off-premise CEVMS billboards on road users.

The following are statewide minimum criteria for regulating off-premise CEVMS in New York State. CEVMS that change advertising message once in a 24-hour period or longer are considered static signs and are treated like conventional billboards with the exception that the brightness criterion contained in the Criteria is applied to all CEVMS.

Duration of Message

Minimum duration of message is 6 seconds. Studies have shown that it takes at least six seconds to read and comprehend a billboard. Many states that allow the use of off-premise CEVMS have specified a minimum message duration of six seconds. There is no empirical evidence at this time to indicate that a CEVMS message changing every six seconds results in an increased risk of accidents. This six second duration is consistent with existing NYS Highway Law. However, in the Criteria, it stated that if accident rates increase at a CEVMS location and NYSDOT has a reasonable engineering basis that the CEVMS was a contributing factor, NYSDOT will revoke existing CEVMS permits for that location and all comparable locations and issue new permits with a longer minimum message duration.

Transition Time

Transition occurs instantaneously. Given that the change of sign faces is one of the elements which can lead to motorist distraction, especially among older drivers, the sign face transition is required to occur instantaneously to minimize the distraction as much as possible.

Spacing

The spacing of the signs, such that if more than one CEVMS sign face is visible to the driver at the same time on either side of the highway, must be spaced at least 5,000 feet apart from each other. As such, a motorist should not be able to clearly view more than one CEVMS at the same time in order to have less distraction.

Brightness

Maximum Brightness for CEVMS is 5,000 cd/m^2 (daytime), 280 cd/m^2 (nighttime). The brightness of CEVMS is not only potentially distracting due to its ability to attract increased attention, but may also create problems with dark adaptation among older drivers. In order to minimize these dangers, the brightness of this technology is constrained such that CEVMS do not appear brighter to drivers than existing static billboards.

Location

- In villages and cities on interstate highways and controlled access highways on the primary highway system, CEVMS may not be located within an interchange or intersection at grade.
- Outside villages and cities on interstate highways and controlled access highways on the primary highway system, CEVMS may not be located within 800 feet of an interchange or intersection at grade.
- CEVMS may not be located within 800 feet of a toll plaza, safety rest area, or information center.
- CEVMS may not be located within 800 feet of a signed curve as measured from the curve warning sign.
- CEVMS may not be located in such a manner as to obstruct, obscure or otherwise physically interfere with the effectiveness of an official traffic sign, signal or device, or with the driver's view of approaching, merging or intersecting traffic, or interfere with the driver's operation of a motor vehicle.

By prohibiting the placement at locations that already place high demands upon driver attention and could interfere with the safe operation of their motor vehicles, the distracting characteristics of off-premise CEVMS can be minimized.

1.3 Scope of This Study

The first off premise CEVMS billboard was installed in New York State in 2007. There are currently eleven approved CEVMS permit applications in the State (excluding New York City) and ten of them are operating. Six CEVMS permits are approved in Albany County (one permit is not currently operating), one permit in Onondaga County, two permits in Monroe County and two permits are under the jurisdiction of the NYS Thruway Authority in Albany County. Two of the approved permits are CEVMS billboards that change their message once every 24 hours; one in Albany and one in Syracuse (Onondaga County). Some of these permits are for CEVMS installations that have two separate sign faces, while other CEVMS installations have only one sign face. This distinction is shown in Exhibit 2.1 under the "Direction" column.

This report applies the accident analysis methodology, found in the New York State Department of Transportation Highway Design Manual §5.3 Accident Analysis, on seven Off-Premise Commercial Electronic Variable Message Signs (CEVMS) along New York State Interstate highway and provides the general outline of the "before and after" crash rates, severity of the crashes, and the type of crashes in the vicinities of CEVMS installations. Two signs on the New York State Thruway (Albany County) and one sign in Syracuse (Onondaga County) are not included because the permit information is not available. One of the CEVMS billboards in Albany changes its message once every 24 hours and is included in the study because we have limited CEVMS sites Although it is treated like a conventional billboard, the brightness is identical to the variable message signs. The data utilized in the study was collected from New York State Safety Information Management System (SIMS). The DMV reports have been reviewed when they are available to verify the crash locations, environmental condition, crash types and contributing factors.

2. CRASH ANALYSIS

2.1 CEVMS Permits Issued along New York State Interstate Highways

There are eleven approved permits along the interstate highways in the New York State (excluding New York City). Permits issued in New York City are excluded since NYC is self-certified for the outdoor advertising program. Refer to Exhibit 2.1 for the permits and locations. As we mentioned before, the CEVMS locations for R3 (Syracuse) and NYS Thruway are not included in this study.

Exhibit 2.1 Permit Issued in NYS along Interstate Highways

Region	Permit Number	Permit Holder	Route	Reference Marker	Direction	Note
1 (Albany)	1105315	LAMAR	I-90	90I-1101-1029	EB & WB	-
1 (Albany)	1105710	LAMAR	I-90	90I-1101-1036	EB & WB	1 change per 24 hr cycle
1 (Albany)	1100200	LANG	I-90	90I-1101-3014	EB & WB	-
1 (Albany)	1100175	LAMAR	I-787	787I-1101-1027	SB & NB	-
1 (Albany)	1007325	N/A	I-90	Not Used		
1 (Albany)	1107324	LANG	I-787	787I-1101-2001	SB	-
3 (Syracuse)	3303452	N/A	I-690	N/A	WB	1 change per 24 hr cycle
4 (Rochester)	4307897	LAMAR	I-390	390I-4303-7003	SB	-
4 (Rochester)	4307872	LAMAR	I-490	490I-4302-2012	EB & WB	-
NYS Thruway Authority (Albany)	N/A	N/A	I-190	N/A	SB	-
NYS Thruway Authority (Albany)	N/A	N/A	I-190	N/A	NB	-

2.2 Study Site Selection

2.2.1 CEVMS Study Site Data

Seven sites in the Albany and Rochester (Monroe County) areas were selected for this study. Refer to Exhibit 2.2.1 for CEVMS site characteristics. Signs 5 and 6 only have one face installed while the others have both faces. Total of twelve segments were analized.

Exhibit 2.2.1 CEVMS Site Characteristics

Sign #	Route #	Reference Marker	Average Annual Daily Traffic (AADT)[1]	Activation Date	Posted Speed Limit (mph)	On/Off Curve	Approx. Distance to Entrance/Exit Ramp (ft)[2,3]
1EB	I-90	90I-1101-1029	101000	5/1/2009	55	On	860 (Exit 5 I-90)
1WB	I-90	90I-1101-1029	101000	5/1/2009	55	On	920 (Exit 5 I-90)
2EB	I-90	90I-1101-1036	111400	6/1/2007	55	On	1800 (Exit 5 I-90)
2WB	I-90	90I-1101-1036	111400	6/1/2007	55	On	765 (Exit 5A I-90)
3EB	I-90	90I-1101-3014	71760	1/15/2010	55	On	971 (Exit 5 I-787)
3WB	I-90	90I-1101-3014	71760	3/1/2009	55	On	1075 (Exit 6 I-90)
4NB	I-787	787I-1101-1027	114500	7/1/2009	55	On	975 (Exit 4B I-787)
4SB	I-787	787I-1101-1027	114500	7/1/2009	55	On	1010 (Exit 4B I-787)
5SB	I-787	787I-1101-2001	95710	6/1/2009	55	On	1740 (Exit 6 I-787)
6SB	I-390	390I-4303-7003	95850	10/15/2009	55	Off	1065 (Exit 18 I-390)
7EB	I-490	490I-4302-2012	90640	11/20/2009	55	Off	1200 (Exit 11 I-490)
7WB	I-490	490I-4302-2012	90640	1/13/2010	55	Off	1000 (Exit 11 I-490)

[1] Average annual daily traffic (AADT) used is from New York State's 2006 Highway Sufficiency Ratings. This data was either collected in 2005 or was extrapolated out to 2005 from previous data.

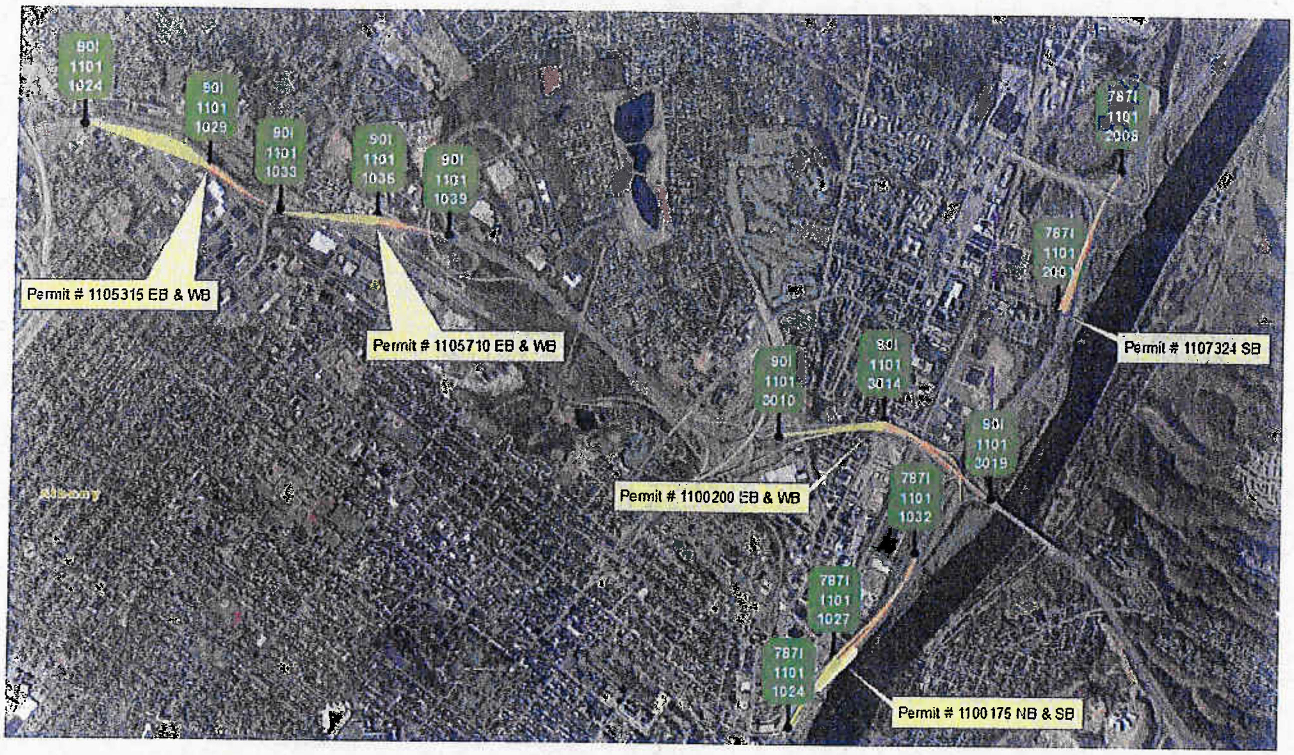
[2] The CEVMS billboards are installed in between two Interstate highway interchanges. This distance measurement is to the nearest Interstate interchange. This distance was measured in ArcMap (GIS) and goes from the CEVMS installation to the physical nose of the gore.

[3] Each CEVMS installation is within the city limits of Albany or Rochester, with the exception of Sign 6SB, which is located in the Town of Gates, outside the city limits of Rochester, NY.

2.2.2 CEVMS Study Site Location Maps

Refer to Exhibit 2.2.2.a and Exhibit 2.2.2.b for the CEVMS location maps in the Albany and Rochester areas.

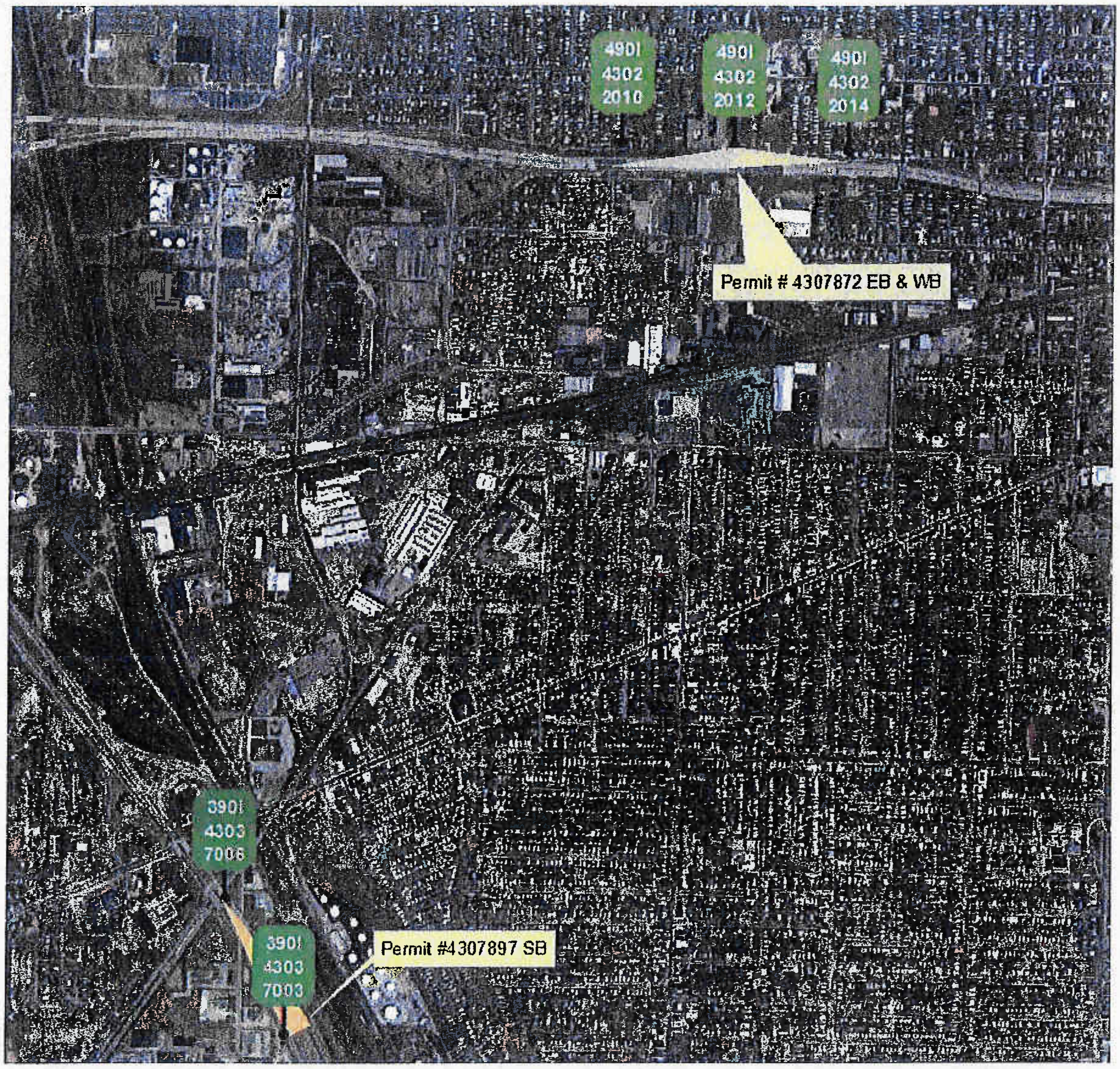
Exhibit 2.2.2.a CEVMS Sites in Albany, NY



EB/NB Sight Distances

WB/SB Sight Distances

Exhibit 2.2.2.b CEVMS Sites in Rochester, NY

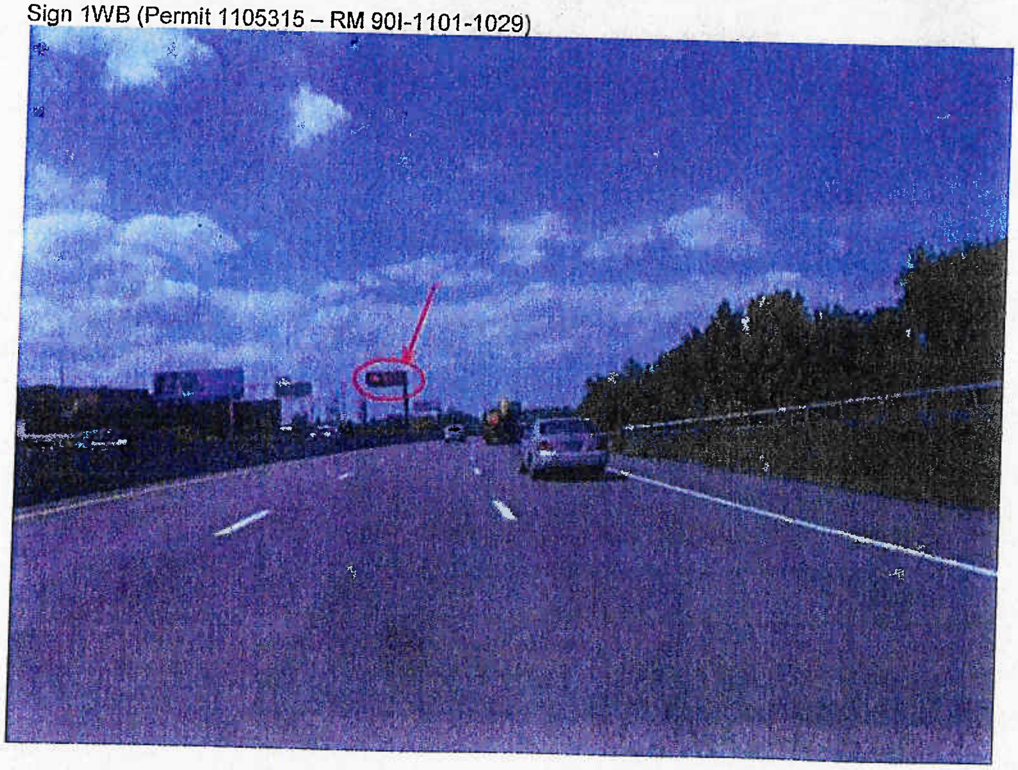


EB/NB Sight Distances
WB/SB Sight Distances

2.2.3 CEVMS Study Site Pictures
I-90 Locations:

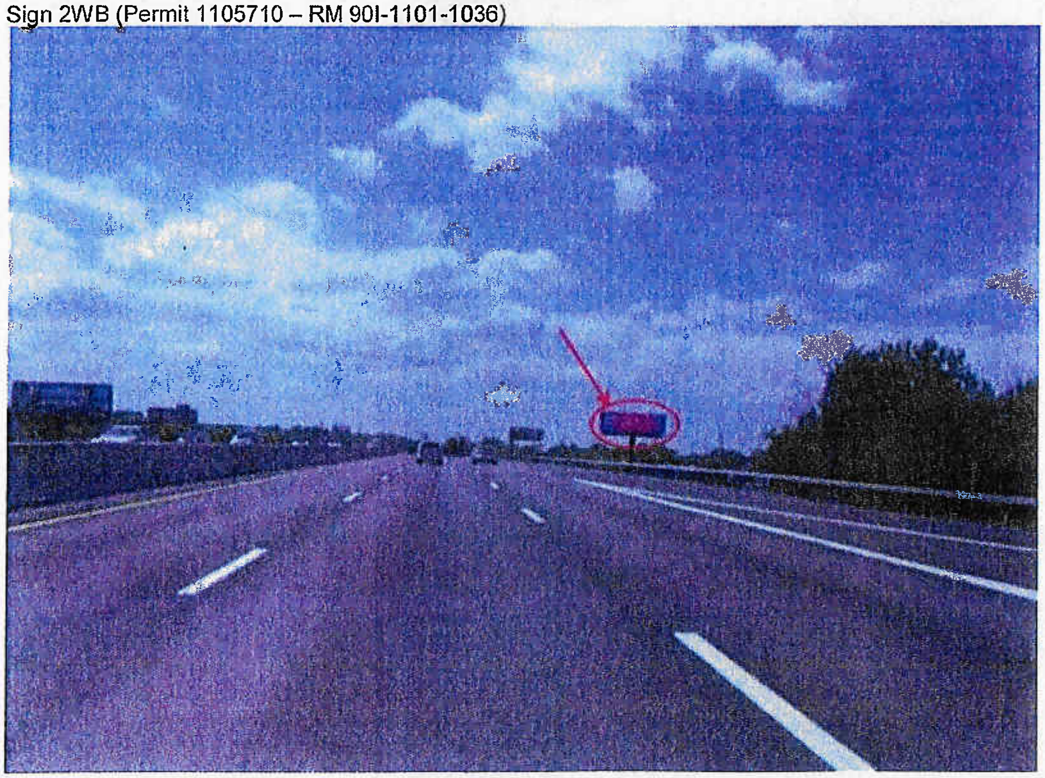
Sign 1EB (Permit 1105315 – RM 90I-1101-1029)

Sign 1WB (Permit 1105315 – RM 90I-1101-1029)

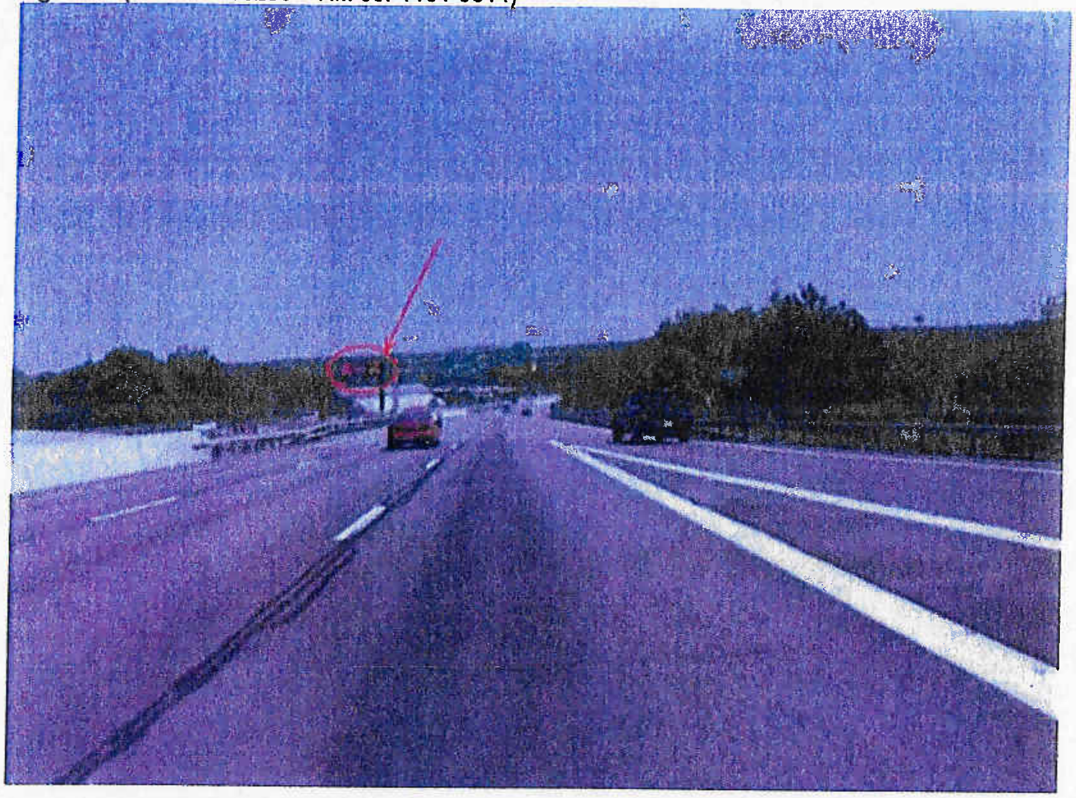


Sign 2EB (Permit 1105710 – RM 90I-1101-1036)

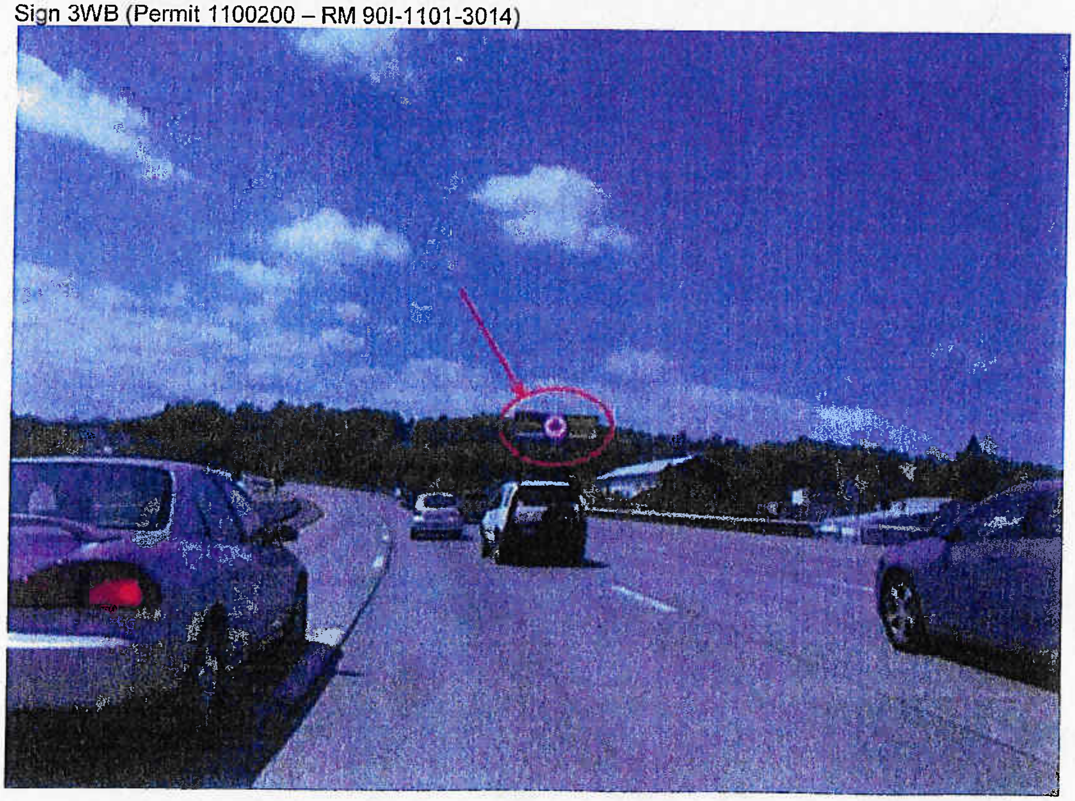
Sign 2WB (Permit 1105710 – RM 90I-1101-1036)



Sign 3EB (Permit 1100200 – RM 90I-1101-3014)

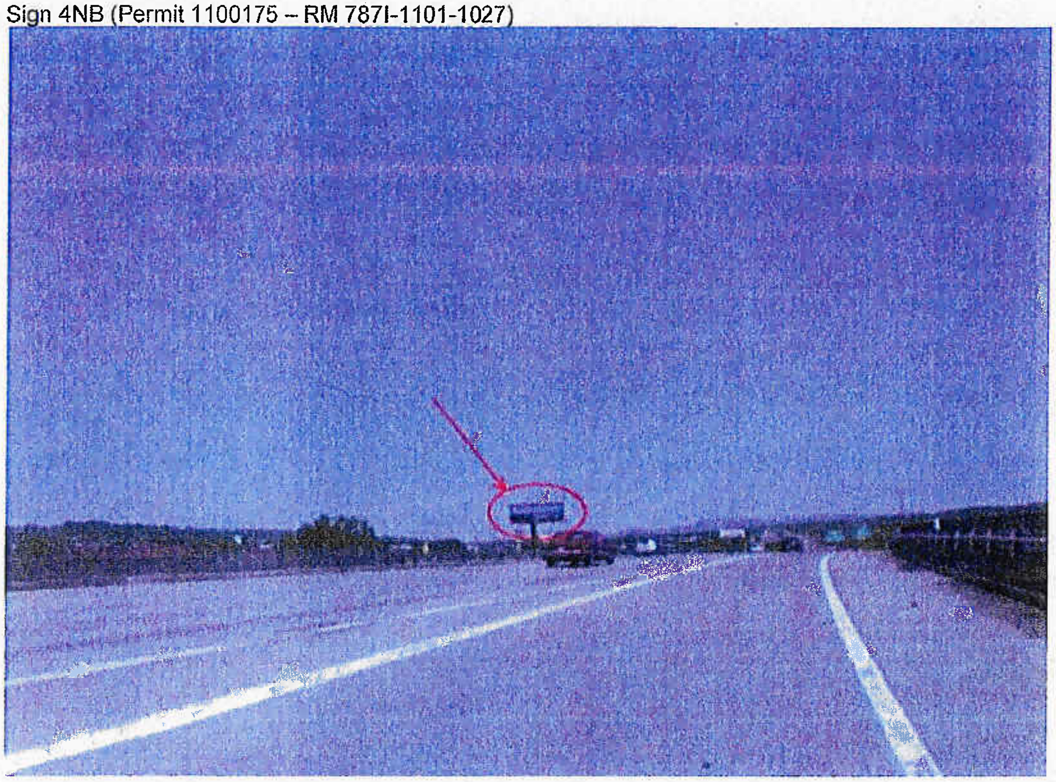


Sign 3WB (Permit 1100200 – RM 90I-1101-3014)



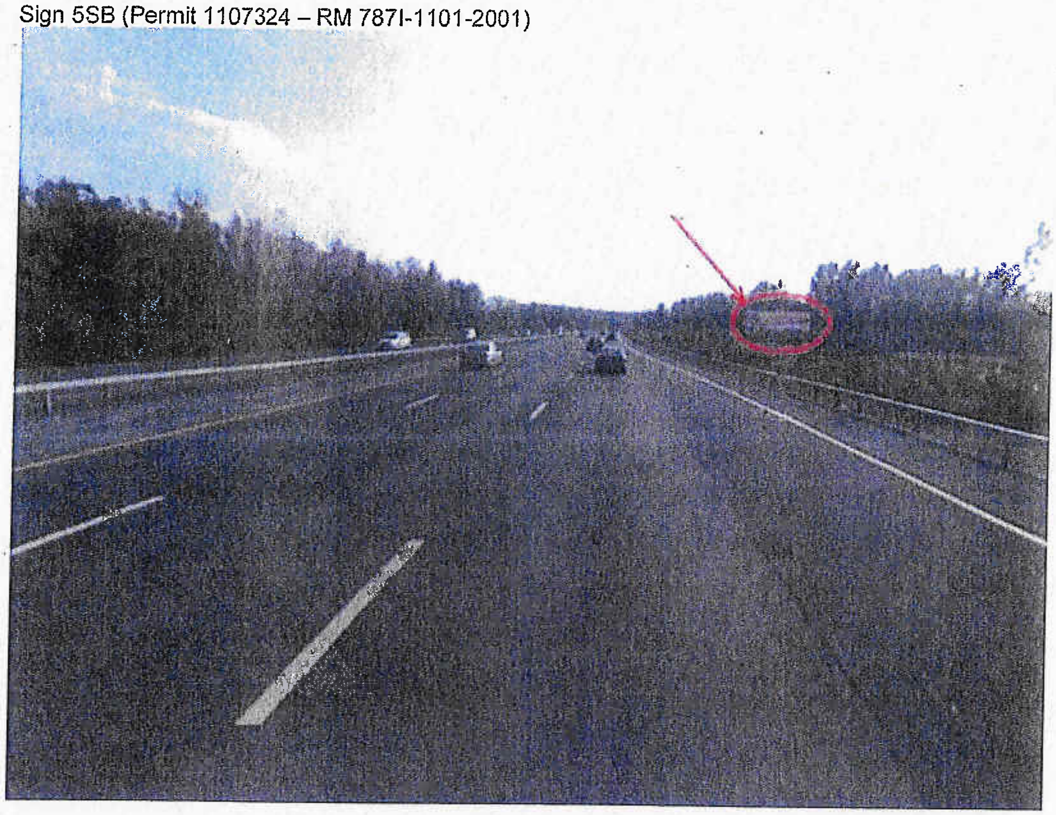
I-787 Locations:

Sign 4NB (Permit 1100175 – RM 787I-1101-1027)



Sign 4SB (Permit 1100175 – RM 787I-1101-1027)

Sign 5SB (Permit 1107324 – RM 787I-1101-2001)



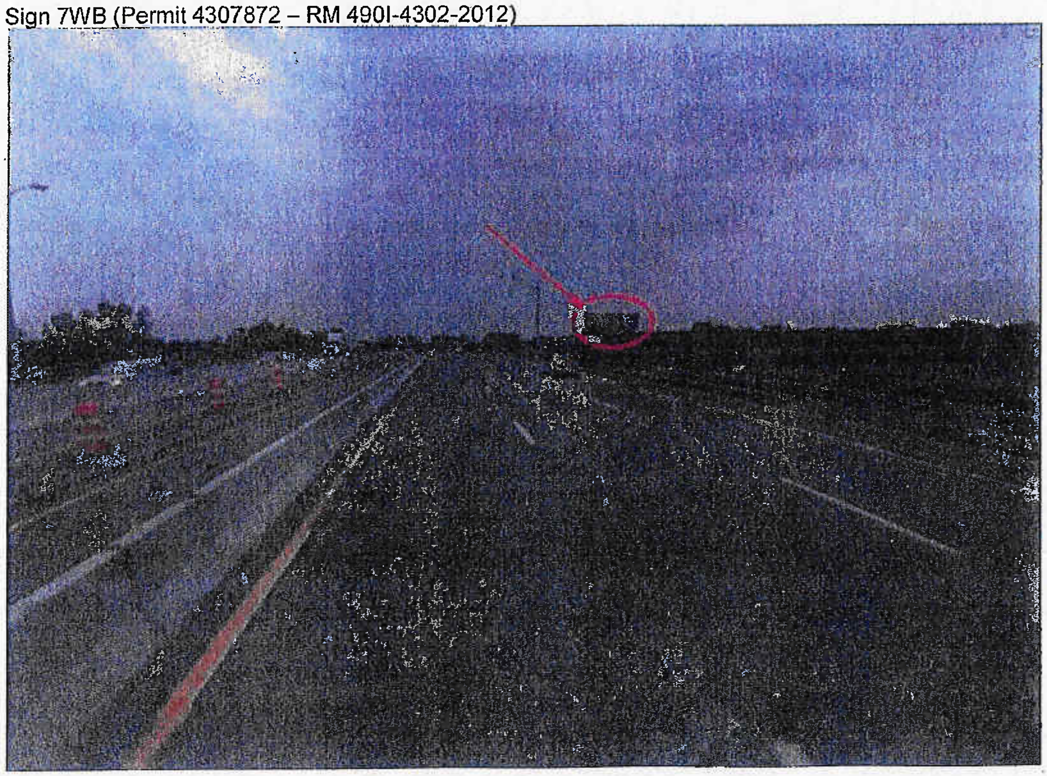
I-390 Location:

Sign 6SB (Permit 4307897 – RM 390I-4303-7003)

I-490 Locations:

Sign 7EB (Permit 4307872 – RM 490I-4302-2012)

Sign 7WB (Permit 4307872 – RM 490I-4302-2012)



2.3 Crash Data Collection

The crash data was obtained from Safety Information Management System (SIMS) for all studied sites. The non-reportable crash data is incomplete in SIMS for the study period and therefore, was removed from this study. Only the reportable crashes (the property damage of any person involved is $1001 or more) will be included. The study period for pre CEVMS installation is approximately five years. The data for post CEVMS installation are from the sign activation dates to the date that the complete reportable crash data was available in SIMS at the time of the study. CEVMS activation dates were acquired from the NYSDOT Real Estate Office.

2.3.1 Accident Analysis Methodology

The methodology used for this accident analysis is found in the New York State Department of Transportation Highway Design Manual §5.3 Accident Analysis. The premise is that identifying the causes of accidents along a roadway corridor can help provide an insight into what type of corrective measures can be taken during the design process to minimize future accidents and lessen the severity of these accidents. To identify the safety problems, accident data is collected from the Safety Information Management System (SIMS) for the studied roadway corridor, as well as the areas adjacent to the project areas, including intersecting roadways. This can help to identify any abnormal patterns or clusters of accidents within the project area.

The procedure for this process is as follows:

1. Identify the study area for the accident analysis. Use NYS reference markers for State highways or link/nodes for local roadways. Identify other physical boundaries, such as cross streets, intersecting roads, jurisdictional boundaries, etc. if these exist within the project area.
2. Indentify the time period for the analysis, generally the most recent 3 years of complete available data is used. Based on the formula used to calculate the crash rate, it may be necessary to examine the accident history over more than a 3 year period (5 years suggested) to have enough data to analyze the accidents adequately.
3. Collect all accident data and records for the analysis, including pedestrian and bicycle accidents as follows:
   - Obtain computerized accident data for the study area from the NYS Department of Transportation's Safety Information Management System (SIMS). Most situations will be covered by the State Accident Surveillance System (SASS) for State highways and by the Centralized Local Accident Surveillance System (CLASS) for local roads/streets; which are both now contained in the enhanced SIMS.
   - Retrieve police and motorist accident reports (MV-104A and MV-104) as needed for the study area. Electronic copies of these reports are available in SIMS and hard copies are available from the Office of Modal Safety and Security.
   - A field visit to the study area can be useful in observing areas that would indicate past accidents (such as damaged guide rail or signs, skid marks, etc.) and the potential sites for future accidents in the study area (such as school zones, playgrounds, parks, etc.). Some accidents will inevitably go unreported or are generally underreported, so discussions with local residents, police, and elected officials may help identify an unreported/underreported safety problem or better quantify a marginal one.
4. Identify, discuss, and consider including the recommendations made in any prior Highway Safety Investigation (HSI) studies performed within the last 5 years involving the study area. These HIS studies are available through the Regional Transportation Systems Operations Group.
5. Calculate the severity distribution of the accidents and determine if it is normal or abnormal. This determination can be found in the TE-164 (Safety Benefits Evaluation Form) Instructions. See page A-32 of the Highway Safety Improvement Program: Procedures and Techniques. An electronic version of this form and the instruction are available from the Office of Traffic Safety and Mobility.
6. First, calculate the accident rate(s) in accidents per million vehicle miles (MVM) for the entire study area, using all non-intersection accidents. Next, calculate the accident rate(s) for linear segments within the study area that have different highway characteristics or development density/land use (AADT; number of lanes; divided or undivided; functional class; rural or urban; controlled or uncontrolled access) using all non-intersection accidents.

Segment Accident Rate (acc/MVM) = $\frac{1{,}000{,}000 \times \text{No. of accidents per year}}{365 \text{ days} \times \text{AADT} \times \text{Segment Length (miles)}}$
(One Year Rate)

7. Compare the calculated accident rate(s) to the statewide average accident rate(s) for similar facilities. The current statewide average accident rates are listed in the "Annual Update of Average (Mean) Accident Rates and Accident Costs/Severity Distribution" produced by the Office of Modal Safety and Security and is available through SIMS or the NYSDOT Internet site. If the project limits include highway segments having different characteristics (urban/rural functional class, divided/undivided, number of lanes, controlled/uncontrolled access), accident rates should be computed for each segment/intersection and compared to the appropriate statewide rate. The amount an accident rate varies from the statewide average for similar facilities can help identify and quantify an accident problem on the overall highway segment under study.
8. Organize, summarize, and analyze all the collected accident data. This involves assembling an Accident History Details form (use form TE-213 or equivalent) and completing an Accident Summary Sheet (Figure 23 in Highway Safety Improvement Program: Procedures and Techniques). Use resources such as the Regional Transportation System Operations Group or the Regional Safety Evaluation Engineer to assist with determining accident patterns and causes.

   The accident analysis should identify specific locations with clusters of accidents. An accident cluster is defined as an abnormal occurrence of similar accident types occurring at approximately the same location or involving the same geometric features. The severity of the accidents should also be considered.

   A history of accidents is an indication that further analysis is required to determine the cause(s) of the accident(s) and to identify what actions, if any, could be taken to mitigate the accidents. Some general elements that may contribute to or cause and accident are as follows:
   - Condition or actions of the driver
   - Condition of the vehicle
   - Environmental conditions
   - Condition of the engineering features of the highway or bridge
   - External causes such as deer and other motorists
   - Missing or improper signing, delineation, or other traffic control devices not in accordance with the NYS MUTCD

   When you analyze the accident data, take care to not put too much weight on certain contributing factors that are often listed, such as "driver error", "unsafe speed", or "following too close". These factors alone are not a reason to conclude that highway geometrics were not involved and that no further consideration is required. As mentioned before, a field visit with the completed accident forms can be extremely helpful in determining contributing factors to the accidents and possible mitigation measures.

9. Using the data and analysis results obtained, identify, evaluate, and select appropriate accident countermeasures (solutions to accident problems) to incorporate into the project. This may include adjustments to the project limits if necessary. For accident countermeasure ideas, refer to:
   - Table 1 in Appendix D of the Highway Safety Improvement Program: Procedures and Techniques. Although this table is extremely useful, it is not all-inclusive and should be used as a guide rather than a standard.
   - The Department's Internet site for a list of "Accident Reduction Factors" for various improvements.
   - Table 7-13 and 7-14 in the 1999 *Traffic Engineering Handbook*.
   - The Regional Safety Evaluation Engineer in the Regional Transportation System Operations Group for assistance.

2.4 Crash Analysis

There are seven CEVMS installations within Albany and Monroe Counties that affect twelve directions of traffic. Three locations are on Interstate 90, two on Interstate 787, one on Interstate 390, and one on Interstate 490. The study segment lengths were determined by identifying the sight distance(s) to each off-premise CEVMS installation. Since the analyzed CEVMS installations are located on divided Interstate highways, the data for each installation was parsed directionally. This assured that only those crashes, within the sight lines and approaching the CEVMS installations, were considered. To determine if these installations increased crashes or changed the pattern of crashes, the study was broken down into two time periods as mentioned in section 2.3, with a five year pre-installation time period and varying post installation time periods.

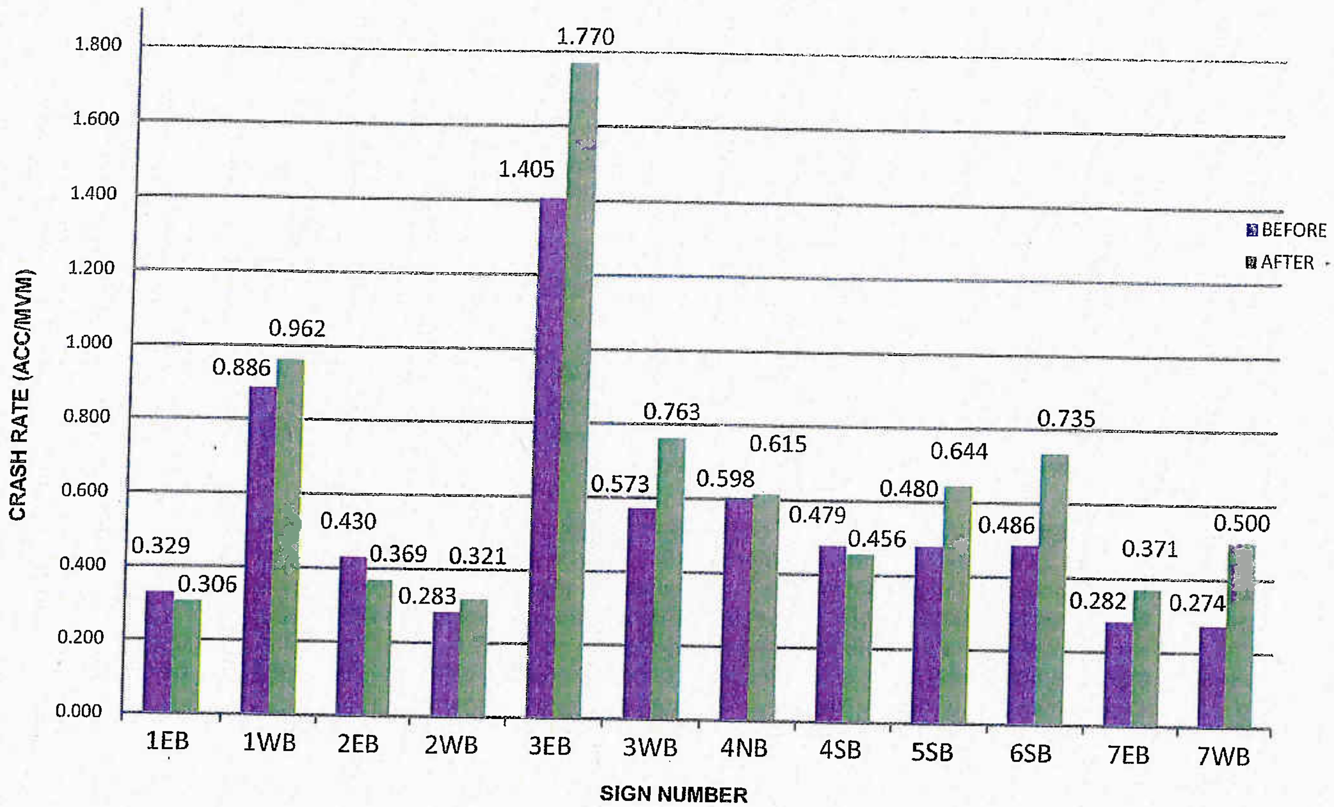
Within the twelve directional traffic segments, there were a few accident patterns found which are typical for high traffic volume interstate segments in urban areas. These frequent accident types are rear-end collisions, overtaking collisions, and collisions with fixed objects, such as guiderail and median barrier. It is also noted that many accidents took place during the weekday morning and afternoon commuting rush hours when there would be a higher concentration of traffic. However, the same accident patterns that were found pre-installation were seen again post-installation, including rear-end collisions, overtaking collisions, collisions with fixed objects, and collisions during rush hour drive periods.

The crash data is entered on the NYSDOT Traffic Details, History Location form (TE 213) for CEVMS studied sites and is organized chronologically. This study is trying to determine if there were differences in crash rates and accident patterns after the installation of CEVMS billboards, so the data in form TE-213 has been split into these two categories. The post installation data has been highlighted in orange. The complete TE 213 data can be found in Appendix A – Crash Details. A summary sheet has also been made for each section of the study, both pre-installation and post installation, and shows different accident patterns or trends that occurred during the study period. The complete Accident Summary data can be found in Appendix B – Crash Summary. The crash rates for the twelve selected segments are shown in Exhibit 2.4.a. A graph has been made to compare the pre-installation and post installation crash rates per CEVMS installation and is shown in Exhibit 2.4.b.

Exhibit 2.4.a Comparison of Pre-installation and Post installation Accident Rates							
Sign #	Route #	Sign Placement (Driver Side)	Pre-Installation Studied Period (Months)	Pre-Installation Crash Rate (ACC/MVM)[4]	CEVMS Activation Date	Post-Installation Studied Period (Months)	Post Installation Crash Rate (ACC/MVM)
1EB	I-90	Right	61	0.329	5/1/2009	23	0.306
1WB	I-90	Left	61	0.886	5/1/2009	23	0.962
2EB	I-90	Left	60	0.430	6/1/2007	46	0.369
2WB	I-90	Right	60	0.283	6/1/2007	46	0.321
3EB	I-90	Left	66.5	1.405	1/15/2010	14.5	1.770
3WB	I-90	Right	56	0.573	3/1/2009	25	0.763
4NB	I-787	Left	60	0.598	7/1/2009	21	0.615
4SB	I-787	Right	60	0.479	7/1/2009	21	0.456
5SB	I-787	Right	59	0.480	6/1/2009	22	0.644
6SB	I-390	Right	60	0.486	10/15/2009	17.5	0.735
7EB	I-490	Left	60	0.282	11/20/2009	16.5	0.371
7WB	I-490	Right	62	0.274	1/13/2010	14.5	0.500

[4] The average annual daily traffic (AADT) volume used to compute the Pre-Installation and Post Installation crash rates are from New York State's 2006 Highway Sufficiency Ratings. This data was either collected in 2005 or was extrapolated out to 2005 from previous data.

Exhibit 2.4.b Comparison of Pre-installation and Post installation Crash Rates



From this comparison chart of pre-installation and post installation crash rates, you can see that there is little variation in the crash rates before and after the CEVMS installations and some post installation rates actually decrease from the pre-installation rates. The sites in which there was a large increase in crash rates, post installation, are explained in more detail below.

Many of the off-premise CEVMS installations took place in 2009 or later and only one location was installed in 2007. Therefore, the SIMS crash data was limited for the post-installation analysis, with many locations having less than two years of complete data when collections took place. Based on the comparison of pre-installation and post installation crash rates shown on the graph above, the crash rate for most CEVMS locations were similar before and after the billboard was installed. Even at the 2EB and 2WB sites, where more than two-years of post installation data were available, the pre and post crash rates are similar. There are a few locations where the post installation crash rate increased a noticeable amount. This may be due to a variety of factors that affect the calculation of the crash rate, including lower AADT values, site specific considerations, and a lack of considerable post installation data. These locations are 3EB, 3WB, 6SB, and 7WB. The formula for determining crash rates is as follows:

$$\text{Segment Accident Rate (acc/MVM)} = \frac{1{,}000{,}000 \times \text{No. of accidents per year}}{365 \text{ days} \times \text{AADT} \times \text{Segment Length (miles)}}$$

(One Year Rate)

The section of I-90 where signs 3EB and 3WB are installed has a lower AADT than the remaining sections of I-90, which will affect the crash rate calculation. For 3EB, there were 28 accidents within the 14.5 month post installation period and for 3WB, there were 25 accidents within the 25 month post installation period, which may be an idiosyncratically large number of accidents for a short studied period. The placement of the off-premise CEVMS billboard is in the direction of 3WB traffic, off the right shoulder of the motorists, (see Section 2.2.3 for picture) and this proximity might be more of a perceived distraction to the westbound motorists as compared to the eastbound vehicles. The section of I-390 where sign 6SB is installed also has a lower AADT than most other interstate highway sections in the study and only had 17.5 months of post installation data, in which 15 accidents took place. The placement of the CEVMS billboard is also in this direction of travel and is relatively close to the edge of travel lane, which may contribute to the higher crash rate after the installation. The section of I-490 where sign 7WB is installed once more has a lower AADT than most of the other sections and there were only 14.5 months available of post installation data, which will greatly skew the crash rate calculation. The placement of the CEVMS billboard is in the direction of travel, similar to the previously discussed two installations, and is closer to the WB traffic than to the EB. This might be more of a perceived distraction to the westbound road users.

The severity of the accidents was evaluated. Only in the vicinity of sign 5S did fatalities exist, with two occurring before the installation of the CEVMS billboard. The first fatality occurred at reference marker 787I-1101-2002 on April 3, 2007 at 5:07 PM, in which a southbound emergency vehicle with its sirens on was attempting to get onto the northbound lanes through a median crossover from the center travel lane. A vehicle going southbound in the left travel lane could not change lanes in time to avoid a collision. The other fatality occurred at reference marker 787I-1101-2001 on July 11, 2007 at 3:53 AM, in which a vehicle whose driver was under the influence of alcohol was traveling northbound in the southbound lanes. Two large trucks were nearly side by side traveling in the southbound lanes when they were struck head on by the smaller vehicle.

The injury and property damage only accidents were compared for pre and post CEVMS installation. The following graphs (Exhibit 2.4.c and Exhibit 2.4.d) summarize the crash rates breakdown for Injury and PDO accidents. These graphs show that, at certain locations, there was a change in the severity of accidents in which a location with a lower post installation injury crash rate has a higher post installation PDO crash rate. But, overall, Injury or PDO crash rates for the studied segments do not appear to be affected by the CEVMS installation. Without more post installation data, it is difficult to conclude that the CEVMS billboards will lead to more accidents that are less severe in certain locations or will lead to fewer accidents that are more severe in certain locations.

Exhibit 2.4.c Comparison of Pre-installation and Post installation Crash Rates – Injury

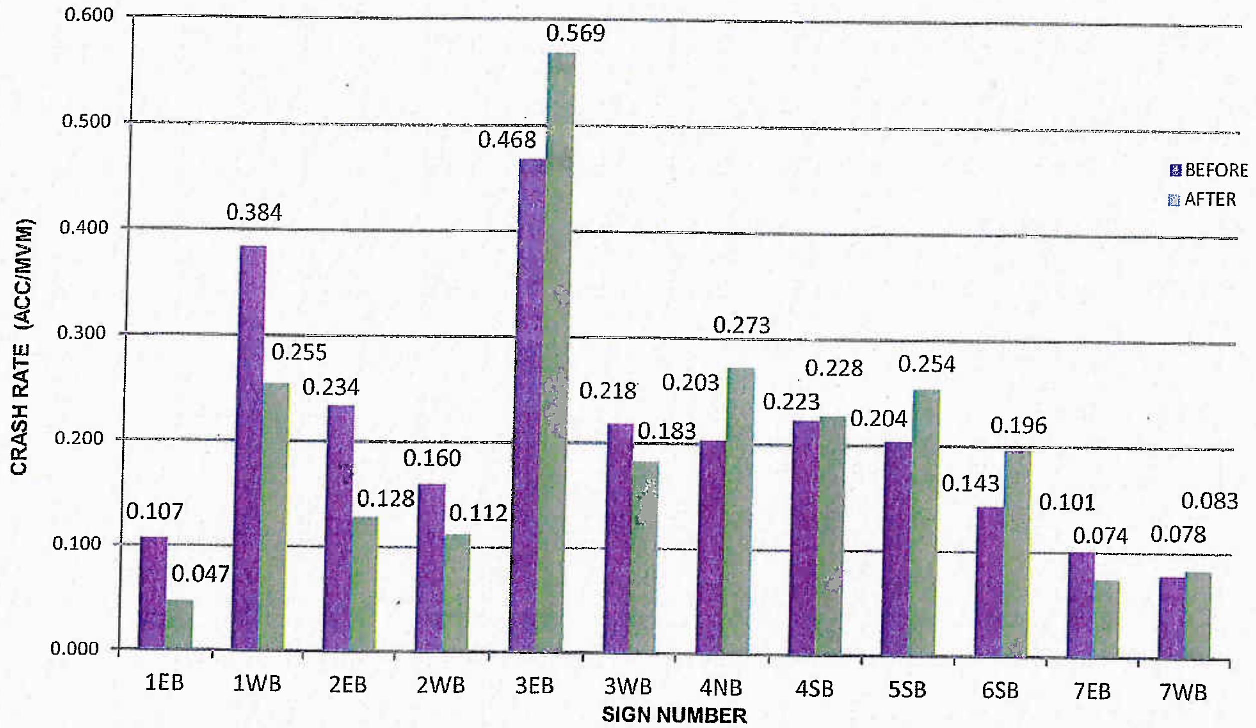
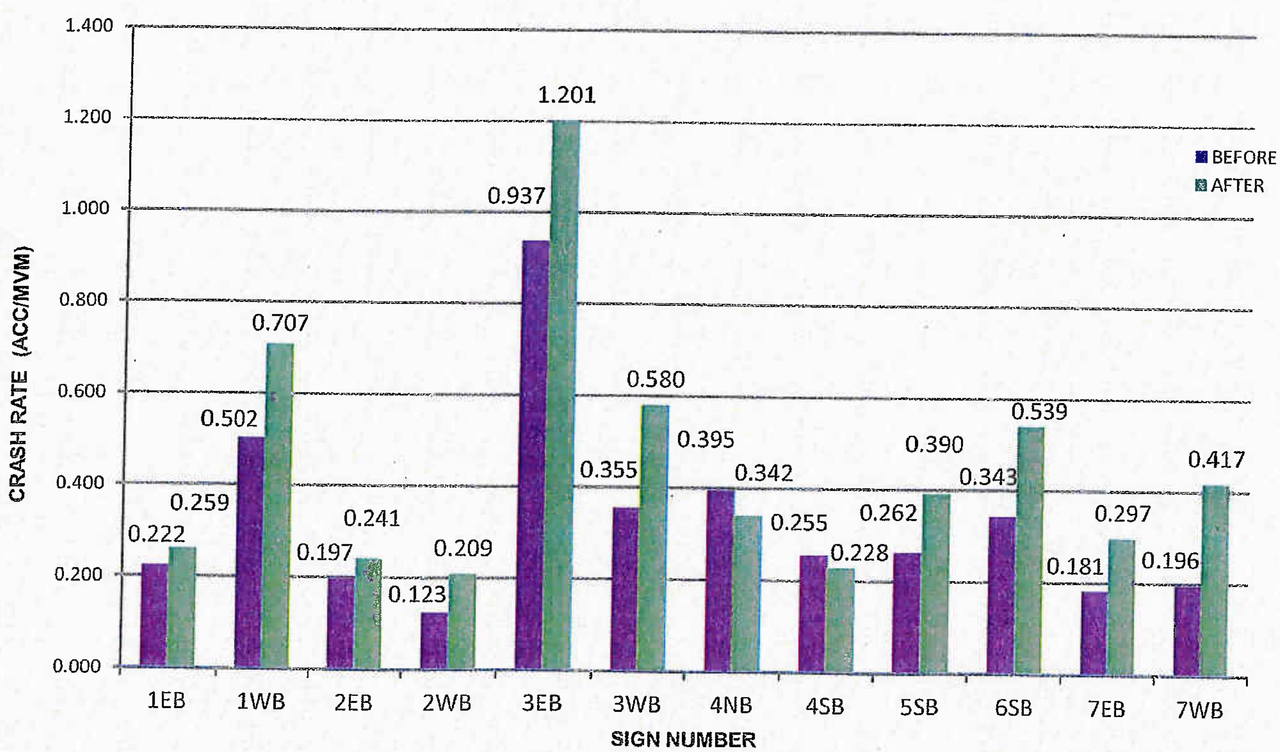
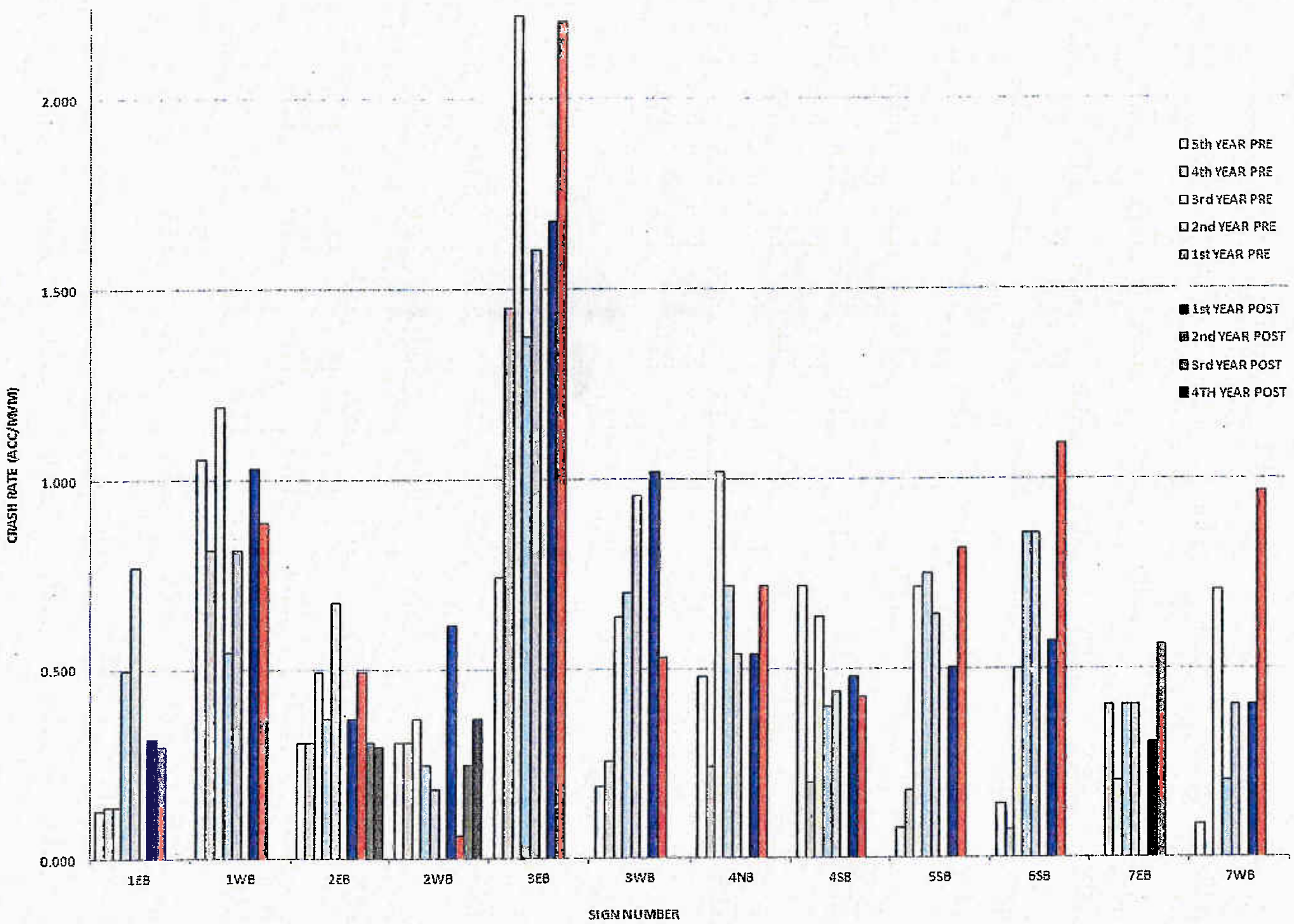


Exhibit 2.4.d Comparison of Pre-installation and Post installation Crash Rates – PDO



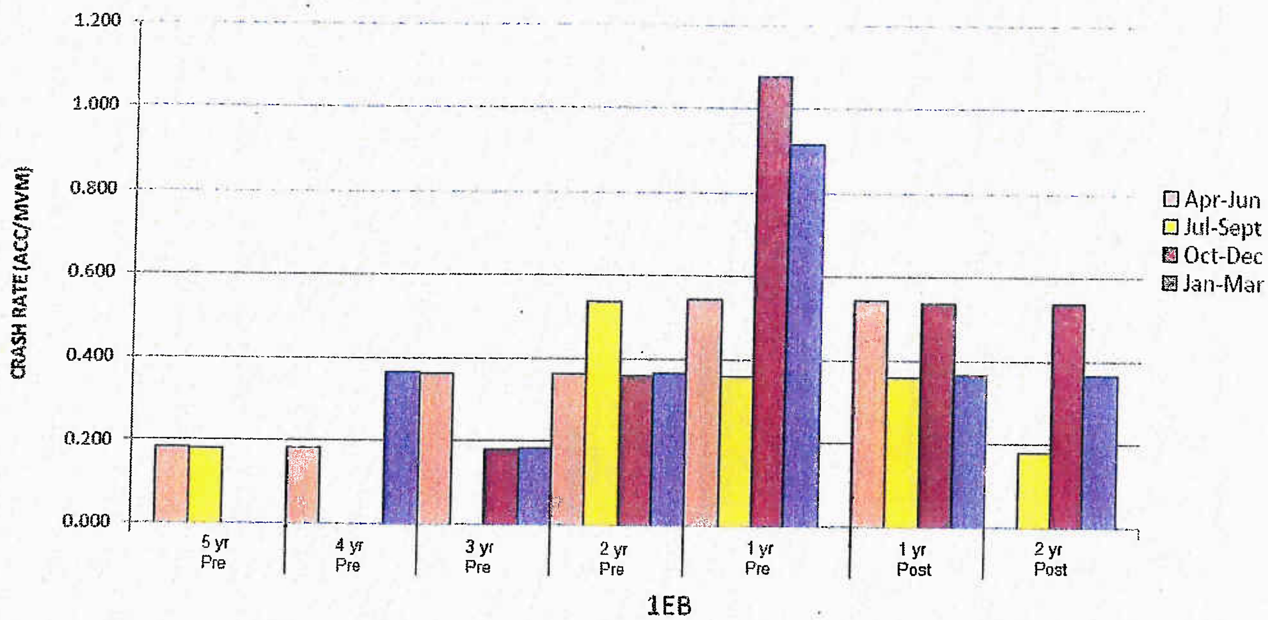
The crash rates for each year and each season during the studied period were also calculated. The results are shown in Exhibit 2.4.e and Exhibit 2.4.f below. The graphs showed the pre CEVMS installation crash rates varied year by year and season by season for the same site, as well as the post installation crash rates. There are no consistent patterns for yearly or seasonal crash rates. Due to the volatility of the data, a longer CEVMS post installation period would be required in order to see the trend and determine if the CEVMS installations would have a safety impact to the travelling public.

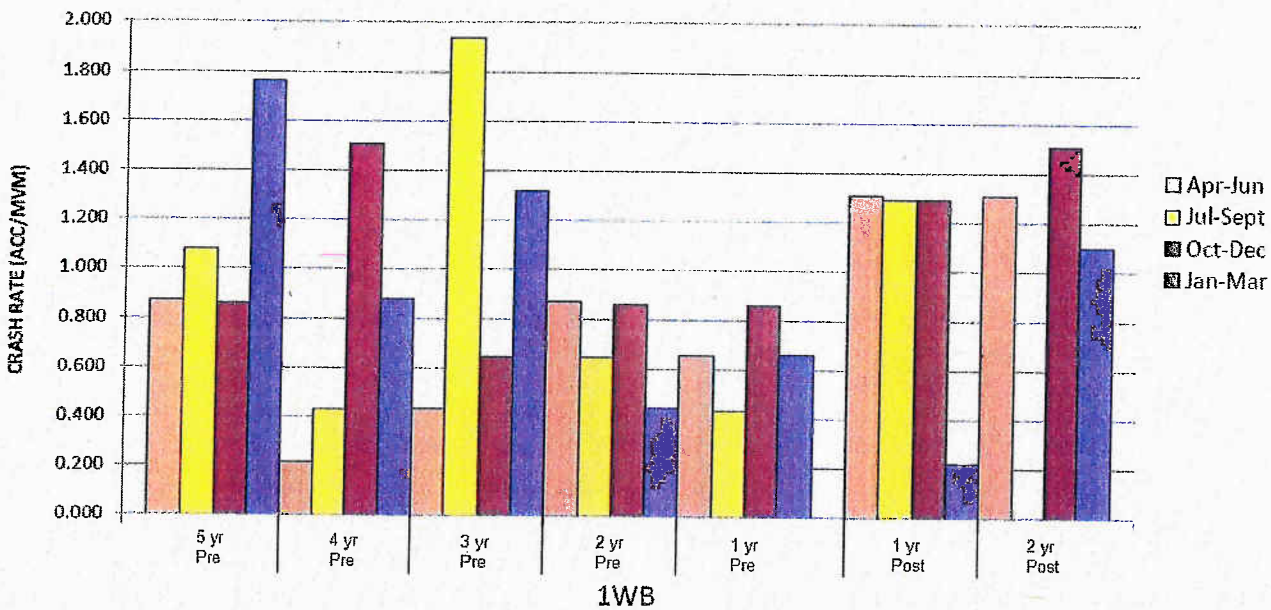
Exhibit 2.4.e Pre-installation and Post installation Crash Rates by Year



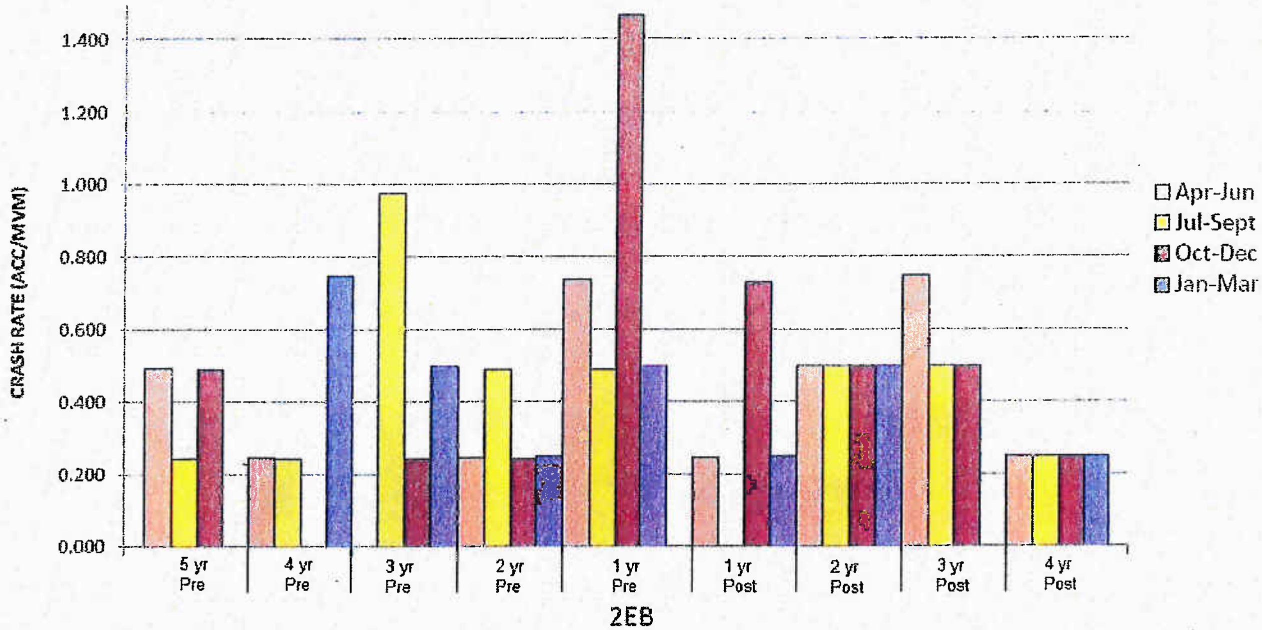
This graph shows that even before the CEVMS installation, crash rates can vary each year at the same location. Based on the installation date of the particular CEVMS billboards, the majority of locations have less than two years of post installation data. Signs 2EB and 2WB each have greater than three years of post installation data. The post installation crash rates at these two locations also vary per year.

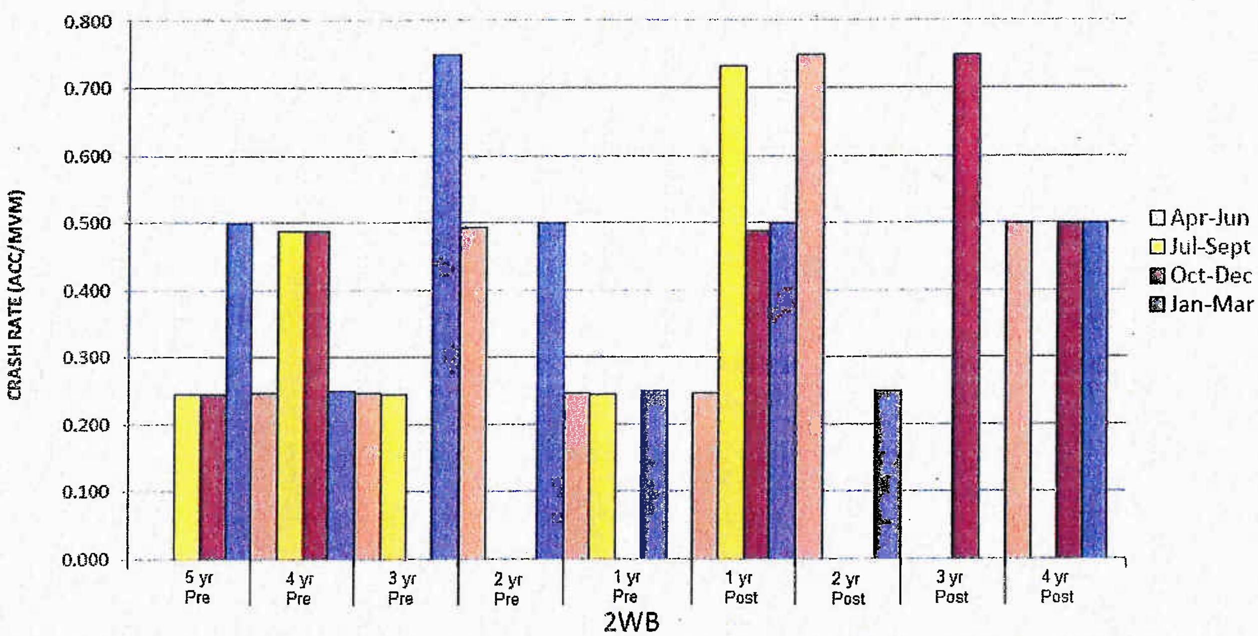
Exhibit 2.4.f Pre-installation and Post installation Crash Rates by Season



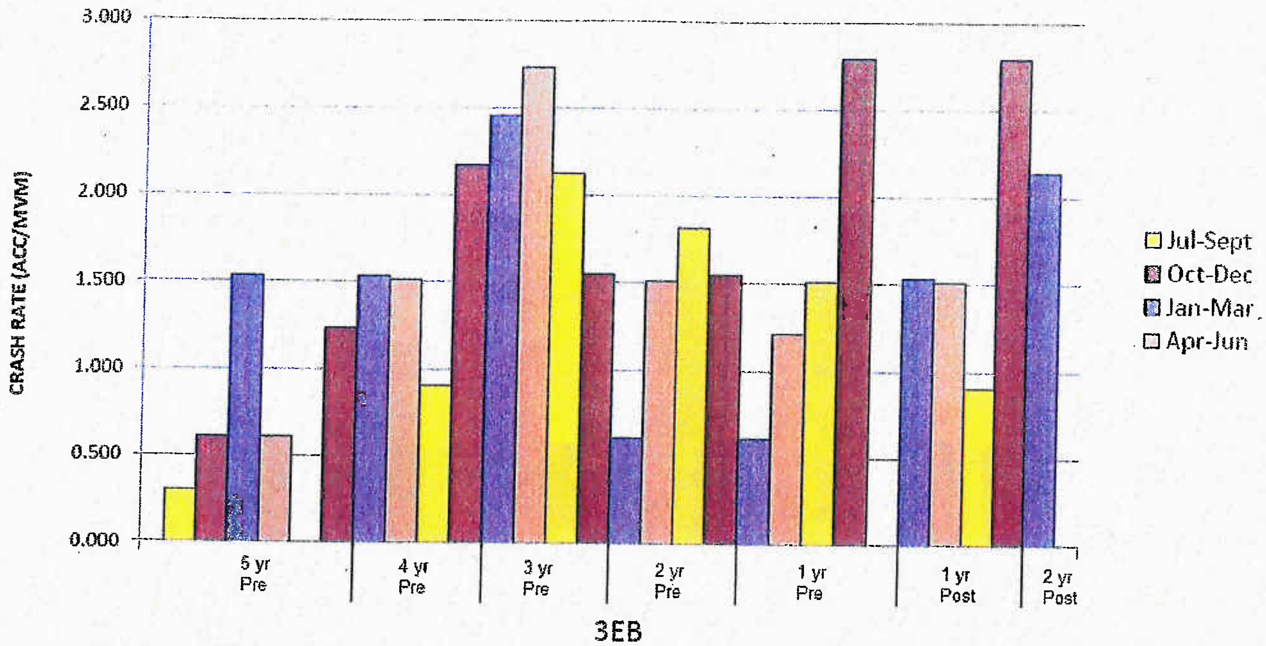


For the locations of CEVMS billboards, 1EB and 1WB, there are no distinct patterns of crash rates linked to a particular season. There is no consistency in crash rates from year to year for any season.

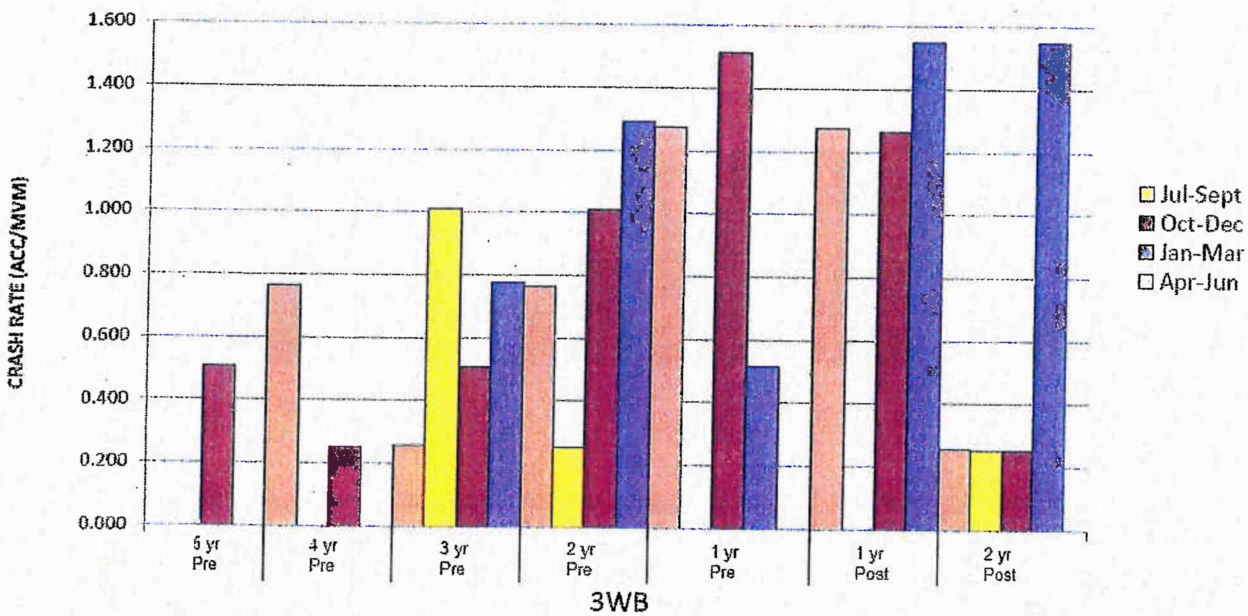




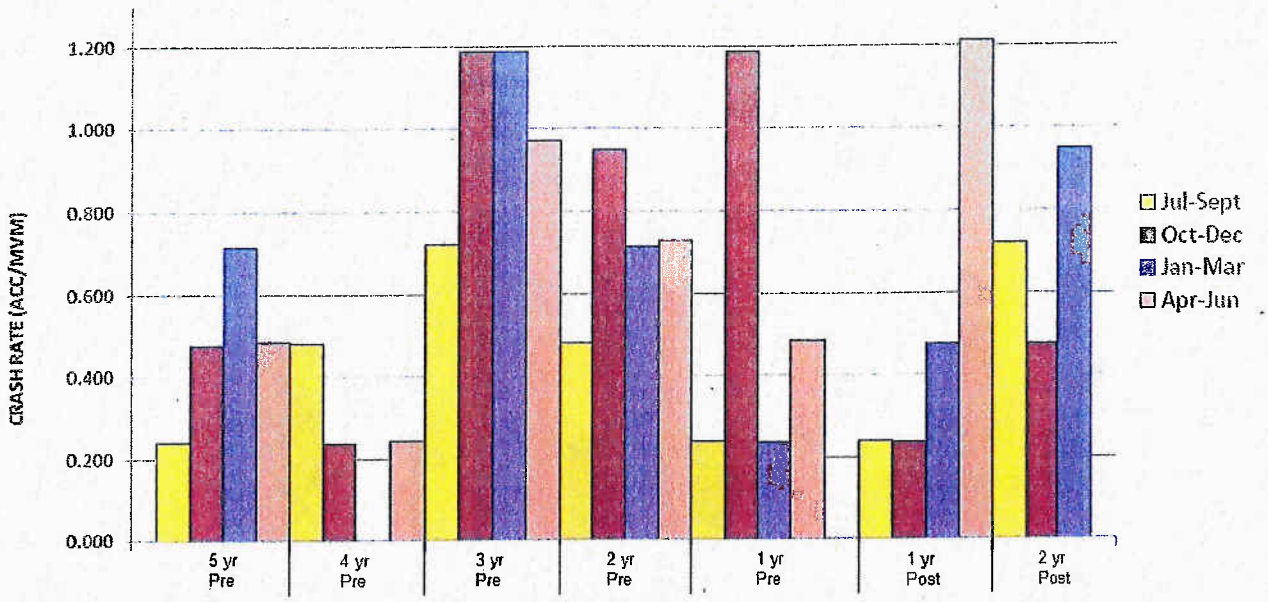
For the locations of CEVMS billboards, 2EB and 2WB, there are no distinct patterns of crash rates linked to a particular season. There is no consistency in crash rates from year to year for any season. These particular locations have nearly four years of post installation data and the crash rates vary as they did pre-installation.



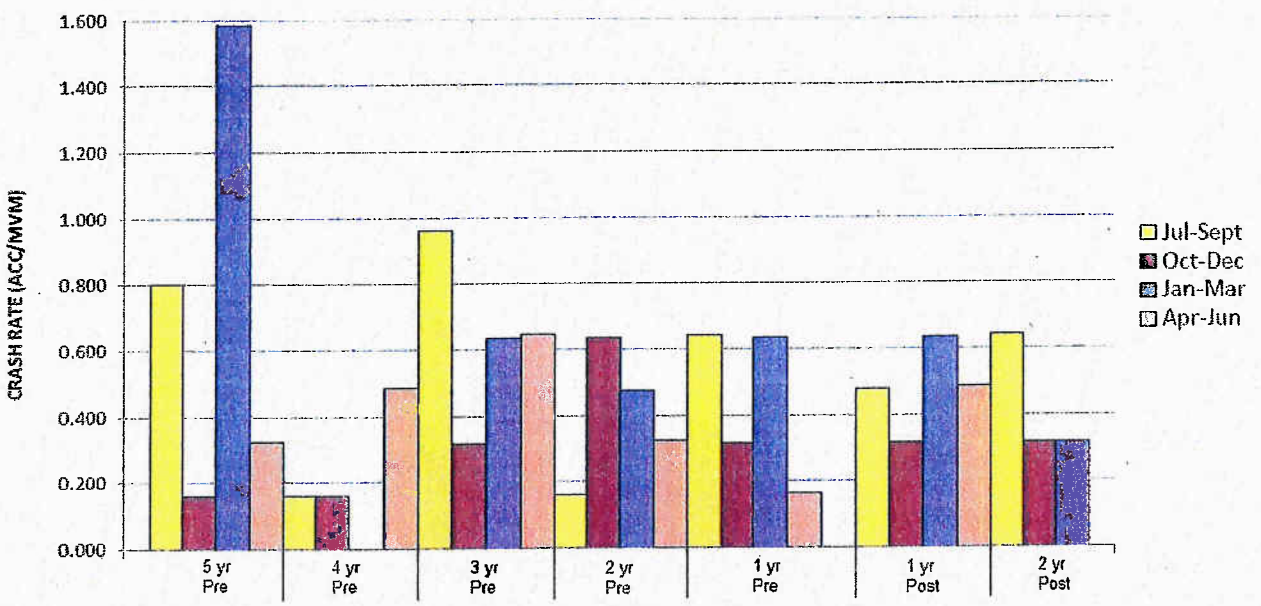
For the location of CEVMS billboard, 3EB, there are no distinct patterns of crash rates linked to a particular season. There is no consistency in crash rates from year to year for any season. There is little post installation data for this particular billboard, so there is no way to determine any potential patterns after the billboard was installed.



For the location of CEVMS billboard, 3WB, there are no distinct patterns of crash rates linked to a particular season. There is no consistency in crash rates from year to year for any season.

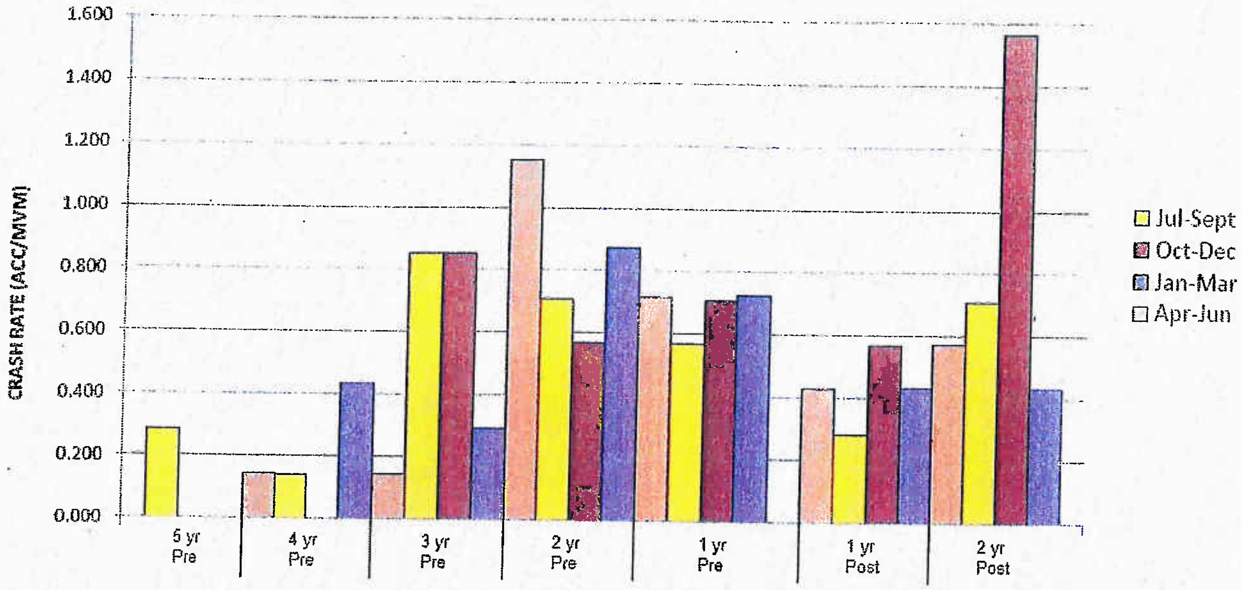


4NB

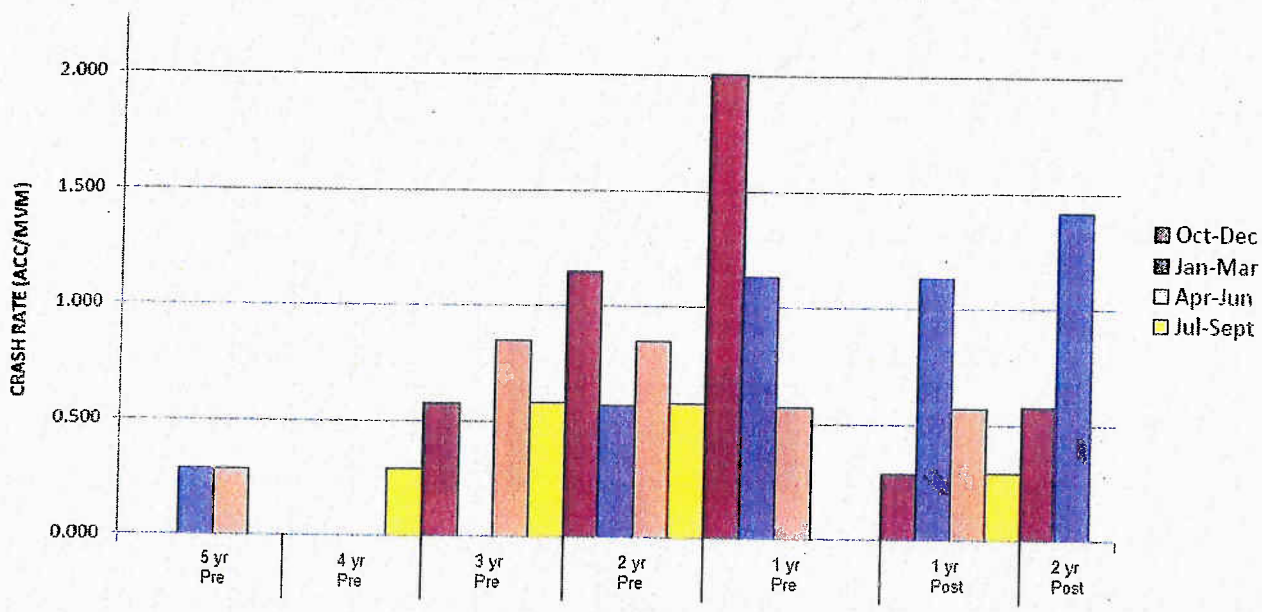


4SB

For the locations of CEVMS billboards, 4NB and 4SB, there are no distinct patterns of crash rates linked to a particular season. There is no consistency in crash rates from year to year for any season.

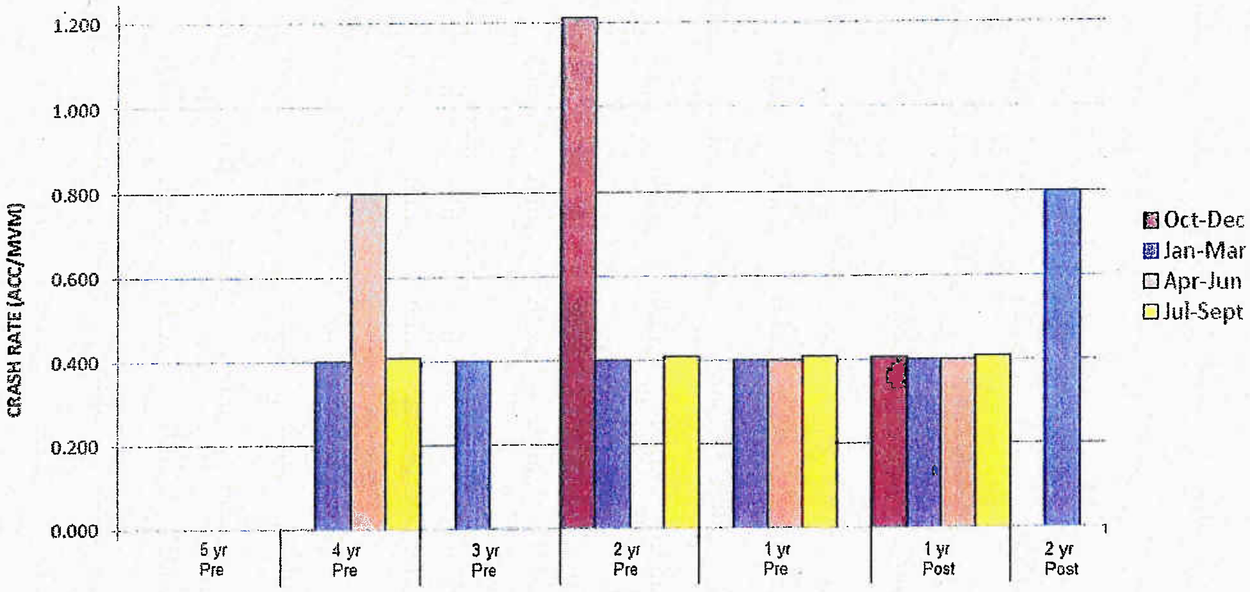


5SB

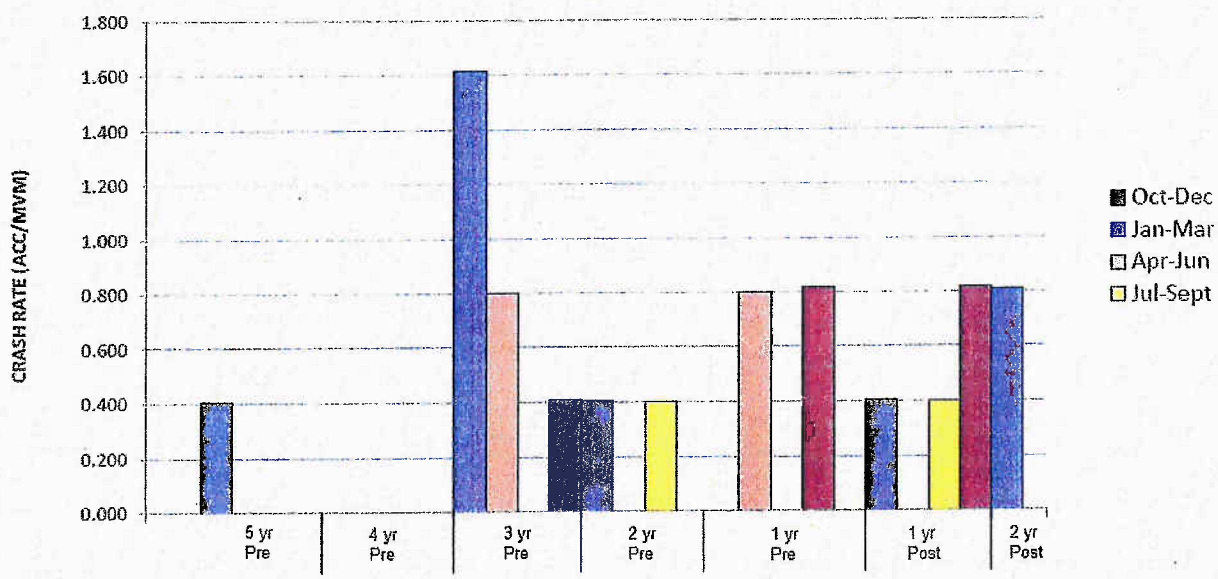


6SB

For the location of CEVMS billboard, 5SB and 6SB, there are no distinct patterns of crash rates linked to a particular season. There is no consistency in crash rates from year to year for any season.



7EB



7WB

For the location of CEVMS billboard 7EB, there are no distinct patterns of crash rates linked to a particular season. The perceived pattern for sign 7EB may be idiosyncratic based on the amount of accidents at this location per season, which is possibly based on the lower AADT of this corridor.

For the location of CEVMS billboard, 7WB, there are no distinct patterns of crash rates linked to a particular season. There is no consistency in crash rates from year to year for any season. There is little post installation data to determine if the billboard has an effect on motorists.

Due to the limited study, there are concerns below with the crash analysis results obtained in this report:

1. There are a limited number of active sites available for this study.
2. There is not enough accident data after the installation of the CEVMS billboards to make any sound conclusions on the potential negative impact these may have on road users.
3. The data used in the study are for all types of reportable accidents. In a majority of cases, the DMV reports do not indicate the factor that caused the drivers' distraction or inattention.
4. The data for the non-reportable accidents was incomplete in the New York State Safety Information Management System (SIMS) for the study period and was not included in this analysis, but it is possible that some of these accidents involved distraction of the drivers.
5. The highway condition might have been changed during the study period, such as temporary construction. The table below lists construction contracts that took place during the study period for this accident analysis. The extent of the impacts of these construction activities is undetermined because we do not have accurate traffic counts during the construction period, especially if detours were used.

Exhibit 2.4.g NYSDOT Construction Contracts during Study Period

Contract Number	Description of Project	Description of Traffic Control/Detour	CEVMS Signs Affected	Before/After CEVMS Installation
D259723	Recon/Rehab of I-90 from Exit 1 to Patroon Island Bridge	EB & WB - Temporary Single and Double lane closures	1EB, 1WB 2EB, 2WB	Before Before/After
D260096	Installing infrastructure for future fiber optic network	EB & WB – Temporary Shoulder and Single lane closures	1EB, 1WB 2EB, 2WB	Before Before/After
D259341	Bridge Rehab and Mainline Widening, I-90 between Exit 6 and I-787	Detours at Exit 5A and 6; EB & WB – Temporary Single and Double lane closures	2EB, 2WB 3EB, 3WB	Before Before
D260683	Rail Repair, I-90 Bridge over Hudson River	Detour at Exit 6; EB & WB – Temporary Single lane closures	3EB, 3WB	Before
D260816	Replace Navigation Waterway Lights I-90	EB & WB – Temporary Single lane closures	3EB, 3WB	Before
D260218	Resurfacing I-787	Detour at Exit 5, 6, 7; NB & SB – Temporary Double and Single lane closures	4NB, 4SB 5SB	Before Before
D260179	Resurfacing I-390, Mill & Fill Ramps	Ramp Closures at Exit 18, 19; SB – Temporary Shoulder, Double lane and Single lane closures	6SB	Before
D260409	Resurfacing I-390 mainline	Temporary Single Lane and Shoulder closures	6SB	Before
D260427	Reg 4 ITS Installation	SB – Temporary Single lane and Shoulder closures	6SB	Before
D260864	Guiderail Replacement	Unknown – possibly Temporary Single lane and Shoulder closures	6SB	Before
D260481	Rehab/Recon of I-490	EB & WB – Temporary Single lane closures, occasional Double lane closures at certain times of the day	7EB, 7WB	Before

3. CONCLUSIONS

The crash evaluation in this study shows that the data collected is insufficient to make any statistically substantive conclusions about the impact of the CEVMS billboards on motorists. The limited data suggests that there is no change in the crash patterns in the vicinity of the off-premise CEVMS billboards, but this may be based on the limited time frame of the post installation data and the effect this short time frame has on the crash rate calculation (refer to Section 2.3.1.6 for the crash rate formula). There were a number of rear-end, overtaking, and fixed object collisions which could be contributed to driver distraction (internal or external to the vehicle, which includes CEVMS), but these types of accidents were prominent before and after the CEVMS installations. It is undetermined if the off-premise CEVMS billboard was the predominate distraction and caused these crashes. Due to the lack of data, it is not possible to make a more categorized analysis, such as the effects based on driver's age group, the season of the year, the weather, the time of day, the size of the billboard, the dwell time of the messages, etc. Therefore, more time will have to pass to obtain more accident data to determine if the CEVMS installations have an adverse affect on the traveling public. More study sites and crash data with specific indication of the driver's distraction factor will definitely benefit a future study.

Based on this crash analysis, the research of other similar studies, good human factors practice, and guidelines or regulations developed in New York State, the recommendation of this report is to continue monitoring accident data in the vicinity of the off-premise CEVMS billboards to determine if CEVMS installations have a negative impact to road user safety.