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EVALUATION OF MEDIAN BARRIER SAFETY ISSUES



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EVALUATION OF MEDIAN BARRIER SAFETY ISSUES

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TABLE OF CONTENTS

	Page
Acknowledgements	i
Executive Summary.....	ii
1.0 Introduction.....	1
2.0 Procedure.....	2
2.1 Literature Review.....	2
2.2 Kentucky Crash Data Collection and Analysis.....	2
2.3 Kentucky Performance of Median Cable Barrier System.....	2
2.4 Guidelines for Median Barrier Systems.....	2
3.0 Results	3
3.1 Literature Review.....	3
3.1.1 Installation Guidelines.....	3
3.1.2 Types of Median Barriers.....	6
3.1.3 Evaluation of Cable Median Barrier Installations.....	7
3.1.4 Cost Comparison.....	9
3.1.5 Use of Cable Barrier.....	10
3.2 Kentucky Installations of Cable Barrier.....	11
3.3 Kentucky Crash Data Collection and Analysis.....	12
3.4 Kentucky Performance of Median Cable Barrier System.....	14
3.5 Summary of Crash Data.....	14
4.0 Recommendations	16
5.0 References.....	17
Appendix A. Description of Crashes	20
Appendix B. Kentucky Guidelines	62

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EXECUTIVE SUMMARY

The objective of this study was to evaluate the effectiveness of the Brifen TL-4 and Trinity CASS median cable barrier systems in preventing cross-median collisions on sections of I-64, I-71, and I-265 (Brifen system) and I-265 (Trinity system) in Jefferson County and on KY 4 (Brifen system) in Fayette County.

An effort was made to identify crashes which involved a vehicle crossing a median. Using specific logic to identify this type of crash, 392 crashes were identified for the five-year period of 2001 through 2005. Using crash and mileage data resulted in an average of 0.28 crossover crashes per mile in the five years and an average of 0.05 fatal crossover crashes per mile. Using a statistical test, critical numbers of 0.35 cross-median crashes per mile per year for crashes of any severity and 0.20 fatal crashes involving cross-median crashes per mile per year were recommended as guidelines for median barrier applications.

The study involved an evaluation of 325 crashes with a police reports obtained for 185 of the crashes. The large majority of the crashes where a police report was not located involved a minor impact where the vehicle probably continued with no report. The number of damaged posts ranged from one to 70 with an average of about six posts. A tractor trailer was involved in the crash where 70 posts were damaged. Only 29 of the 325 crashes (8.9 percent) resulted in a reported injury related to the impact with the cable system with no fatalities.

There were 61 crashes in which the vehicle crossed the median before contacting the cable system; therefore, these crashes would likely have resulted in a vehicle encroaching into the opposing lane. There were 96 additional crashes in which the vehicle collided with the cable system when it was positioned adjacent to the travel lane and an analysis of the crash (including variables such as the impact angle) indicated that the vehicle had a substantial probability of crossing the median into the opposing lane. This is an indication that in the approximate 21-month time period of the study (less for the KY 4 installation) the cable system prevented up to 157 encroachments into the opposing lanes. On these high volume and high speed roadways, an encroachment into the opposing lane has the possibility of resulting in a crash with a severe or fatal injury.

The cable system was found to successfully redirect the vehicles. A wide range of types of vehicles hit the cable at consistently high speeds. In only three crashes (0.9 percent) did a vehicle continue through the cable system and into the opposing travel lanes.

The successful performance of cable barrier, along with the ability to repair damage with no disruption of traffic, warrants expanded use of this type of median barrier. The analysis of crash data in Kentucky should be used to identify locations where this type of median barrier would be cost effective. This will involve determining locations which have had the highest concentration of cross-median crashes.

1.0 INTRODUCTION

Median barriers are longitudinal barriers that are most commonly used to separate opposing traffic on a divided highway. Their performance requirements are identical to those for roadside barriers as detailed in NCHRP Report 350 (1). The AASHTO Roadside Design Guide provides guidelines for median barriers on high-speed, controlled-access roadways that have flat, traversable medians (2). Criteria for determining median barrier need are based on average daily traffic and median width. Frequency of cross-median crashes is another factor that should be considered when determining whether a barrier is warranted.

Traditionally, barriers have not been used in medians 30 feet or more in width. This was based on the premise that 80 percent of errant drivers could recover in that distance. The AASHTO Policy on Geometric Design of Highways and Streets also contains general median width and median side-slope design guidance that has remained unchanged for many years (3). Given changes in the vehicle fleet, travel speeds, and traffic volumes, efforts have been made to better understand the vehicle dynamics associated with median crossover crashes on high-speed highways in rural and urban areas.

State transportation agencies have considered revised median designs and the installation of median barriers on divided highways to prevent crossover crashes. In some instances, right of way costs require the use of designs more narrow than typically used. Therefore, there has been a need for more specific guidelines that designers can use to evaluate median barrier design.

Cable barriers provide an alternative median barrier design not typically used in Kentucky. The Brifen TL-4 Wire Rope Safety Fence (WRSF) is a four-cable interwoven high tension barrier system. The interweaving and high tension in the wire ropes causes friction in the post/rope interface, making each post serve as a mini-anchor, which limits the extent of damage to the immediate area of contact. The WRSF is designed to remain functional after most impacts so it can sustain additional impacts prior to being repaired. The WRSF has been in use since 1989 and, in 2006, had been used in 13 states. Installations on Interstate 64 (I-64) and Interstate 71 (I-71) in 2006 were Kentucky's first application of cable barrier systems in medians.

The second application of cable barriers in Kentucky (in 2007) used the Trinity CASS cable barrier system. This is a three-cable (pre-stretched) high-tension system.

The objective of this study was to evaluate the effectiveness of the Brifen TL-4 and Trinity CASS median cable barrier systems in preventing cross-median collisions on the sections of I-64, I-71, and I-265 (Brifen system) and I-265 (Trinity system) in Jefferson County and on KY 4 (Brifen system) in Fayette County.

A secondary objective of this study was to review guidelines for the use of median barriers. Horizontal and vertical alignment, interchange presence, median width, traffic volumes, composition of traffic, and median side slopes were variables considered and evaluated.

2.0 PROCEDURE

2.1 Literature Review

A literature search was conducted and reference materials obtained related to the design and application procedures for median barriers. Emphasis was placed on literature relating to warrants or guidelines and evaluation of the performance of various types of median barriers. Specific attention was given to recent work underway to update the chapter on median barriers contained within AASHTO's Roadside Design Guide (2).

2.2 Kentucky Crash Data Collection and Analysis

An analysis of crash data was performed to determine the location and frequency of crashes involving vehicles crossing the median. The analysis was conducted using the Crash Report Analysis for Safer Highways (CRASH) data base. The relationships between various parameters and crashes were investigated. Variables and parameters of interest included median width, traffic volume, traffic composition, median slope profile, and horizontal or vertical alignment.

Average cross-median crash numbers and rates were determined to use to calculate critical numbers and rates. High crash locations for median crossover crashes were identified.

2.3 Kentucky Performance of Median Cable Barrier System

The installation and operational performance of the Brifen and Trinity cable barrier systems were monitored and evaluated. Issues addressed include installation and maintenance costs and requirements.

Impacts involving the cable barrier were investigated and summarized to determine the effectiveness of the system, as well as the damage characteristics to the involved vehicles and the cable barrier. The installation and repair costs were used to compare to the crash results to evaluate the cost effectiveness of the cable system.

2.4 Guidelines for Median Barrier Systems

Guidelines were reviewed for the selection of median barrier systems for installation in Kentucky. These guidelines focused on when to install a median barrier and what type to use. Selection criteria included the following variables; median width, traffic volume, traffic composition, median slope profile, horizontal or vertical alignment, crash experience, and speed.

3.0 RESULTS

3.1 Literature Review

An extensive literature review was conducted to document available information concerning median barrier installation guidelines, available types of median barriers, evaluations of cable median barrier installations, cost comparisons, and current use of cable barriers. Following is a discussion of the review.

3.1.1 Installation Guidelines

Installation guidelines are presented in Chapter 6 of the AASHTO Roadside Design Guide for median barrier application (2). In the past, median barriers have not typically been used where the median is more than 30 feet wide since it was felt that 80 percent of drivers could recover within this distance. However, in recent years some states have developed new guidelines that expanded use of median barriers where the median width is 50 to 75 feet wide. A survey of cross median crashes found that a significant percentage of fatal crashes occur where the median width exceeds 30 feet, and two thirds of all the cross median crashes occurred where the median was less than 50 feet.

The disadvantages of installing median barriers include significant initial costs and an increase in reported crashes due to the reduction in available recovery area. More crashes create a maintenance cost issue and an exposure of maintenance crews to traffic. Also, the ability of emergency and maintenance vehicles to cross the median is affected. However, studies (4, 5) have shown that median barriers reduce the number of cross-median crashes and the severity of median related crashes. These benefits have resulted in guidelines in the AASHTO Roadside Design Guide for median barriers on high-speed, fully controlled access roadways (2). The variables used in the guidelines include the median width and the average daily traffic (ADT).

The latest Roadside Design Guide provides that a median barrier is not normally considered when the median width is over 50 feet except in special circumstances (such as a significant history of cross-median crashes). States are encouraged to conduct a study (such as a benefit/cost analysis) for medians on their system to determine whether a barrier is appropriate at locations where the median width is between 30 and 50 feet and for a median width under 30 feet where the ADT is under 20,000. For median width under 30 feet, a median barrier is recommended where the ADT is over 20,000.

An alternate guideline would involve cross-median crashes. California conducted a study that suggested medians as wide as 75 feet with an ADT in excess of 60,000 would be candidates for a median barrier study (6). A crash study warrant is used which requires a minimum of 0.50 cross-median crashes per mile per year (with a minimum of three crashes within a five-year period) or 0.12 fatal crashes per mile per year.

An analysis was conducted to determine the magnitude of median crossover crashes on Wisconsin's divided highways (7). Over 15,000 crash reports were reviewed for a three-year period revealing 631 median crossover crashes. While Wisconsin guidelines do not warrant a median barrier for a roadway with a median width greater than 60 feet, it was found that 81.5 percent of the median crossover crashes occurred at ADT and median width combinations where a median barrier was not warranted. Data did not reveal a strong correlation between median width and crossover median crashes. Five locations were identified that exceeded the selected benchmark of 0.5 median crossover crashes per mile per year with one location exceeding the benchmark of 0.12 median crossover fatalities per mile per year. It was recommended that median barrier installations be considered at those locations and that the procedure used to warrant median barrier installation should be reconsidered.

Several states have installed median barriers at locations where they haven't typically been placed. Cable median barriers were installed on all freeway sections in South Carolina with a median width less than 60 feet (8) while North Carolina installed cable median barriers on all freeway sections with a median width less than 70 feet (9). North Carolina noted that cable barrier can be installed when median widths are 36 feet or greater if median slopes are 6:1 or flatter but should be placed four feet from the centerline of the ditch.

Washington State installed cable median barriers at test sites with widths varying from 40 to 82 feet (10). Their design manual suggests that median barrier be installed on full access control, multilane highways with median widths of 50 feet or less and posted speed limits of 45 mph or greater. Median barrier may also be warranted when median widths are wider or posted speed limits are lower if there is a history of cross-median crashes.

Connecticut's Highway Design Manual (11) states that median barrier is warranted on freeway medians with widths of 66 feet or less and on wider medians depending on crash history. Some judgment should be used on non-freeways, considering crash history, ADT, travel speeds, median width, alignment, sight distance, and construction costs.

A comprehensive review of median crossover crashes was conducted in Pennsylvania (12). Only 267 crashes were found (in a five-year period) in which a vehicle crossed the median and collided with a vehicle traveling in the opposite direction. While crash rates decreased as median width increased, a high incidence of crossover crashes was found at locations with a median width of 60 feet. A majority of the crashes occurred on road segments with either lower traffic volumes or medians wider than would typically warrant a median barrier based on AASHTO guidelines.

Recommended guidelines for installing median barriers on Texas interstates and freeways were developed using median width and ADT (13). The criteria are based on an economic analysis. The guideline is divided into four zones with an associated mean cross-median crash (CMC) rate for each zone to evaluate crash history on a specific section. The zone where barrier is normally required is associated with high traffic volumes (minimum of 70,000 with median width under five feet) and low median width (maximum of 60 feet with ADT of 125,000) with a mean CMC rate of 0.7 per mile per year. The other zones were for an evaluation of need (with a

CMC rate of 0.4 per mile per year), optional barrier (with a CMC of 0.2 per mile per year), and barrier not normally considered (ADT up to 15,000 with a median width under 60 feet and ADT up to 125,000 with a median width up to 125 feet).

Florida requires interstate highways to have median barriers if the median width is less than 64 feet and on freeways with design speeds of 60 mph or more and a median width less than 60 feet (14). If the design speed is less than 60 mph, median barriers are required where the width is less than 40 feet. Median barriers are provided (with no benefit cost analysis) on any interstate or expressway project where there has been three or more cross-median crashes in the most recent five-year period. This equates to about 0.35 to 0.4 cross-median crashes per mile per year. A benefit cost analysis is conducted for segments with less than three cross-median crashes.

Proposed guidelines for median barrier applications were developed by the Kentucky Transportation Cabinet in March 2006 and updated in April 2008. (15). It was noted that median barrier protection should be considered for all fully controlled-access highways with traversable, depressed median locations up to 30 feet in width and for divided, high-speed (55 mph and greater) highways with an ADT over 40,000 and widths between 30 and 72 feet. For medians outside these parameters, barrier is recommended if there has been a history of cross-median crashes (three cross-median crashes in five years and either 0.50 crashes per mile per year or 0.12 fatal crashes per mile per year). These are the same crash frequency guidelines previously recommended by the California DOT in their 1997 study (6).

AASHTO has an initiative to provide information relative to cable median barrier best practice guidelines (16). Information given relative to criteria for installation of median barriers include: Wisconsin uses a criteria of less than 20 feet at a 20,000 ADT; West Virginia uses a frequency and rate methodology; Alabama has a criteria of two crashes in a two-mile section and notes problems start to occur at an ADT of 35,000; Iowa places barriers in highly dense areas downstream of interchanges; Georgia has a criteria of a median width of 40 feet or less.

The following state responses (related to installation criteria) were obtained from a request by an organization of state highway safety engineers for information about the use of cable barriers. Indiana identified all fatal and injury cross-median crashes for three years. Roadways with a median greater than 60 feet were eliminated. Five-mile segments with 13 fatal or injury cross median crashes in the three years were identified for installation of cable barrier. Also, any five-mile section with an ADT over 40,000 was identified for installation. Iowa has used criteria to install cable barriers based on the five percent of mileage with the highest number of cross median multi-car crashes. Installation criteria in Minnesota include: gaps in existing barriers, median width, ADT, crash history, and crash density. Ohio considers median width, crash frequency, and crash rate. Mississippi has considered using high crash locations but did not identify any locations with five crashes per mile when using three years of crash data. North Carolina noted cable barriers are used where median widths and slopes allow with 6:1 or flatter slopes and median widths 36 feet or greater.

3.1.2 Types of Median Barrier

Median barriers can be categorized as flexible, semi-rigid, or rigid. Crashworthy median barrier systems have met the criteria of NCHRP Report 350. Following is a list of the alternate types of median barriers as given in the Roadside Design Guide (2).

- weak-post, W-beam guardrail
- 3-strand cable, weak post
- high tension cable barrier
- box-beam barrier
- blocked-out W-beam (strong post)
- blocked-out thrie-beam (strong post)
- modified thrie-beam
- concrete barrier

The Roadside Design Guide lists criteria for the use of various types of median barrier systems. Cable systems include three-strand cable, weak post and high tension cable barrier. The deflection of the high tension barriers is 6.6 to 9.2 feet (depending on the system and post spacing) compared to 12 feet for the three-strand system. Less damage occurs with the high tension systems and, in many cases, the cable remains at the proper height after an impact which damages several posts. The posts can be installed in sleeves to aid in removal and replacement. The following four high tension cable barrier systems were listed as approved and meeting NCHRP Report 350, Test Level 3 conditions. A modified version of the Brifen system has been successfully tested at Test Level 4 conditions (along with a couple of other cable systems).

- Brifen Wire Rope Safety Fence: uses four cables, one placed in a slot on the post and the others intertwined between the posts (manufactured by Brifen USA)
- CASS: uses three cables placed in a slot on the posts and separated by spacer blocks (manufactured by Trinity Industries)
- Marion Steel Cable Barrier: uses three cables attached to U-channel posts by hook bolts (manufactured by Marion Steel Company)
- Blue Systems: uses four cables centered within top portion of slotted posts (Swedish design not currently manufactured in the United States)

A recent literature search and survey of the state-of-the practice of cable barrier installations identified the following six wire rope systems used in the United States (17):

1. U.S. low tension
2. Brifen USA wire rope safety fence (WRSF)
3. Blue Systems Safefence 350 wire rope barrier
4. Nucor high tension cable barrier
5. Trinity Industries cable safety system (CASS)
6. Gibraltar cable barrier system

Median barrier options in Kentucky have included: W-beam, concrete, and proprietary Test Level 4 (TL4) cable. Several companies have started to test cable median barrier systems on

4:1 slopes with approval given for a few companies.

The Texas study of median barrier guidelines found that high-tension cable median barriers were more cost-effective than concrete median barriers for the range of median widths for which they are applicable (13). The dynamic design deflection of high-tension median barriers limit their use to medians 20 feet or greater.

Generally cable median barriers have been used to prevent cross-median crashes with median widths over 20 feet. Given the deflection distance of about eight feet for the TL4 cable median barrier, the barrier must be located a sufficient distance from traffic. Cable barrier should not be placed in ditch lines since regular water flow and ponding may hinder its performance. The cable barrier should be installed about 10 feet upslope from the bottom of the ditch while maintaining the eight-foot distance from the traveled way. Cable barrier on curves should be placed on the opposite median side of traffic flow most likely to enter the median.

Pre-stretched and pre-tensioned cable systems have the advantages of reducing the crash force imparted to vehicle occupants while causing the cables to remain upright after impact and remain effective until repairs can be completed. Socket post installations result in rapid repairs which reduce maintenance costs and the amount of time that crews are exposed to traffic hazards. Cable barriers do not reduce sight distance and prevent drifting snow accumulation.

The AASHTO cable barrier initiative (16) listed the following design issues: cable barrier not recommended for use for medians with a width of 36 feet or less; typically offset cable four feet from ditch line due to potential drainage and maintenance concerns; only use on 6:1 slopes or flatter; cable heights of current projects range from 20.5 inches for the bottom cable to 30 inches to the top cable; high tension systems have a 10-foot deflection with a 16-foot post spacing; Ohio originally designed a non-socketed system but maintenance problems resulted in switching to a concrete socketed system as posts are damaged; median should have a compacted surface; cable should be offset from water flow to facilitate winter maintenance and avoid erosion around foundations; concrete sockets should be flush with ground to avoid vehicle contact; post spacing varied from 10 to 20 feet from various companies in order to achieve less than eight-foot deflection.

3.1.3 Evaluation of Cable Median Barrier Installations

In South Carolina, median crossover fatalities were reduced from over 70 during two years before installation to only eight fatalities in the three years after the installation of cable median barrier on all freeway sections with a median width less than 60 feet (8). In this three-year period, the cable system was hit 3,000 times with only 15 vehicles penetrating the system.

North Carolina found an average of 25 to 30 lives saved per year with an estimated 90 percent reduction in crossover crashes after cable median barriers were installed on all freeway

sections with a median width less than 70 feet (9).

Some motorcyclists have expressed concerns about cable barriers. However, researchers in the United Kingdom found little difference between crashes into cable median barriers and other barrier types (18). According to the data, most riders are separated from their motorcycles soon after leaving the pavement and are sliding on the ground when they contact the cable system.

Ohio conducted an evaluation of cable barrier installations with 233 crashes included (19). Crash performance of the barrier was very effective. In two years after installation no serious injuries or fatalities occurred. There were a few instances of penetration involving under-ride of the bottom cable. The average cost of repairs of the socketed section was about \$54 per post. However, repairs of driven posts were difficult when the ground was wet with an average cost of repair for non-socketed posts of \$115 per post.

Washington State evaluated cable median barriers installed in the mid-1990's to analyze their installation cost, maintenance cost and experience, and crash history (20). While the total number of crashes increased, the number of severe crashes decreased significantly. Annual cross median fatal crashes decreased from 3.00 to 0.33 fatalities per 100 million miles while annual disabling crashes decreased from 3.60 to 1.76. It was estimated that the installation of cable barriers had an annual benefit of \$420,000 per mile.

After an installation of cable guardrail on I-70 in Missouri, the number of crossover fatalities decreased from 24 in 2002 to six in 2005 with four of those in spots with no cable installed (21). A study found the cable system was effective in 94 percent of the crashes in that the vehicle did not travel into the opposing lanes.

The AASHTO cable barrier initiative (16) listed the following maintenance issues: North Carolina reported an average of \$600 per hit for 1,592 impacts; Washington reported an average of 5.4 posts damaged per hit with an average repair cost of \$634 for 18 hits on a high tension cable with concrete sockets; estimate that repair of cable requires 30 percent less time than W-beam guardrail; tensioned cable was ready for another crash after an impact; mowing and snow removal concerns have been noted; Texas estimated an average of 40 minutes to repair each hit with an average of 10 posts taken out for each hit; Texas also noted that repairs are completed each day and that maintenance is supplied with a tension meter with the finding that systems have not lost a lot of tension.

The AASHTO cable barrier initiative (16) listed the following relative to benefits and evaluation: North Carolina estimated 59 fatal cross-median crashes were avoided from January 1999 to December 2003 with 96 lives saved and a crash cost savings of \$205 million in fatal crashes; North Carolina also noted a 62 percent decrease in total and a 75 percent decrease in fatal cross-median crashes for 175 miles of cable barrier with 4.5 percent of the crashes involving a breach of the system; cable barriers had the lowest crash severity of any median barrier type; Washington noted that total crashes increased after barrier installation but fatal and disabling crashes decreased with a resulting benefit of \$420,000 per mile per year; an installation of Brifen

cable in Ohio showed 233 hits with eight possible penetrations and a 26 percent increase in total crashes but no fatal crashes; Utah reported an increase in incidents but the severity was reduced by half; Texas noted numerous impacts with no penetrations; Oregon had 300 hits in a section of cable rail with three penetrations.

The AASHTO cable barrier initiative (16) noted the following issues of potential concern for cable barriers: North Carolina reported 23 penetrations in a four-year period for 238 miles with most on tangent sections at impact angles from 11 to 90 degrees; it was noted that vehicle suspension dynamics are the key to under-ride crashes with cable height and ditch placement also related; Washington reported “through barrier” rates of five percent for a cable barrier with four percent for beam guardrail and one percent for concrete barrier; Ohio noted that cable sags slightly on the high tension system when several posts are damaged; installations adjacent to paved shoulders should have reflectors to reduce nuisance minor hits.

Following is information from various state responses (related to effectiveness of the cable barrier) to a request by an organization of state highway safety engineers for information about the use of cable barriers. Indiana has used 95 percent effectiveness as a crash modification/reduction factor. Concerns relate to motorcycle impacts and an increase in property damage only crashes. Missouri reported a 95 percent success rate in preventing vehicles from entering opposing lanes. North Carolina noted a 41 percent reduction in fatal crashes and 48 percent reduction in fatalities. Oregon noted that there were 420 impacts in 10 years with only one fatal and a significant reduction in injuries (with a large percentage of the impacts drive off type of crashes with no report). Ohio reported that the cable has been very effective in eliminating cross median crashes with an overall increase in the total number of crashes.

3.1.4 Cost Comparison

The installation cost of cable barrier has been shown to be less than other alternatives based on various comparisons that have been made. Following is a comparison of initial costs per foot from data from Washington State (20).

Cable median barrier	\$8.33
W-beam guardrail	\$13.65
Precast concrete barrier	\$24.64
Single slope concrete barrier	\$44.94
Cast in place concrete barrier	\$79.36

Another cost estimate of cable systems with socketed posts was about \$12.50 per foot (21). The cost for terminals about 50 feet in length was approximately \$2,000. Texas noted a cost of high tension cable systems ranging from \$9 to \$12 per foot (16).

Missouri estimated the installation of median cable barrier at \$60,000 to \$100,000 per mile, depending on the amount of grading work required (23). The estimated maintenance cost was \$6,000 to \$10,000 per mile, depending on the frequency of hits.

Following is information from various state responses (related to maintenance of the cable barrier) to a request by an organization of state highway safety engineers for information about the use of cable barriers. Indiana has estimated a maintenance cost of \$10,000 per mile or 10 percent of installation cost. However, data have not been obtained to determine actual costs. Florida has noted a problem with emergency responders cutting the cable which has added to maintenance costs. Minnesota noted a maintenance cost from 45 impacts of about \$58,500 (\$1,300 per crash) for a 7.6-mile section of interstate (\$21,500 for labor, \$28,400 for materials, and \$8,600 for equipment). North Carolina reported a state cost from 1,592 impacts of \$955,763 or \$600 per crash.

3.1.5 Use of Cable Barrier

Data on the extent of the use of cable barrier is contained in the survey conducted for NCHRP (17). It was found that the use of wire rope systems continues to increase with about 1,645 miles installed through July 2007. Of 29 states that participated in the survey, 27 indicated they have cable barrier system installed. The most common cable systems were Trinity (38 percent) and Brifen (37 percent). The next most common systems were Gibraltar and Nucor with 10 percent each.

While some states continue to use the non-proprietary low tension system, there is increased usage of the proprietary high tension systems. States are using more pre-stretched ropes due to reduced maintenance after initial installation. Many states install socketed systems that facilitate repair. Mow strips simplify mowing operations and eliminate socket and anchor movements in weaker soil conditions.

When used as a median barrier, the narrowest median width (between lane lines) where the barrier has been installed is eight feet (24). High-tension cable barrier was installed along a two-mile section of road where there had been fatal crossover crashes. A remaining question for this type of installation is the deflection for this narrow median width.

A recent NCHRP describes the use of cable barrier as a strategy for reducing head-on crashes on freeways (25). The use of cable in various states is summarized along with the performance. The severity of crashes involving cable was less than for concrete barrier and W-beam guardrail. The effectiveness of cable barriers in several states was documented.

3.2 Kentucky Installation of Cable Barrier

There have been four contracts for the installation of cable barrier systems. The cost has

included construction other than the cable barrier. The cost of the cable has been about \$20 per foot for the Brifen (four cables with 10-foot post spacing) and \$16 per foot for the Trinity (three cables with 20-foot spacing). Following is a summary of these projects.

Location: Jefferson County; I-64 (2.911 miles) and I-71 (11.552 miles)
Project Cost: \$3,368,871
Product: Brifen
Depth of
Concrete Sockets: 36 inches
Repair cost/post: \$82
Letting date: 3/3/06

Location: Jefferson County; I-265 (12.851 miles)
Project Cost: \$1,447,782
Product: Trinity
Depth of
Concrete Sockets: 36 inches
Repair cost/post: \$70
Letting date: 12/15/06

Location: Fayette County; KY 4 (New Circle Road); 11.10 miles
Project Cost: \$2,419,328
Product: Brifen
Depth of
Concrete Sockets: 30-inch post base; four-foot concrete mow strip
Repair cost/post: \$40
Letting date: 4/20/07

Location: Jefferson County; I-265 (12.199 miles) and I-64 (1.506 miles)
Project Cost: \$2,495,623
Product: Brifen
Depth of
Concrete Sockets: 36 inches
Repair cost/post: \$65
Letting date: 8/24/07

3.3 Kentucky Crash Data Collection and Analysis

An effort was made (using the CRASH data base) to identify crashes which involved a

vehicle crossing a median. There was no logic which could be used to identify a single vehicle crash so the crashes identified involved multiple vehicles. The following variables were used:

- lane use of limited access
- not involving a ramp
- not at an intersection
- traffic control of median
- opposite direction
- manner of collision; angle, head on, or opposite direction sideswipe

Using this logic, 392 crashes were identified for the five-year period of 2001 through 2005 with 71 involving a fatality and 211 involving an injury or fatality. The crash data were matched with a file containing data describing roadway characteristics. Of interest were access control and median type information. Roadway sections which had full or partial access control with an unprotected median type were identified. Matching the files resulted in about 1,368 miles meeting these criteria.

Using crash and mileage data resulted in averages of 0.28 crossover crashes per mile in the five years with 0.05 fatal and 0.15 injury crossover crashes per mile. A statistical test can be used to determine the critical number of crashes using the following formula.

$$\text{Critical number of crashes (Nc)} = N_a + K \sqrt{N_a + 0.5}$$

in which

N_a = average number of crashes and

K = constant related to level of statistical significance selected

Using a probability of 0.95 (with a K value of 1.645) resulted in critical numbers of crashes per mile of 1.65, 1.29, and 0.93 for all crashes, injury crashes, and fatal crashes, respectively, for a five-year period. The critical annual number per year would be 0.33 for all crashes, 0.26 for injury crashes and 0.19 for fatal crashes. Using these critical annual numbers and rounding, the following criteria could be used:

- 0.35 cross-median crashes (of any severity) per mile per year
- 0.25 injury or fatal crashes involving cross-median crashes per mile per year
- 0.20 fatal crashes involving cross-median crashes per mile per year

When data for 2006 were added to the previous five years, there was a total of 469 crossover crashes. There was an average of 78 per year over these six years. These crashes were sorted by county, route, and milepoint. Following is a summary of the sections (showing only the milepoint range with crash occurrence) which had three or more crashes in a one-mile section in the six-year period of 2001 through 2006.

<u>Route</u>	<u>County</u>	<u>Milepoint Range</u>	<u>Number Crossover Crashes</u>
KY 4	Fayette	6.0 - 6.4	4

		7.0 - 8.0	6
		9.2 - 9.6	5
I-24	McCracken	6.3 - 7.3	3
I-64	Jefferson	7.2 - 7.8	3
		9.0 - 10.0	3
		11.0 - 11.8	3
I-65	Warren	15.3 - 16.2	3
	Edmonson	43.3 - 44.1	3
	Barren	51.5 - 52.4	3
		53.4 - 54.1	3
	Hart	61.0 - 61.8	4
		63.5 - 64.5	3
	Hardin	82.3 - 82.7	3
		85.4 - 86.1	3
		94.4 - 95.3	5
		97.9 - 98.7	5
	Bullitt	110.3 - 111.2	3
		119.7 - 120.0	3
		122.7 - 123.5	3
I-71	Jefferson	3.0 - 3.9	3
		7.4 - 8.0	3
I-75	Whitney	20.0 - 20.9	3
	Rockcastle	56.0 - 57.0	4
	Kenton	185.2 - 185.8	3
I-264	Jefferson	8.0 - 9.0	3
I-265	Jefferson	12.9 - 13.0	3
I-275	Kenton	76.4 - 77.4	4
		78.6 - 79.0	3
Purchase Parkway	Marshall	42.0 - 42.7	4
		44.6 - 45.5	5

Any crash which involved a fatality was also identified. Following is a summary of the sections (milepoint range with crash occurrence) which had two or more fatal crashes in a one-mile section in the six-year period of 2001 through 2006.

<u>Route</u>	<u>County</u>	<u>Milepoint Range</u>	<u>Number Crossover Crashes</u>
KY 4	Fayette	0.3 - 1.2	3
		7.1 - 8.0	3
I-64	Jefferson	9.9 - 10.9	2
I-65	Hardin	94.8 - 95.3	2
	Bullitt	122.9 - 123.5	2
I-75	Whitley	20.0 - 20.9	2
	Rockcastle	57.8 - 58.6	2
I-265	Jefferson	30.9 - 31.7	2

3.4 Kentucky Performance of Median Cable Barrier System

An effort was made to communicate with Kentucky Transportation Cabinet personnel responsible for repair of the Brifen or Trinity cable barrier to determine when the system was involved in a crash. When possible, an inspection was made before repair but, given the quick response for repair, this was not possible in most cases. Photographs of the damage to the barrier were obtained in almost all cases. A search was made (using the CRASH data base) for police crash reports.

A total of 325 crashes were documented during the period of August 2006 through a portion of May 2008. A description of these crashes is given in Appendix A. In most crashes, the cable was adjacent to the travel lanes. A notation was provided if the vehicle crossed the median to contact the cable.

3.5 Summary of Crash Data

Following is a summary of the number of crashes involving a cable system for the period of August 2006 through a portion of May 2008. Crashes are summarized by location and manufacturer. Repair costs are based on the contract replacement cost per post.

<u>Location</u>	<u>Type</u>	<u>Number Crashes</u>	<u>Police Report</u>	<u>Posts Damaged</u>		<u>Repair Cost</u>	
				<u>Total</u>	<u>Average</u>	<u>Total</u>	<u>Total</u>
<u>Average</u>							
Jefferson County							
I-64	Brifen	26	15	149	5.7	\$12,218	\$470
I-71	Brifen	124	64	784	6.3	64,288	518
I-265	Trinity	40	17	220	5.5	14,320	358
I-265	Brifen	78	49	444	5.7	31,055	398
Fayette County							
KY 4	Brifen	57	40	327	5.9	13,080	229

Police reports were found for 185 of the 325 crashes (57 percent). The large majority of the crashes where a police report was not located involved a minor impact where the vehicle was

driven away without police involvement. For example, a police report was found in 72 percent of the crashes where there was damage to more than five posts; however, a report was not found for a few significant impacts where a police report should have been prepared.

The number of damaged posts ranged from one to 70 with an average of about six posts. The average number of posts was similar at all the installation locations. A tractor trailer was involved in the crash where 70 posts were damaged. For impacts in which no report was obtained, the number of posts damaged ranged from one to 18 with an average of approximately four posts.

Observations were made during several repairs. The repairs were made without the need for a lane closure. The typical repairs could be made in a few minutes with no disruption of traffic.

Following is a summary of the crashes which provides more details about the type of crash. The “cross median” crash involves a vehicle crossing the median before impacting the cable on the opposite side of the median. The “adjacent potential crossover” crash involves a contact with the cable system located adjacent to the travel lanes with the judgment that there was a substantial potential for the vehicle to cross the median. The “crossover” crash involved a vehicle which crossed the median into the opposing lanes.

<u>Location</u>	<u>Type</u>	<u>Number Crashes</u>	<u>Injury Crashes</u>	<u>Cross Median</u>	<u>Adjacent Potential Crossover</u>	<u>Crossover</u>
Jefferson County						
I-64	Brifen	26	1	5	9	1
I-71	Brifen	124	10	20	33	1
I-265	Trinity	40	2	5	14	1
I-265	Brifen	78	5	17	22	0
Fayette County						
KY 4	Brifen	57	11	14	14	0

Only 29 of the 325 crashes (8.9 percent) resulted in a reported injury related to the impact with the cable system, and there were no fatalities. The Brifen system in Fayette County on KY 4 had an injury crash involvement rate near 20 percent, which was more than twice the rate of any of the cable installations in Jefferson County. A police report was not obtained in many crashes but a logical assumption would be that those crashes did not involve an injury. The installations were on roads with speed limits ranging from 55 to 70 mph. The impacts were high speed with typically significant damage to the vehicles but the cable system was effective in preventing injuries. The low percentage of injury crashes for the installations in Jefferson County (approximately 7 percent) is illustrated by a comparison with all crashes on I-265 in 2006 that showed 20 percent involved an injury (26).

There were 61 crashes in which the vehicle crossed the median before contacting the cable system; therefore, these would have resulted in a vehicle encroaching into the opposing lane. There were 92 additional crashes in which the vehicle collided with the cable system adjacent to

the travel lane and a subjective analysis of the crash (including variables such as the impact angle) indicated that the vehicle had a substantial probability of crossing the median into the opposing lane. This shows that in the approximate 21-month time period of the study (less for the KY 4 installation) the cable system prevented up to 153 encroachments into the opposing lanes. On these high volume and high speed roadways, an encroachment into the opposing lane has the possibility of resulting in a crash with a severe injury. There were many minor sideswipe contacts; several with no report obtained. In these cases, the driver may have recovered with no crash if the cable system had not been installed. While the cable system has increased the number of crashes, it has decreased the potential for many severe cross median crashes.

The cable system was found to successfully redirect the vehicles. A wide range of types of vehicles hit the cable at consistently high speeds. In only three crashes (0.9 percent) did a vehicle continue past the cable system into the opposing lanes. There were five crashes in which a tractor trailer hit the cable, resulting in one crossover. The second crash involved two vehicles where one vehicle crossed the median and hit the cable and was redirected with the second vehicle crossing the cable immediately after the first contact. No police report was obtained in the other crash which involved a vehicle crossing the median before contacting the cable.

The deflection was observed to be less for the Brifen system than for the Trinity system. This would be related to the closer post spacing for the Brifen as well as the use of four cables for Brifen compared to three cables for Trinity. There were a few instances in which the concrete footing moved in the Louisville installations. This did not occur in Lexington where a four-foot mow strip was used.

About 64 percent of the vehicles colliding with the cable system (where a police report was obtained) involved a passenger car. There was 15 percent involving a sport utility vehicle and 13 percent with a pickup.

4.0 RECOMMENDATIONS

The successful performance of cable barrier warrants expanded use of this type of median barrier. The cable barrier was found to prevent median crossovers (on high speed roadways) and the damage to the cable system could be repaired relatively easily with no major disruption to traffic. Future installations should include the mow strip used in the Lexington installation to provide additional post stability and reduce maintenance.

It is recommended that guidelines for median barrier applications developed by the Kentucky Transportation Cabinet in March 2006 (updated in April 2008) be implemented (15). A copy is included as Appendix A. In order for the guidelines to be more representative of Kentucky

crash data (developed as part of this research), it is recommended that the following crash criteria should be used in the guidelines.

- 0.35 cross-median crashes (of any severity) per mile per year
- 0.25 injury or fatal crashes involving cross-median crashes per mile per year
- 0.20 fatal crashes involving cross-median crashes per mile per year

It should be noted that, due to the small number of this type of crash, these critical numbers may not be met. An analysis of crash data in Kentucky should be used to identify locations where this type of median barrier would be most cost effective. This would involve determining the locations which have had the highest concentration of median crossover crashes.

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APPENDIX A

Description of Crashes

Date/ Location/ Description

8/9/06; I-64; milepoint (MP) 10.8

Driver of a 2000 Honda Accord sideswiped another vehicle and rebounded into the median. About 53 feet of the cable was contacted, resulting in damage to four posts. The evidence is that the vehicle stopped at the barrier. The cable was located adjacent to the shoulder. A speed estimate of 45 to 50 mph was listed on the police report. Moderate damage was reported to the vehicle with no injury to the driver.

8/10/06; I-64; MP 9.6

Driver of a 1990 Toyota Cressida lost control on a wet pavement. The damage to the vehicle was described as severe with no injury to the driver. A speed estimate of 50 to 55 mph was listed on the police report. Six posts were damaged with tension remaining in the system. Evidence is the vehicle stopped at the barrier. The cable was located adjacent to the shoulder.

8/20/06; I-71; MP 10.4

While racing another vehicle, the driver of a 2000 Dodge Viper (at an estimated speed of 80 mph) lost control and contacted the cable which was being installed and had not been fully tensioned. There was contact to about 187 feet of cable with 17 posts damaged. The cable was located adjacent to the travel lanes. The vehicle traveled about 295 feet from entering the median to final rest. The vehicle traveled over the cable (remaining in the median) near its final rest position. The vehicle sustained very severe damage with a "non-incapacitating" injury to the driver with no injury to the passenger.

8/22/06; I-71; MP 7.5

The driver of a 1996 Lexus ES300 fell asleep while traveling at an estimated speed of 60 to 70 mph with the vehicle contacting four posts as it crossed the median. The cable portion of the system had not yet been installed. The vehicle sustained moderate damage with a possible injury reported.

8/26/06; I-71; MP 7.9

The driver of a 2000 Chevrolet Malibu became sick and lost control of his vehicle with it traveling into the median where contact was made with the cable barrier which was located adjacent to its lane of travel. The vehicle then crossed back over its original lanes of travel stopping on the shoulder. Five posts were damaged. The vehicle sustained moderate damage with no injury reported for the two occupants.

9/11/06; I-64; MP 9.0

The driver of a 2001 Toyota Tacoma lost control of her vehicle on wet pavement at an estimated speed of 55 to 60 mph and struck the cable barrier. The vehicle sustained moderate damage with no injury reported for the driver. Four posts were damaged.

9/20/06; I-71; MP 5.7

Driver of a 2005 Ford Focus lost control (at an estimated speed of 60 to 70 mph) and crossed the median to the "non-traffic" side where it contacted the cable barrier and was redirected to a final rest position in the median. The vehicle sustained moderate damage with a possible injury to the driver. There was damage to 10 posts. The vehicle traveled about 150 feet in the grass median before contacting the barrier at an angle of about 45 degrees.

9/22/06; I-71; MP 9.2

The driver of a 1998 Ford Explorer lost control on wet pavement on the ramp from I-265 to I-71 (at an estimated speed of 30 to 35 mph) and rotated into the barrier where it overturned. The vehicle sustained moderate to severe damage with no reported injury to the driver. Approximately six posts were damaged.

9/23/06; I-71; MP 11.0

An unknown vehicle slid on wet pavement, contacted the cable barrier and returned to the pavement. Three posts were damaged with two knocked down and one twisted. The cable was located adjacent to the shoulder. No police report was located.

9/28/06; I-71; MP 9.0

An empty 2006 Freightliner combination five-axle truck was struck by a vehicle changing lanes. The truck then ran into the cable barrier damaging 19 posts. The cable was located adjacent to the shoulder. The truck stopped along the rail with the cable penetrating the left front fender. There was no reported injury. The estimated speed was 45 to 55 mph.

9/29/06; I-71; MP 6.0

The driver of a southbound 2004 Pontiac Grand Am was distracted and allowed his vehicle to travel into the median where it struck the cable barrier with damage to six posts. The vehicle then traveled back across the two southbound lanes and stopped in the ditch on the opposite side of the road. There was no reported injury. The estimated speed was 65 to 75 mph.

10/27/06; I-71; MP 0.9

The driver of a 2000 Chevrolet Impala swerved into the cable barrier while avoiding another vehicle. The vehicle sustained moderate damage with no injury reported. The estimated speed was 50 to 55 mph. One post was damaged. The cable was located adjacent to the travel lanes and the vehicle's final rest position was in its lane of travel.

10/27/06; I-71; MP 9.1

A 1987 Volvo 240 passenger car hydroplaned on wet pavement into the cable barrier at an estimated speed of 65 to 70 mph. The vehicle sustained moderate to severe damage with no reported injury. Two posts were damaged. The cable was located adjacent to the lane of travel.

10/27/06; I-71; MP 8.7

After a rear end collision at an estimated speed of 40 to 50 mph, a 2001 Volkswagon Jetta traveled into the cable barrier. There was no reported injury. There was damage to eight posts.

10/28/06; I-64; MP 10.2

A minor impact occurred with one post damaged. No police report or additional information was available.

10/28-30/06; I-71; MP 2.2, 5.4 and 9.0

Impacts occurred at these locations during wet weather with no police reports located. The number of posts damaged ranged from two to eight.

11/1/06; I-71; MP 6.9

The driver of a 1999 Ford Explorer lost control on a wet pavement and struck cable barrier. The impact was in a transition area where the cable goes from one side of the median to the other. At impact, the cable was in the center of the median. The damage shows the vehicle changed direction as it traveled along the cable and came to rest adjacent to the cable. About 14 posts were damaged with a couple of post bases pulled from the ground. The vehicle sustained moderate to severe damage with no injury reported. Tire marks indicated a departure angle of about 25 degrees. The cable had a deflection of about seven feet.

1/10/06; I-71; MP 10.3

An unknown vehicle damaged 10 posts when it struck the cable system adjacent to the travel lanes. No report was obtained.

11/15/06; I-71; MP 7

The driver of a 1979 Chevrolet Corvette lost control (at an estimated speed of 70 to 75 mph) on wet pavement and struck the cable barrier. The cable was located adjacent to the shoulder. A total of 11 posts were damaged as the vehicle rotated along the rail and stopped on the shoulder. One post came out of the ground. The vehicle sustained moderate damage with no reported injury.

11/17/06; I-71; MP 10.5

An unknown vehicle damaged 14 posts when it struck the cable system adjacent to the travel lanes. No report was obtained.

11/17/06; I-71; MP 10.5

An unknown vehicle damaged 2 posts when it struck the cable system adjacent to the travel lanes. No report was obtained.

11/24/06; I-64; MP 9.6

Two vehicles sideswiped resulting in a 1987 Toyota Camry hitting the cable barrier with damage to 25 posts. The cable was located across the median adjacent to the opposing lanes. The second vehicle (a 1997 Buick Century) rebounded off a W-beam guardrail and crossed the median in the area where the cable had just been pushed to the ground. The Camry sustained moderate damage with no reported injury. The departure angle was close to 45 degrees. There was a deflection of about four feet as the vehicle rotated along the cable. One post was pulled from the ground.

12/6/06; I-71; MP 8.0

A mechanical failure caused a 2002 Ford F250 pickup to pull to the left into the cable barrier (at an estimated speed of 65 to 70 mph). The cable was located adjacent to the shoulder. The vehicle stopped at the cable after impacting 23 posts. The vehicle sustained moderate to severe damage with no injury reported.

12/11/06; I-71; MP 4.8

The driver of a 2006 Volkswagen Jetta lost control and hit the cable barrier while avoiding another vehicle. The cable was located adjacent to the shoulder. The estimated speed was 55 to 60 mph with very severe damage listed for the vehicle. No injury was reported. The car slid along the cable to final rest damaging over 10 posts with some posts partially pulled from the ground.

12/18/06; I-71; MP 10.6

A sideswipe impact damaged four posts on the cable which was located adjacent to the lane of travel of the impacting vehicle. No police report was available.

12/21/06; I-71; MP 6.0

A sideswipe impact damaged seven posts. The cable was located adjacent to the lane of travel. For a portion of the damaged cable, three of the four cables remained on the ground. No police report was available.

12/21/06; I-71; MP 9.1

The driver of a 1998 Toyota Camry lost control when entering I-71 from I-265 and rotated into the path of a 2007 Freightliner tractor trailer. The car was trapped between the driver's side of the truck and cable system. Estimated speeds were 40 to 45 mph for the car and 60 to 65 mph for the truck. The Camry sustained very severe damage with no injuries reported. There was damage to 24 posts. The vehicles slid along the cable to final rest. The impact resulted in a significant amount of DGA material being displaced. There was standing water in the area around the posts with a couple of the post bases buried in mud.

12/22/06; I-71; MP 9.1

The driver of a 2006 Ford Ranger lost control on wet pavement when entering I-71 from I-265 and slid into the cable. The Ranger was then hit by a 2005 Freightliner tractor trailer. Estimated speeds were 50 to 60 mph for the Ranger and 60 to 65 mph for the truck. The Ranger sustained moderate to severe damage with the driver injured. This impact was within about six posts of an impact the previous day which had not been repaired. This impact pulled some of the slack in cable from the previous collision. Four posts were damaged.

12/25/06; I-71; MP 9.1

The driver of a 1976 Oldsmobile Cutlass lost control on wet pavement when entering I-71 from I-265 and slid into the cable with contact to the right rear bumper. The vehicle sustained moderate damage with no reported injuries. There was damage to two posts.

12/25/07; I-64; MP 10.0

The driver of a 1995 BMW passenger car lost control on a wet pavement and struck the cable adjacent to the travel lane. The damage to the vehicle was described as very severe with a speed estimate of 50 to 60 mph. There was damage to four posts. No injury was reported.

12/26/07; I-71; MP 9.0

The driver of a 2004 Lincoln Town Car fell asleep with the driver's side of the car contacting the cable (adjacent to the lane of travel) at a speed of about 60 to 65 mph. There was damage to six posts. The vehicle sustained moderated damage with no reported injuries.

12/31/06; I-71; MP 9.0

The driver of a 1997 Mercury Marquis lost control on a wet pavement when entering I-71 from I-265 and slid into the cable with contact to the front of the car. There was damage to about six posts. The vehicle sustained severe damage with no reported injury.

1/14/07; I-64; MP 9.2

The driver of a 2003 Nissan Maxima lost control on wet pavement with the front of the vehicle contacting the cable system (located adjacent to the travel lane). The estimated speed was 50 to 55 mph. Only one post was bent. There was no reported injury.

1/14-15/07; I-71; MP 7 and 7.5

No police reports were located for these two impacts which occurred over a weekend. Both involved an impact with the cable system located adjacent to the lane of travel. The impacts involved damage to seven and eight posts. The evidence in both collisions was that the vehicle was redirected back into its lane of travel.

1/26/07; I-71; MP 6.2

A rear end impact pushed a 1998 Ford F150 pickup into the cable located adjacent to the travel lanes. The speed estimate was 45 to 55 mph with no reported injuries. There was damage to a total of three posts (two posts followed by no damage to three posts and then damage to one post).

2/14/07; I-71; MP 4.8

The driver of a 2000 Ford F250 pulling a trailer lost control with contact to the driver's side of the pickup. The estimated speed was 50 to 55mph. There was minor damage with no reported injury. There was damage to 11 posts.

2/14/07; I-71; MP 2.3

Damage was reported to one post. No police report was found.

2/18/07; I-64; MP 11.3

Damage was reported to five posts. No police report was found.

3/4/07; I-71; MP 7.4

One post was pushed down with evidence that the vehicle was redirected back to the road. The cable is located adjacent to the travel lanes. No police report was available.

3/4/07; I-71; MP 7.5

Six posts were pushed down. Tire tracks in the gravel between the cable and paved shoulder showed the travel path of the vehicle into the cable adjacent to the travel lanes and back to the travel lanes. No police report was available.

3/4/07; I-71; MP 7.8

The driver of a 2004 Ford Excursion pulling a trailer lost control on icy pavement with the front of the vehicle contacting the cable. The estimated speed was about to 50 mph. The vehicle sustained minor to moderate damage with one possible injury reported. Six posts were contacted (with three posts contacted followed by one post with no contact and then contact with three additional posts). The vehicle rotated counterclockwise to a final rest position with the front of the vehicle at the cable (located adjacent to the travel lanes).

3/4/07; I-71; MP 7.9

One post was pushed down. A skid mark led to this post with evidence that the vehicle stopped at this location (adjacent to the travel lane). No police report was available.

3/4/07; I-71; MP 8.0

Three posts were pushed down. There was evidence that the vehicle was redirected back to the roadway after contacting the cable adjacent to the travel lanes. No police report was available.

3/4/07; I-71; MP 8.1

There was damage to two posts (contact to one post with no damage to two posts and then damage to another post). The evidence is that the vehicle rotated to a final rest position at the cable (located adjacent to the travel lanes). No police report was available.

3/4/07; I-71; MP 8.2

A southbound vehicle crossed the median and struck the cable located adjacent to the northbound lanes. There was damage to three posts. The vehicle was redirected into the median. No police report was available.

3/5/07; I-71; MP 7.2

The driver of a northbound 1994 Mercury Topaz lost control with the driver side of the car contacting the cable. The vehicle sustained moderate damage with no reported injury. There was damage to 15 posts (six posts pushed down followed by four with slight damage and then five pushed down). The vehicle rotated to a final rest position in the northbound lanes.

3/5/07; I-71; MP 8.8

A rear end impact pushed a vehicle into the cable. The estimated speeds were low at 15 to 20 mph but severe vehicle damage was noted. There were no reported injuries. Six posts were damaged. The cable was impacted at a sharp angle with the vehicle redirected.

3/9/07; I-71; MP 0.6

The driver of a 1988 Volvo passenger car lost control while avoiding a crash and contacted the cable system adjacent to the travel lanes. There was damage to ten posts. The damage to the car was described as severe. The speed estimate was 50 to 55 mph. No injury was reported.

3/26/07; I-71; MP 7.0

A sideswipe contact forced a 1996 Dodge Neon into the adjacent cable system with damage to four posts. The estimated travel speed was 65 to 70 mph with moderate to severe damage to the car. A “non-capacitating” injury was reported.

4/2/07; I-71; MP 10

A total of 13 posts were damaged by a vehicle that contacted the cable barrier adjacent to the travel lane. The cable was deflected about six feet with the vehicle then continuing in its lane of travel after the accident. No police report was located.

4/5/07; I-71; MP 11

The driver of a 2005 Chevrolet Colorado LS pickup steered to his left to avoid another vehicle and contacted the cable (which was located adjacent to his lane of travel). The initial contact was to the left front of the pickup. The speed estimate was 70 to 75 mph. No injury was reported. A total of 17 posts were damaged with the vehicle redirected to its lane of travel.

4/5/07; I-265; MP 15.2

The driver of a 1999 Oldsmobile Caravan lost control of his vehicle (medication was listed as a factor) and his vehicle crossed the median before impacting the barrier. The speed estimate was 55 to 65 mph. A “possible injury” was noted. Construction of the barrier had not been completed. While the barrier was in place, the cable had not been fully tensioned with enough tension provided to hold the cable in place. Initial contact was with the left rear bumper of the van. The initial contact pushed four posts down with the next three posts undamaged followed by five posts pushed down. The final rest position of the van was in the median a few feet past the last damaged post.

4/11/07; I-265; MP 13.5

The driver steered into the median to avoid another accident. The 1997 Chevrolet S10 pickup sustained moderate damage. The driver was not using his safety belt and sustained a “possible” injury when he struck his head on the windshield. The speed estimate was 55 to 60 mph. A total of eight posts were damaged with the vehicle impacting the cable at a significant angle. The cable was located adjacent to the travel lanes. The impact occurred at a splice location with no damage observed to the splice.

4/16/07; I-71; MP 10.5

The vehicle traveled into the center of the median and contacted the cable with 12 posts damaged. The location is where the cable crosses the median. The path of the vehicle was behind a W-beam guardrail and a sign pole base. The vehicle struck the cable at a shallow angle and stopped along the cable. No police report was available.

4/19/07; I-71; MP 2.1

A total of four posts were damaged. One post was hit and then, after two posts were not contacted, an additional three posts were hit. The final rest position of the vehicle was adjacent to the cable which was adjacent to the travel lanes. No police report was available.

4/19/07; I-71; MP 4.0

One post was damaged by a glancing blow to the cable system (located adjacent to the travel lanes). The base was damaged with minor damage to the post. The tire path is shown in the DGA material. No police report was available.

4/19/07; I-71; MP 7.5

The contact resulted in damage to six posts. The contact involved two posts with one skipped before contact with four additional posts. The final rest position of the vehicle was at the last contacted post. No police report was available.

4/21/07; I-71; MP 6.8

A sideswipe impact resulted in damage to two posts. The vehicle was redirected with no accident report obtained.

4/25/07; I-71; MP 13.9

A truck driver changed lanes and contacted a 2007 Kia Optima causing the Kia to rotate into the median where it contacted the cable barrier located next to the shoulder. The Kia sustained moderate to severe damage with no injury to the driver. The speed estimate was 60 to 65 mph. There was damage to four posts with 60 feet of the erosion control blanket damaged. The bases to the posts were also cracked.

4/25/07; I-71; MP 13.3

The driver of a 2006 Ford Crown Victoria swerved to avoid slow moving traffic and hit the cable barrier (located next to the shoulder) with a speed estimate of 65 to 70 mph. The car sustained minor damage with the driver not injured. One post was damaged along with 40 feet of erosion control blanket.

4/26/07; I-265; MP 11.1

The driver of a 1983 Chevrolet pickup lost control when he swerved to avoid a slowing vehicle. No speed estimate was given. The vehicle sustained minor damage with no injury to the driver or passenger. One post and 190 feet of erosion control blanket were damaged. The cable barrier is located adjacent to the shoulder.

4/30/07; I-71; MP 6.5

A sideswipe impact occurred with the cable barrier located adjacent to the travel lanes. The vehicle rode the rail after contact and then came off the rail and clipped the end anchor. The impact with the end anchor broke the connection between the cable and the splice coupler. This resulted in one cable losing tension. A post was bent where the turnbuckle tried to pass through the top notch in the post. The turnbuckle moved because it was located in the cross-over where the cable transitions from between shoulders and the impact tried to pull the cable to the center of the median. The vehicle continued past the end anchor stopping at the edge of the pavement. No police report was available.

5/2/07; I-71; MP 4.5

A minor sideswipe collision occurred with damage to two posts. The cable was located adjacent to the travel lanes. Evidently the vehicle continued with no police report available.

5/2/07; I-264; MP 13.8

One post was hit with damage to the erosion control blanket as a vehicle slid to a stop at the post. The cable barrier is located adjacent to the travel lanes. The very minor damage would not have resulted in any significant damage to the vehicle with no police report available.

5/14/07; I-265; MP 16.7

A 1994 Toyota Camry contacted the cable system adjacent to the travel lanes after a tire failure. There was damage to four posts. The speed estimate was 60 to 65 mph. Damage to the car was described as moderate. There was no reported injury.

5/21/07; I-71; MP 10.0

The vehicle was a 1993 Ford Taurus with the impact to the front of the car. The vehicle sustained moderate to severe damage with an estimated speed of 65 to 75 mph. No injury was reported. The impact was at the end of a portion of the cable system located adjacent to the travel lanes. The impact damaged the end anchor posts but did not detach the cable from the anchor bolts and turnbuckles. The vehicle hit the full height portion of the cable and drove off the end of the system pushing down the last two posts.

5/23/07; I-265; MP 20.0

The driver of a 2000 Chevrolet Malibu stated she lost control of her vehicle when the right rear tire failed. The vehicle sustained moderate to severe damage when the left front of the car impacted the cable (located adjacent to the travel lanes) with the final rest position of the car at the cable barrier. The estimated speed was 65 to 70 mph with no injury reported. The collision damaged four posts. The crash created enough slack in the cable to result in a situation where the bottom cable was on the ground with the other two cables sagging significantly. An investigation revealed that the cables were tightened during cold weather and not readjusted based on warmer conditions. The cable had a small amount of slack between each post.

5/27/07; I-71; MP 7.0

The driver of a 2006 Ford F150, towing a camper trailer, lost control of his vehicle with the pickup rotating into the cable barrier (located adjacent to the travel lanes). The pickup sustained moderate to severe damage with a "non-capacitating" injury reported to the front seat passenger. The estimated speed was 65 mph. There was initial contact to the guardrail on the right side of the road. The driver overcorrected with the pickup rotating into the cable. The pickup and trailer slid into the cable while on its side. The pickup became upright after contacting the cable. At final rest, the front portion of the pickup was across the cable with the trailer against the cable. The driver's side rear tire became entangled in the cable. The pickup and trailer were stopped in less than 200 feet from initial contact to final rest. The crash resulted in damage to over 12 posts.

6/10/07; I-265; MP 13.8

The driver of a 2007 Ford Mustang lost control of his vehicle as he was entering I-265 and swerved to avoid another vehicle contacting the cable system near the travel lanes. The damage was listed as moderate with a speed estimate of 50 to 60 mph. No injury was reported. The car rotated into the cable with contact to the rear. The car slid under the top two cables with these cables sliding onto the roof before dropping onto the driver's side of the car. The bottom cable caught the car in the middle of the passenger door with the car stopping along the cable. A portion of two posts bent allowing the cables to move free.

6/11/07; I-265; MP 15.8

The driver of a 2006 Hyundai Tiburon overcorrected when he fell asleep and initially ran off the right side of the road before crossing the travel lanes into the median where contact was made to the cable barrier (located adjacent to the travel lanes). There was no reported injury with moderate to severe damage to the vehicle. The speed estimate was 65 to 70 mph. The impact resulted in damage to seven posts with the cable defected about 10 feet. The top of several posts leaned over allowing one cable to drop to the ground. One post was sheared off at the top of the base.

6/14/07; I-265; MP 12.8

The operator of a 2005 Chrysler Pacifica had a seizure with the vehicle traveling into the median. The vehicle crossed the median with contact to the rear of the cable near the end anchor. There is no evidence of an injury related to the contact with the anchor posts. Damage to the vehicle was listed as minor to moderate with a speed estimate of 60 to 70 mph. The impact resulted in damage to five posts (the three anchor posts and the next two connector posts).

6/14/07; I-71; MP 8.0

A 1992 Ford Explorer rebounded into the cable system adjacent to the lane after a rear end collision. There was moderate damage to the vehicle. The speed estimate was 60 to 65 mph. Three posts were damaged. There were two reported injuries which were probably related to the frontal contact in the initial rear end collision.

6/20/07; I-265; MP 17

The vehicle slid sideways into the cable located adjacent to the travel lanes. At least two of the cables went over the car with the car rotating to a final rest in the median at the other side of the cable. Four posts were contacted. No police report was obtained.

6/24/07; I-71; MP 6.6

A vehicle crossed the median and contacted cable system resulting in damage to two posts. No police report was available.

6/28/07; I-71; MP 5.5

The driver of a 1997 Buick LeSabre swerved to avoid another vehicle and lost control. The vehicle crossed the median and hit the cable system with the final rest position in the median. There was damage to three posts. The damage to the vehicle was described as moderate with no reported injury.

6/28/07; I-265; MP 19.2

The driver of a 2003 Chevrolet Impala lost control on a wet pavement and slid into the cable barrier (located adjacent to the travel lanes). The estimated speed was 50 to 55 mph with moderate damage reported to the car. The two vehicle occupants were not injured. The vehicle clipped two posts (at a small angle) and then skipped a post before contacting two more posts. The first post was pulled completely out of the sleeve. The final rest position of the car was at the last post contacted.

6/29/07; I-71; MP 8.4

In slow moving traffic (estimated at 25 to 30 mph) a 1989 Chevrolet Astro van pulling a boat hit the rear of a Ford Windstar van pushing it into a Honda Odyssey van. The Astro van then hit the cable adjacent to the northbound lanes with the trailer and boat separating from the van. The Chevrolet Astro sustained severe damage. The trailer did most of the damage to the posts and stopped at the cable. The boat came off the trailer and went over the cable into the median. The only injury reported was to an occupant of the Ford Windstar. About eight posts were damaged.

7/1/07; I-265; MP 13

The driver of a Pontiac Grand Am steered left to avoid a stopped vehicle and contacted the cable barrier located adjacent to his lane of travel. There was damage to one post. The speed estimate was 55 to 65 mph with minor damage to the car. No injury was reported.

7/3/07; I-71; MP 8.9

The driver of a 1995 Toyota 4Runner lost control avoiding another vehicle and hit the cable barrier. The vehicle hit the barrier, spun, and hit the barrier a second time with damage to six posts. There was initial damage to three posts and then the vehicle rotated missing one post before damage to three additional posts. More than one post was pulled from their sleeve with no damage to the bases. The estimated speed was 55 to 60 mph with moderate damage to the vehicle and no injury reported.

7/4/07; I-71; MP 9.4

The driver of a 2001 Ford Expedition lost control entering I-71 from the ramp from I-265 and struck a 2003 Toyota Corolla with both vehicles then hitting the cable barrier located adjacent to the travel lanes. Both vehicles stopped along the cable system where the left front of each vehicle hit the cable. Speed estimates were 35 to 45 mph for the Expedition and 55 to 65 mph for the Corolla. Moderate damage was reported for both vehicles. Injuries were reported for the two occupants of the Corolla. There was damage to nine posts.

7/5/07; I-64; MP 11.4

The driver of a 2004 Ford Explorer lost control on wet pavement and contacted the guardrail on the right side of the road before rebounding into the cable adjacent to the travel lanes. Three posts were damaged. There was minor damage to the vehicle with an estimated speed of 60 to 65 mph. No injuries were reported.

7/7/07; I-265; MP 14

A driver was forced off the road and traveled across the median where it contacted the cable system damaging two posts. The vehicle then stopped at the cable.

7/9/07; I-265; MP16.1

The driver of a loaded tractor trailer swerved into the median to avoid a collision and contacted the cable barrier adjacent to the travel lanes. The final rest position of the truck was against the cable about 1,600 feet after the initial contact (damaging 70 posts). The truck originally damaged 53 posts while being directed away from a center bridge pier. The driver accelerated at one point to prevent the trailer from overturning and missed seven posts. The truck then hit 10 posts and then missed four posts in a second attempt to recover but hitting seven posts to final rest. The speed estimate was 60 to 65 mph with moderate damage reported. No injury was reported.

7/11/07; I-265; MP 15

The driver of a Mercury Cougar lost control of his vehicle when it hydroplaned and went into the median contacting a cable adjacent to the travel lanes. The contact resulted in damage to seven posts. The rear of the vehicle contacted the cable with the final rest position adjacent to the rail. The speed estimate was 55 to 60 mph with moderate damage to the car. No injury was reported.

7/30/07; I-265; MP 19

The driver of a Toyota Corolla swerved due to slowing traffic from a previous crash and contacted the cable barrier (located adjacent to the travel lanes) damaging three posts. The car came to rest against the cable. The estimated speed was 50 to 55 mph with moderate damage to the vehicle. No injury was reported.

8/1/07; I-265; MP 12

The driver of a Chevrolet Astro van swerved to miss another vehicle and lost control of his vehicle. The van traveled off the right side of the road and hit a breakaway pole before traveling back across the median and hit the cable barrier at a steep angle. A total of 10 posts were damaged with three posts pushed to the ground. The van came to rest in the median adjacent to the barrier. The impact resulted in the loss in tension of the lower cable for several thousand feet. The vehicle sustained moderate to severe damage with no injury reported.

8/2/07; I-265; MP 18.7

A vehicle crossed the median at a steep angle contacting the cable and stopping in the median adjacent to the barrier. Three posts were pushed down. The cable defected about seven feet.

8/3/07; KY 4; MP 0.4

The driver of a Plymouth Breeze lost control during a lane change and rotated into the cable barrier (located adjacent to the travel lanes). The final rest position of the vehicle was at the barrier. Moderate to severe damage was reported for the vehicle with no injuries. About five posts were damaged.

8/8/07; I-265; MP 14.8

The driver of a 2003 Dodge Neon swerved into the median to avoid stopped vehicles. The driver's side of the car hit the cable (located near the travel lanes). The damage to the vehicle was listed as moderate with no reported injury. The speed estimate was 65 to 70 mph. Only one post was damaged.

8/12/07; I-71; MP 0.4

The driver of a 2006 Chevrolet Impala lost control when the left, front tire failed. The car then collided with the cable located adjacent to the roadway. A total of 13 posts were damaged with 10 posts damaged before three were skipped before damage to three more posts. The vehicle sustained moderate damage with no injury reported. The speed estimate was about 60 mph.

8/14/07; I-265; MP 21.8

The vehicle was westbound on I-265 and traveled off the right shoulder for about 350 feet before crossing the westbound lanes and median where it contacted the cable barrier. The vehicle traveled about 550 feet from the first evidence of a path in the grass off the westbound shoulder to impact with the cable barrier. The impact angle was about 25 degrees. Four posts were damaged and the vehicle continued into the eastbound lanes (about 130 feet past the cable). No police report was available.

8/16/2007; I-71; MP 10.2

The driver of a 2005 Chevrolet pickup lost control on wet pavement. Four posts were knocked down when the northbound pickup crossed the median and contacted the cable barrier adjacent to the southbound lanes. The vehicle then rebounded back across the median into the northbound lanes. The vehicle sustained minor damage. The speed estimate was 60 to 65 mph. No injury was reported.

8/21/07; I-265; MP 11.2

The driver of a 1998 Toyota Camry swerved to avoid a truck with the car crossing the median before hitting the cable barrier adjacent to the northbound lanes. Three posts were damaged with one post base pulled out of the ground. The vehicle stopped adjacent to the cable. The vehicle sustained moderate damage with no reported injury. The speed estimate was 50 to 55 mph.

8/22/07; I-71; MP 2.8

The driver of a 2003 Nissan Altima swerved to miss a truck changing lanes and lost control with her vehicle crossing the median and contacting the cable system. The vehicle stopped at the cable with damage to five posts. Damage to the vehicle was described as minor to moderate. The speed estimate was 60 to 70 mph. One “non-incapacitating” injury was reported.

8/24/07; I-265; MP 13.8

A westbound 2000 Dodge minivan entered and crossed the median and hit the cable barrier. The cable deflected several feet as the van came to rest against the cable. The vehicle damage was described as severe with no injury reported. Approximately six posts were pushed down. The speed estimate was 60 to 65 mph.

8/25/07; I-265; MP 22.0

The driver of a 2005 Pontiac Vibe fell asleep and crossed the median and contacted the cable barrier at a relatively shallow angle. Five posts were damaged. The estimated speed was 45 to 55 mph. There was moderate damage to the vehicle with no reported injuries to the two occupants.

8/25/07; I-265; MP 11.2

A vehicle damaged five posts when it contacted the cable system adjacent to its travel lanes. The evidence shows the vehicle stopped adjacent to cables at the edge of the road. No police report was obtained.

8/30/07; I-71; MP 6.2

A 2006 Infiniti passenger car damaged ten posts when it contacted the cable system adjacent to its travel lanes. The evidence is that the vehicle continued along the system to its final rest position. The damage to the car was described as severe with no reported injury. A speed estimate of 45 to 55 mph was given.

8/30/07; I-64; MP 10.7

A vehicle crossed the median and damaged three posts when it contacted the cable. The final rest position of the vehicle was adjacent to the cable system in the median. No police report was obtained.

9/7/07; I-64; MP 7.6

The driver of a Jeep Cherokee lost control and contacted the cable adjacent to lane of travel. The vehicle came to rest adjacent to the cable at the edge of the travel lanes. The impact occurred at a turnbuckle area but the cable retained tension. The impact damaged 12 posts. The collision resulted in moderate to severe damage to the vehicle with no reported injury. The speed estimate was 65 to 75 mph.

9/9/07; I-64; MP 10.9

The driver of a 2001 Ford F150 pickup lost control on a wet pavement and contacted the cable system adjacent to the travel lanes. The vehicle was redirected and stopped along the cable. The impact resulted in damage to six posts. The vehicle sustained minor damage with a speed estimate of 55 to 60 mph. There was no reported injury.

9/10/07; I-71; MP 1.8

A 1998 Pontiac Trans Am rebounded from the guardrail on the right side of the road across the road into the cable system. The vehicle came to a stop along the cables with damage to 12 posts. The vehicle sustained moderate to severe damage with a speed estimate of 65 to 75 mph. The driver was not injured as a result of this accident. It should be noted that the driver exited his vehicle and walked into the road using his cell phone where he was hit and sustained fatal injuries. The accident occurred during darkness.

9/12/07; KY 4; MP 1.0

The impaired driver of a 1994 Toyota 4Runner drifted into the cable barrier with damage to 29 posts. The vehicle rode along the cable system coming to rest against the cable. The damage to the vehicle was described as minor to moderate with no reported injury.

9/12/07; KY 4; MP 18.8

The driver of a 2003 Oldsmobile Alero swerved to miss another vehicle and contacted the cable damaging two posts. The vehicle sustained moderate damage with no reported injury.

9/19/07; I-265; MP 16.6

An unknown vehicle damaged two posts adjacent to the travel lanes with a minor contact. No police report was obtained.

9/19/07; I-265; MP 12.4

The driver of a 1991 Toyota Tacoma swerved into the cable system in an attempt to avoid stopped traffic. The contact resulted in damage to three posts. The estimated speed was 50 to 55 mph with moderate to severe damage to the vehicle. There was no reported injury.

9/23/07; KY 4; MP 2.2

The driver of a 1990 Mercury Grand Marquise swerved to avoid a vehicle merging from an on-ramp and crossed the median and contacted the cable system with damage to three posts. There was a deflection of about one foot with the final rest position of the vehicle in the median adjacent to the cable. The impact angle was only about 15 degrees. Moderate damage was reported for the vehicle with no reported injuries. The estimated speed was 45 to 55 mph.

9/27/07; I-265; MP 19.7

The driver of a 2007 Ford Focus lost control on wet pavement with the car striking the adjacent cable system. There was damage to two posts. The speed estimate was 60 to 65 mph. Damage to the vehicle was described as moderate. There was no reported injury.

9/29/07; KY 4; MP 0.7

A steering failure resulted in a 1994 Nissan Sentra moving into the cable system located adjacent to the travel lane. There was damage to six posts with a deflection of less than one foot. The final rest position of the car was adjacent to the cable system about 15 to 20 feet past the last damaged post. The damage to the vehicle was described as very severe. There was no reported injury.

10/6/07; I-64; MP 10.6

A vehicle contacted the cable system located near the middle of the median with damage to seven posts. There was contact to two posts with the next two skipped with then two posts hit following by three skipped and then damage to three more posts. No police report was obtained.

10/7/07; KY 4; MP 17.0

The impaired driver of a 2002 Jeep Liberty drifted into the cable system adjacent to his travel lane and continued past the accident scene. There was damage to three posts with moderate to severe damage to the vehicle. The estimated speed was 55 to 60 mph. There was no reported injury.

10/9/07; KY 4; MP 18.0

An unknown contacted the cable system adjacent to the travel lanes damaging four posts. No police report was obtained.

10/11/07; I-265; MP 15.2

The driver of a 2000 Chevrolet Tracker steered to avoid a truck changing lanes and contacted the cable system adjacent to the travel lanes resulting in damage to two posts. The damage to the vehicle was described as minor to moderate with no reported injury.

10/23/07; KY 4; MP 9.9

The driver of a 1998 Nissan Maxima lost control on a wet pavement and slid, at a shallow angle, into the median and cable system with damage to three posts. The cable is located adjacent to the travel lane. Tire marks on the concrete base showed there was no deflection with tire marks showing the car was redirected at a shallow angle back into its travel lane. There was no reported injury with moderate damage to the car. The speed estimate was 50 to 55 mph.

10/23/07; I-265; MP 12.0

The driver of a 2006 Chevrolet Silverado pickup lost control on a wet pavement and slid into the cable system with contact damage to six posts and damage to the top of two posts. There was damage to the base of two posts which required repair. The cable was defected several feet with the vehicle redirected. The cable is located adjacent to the travel lane. There was no reported injury with moderate to severe damage to the pickup. The speed estimate was 50 to 60 mph.

10/27/07; I-71; MP 11.5

The driver of a 2004 Ford F150 steered to his left to avoid a vehicle changing lanes and contacted the cable system (adjacent to the travel lanes) resulting in damage to four posts. The damage to the pickup was described as moderate to severe. No injury was reported.

10/28/07; I-265; MP 11.8

A minor impact resulted in damage to two posts.

10/28/07; I-265; MP 17.0

The accident involved a 2003 Toyota Camry. The driver lost control and rotated into the cable system with a final rest position 160 feet after contact. A total of 16 posts were damaged. The contact resulted in a failure of the bottom cable. The cables stopped the vehicle with its final rest position at the cable system. Damage to the car was described as severe. The speed estimate was 70 to 75 mph. There was no reported injury.

10/29/07; I-71; MP 11.6

A vehicle rotated into the cable system close to the transition area. The collision resulted in damage to 18 posts (including seven of the transition posts at the anchor). The vehicle traveled over the cable with a final rest position in the median just behind the cable. The first tire mark on the pavement started adjacent to the end of the system with yaw marks leading to the contact. Contact was at about 15 degrees. The final rest was about 175 feet past the location of the first contact with the cable.

11/5/07; I-265; MP 14.0

A passenger of a Acura Integra distracted the driver causing the car to spin into the median. The car crossed the median and contacted the cable system. The final rest position of the car was in the cable system with one of the cables on top of the car. There was damage to three posts. The speed estimate was 60 to 70 mph. The vehicle damage was described as minor to moderate with no reported injuries.

11/5/07; KY 4; MP 0.3

The driver of a 1998 Ford Ranger fell asleep and drifted into the cable system adjacent to the lane of travel. The vehicle then rotated and came to rest in the travel lane. There was damage to three post followed by a gap of 50 feet with damage to three additional posts. The contact resulted in minor to moderate damage to the pickup with no reported injury. The estimated speed was 60 to 65 mph.

11/7/07; I-265; MP 30.4

The driver of a 1987 Chevrolet Astro van lost control of her vehicle when she swerved to avoid another vehicle changing lanes. The van spun into the cable (adjacent to the travel lane) resulting in damage to five posts. The cable system was being installed at this location with the cable partially tensioned. The van came to rest against the cables. The damage to the van was reported as minor to moderate with a "possible injury" listed for the driver.

11/8/07; I-265; MP 24.8

An impact occurred with a portion of the cable system (adjacent to the travel lanes). The system was under construction. Impact was at a substantial angle. There was damage to three posts.

11/11/07; I-71; MP 3.4

A vehicle contacted the cable located adjacent to the travel lane (at a shallow angle) with tire marks showing the vehicle was redirected back into its lane of travel. There was damage to three posts.

11/12/07; KY 4; MP 0.3

The driver of a 2000 Mercury Cougar lost control of his vehicle when a tire failed with the car crossing the median and contacting the cable system at an angle of about 20 degrees. There was damage to six posts with the vehicle redirected to a final rest position in the median. The cable deflected about four feet. The vehicle sustained moderate to severe damage with no reported injury. The speed estimate was 50 to 55 mph.

11/13/07; KY 4; MP 4.5

An unknown vehicle sideswiped the cable damaging one post.

11/15/07; KY 4; MP 15.4

The driver of a Ford F250 pickup (towing a loaded trailer) lost control when avoiding another vehicle with the pickup and trailer rotating counterclockwise into the cable system (located adjacent to his lane of travel). The maximum angle of impact was about 35 degrees as the vehicle rotated into the cable system. There was damage to four posts with a deflection of only 18 inches. The final rest positions of the pickup and trailer were in the travel lanes adjacent to the cable. Vehicle damage was described as minor to moderate with no reported injury. The speed estimate was 35 to 45 mph.

11/18/07; I-71; MP 8.0

A vehicle struck the cable system located adjacent to the travel lanes. The vehicle hit two posts and then rotated contacting ten more posts. The vehicle then rebounded back across the travel lanes with a final rest position on the shoulder.

11/18/07; I-265; MP 10.8

The driver of a 1999 Volvo steered to his right to avoid a vehicle merging on the road and contacted two posts adjacent to the travel lanes. The final rest was at the cable system. The vehicle damage was described as severe with no reported injury. The speed estimate was 60 to 70 mph.

11/19/07; KY 4; MP 2.2

The intoxicated driver of a 1999 Dodge Neon lost control of his vehicle and crossed the median striking the cable at an angle of about 40 degrees. The car pushed over one post and rotated to a stop adjacent to the post. The car damage was described as moderate to severe with a "possible injury" reported for the driver. An inspection found scraping down the passenger side as the car rotated to a stop with no major crush. The speed estimate was 60 to 65 mph.

11/21/07; KY 4; MP 2.5

The driver of a 1994 Cadillac DeVille swerved to avoid another vehicle and crossed the median into the cable system. The vehicle rebounded from the cable and crossed back across the median and original lanes of travel. The impact angle was about 10 degrees. Seven posts were damaged with a deflection of about 18 inches. The total distance traveled from entering the median to final rest was about 320 feet. The damage to the vehicle was described as moderate to severe with no reported injury.

11/21/07; KY 4; MP 6.2

A trailer being towed by a Dodge Ram 2500 pickup became disengaged and crossed the median into the barrier system. Two posts were damaged with no noticeable deflection to the cable. The impact angle was about 20 degrees with the trailer stopping at the cable.

11/23/07; I-265; MP 30

The driver of a 1992 Honda Accord lost control of his vehicle while attempting to avoid debris in the road. The final rest position of the car was at the cable. The car struck the barrier adjacent to the travel lanes. The car hit two posts and then rotated with damage to six posts. Vehicle damage was described as minor to moderate with a speed estimate of 65 to 75 mph. There was no reported injury.

11/25/07; I-265; MP 34

A 1996 Cadillac Deville struck the barrier adjacent to the travel lanes at an angle indicating the potential for a crossover. Six posts were damaged. The damage to the vehicle was described as moderate to severe with no reported injury.

11/26/07; I-71; MP 4.2

The driver of a 2005 Scion XB passenger car lost control of his vehicle on wet pavement and struck the cable system located adjacent to the travel lane. Impact was at a shallow angle with damage to four posts. The vehicle sustained very severe damage with a speed estimate of 50 to 60 mph. There was no reported injury.

11/26/07; I-265; MP 18.5

One post was damaged with an impact to the barrier adjacent to the travel lanes.

11/26/07; I-64; MP 7.0

Four posts were damaged with an impact to the barrier adjacent to the travel lanes. The damage indicates a sideswipe impact with the vehicle continuing.

11/27/07; KY 4; MP 6.0

An unknown vehicle sideswiped the cable damaging one post.

11/27/07; I-265; MP 22.0

A vehicle struck the cable system adjacent to the travel lanes at a substantial angle and was redirected. Three posts were damaged.

11/28/07; I-265; MP 15.3

The intoxicated driver of a 1999 Oldsmobile Intregue swerved into the cable system adjacent to the travel lanes with the vehicle then redirected. A total of 12 posts were damaged. A portion of the concrete base around one post was damaged but there was limited movement resulting to the post so it did not compromise the structural rigidity of the system. Very severe damage was reported to the vehicle with no reported injury.

11/28/07; I-265; MP 11.8

The driver of a 1990 Cadillac Eldorado steered to miss a tractor trailer and struck the cable adjacent to his lane of travel. Moderate damage was reported for the vehicle with no reported injury. The estimated speed was 45 to 50 mph.

12/7/07; I-265; MP 14.3

A vehicle impacted the end of the cable system breaking the three anchor posts (as designed). There was damage to eight posts (three anchor posts, four line posts at turnbuckles, and one line post). The posts at the turnbuckles were bent when the turnbuckles were locked in the post with the tension bending the post (in the opposite direction of the impact). Two of the three cables were dislodged.

12/8/07; I-71; MP 2.0

A vehicle sideswiped the cable adjacent to the lane of travel and was redirected. Two posts were damaged.

12/9/07; I-265; MP 33.5

A 2001 Ford Escape hydroplaned into the cable system (adjacent to the lane of travel) at a substantial angle and was redirected. Four posts were damaged. The speed estimate was 50 to 60 mph. The vehicle damage was described as moderate to severe with no reported injury.

12/9/07; KY 4; MP 0.5

The driver of a 2007 KIA Optima swerved to miss another vehicle and contacted the cable adjacent to her lane. The car rotated and struck the cable a second time before stopping in the roadway. Five posts were damaged. Damage to the vehicle was described as moderate to severe with no reported injuries.

12/13/07; I-265; MP15.5

A 2004 Mitsubishi Eclipse was forced off the road into the cable system. The impact involved the anchor system. Eight posts were damaged including the majority of the anchor system. Two of the three cables were dislodged. The vehicle sustained moderate damage with no reported injury.

12/14/07; I-71; MP 9.1

An unknown vehicle damaged six posts.

12/15/07; I-265; MP 28.7

An unknown vehicle contacted the cable system adjacent to its travel lane with damage to five posts. Evidence shows the impact was at a shallow angle with the vehicle stopping adjacent to the cables.

12/15/07; I-265; MP 34.7

An unknown vehicle contacted the cable system adjacent to its travel land with damage to three posts. Evidence shows the impact was at a fairly steep angle and the vehicle rebounded back toward the roadway.

12/15/07; I-265; MP 23.0

An unknown vehicle damaged two posts.

12/15/07; I-265; MP 19.5

An unknown vehicle damaged six posts.

12/15/07; I-64; MP 6.6

An unknown vehicle contacted the end anchor with damage to 11 posts. The cable came loose from the anchor plate. The impact angle was substantial.

12/17/07; I-265; MP 27.0

The driver of a 2003 Ford Focus fell asleep with the vehicle drifting into the cable system adjacent to its travel lane resulting in damage to 20 posts. Evidence shows the impact was at a shallow angle. The vehicle's final rest position was in the original lane of travel. The vehicle sustained moderate to severe damage with no injury reported.

12/29/07; I-265; MP 17.6

The driver of a 1997 Ford Escort swerved to avoid a merging vehicle and contacted the cable barrier adjacent to the travel lanes resulting in damage to seven posts. The impact was at a substantial angle with the final rest position in the median. The speed estimate was 65 to 70 mph. Damage to the car was described as very severe with no injury reported.

12/30/07; I-265; MP 27.0

The driver of a 2002 Chevrolet Monte Carlo swerved to miss a deer and hit the cable barrier. There was damage to five posts to the cable adjacent to the travel lanes. Evidence was the car was redirected back to the road. The speed estimate was 60 to 65 mph. The vehicle damage was described as moderate to severe. No injury was reported.

12/31/07; I-265; MP 17.1

The impact occurred on the ice-covered roadway with no report obtained. The vehicle crossed the median and was redirected by the cable (with damage to four posts) with the final rest position in the median.

12/31/07; I-265; MP 25.7

The impact occurred on the ice-covered roadway with no report obtained. The contact was a sideswipe impact with the cable adjacent to the travel lanes with damage to four posts. The evidence is the vehicle was redirected back to the roadway.

12/31/07; I-265; MP 33.2

The impact occurred on the ice-covered roadway with no report obtained. The contact was a sideswipe impact with the cable adjacent to the travel lanes with damage to two posts. The evidence is the vehicle was redirected back to the roadway.

12/31/07; I-71; MP 1.8

The driver lost control on the ice-covered road with the vehicle crossing the median before contacting the cable. There was damage to two posts with the vehicle redirected back into the median. No report was obtained

12/31/07; I-71; MP 2.0

The contact was a small angle sideswipe with the adjacent cable. The vehicle was redirected to the travel lanes. No report was obtained.

12/31/07; I-71; MP 3.8

The driver lost control on the ice-covered road with the vehicle crossing the median before contacting the cable. There was damage to three posts with the vehicle redirected back into the median. No report was obtained.

12/31/07; I-71; MP 4.8

The contact was a small angle sideswipe with the adjacent cable. The vehicle was redirected to the travel lanes. No report was obtained.

12/31/07; KY 4; MP 1.9

The driver of a 2003 Dodge Dakota pickup lost control on an overpass and contacted the end of the cable system with damage to eight posts. The damage to the vehicle was described as severe. The estimated speed was 55 to 65 mph. A possible injury was reported.

12/31/07; KY 4; MP 2.3

The driver of a 2003 Ford Mustang lost control on an overpass and contacted a guardrail coming to rest at the cable with one post damaged. There was minor to moderate damage to the car with a possible injury listed.

12/31/07; KY 4; MP 4.9

The driver of a 2004 Nissan Pathfinder lost control on an overpass and contacted the end of the cable system with damage to 10 posts. The damage to the vehicle was described as moderate to severe. No injury was reported.

12/31/08; I-71; MP 0.6

The driver of a 2000 Ford Explorer lost control on an ice-covered overpass and struck the cable barrier adjacent to the travel lane. A total of 19 posts were damaged. The cable system was defected about three to four feet with the vehicle redirected to the roadway. The speed estimate was 50 to 55 mph. The vehicle damage was described as moderate. No injury was reported.

12/31/08; I-71; MP 3.4

The driver of a 1995 Jeep Wrangler lost control on an ice-covered overpass and struck the cable barrier. A total of eight posts were damaged. The contact to the cable adjacent to the travel lanes was at a shallow angle with the vehicle redirected back into the roadway. The speed estimate was 40 to 50 mph. The vehicle damage was described as minor to moderate. No injury was reported.

1/2/08; KY 4; MP 0.2, 0.3, 14.9; 18.0

Three incidents occurred when an unknown vehicle slid on snow and sideswiped the cable damaging one post in three instances and six posts in the other.

1/2/08; I-265; MP 11.7

The driver of a 1997 Dodge Intrepid fell asleep with her vehicle drifting into the cable barrier. There was damage to four posts. The final rest position of the vehicle was adjacent to the cable system. Damage to the vehicle was described as moderate with no injury reported.

1/3/08; KY 4; MP 18.2

The driver of a 2003 Ford Mustang lost control as she was accelerating from an on-ramp contacting the cable adjacent to the lane of travel. Six posts were damaged with moderate damage to the car. There was no reported injury.

1/6/08; I-265; MP 29.4

The driver of a 1995 Ford Ranger pickup swerved to avoid a truck changing lanes and lost control. The pickup traveled into the median contacting the cable system adjacent to the travel lane (at a sharp angle) with damage to eight posts. The vehicle damage was described as moderate with no reported injury.

1/11/08; I-64; MP 10.5

An impaired driver of a 1994 Ford Taurus ran off the road contacting the guardrail on the right side of the road and then rebounded into the cable barrier adjacent to the travel lanes. There was damage to four posts. The speed estimate was 50 to 60 mph with the vehicle damage described as moderate. No injury was reported.

1/13/08; I-265; MP 14.5

The driver of a 2004 Honda Accord fell asleep and lost control of her vehicle. There was a shallow angle impact with the cable system adjacent to the travel lanes. The vehicle stopped adjacent to the cables. There was damage to 11 posts with the concrete base of one post pushed in the direction of the vehicle. The estimated speed was 55 to 65 mph. The vehicle damage was described as severe with no reported injury.

1/14/08; I-265; MP 11.2

A vehicle crossed the median and contacted the cable with damage to two posts. There was about two feet of deflection of the cable with the vehicle redirected into the median. No report was obtained.

1/14/08; I-265; MP 15.0

The driver of a 1999 Ford Explorer lost control on the snow first contacting the guardrail on the right side of the road before rebounding in the cable on the left (adjacent to the travel lanes). There was damage to four posts. The estimated speed was 60 to 65 mph. The vehicle damage was described as moderate to severe with no reported injury.

1/14/08; I-265; MP 31.6

The driver of a single unit truck lost control on the ice with resulting contact with the cable system adjacent to the travel lanes. The contact was at a substantial angle. The collision resulted in damage to 10 posts. The cable redirected the truck.

1/14/08; I-71; MP 2.8

The driver lost control on the snow with a collision occurring to the adjacent cable system. There was damage to six posts. No police report was obtained.

1/16/08; KY 4; MP 0.5

An unknown vehicle sideswiped the adjacent cable resulting in damage to two posts.

1/16/08; KY 4; MP 5.2

The driver of a 2008 Chevrolet Express single unit truck lost control when he became sick. The truck contacted the cable system adjacent to its lane of travel at a shallow angle with damage to 64 posts. There was moderate to severe damage to the truck with no reported injury.

1/17/07; I-71; MP 9.0

A vehicle contacted the cable adjacent to the travel lanes resulting in a sideswipe impact. There was damage to two posts. No report was obtained.

1/17/07; I-71; MP 11.0

A vehicle contacted the cable adjacent to the travel lanes resulting in a sideswipe impact. There was damage to five posts. No report was obtained.

1/17/07; I-71; MP 930.0

A vehicle contacted the cable adjacent to the travel lanes resulting in a sideswipe impact. There was damage to one post. No report was obtained.

1/18/08; KY 4; MP 2.5

The driver of a 1998 Chevrolet Cavalier lost control of his vehicle when the left front tire failed. The vehicle contacted the cable adjacent to the travel lanes. The driver steered back to the left with the final rest position in the ditch on the right side of the road. The car traveled about 300 feet from contact with the last post to final rest. Five posts were damaged. The deflection was less than one foot. The vehicle damage was described as moderate to severe. No injury was reported.

1/19/08; I-265; MP 13.5

The driver of a 1994 Ford Crown Victoria lost control of his vehicle when the right front tire failed. The vehicle entered the median at an angle of about 25 to 30 degrees contacting the cable adjacent to the travel lanes. Seven posts were damaged. One or more of the cables may have passed over or under the car's final rest position of the car was in the median. The speed estimate was 70 to 75 mph. The vehicle damage was described as moderate with no reported injury.

1/22/08; I-265; MP 13.8

A vehicle contacted the cable system adjacent to the travel lanes with damage to four posts. Impact was at a shallow angle with damage to four posts and then one additional post after one post was not damaged (showing the rotation of the vehicle to its final rest position adjacent to the cable). No report was obtained.

1/22/08; I-265; MP 34.0

A minor unreported contact resulted in damage to one post.

1/22/08; I-71; MP 9.0

Six posts were damaged when a vehicle contacted the cable system at a significant angle. The vehicle was redirected away from median piers for an overpass. No report was obtained.

1/23/08; I-265; MP 17.5

The driver of a 2008 Chevrolet Silverado lost control when he changed lanes due to a steering failure. The vehicle proceeded into the median when it damaged 23 posts before stopping with the driver side still contacting the cable. The speed estimate was 65 to 70 mph. Damage to the vehicle was described as severe with no reported injury.

1/23/08; I-71; MP 3.8

The driver of a 1998 Chevrolet Cavalier lost control on ice. The car crossed the median and struck the cable system with damage to six posts. The vehicle damage was described as minor to moderate. There was no reported injury.

1/24/08; I-265; MP 15.6

A vehicle crossed the median and struck the cable system with damage to seven posts. No report was obtained.

1/24/08; KY 4; MP 18.9

A vehicle crossed the median and struck the cable system with damage to two posts. Tire marks show the vehicle was redirected into the median. No report was obtained.

1/25/08; KY 4; MP18.1

The cable system was contacted by a 2002 Chrysler PT Cruiser as a result of a sideswipe contact with a Toyota Camry. Both vehicles were entering KY 4 from an on-ramp. The PT Cruiser sustained very severe damage as result of both impacts. The vehicle was redirected back onto the roadway. There was a deflection of two feet with damage to four posts. A "possible injury" was listed for both drivers as a result of the two collisions.

1/28/08; KY 4; MP15.3

The driver of a 2001 Ford Focus swerved to avoid a vehicle changing lanes and contacted the cable system adjacent to the travel lane. The car was redirected back into the travel lanes. Three posts were damaged with less than two feet of deflection. There was moderate to severe damage to the vehicle with an injury reported for the driver.

1/30/08; I-71; MP 4.6

The driver of a 1994 Lexus ES300 steered to avoid a truck changing lanes. The car crossed the median into the cable system. The cable redirected the car to a final rest position in the median with damage to eight posts. There was minor end anchor damage. The speed estimate was 55 to 60 mph. Vehicle damage was described as moderate to severe. There was no reported injury.

1/30/08; I-71; MP 11.6

A vehicle contacted the cable adjacent to the travel lanes at a shallow angle. No police report was obtained.

1/31/08; I-71; MP 0.7

The driver of a 2003 Hyundai Elantra lost control of her vehicle when sideswiped by an unknown vehicle. There was damage to 12 posts located adjacent to the travel lanes. The speed estimate was 50 to 60 mph. There was no reported injury.

2/3/08; KY 4; MP 2.0

The driver of a 2002 Nissan Maxima steered to avoid a vehicle merging onto the road. The vehicle crossed the median impacting the cable system with damage to five posts. There was a deflection of about three feet. The impact angle was about 25 degrees. The damage to the vehicle was described as severe with a speed estimate of 55 to 65 mph. A "possible injury" was reported.

2/3/08; I-71; MP 6.3

A 1987 Chevrolet Silverado ran into the rear of a 1987 Dodge Pioneer with the Silverado then crossing the median and impacting the cable barrier. There was moderate to severe damage to the Silverado with no reported injury. There was damage to six posts.

2/4/08; I-71; MP 5.2

A vehicle crossed the median and contacted the cable system with damage to three posts. No report was obtained.

2/4/08; I-71; MP 5.3

A vehicle crossed the median and contacted the cable system with damage to nine posts. No report was obtained.

2/4/08; I-64; MP 7.0

A vehicle contacted the cable system adjacent to the travel lane with damage to one post. No report was obtained.

2/5/08; I-265; MP 13.3

A 2002 Dodge Ram 1500 pickup ran into the rear of a truck and then crossed the median hitting the cable. The police report noted that the cable prevented the pickup from entering the opposing lanes. The speed estimate for the pickup was 60 to 65 mph with very severe damage to the vehicle. There was damage to three posts. The unrestrained driver of the pickup was injured.

2/6/08; KY 4; MP 15.8

The driver of a 2006 Mazda RX8 passenger car steered to miss a slowing vehicle and contacted the cable system adjacent to her lane. The damage to the car was described as moderate to severe. There was damage to one post with no reported injury.

2/8/08; I-265; MP 25.8

A 1996 Toyota Camry was pushed into the cable system adjacent to the travel lanes (at a substantial angle) when a truck moved into its lane. There was moderate damage to the Camry. The estimated speed was 55 to 65 mph. The car was redirected back to the travel lanes. There was no reported injury. There was damage to six posts.

2/9/08; KY 4; MP 3.2

The driver of a 2008 Kia Rio steered to avoid a vehicle changing lanes and struck the cable system adjacent to the travel lanes. There was minor to moderate damage to the car with two posts damaged. The car was redirected to the roadway. No injury was reported.

2/10/08; I-265; MP 31.5

The driver of a 2006 Ford Explorer left the road and struck the cable system adjacent to his lane. A wheel was detached from the vehicle and crossed the median striking a vehicle. Damage to the Explorer was described as moderate to severe. No injury was reported. There was damage to 21 posts.

2/10/08; I-265; MP 10.5

The driver of a 1991 Toyota Camry swerved to miss a vehicle and struck the cable system adjacent to the travel lane. The speed estimate was 60 to 65 mph. Damage to the vehicle is described as moderate with no reported injury. The impact angle was substantial with a deflection of up to six to eight feet. There was damage to 10 posts.

2/10/08; I-265; MP 11.7

A vehicle left the roadway at a substantial angle and contacted the cable adjacent to the travel lanes. There was damage to two posts. No report was obtained.

2/10/08; I-265; MP 25.8

There was damage to one post resulting from contact to the cable adjacent to the travel lanes. No report was obtained.

2/12/08; I-71; MP 3.9

The driver of a 1996 Honda Accord lost control his vehicle striking the cable system. Damage to the vehicle was described as minor to moderate. No injury was reported. There was damage to two posts.

2/12/08; I-71; MP 5.4

One post was damaged with no police report.

2/12/08; I-71; MP 4.0

A vehicle crossed the median contacted the cable with damage to one post. No report was obtained.

2/12/08; I-71; MP 2.9

A vehicle crossed the median contacted the cable with damage to one post. No report was obtained.

2/12/08; KY 4; MP 4.0

A vehicle crossed the median and contacted the cable damaging one post. No report was obtained.

2/12/08; KY 4; MP 16.9

A vehicle contacted the cable system adjacent to the travel lane with damage to five posts. No report was obtained.

2/12/08; I-265; MP 19.6

One post was damaged. No report was obtained.

2/12/08; I-265; MP 27.7

The driver of a 2007 Volvo passenger car lost control on wet pavement and rotated into the cable system with damage to seven posts. There was moderate damage to the vehicle with no reported injury.

2/14/08; KY 4; MP 18.2

The driver of a 1996 Toyota Camry lost control on ice when she slowed for another vehicle and hit the cable system adjacent to the lane of travel. There was moderate damage to the car with no reported injury. There was damage to two posts.

2/14/08; I-265; MP 28.9

A sideswipe collision occurred between a 2003 Mack combination truck and a 1995 Infinity J30 passenger car. The speeds were estimated as 60 to 65 mph. The truck sustained minor damage when it contacted the cable adjacent to the travel lane. The truck driver was not injured. There was damage to five posts.

2/14/08; I-265; MP 29.8

A vehicle crossed the median and contacted the cable barrier with damage to five posts. The vehicle was then redirected into the median. No report was obtained.

2/14/08; I-265; MP 30.1

A vehicle contacted the cable system adjacent to the travel lanes and was redirected back into the road. The impact angle was substantial. No report was obtained.

2/14/08; I-265; MP 34.8

A vehicle contacted the cable system adjacent to the travel lanes. The impact was at a shallow angle. Two posts were damaged.

2/14/08; I-71; MP 9.0

A vehicle contacted the cable adjacent to the travel lanes. The vehicle rotated after deflecting the cable about three feet and then contacted the cable again. There was damage to seven posts.

2/14/08; I-71; MP 6.4

A vehicle contacted the cable adjacent to the travel lanes. The impact angle was substantial and the cable was deflected up to three feet. There was damage to six posts. The vehicle was redirected back into the road. No report was obtained.

2/15/08; KY 4; MP 1.5

A lane change resulted in a sideswipe collision between a 2003 Dodge Neon and 2000 Toyota Camry. Both vehicles contacted the cable system. The final rest positions of both vehicles adjacent were to the cable. Both vehicles sustained moderate to severe damage. There was no reported injury. Three posts were damaged. There was a maximum deflection of about two feet.

2/21/08; KY 4; MP 17.8

The driver of a 2002 Saturn SC2 passenger car lost control on a wet pavement and sideswiped the cable system (adjacent to the travel lane) at an angle of only about 10 degrees. There was damage to four posts resulting from contact with three posts and then the vehicle rotated with contact to another post where the vehicle came to final rest. Damage to the vehicle was described as moderate with a speed estimate of 45 to 55 mph. One "possible injury" was listed.

2/22/08; KY 4; MP 4.9

A 1993 Toyota Camry hit the cable system after the driver lost control as a result of a sideswipe with another vehicle (while changing lanes). There was minor to moderate damage to the car with no injury reported. There was damage to 10 posts which resulted from the car striking the cable and then rotating and hitting the cable a second time. The final rest position of the car was at the cable system.

2/22/08; I-265; MP 31.0

A 1994 pickup being towed by a wrecker became disengaged and rolled over before being stopped by the cable system adjacent to the travel lanes. A total of nine posts were damaged.

2/27/08; I-265; MP 14.0

An unknown vehicle crossed the median and struck the cable system damaging nine posts as it rotated along the cable. No report was obtained.

2/27/08; I-265; MP 20.8

An unknown vehicle lost control as it crossed a bridge and contacted the cable system adjacent to the travel lanes. The vehicle was redirected to a final rest in the median. Six posts were damaged. No report was obtained.

2/27/08; I-265; MP 24.0

A minor sideswipe impact occurred with damage to two posts. No report was obtained.

2/27/08; I-265; MP 29.1

A sideswipe impact occurred with damage to four posts. No report was obtained.

2/27/08; I-265; MP 29.2

A minor sideswipe impact occurred with damage to one post. No report was obtained.

2/27/08; I-265; MP 29.7

A vehicle crossed the median and contacted the cable system resulting in damage to 13 posts. The vehicle stopped in the median. No report was obtained.

2/27/08; I-265; MP 32.0

A vehicle crossed the median and contacted the cable system resulting in damage to one post. The vehicle stopped in the median. No report was obtained.

2/27/08; I-71; MP 7.1

A minor sideswipe impact occurred with damage to one post. No report was obtained.

2/27/08; I-71; MP 0.8

A minor sideswipe impact occurred with damage to one post. No report was obtained.

2/27/08; I-64; MP 7.0

A sideswipe impact occurred with damage to six posts. No report was obtained.

2/28/08; I-265; MP 10.4

The driver of a 1993 Oldsmobile Cutlass was traveling at a high speed (near 90 mph) and hit the rear of a 1993 Geo Tracker. The Cutlass then rebounded off the rear end impact and contacted the cable system with damage to one post. The Cutlass sustained moderate damage with injuries noted for the two occupants of that vehicle.

2/29/08; I-265; MP 19.9

The driver of a 2005 Chrysler Sebring lost control of her vehicle and struck the cable adjacent to the travel lanes. There was damage to six posts. The damage to the car was described as very severe. No injury was reported.

2/29/08; I-64; MP 7.4

The driver of a 2002 Chevrolet Impala lost control of her vehicle on wet pavement with the car striking the cable system adjacent to the travel lanes. The car rotated to a final rest against the cable damaging eight posts. The car sustained moderate damage. There was no reported injury.

3/1/08; I-71; MP 1.6

A 2000 Toyota Rav4 sideswiped the cable system adjacent to the travel lanes with damage to two posts. There was some damage to the concrete around the post sleeve. Damage to the vehicle was described as moderate to severe. The speed estimate was 55 to 60 mph. No injury was reported.

3/3/08; I-265; MP 13.1

An unknown vehicle hit the cable system with damage to one post. No report was obtained.

3/3/08; I-71; MP 7.5

An unknown vehicle sideswiped the cable system adjacent to the travel lanes. There was slight movement in the base for one post with damage to three posts. No report was obtained.

3/3/08; I-71; MP 4.5

An unknown vehicle rotated (at a substantial angle) into the cable system adjacent to the travel lanes. There was damage to seven posts. The tire marks showed the vehicle was redirected back to the travel lanes. No report was obtained.

3/3/08; I-71; MP 5.8

The driver of a 2005 Mercury Montego swerved to avoid a truck and rotated into the cable system adjacent to the travel lanes. There was damage to 17 posts as the vehicle contacted the system and then rotated along the cable. The car rotated 180 degrees after initial contact with the system. The damage to the vehicle was described as moderate to severe. The cable cut into the passenger side of the car in the area of the rear bumper. The speed estimate was 55 to 65 mph. There was no reported injury.

3/4/08; I-265; MP 15.3

The driver of a Chevrolet Cavalier lost control on a wet pavement while being passed by a truck with the car rotating into the cable system adjacent to the travel lanes (with contact to the rear of the passenger side of the car). The car rotated along the cable before stopping on the shoulder. There was damage to two posts with a deflection of about three feet. The damage to the car was described as moderate to severe. The speed estimate was 60 to 65mph. No injury was reported.

3/4/08; I-265; MP 16.7

The driver of a 1992 Lexus SC300 lost control of his vehicle and contacted the cable adjacent to the travel lanes at a shallow angle. The vehicle was redirected into the road with damage to four posts. The speed estimate was 55 to 60 mph with moderate damage to the car. No injury was reported.

3/4/08; I-71; MP 1.8

The driver of a 1997 Chevrolet Tahoe hydroplaned and spun into the cable adjacent to the travel lanes with damage to one post. There was moderate to severe damage to the vehicle. The speed estimate was 55 to 60 mph. There was no reported injury.

3/5/08; I-71; MP 7.5

The driver of a 1994 Mercury Topaz was distracted with his vehicle drifting into the cable system adjacent to the travel lanes. There was damage to four posts. There was moderate damage to the car with no reported injury.

3/7/08; I-265; MP 11.4

The driver of a 1994 Oldsmobile Park Avenue lost control on snow and with the car sliding into the cable system adjacent to the travel lanes. There was damage to two posts. The speed estimate was 55 to 60 mph. The damage to the car was described as moderate to severe. No injury was reported.

3/7/08; KY 4; MP 4.7

The driver of a 2003 Nissan Sentra lost control due to a medical condition with his car veering into the cable barrier adjacent to the travel lanes. The car continued and contacted the cable a second time. There was damage to five posts. The speed estimate was 50 to 55 mph with moderate to severe damage to the car. A “non-incapacitating” injury was listed for the driver.

3/8/08; I-64; MP 7.5

An unknown vehicle sideswiped the cable adjacent to the travel lanes with damage to three posts. No report was obtained.

3/8/08; I-71; MP 5.3

An unknown vehicle sideswiped the cable adjacent to the travel lanes and then rotated with a second contact. There was damage to five posts. No report was obtained.

3/8/08; I-265; MP 29.7

A 1994 Cadillac Seville slid on snow into the cable adjacent to the travel lanes. There was damage to two posts. The car stopped against the cable. The speed estimate was 40 to 50 mph. Damage to the car was described as minor to moderate. No injury was reported.

3/8/08; I-265; MP 32.5

An unknown vehicle slid into the cable system adjacent to the travel lanes and was redirected back to the roadway. There was damage to two posts. No report was obtained.

3/8/08; I-265; MP 32.6

An unknown vehicle sideswiped the cable system adjacent to the travel lanes at a shallow angle with damage to six posts. No report was obtained.

3/8/08; I-265; MP 33.8

An unknown vehicle contacted the cable system and was redirected back to the adjacent travel lanes. There was one post damaged. No report was obtained.

3/8/08; I-265; MP 15.2

An unknown vehicle contacted the cable system adjacent to the travel lanes at a shallow angle. There was damage to five posts (with four posts part of the end treatment). No report was obtained.

3/8/08; I-265; MP 21.8

An unknown vehicle contacted the cable system adjacent to the travel lanes and rotated with a second contact to the cable. There was damage to three posts. No report was obtained.

3/8/08; I-265; MP 22.6

An unknown vehicle contacted the cable system adjacent to the travel lanes with damage to one post. No report was obtained.

3/8/08; KY 4; MP 18.4

The driver of a 2002 Dodge Caravan lost control on snow with the van contacting the cable adjacent to the travel lanes and rebounding back into the roadway where a sideswipe collision occurred. There was severe damage to the van with minor damage to the second vehicle. Five posts were damaged. The impact angle was very small with very little deflection of the cable. No injury was reported.

3/8/08; KY 4; MP 18.6

One post (adjacent to the travel lanes) was damaged from a sideswipe impact. No report was obtained.

3/8/08; KY 4; MP 2.1

A vehicle crossed the median and contacted the cable system. The vehicle stopped at the cable with damage to one post. No report was obtained.

3/9/08; I-71; MP 9.4

The driver of a 1988 Volvo 240 Series lost control when attempting to avoid a crash and sideswiped the cable system adjacent to the travel lanes. The speed estimate was 50 to 55 mph. The damage to the car was described as severe. No injury was reported.

3/10/08; I-71; MP 1.7

A 2007 Chevrolet Malibu spun on wet pavement into the cable system adjacent to the travel lanes with damage to four posts. Damage to the vehicle was described as minor to moderate. The speed estimate was 55 to 60 mph. No injury was reported.

3/11/08; I-64; MP 8.8

The driver of a 1994 Ford Explorer steered to avoid a vehicle changing lanes and sideswiped the cable adjacent to the travel lanes. There was damage to four posts. There was minor damage to the vehicle. The speed estimate was 50 to 60 mph. There was no reported injury.

3/12/08; I-64; MP 7.7

A rear end collision resulted in a 1995 Dodge Stratus crossing the median and contacting the cable system. The vehicle rotated to a final rest position in the median. Damage to the vehicle was described as minor with a speed estimate of 50 to 60 mph. There was no reported injury.

3/13/08; I-71; MP 4.6

An unknown vehicle crossed the median contacting the cable system with damage to seven posts. No report was obtained.

3/15/08; I-71; MP 3.2

An unknown vehicle crossed the median contacting the cable system with damage to five posts. No report was obtained.

3/17/08; I-71; MP 11.0

The left front tire on a loaded 1990 Peterbilt tractor trailer failed resulting in the truck contacting the cable system adjacent to the travel lanes. The truck damaged nine posts as it contacted the cable at a shallow angle. The truck continued through the cable system and across the median with a final rest position in the opposing left lane. The bottom three cables were pushed to the ground by a post that was bent over to the ground. The top cable was extended such that it also went under the truck. After the crash, the bottom cables remained on the ground with the top cable returning to its original height. Damage to the truck was described as minor to moderate. The speed estimate was 60 to 65mph. No injury was reported.

3/17/08; KY 4; MP 1.8

An unknown vehicle sideswiped the cable adjacent to the travel lane and continued. There was damage to one post with no report obtained.

3/17/08; KY 4; MP 16.2

An unknown vehicle crossed the median and stopped at the cable system with resulting damage to one post. No report was obtained.

3/20/08; I-71; MP 1.7

A 2001 Nissan Pathfinder slid on black ice into the median cable system adjacent to the travel lanes. Contact was with the right rear of the vehicle with vehicle stopping adjacent to the cable. There was damage to four posts. The speed estimate was 45 to 50 mph. The vehicle damage was described as minor. No injury was reported.

3/25/08; I-265; MP 14.8

The driver of a 1997 Chevrolet Blazer swerved to avoid slowing traffic and struck the cable system adjacent to the travel lanes at a shallow angle with a final rest position at the system. There was damage to four posts. The damage to the vehicle was described as minor to moderate with no reported injury. The speed estimate was 65 to 70 mph.

3/26/08; I-64; MP 11.8

A 2006 Jeep Wrangler crossed the left lane and struck the cable system adjacent to the travel lanes after an initial contact with another vehicle. There was damage to six posts and an anchor. The vehicle was redirected past the cable system with its final rest position in the median against a guardrail. There was very severe damage to the vehicle. The speed estimate was from 55 to 70 mph. No injury was reported.

3/26/08; I-64; MP 9.8

A 1992 Mazda Miata was hit in the rear by a van and pushed across the median where it struck the cable system. The final rest position of the small car was under the cable with damage to three posts. The cable was deflected several feet as the car traveled under the cable with the vehicle stopping in the median at the edge of the opposing lanes. There was very severe damage to the car from the rear end impact with an injury associated with this impact.

3/26/08; I-265; MP 10.6

A 1999 Infiniti passenger car was forced into the median by a truck changing lanes. The car hit the cable adjacent to the travel lanes at a shallow angle with damage to eight posts. The estimated speed was 45 to 50 mph. Moderate damage was reported for the vehicle with no injuries.

3/27/08; I-64; MP 10.4

The driver of a 2000 BMW 323I lost control on wet pavement and hit the cable the driver side of the car. Contact was made to the cable system in three areas with a total of 13 posts damaged. The impact was at a shallow angle with the vehicle rotating along the cable to its final rest position. The vehicle damage was described as very severe with one injury reported.

3/27/08; I-71; MP 8.8

The driver of a 2005 Ford Focus lost control on wet pavement when he swerved to avoid a rear end impact. The car spun into the cable system with damage to three posts. Impact was to the front of the car. The speed estimate was 40 to 45 mph. Damage to the car was described as moderate with no reported injury.

3/30/08; I-265; MP 20.8

The driver of a 1995 Nissan Quest van steered left to avoid a vehicle changing lanes and hit the cable system adjacent to the travel lanes (at a shallow angle). There was damage to 13 posts. The speed estimate was 65 to 70 mph. The damage to the vehicle was described as severe. There was no reported injury.

3/31/08; I-71; MP 11.0

A tractor trailer sideswiped a 1991 Nissan 240SX causing the car to travel into the cable system adjacent to the travel lanes. There was damage to seven posts with the car coming to a final position adjacent to the travel lanes. The speed estimate for the car was 65 to 70 mph. Damage to the car was described as very severe. There was no reported injury.

3/31/08; I-64; MP 10.0

A vehicle crossed the median and hit the cable system damaging two posts. The vehicle came to a stop in the median.

4/2/08; I-71; MP 5.4

The driver of a 2003 Lexus passenger car steered left to avoid another vehicle and hit the cable system adjacent to the travel lanes. There was damage to four posts. The damage to the vehicle was described as moderate with no reported injury.

4/2/08; I-64; MP 10.0

An unknown vehicle crossed the median hitting the cable and stopping in the median. There was damage to two posts. No report was obtained.

4/4/08; I-265; MP 13.8

A 1994 Toyota Tercel crossed the median after tire failure hitting the cable and stopping in the median. There was damage to nine posts with about six feet of deflection. The speed estimate was 50 to 55 mph. Damage to the car was described as very severe. There was no reported injury.

4/6/08; KY 4; MP 15.2

A 1995 Honda Odyssey experienced steering failure and veered into the cable system adjacent to the travel lanes. There was damage to nine posts with a deflection in the cable of about four feet. The van then rebounded back across the road with a secondary contact with guardrail. The damage to the vehicle was described as very severe. Two “possible” injuries were reported.

4/7/08; I-265; MP 33.6

The driver of a 1995 Ford Explorer steered left to avoid a stopped vehicle and struck the cable system adjacent to the travel lanes. There was damage to six posts. The speed estimate was 55 to 65 mph. There was moderate damage to the vehicle with no reported injury.

4/7/08; I-71; MP 9.4

An unknown vehicle struck the cable system adjacent to the travel lanes resulting in damage to seven posts. No report was obtained.

4/7/08; I-71; MP 8.0

An unknown vehicle struck the cable system adjacent to the travel lanes resulting in damage to two posts. No report was obtained.

4/7/08; I-265; MP 18.0

An unknown vehicle struck the cable system adjacent to the travel lanes at a significant angle resulting in about six feet of deflection. There was damage to four posts. No report was obtained.

4/8/08; I-71; MP 7.4

An unknown vehicle crossed the median and was stopped by the cable system. There was damage to three posts. No report was obtained.

4/10/08; KY 4; MP 17.0

The driver of a 2004 Honda Accord was distracted and drove into the cable system adjacent to the travel lanes (at a substantial angle). There was damage to eight posts with a deflection of about three feet. Damage to the vehicle was described as moderate to severe. No injury was reported.

4/11/08; KY 4; MP 15.0

The driver of a 1996 Mazda 626 swerved into the median to avoid a truck changing lanes. The impact damaged eight posts with a deflection of about three feet. The vehicle reported damage was minor. The speed estimate was 25 to 40 mph. There was no reported injury.

4/11/08; I-265; MP 26.0

The driver of a 2003 Ford Escape lost control on wet pavement and struck the cable system adjacent to the travel lanes. There was damage to 10 posts with the impact at a shallow angle. Damage to the vehicle was described as moderate to severe. The estimated speed was 65 to 75 mph. There was no reported injury.

4/11/08; I-71; MP 5.4

A truck sideswiped a 1998 Jeep Wrangler with the Jeep then contacting the cable system adjacent to the travel lanes. There was damage to four posts. There was moderate damage to the Jeep. The speed estimate was 50 to 60 mph. There was no reported injury.

4/19/08; I-71; MP 5.6

The driver of a 2007 Ford Mustang hit a pothole and lost control contacting the cable system adjacent to the travel lanes. Damage to the vehicle was described as minor to moderate. There was no reported injury.

4/20/08; KY 4; MP 18.6

The driver of a 1996 Volkswagen Jetta steered to the emergency lane to avoid a vehicle entering his lane but then had to swerve to the left because a vehicle was stopped in the emergency lane. The vehicle skidded into the cable system adjacent to the travel lanes at a substantial angle and then rotated with a second impact to the cable. There was damage to 13 posts. Damage to the vehicle was described as moderate to severe with an estimated speed of 75 to 80 mph. No injury was reported.

4/20/08; KY 4; MP 17.7

The driver of a 2004 Mitsubishi Lancer passenger car lost control on a wet pavement with contact to the cable system adjacent to the travel lanes. The impact was at a moderate angle with damage to four posts and about two feet of deflection. The estimated speed was 55 to 60 mph. Damage to the vehicle was described as moderate to severe. There was no reported injury.

4/20/08; I-265; MP 25.2

The driver of a 2006 Lincoln Zephyr lost control when entering from I-64 contacting the cable system adjacent to the travel lanes and then overturning. The damage to the vehicle was described as severe. There was damage to about five posts. The speed estimate was 60 to 70 mph. No injury was reported.

4/24/08; I-265; MP 17.0

A vehicle crossed the median contacting the cable system. There was damage to one post with no report obtained.

4/24/08; I-265; MP 18.5

A vehicle contacted the cable adjacent to the travel lanes with one post bent. No report was obtained.

4/25/08; I-71; MP 9.8

The driver of a 1999 Chrysler Sebring overcorrected after dropping a tire off the road contacting the cable system adjacent to the travel lanes. The vehicle was redirected across the two lanes with a final rest on the right shoulder. There was damage to four posts. Damage to the vehicle was described as moderate to severe. The speed estimate was 50 to 55 mph. No injury was reported.

4/25/08; I-71; MP 0.6

A vehicle contacted the cable adjacent to the travel lanes with damage to one post. No report was obtained.

4/26/08; I-71; MP 8.4

The intoxicated driver of a 2000 Jeep Wrangler drifted onto the right shoulder and then overcorrected and crossed the median hitting the cable system. There was damage to 19 posts. Damage to the vehicle was described as moderate. The speed estimate was 50 to 60 mph. A non-incapacitating injury was reported for the unrestrained driver.

4/27/08; I-265; MP 31.8

The driver of a 2001 Hyundai Elantra lost control and rotated into the cable system adjacent to the travel lanes. The vehicle rotated to a final rest position adjacent to the cables. There was damage to 11 posts. Damage to the vehicle was described as moderate to severe. The speed estimate was 60 to 70 mph. No injury was reported.

4/29/08; KY 4; MP 17.5

An unknown vehicle crossed the median and hit the cable system at an angle of about 30 degrees. Six posts were damaged with a deflection of about two feet. The vehicle was redirected. No report was obtained.

4/29/08; KY 4; MP 18.2

An unknown vehicle crossed the median and hit the cable system at an angle of about 10 degrees. Three posts were damaged with a deflection of about one foot. The vehicle was redirected. No report was obtained.

4/29/08; KY 4; MP 15.2

The load on the trailer being towed by a van shifted causing the driver to lose control. The 2001 Ford Econoline van struck the cable system at a high angle with damage to five posts. The vehicle sustained moderate damage with no injury reported.

5/2/08; KY 4; MP 2.7

The driver of a 1996 Chevrolet Cavalier fell asleep with her vehicle crossing the median at a shallow angle into the cable system. Four posts were damaged with the vehicle redirected to a final rest position in the median. The speed estimate was 65 mph. Damage to the car was described as moderate with no injury reported.

5/2/08; I-265; MP 11.7

The driver of a 1999 Chevrolet Cavalier was merging from a ramp when she swerved to avoid traffic and entered the median contacting the cable system damaging about two posts. The speed estimate was 40 to 45 mph. Damage to the vehicle was described as minor to moderate. There was no reported injury.

5/4/08; I-265; MP 12.0

The driver of a 1995 Honda Accord fell asleep with her vehicle spinning into the cable adjacent to the travel lanes with damage to three posts. There was moderate damage to the vehicle with no reported injury.

5/5/08; I-265; MP 30.1

Due to a medical condition, the driver of a Chevrolet S10 pickup allowed his vehicle to cross the median into the cable system. The vehicle was redirected and traveled back across its original lanes of travel into a vertical rock face. Eight posts were damaged. The cables were deflected several feet. The speed was estimated as between 60 and 70 mph. There was severe damage to the front of the vehicle related to the impact with the rock face. One injury was reported but there is no evidence it was related to contact with the cable system.

5/6/08; KY 4; MP 18.2

A 2005 Dodge Neon sideswiped a 1998 Mitsubishi Galant while changing from the right to the left lane. The impact flipped the Galant onto the cable system creating an opening which allowed the Neon to travel into the median where it stopped. Six posts were damaged. Vehicle damage to both vehicles was described as severe. There were two possible injuries to occupants of the van related to the rollover from the sideswipe impact by the Galant.

5/8/08; KY 4; MP 6.0

A 2003 Oldsmobile Alero hydroplaned and rotated into the cable adjacent to the travel lanes damaging six posts. The vehicle rotated to a final rest position facing the opposite direction and was then struck by another vehicle. Vehicle damage was described as moderate to severe. There was no reported injury.

5/8/08; I-265; MP 25.0

The driver of a 2000 Chevrolet Express van lost control on wet pavement when merging and crossed the median contacting the cable with damage to one post. The vehicle stopped at this location. The speed estimate was 45 to 55 mph. Damage to the vehicle was described as minor to moderate. No injury was reported.

5/10/08; I-265; MP 25.2

An unknown vehicle crossed the median contacting the cable with damage to three posts. No report was obtained.

5/10/08; I-64; MP 7.8

The driver of a Chevrolet Cavalier was attempting to make a U-turn when the vehicle hit the anchor of the cable system (damaging three anchor posts). The final rest position of the car was on the cable.

5/13/08; I-265; MP 14.3

A vehicle contacted the cable system adjacent to the travel lanes (at a shallow angle) with damage to 13 posts. The vehicle was redirected along the cable. No report was obtained.

5/13/08; I-265; MP 26.2

A vehicle contacted the cable system adjacent to the travel lanes (at a moderate angle) with damage to three posts. No report was obtained.

5/13/08; I-265; MP34.1

A vehicle contacted the cable system adjacent to the travel lanes with damage to two posts. The vehicle stopped at the location of contact with the cable system. No report was obtained.

APPENDIX B

Guidelines for Median Barrier Application on the Depressed Medians of Fully Controlled-Access Highways



Guidelines for Median Barrier Application on the Depressed Medians of Fully Controlled-Access Highways

ABSTRACT: *The Guidelines for Median Barrier Application on the Depressed Medians of Fully Controlled-Access Highways* provides direction to designers, maintenance engineers, and others on the use of crossover protection on the depressed medians of fully controlled access highways where the installation of median barrier has not been previously warranted by AASHTO guidance. The goal of these guidelines is to decrease the potential for cross-median crashes on divided highways by encouraging the use of median barrier for currently unprotected traversable, depressed medians.

April 16, 2008

BACKGROUND: Nationwide, the severity and frequency of cross-median crashes has increased in recent years, primarily due to more traffic, higher speeds, heavier vehicles, and increased aggressive driver behavior. According to KY CRASH data, from 2003 to 2007 there have been 406 cross-median crashes in Kentucky, which caused 90 deaths and 473 injuries. While previous studies indicate these events are generally random in location, a series of three median cross-median crashes over a 3-week period in the Louisville area elevated the awareness of the issue.

AASHTO's *2002 Roadside Design Guide* suggests guidelines for median barriers on high-speed, controlled-access roadways that have traversable, depressed medians. However, in the 1990's, several states noticed an increase in the number of cross-median crashes and developed new guidelines for their highways that expanded the use of median barrier. As a result, AASHTO is in the process of revising the warrants for median barrier. Their study is not complete. Without further guidance from AASHTO, it has become necessary for Kentucky to modify and expand previous guidance for installing median barriers.

PURPOSE: The *Guidelines for Median Barrier Application on the Depressed Medians of Fully Controlled-Access Highways* provides direction to designers, maintenance engineers, and others (herein referenced as solely "designers") on the use of cross-over protection on depressed medians where the installation of median barrier has not been previously warranted by AASHTO guidance. The goal of these guidelines is to decrease the potential for cross-median crashes on divided highways by encouraging the use of median barrier for currently unprotected traversable, depressed medians.

TECHNICAL GUIDANCE: Median barrier protection should be considered for all fully controlled-access highways with traversable, depressed median locations up to 30 ft. in width. Likewise, median barrier protection should be considered for all divided, high-speed (55 mph and greater) highways with traffic volumes over 40,000 ADT and traversable medians with widths between 30 ft and 72 ft. For medians outside these parameters, barrier is recommended only if there has been a history of cross-median crashes.

With any ADT or median width, median barrier should be considered on sections of highway with a history of at least three cross-median crashes in five years and with a frequency of cross-median crashes meeting or exceeding one of the following criteria:

- 0.50 cross-median crashes per mile of any severity per year
- 0.12 fatal crashes involving cross-median crashes per mile per year

Placement of median barrier may be beneficial in cases other than those suggested here (e.g. partially controlled highways, flush or raised medians, etc.). It should be recognized that a small number of cross-median crashes will continue to occur on medians outside the parameters of these guidelines. While cross-median crashes are few in number, their result is often severe.

BARRIER SELECTION AND LOCATION CONSIDERATIONS: Designers have wide latitude when selecting the type(s) of barrier and its location within the median. Designers should select a median barrier type and location which will reach an optimal balance in minimizing the number and severity of collisions, life-cycle and installation costs, and environmental impacts. Barrier type and location should be considered together since one will affect the other.

Barrier options include: proprietary Test Level 4 (TL4) cable median barrier, W-beam median barrier, and concrete median barrier. In general, it will not be appropriate to use roadside barriers on both sides of such a median, as it would deprive both directions of travel of the opportunity to stop in a median without striking any barrier and it would increase the difficulty of maintenance operations in the median.

It should be noted that the barrier options listed above have been selected for their crashworthy performances for the majority of the vehicles on the road. Because of the diversity of the vehicles on the roads, no single barrier option will successfully perform for the whole fleet. Barriers placed solely for the consideration of small, light weight vehicles (e.g. motorcycles) would not function well for the remainder of the fleet. Barriers placed solely heavy, large-scale vehicles (e.g. tractor-trailer trucks) would be impractical because of cost. Practical measures to reduce risk for the majority of motorist must be taken. Thus, a rational policy on the deployment of barrier is selecting barriers designed to function with majority of the vehicles of the road.

Median openings should be provided for emergency turn-around per AASHTO guidelines at 5-mile intervals and other appropriate locations.

When objects within the median require shielding, it will typically be necessary to use roadside barrier. The designer can refer to the Department of Highways' *Standard Drawings* and to AASHTO's *Roadside Design Guide* for specific information concerning roadside barriers.

APPLICATION OF ENGINEERING JUDGMENT: Because of the many factors involved, no firm rules are being applied to barrier selection and location. Designers should use engineering judgment and consideration of the project-specific factors to determine whether, what, and where to use median barrier on wide traversable, depressed medians. For assistance with these decisions, the designer may contact the Standard Drawings Section in the Division of Highway Design. For the necessary CRASH data, designers should make a request to the Traffic Safety Data Service in the Division of Traffic Operations.

DISCUSSION ON CABLE MEDIAN BARRIERS: With the increase in the number of cross-median crashes, cable median barrier installation may be a good safety solution given the time and financial constraints.

Cable median barrier is used to prevent cross-median crashes on wide traversable medians (over 20'). Because of their large deflection distance (approximately 8' for the proprietary TL4 cable median

barrier) cable median barriers must be located away from traffic. Cable median barrier should not be placed in ditch lines since regular water flow and ponding may hinder the performance of the cable system. Ideally, cable barrier should be placed 10' upslope from the ditch bottom, but it must maintain at least 8' from the traveled way. Since mowing around cable barrier is difficult, a mow prevention strip should be provided. A concrete pad is recommended as a mow strip. (The concrete pad also adds structural strength and allows the post-footings' depths to decrease.) For guidance on cable median barrier placement, the designer may contact the *Standard Drawings* Section in the Division of Highway Design.

The following list covers the identified advantages of cable median barrier:

- Cable median barriers absorb the energy of an impact, minimizing injury to passengers and damage to vehicles.
- Construction cost of cable median barriers is less than other median barrier options.
- Installation of cable median barriers is easier than other median barrier options.
- In terms of repair costs, the proprietary cable median barrier is economical. Even though longer sections must be repaired, the cables are rarely damaged, and these systems are designed to facilitate quick and easy repairs.
- The cable median barrier may be used with median cross-slopes as steep as 4:1.

Disadvantages of cable median barrier are listed below:

- Damage to the cable median barrier may be expected even with moderate impacts.
- Cable barriers are basically "one hit" systems and impacts on damaged barrier may allow penetration. Therefore, cable median barrier will require maintenance after every impact and may require periodic inspections to ascertain if the system is within allowable performance tolerances.
- Cable barriers may have problems stopping low frontal geometry vehicles from passing under the rail system. Also, cable barrier are not designed to stop large trucks (tractor trailer, tanker trailer).

DISCUSSION ON W-BEAM MEDIAN BARRIERS:

Kentucky uses the heavy-post blocked-out W-beam system as a median barrier. It has two W-beams, one on each side of the post.

W-beam median barriers may be the appropriate choice in narrow medians when there is not sufficient space to accommodate the deflection distances needed for cable barrier or if the maintenance of the median barrier would be particularly complicated. W-beam median barriers have a lower required deflection distance and it can survive mild hits with minimal need for repairs.

The following list covers the identified advantages of W-beam median barrier:

- W-beam median barrier required deflection distance is 3.3 feet. These systems can be placed closer to a hazard and still provide the protection needed.
- W-beam median barriers are a semi-rigid system and the damage from a mild hit affects only the impacted zone. The required maintenance is less and the system will continue to function properly after sustaining most hits.

Disadvantages of W-beam median barrier are listed below:

- The main disadvantage of the system is that it produces more severe lateral deceleration of impacting cars than does the cable barrier systems. W-beam median barrier is rigid enough to be considered a hazard in itself. (The decreased safety due to the high rigidity may be offset by the increased safety obtained by limiting repair interruptions.)
- W-beam median barrier is more visually obstructive than cable.
- W-beam median barrier may still require repair after being hit.
- The W-beam median barriers are not approved for use on steep slopes.

DISCUSSION ON CONCRETE MEDIAN BARRIER:

Concrete median barriers are designed to be hit on either side and not to deflect upon impact. Therefore, impacts are more likely to be severe; however it is the most effective barrier at preventing cross-median crashes. Concrete median barrier has a relatively low life-cycle cost, effective performance, and maintenance-free characteristics. Concrete barriers are warranted where positive redirection must be obtained and very little deflection space is available.

The following list covers the identified advantages of concrete median barrier:

- Concrete median barrier provides redirection when there is little or no space available for barrier deflection.
- Concrete median barrier is more easily seen than others and is the most effective barrier at preventing crossover accidents and reducing headlight glare problems.
- Concrete median barrier is very durable. They are seldom out of service, so there is little potential for accidents related to repair and maintenance operations.
- Concrete median barrier's maintenance costs are low. They require very little maintenance or repair.

Disadvantages of concrete median barrier are listed below:

- Concrete median barrier is an unyielding hazard that may produce severe decelerations at all but low-angle impacts.
- Concrete median barrier may contribute to horizontal sight distance problems on curves with narrow medians.
- Concrete median barrier has a high initial cost.
- Concrete median barrier may interfere with drainage.
- Concrete median barrier is considered by some to be aesthetically unappealing and visually obstructive.

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