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Mr. Douglas MacDonald
Secretary of Transportation
Washington State Department of Transportation
P.O. Box 47365
Olympia, Washington 98504-7365

Chief John R. Batiste
Washington State Patrol
General Administration Building
PO Box 42600
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RE: **EXPERIENCE WITH CABLE MEDIAN BARRIERS IN OTHER STATES**

Dear Secretary MacDonald and Chief Batiste:

I am pleased to present this letter report containing my review of the experience of others states with the use of cable median barriers.

BACKGROUND

Cable median barrier has been used for many decades, but its widespread use is a relatively recent phenomena dating from the early 1990s. The New York Department of Transportation was the original developer of the crash-tested low-tension cable guardrail and median barrier in the late 1960s, so it is not surprising that some of the first uses of cable median barriers in median applications occurred in New York.[1,2] New York also performed the first in-service evaluation of cable median barrier in 1989.[2]

The example of New York notwithstanding, the use of cable median barrier was relatively uncommon until the 1980s when the state of Missouri began to experiment with this method of median protection. Missouri tested cable median barriers in locations where serious cross-median crashes occurred, even though those locations were wide enough that median barrier was not normally considered.[3] The Missouri Department of Transportation (MoDOT) used a 33-inch-high low-tension cable median barrier in these locations and, based on the good performance in some pilot installations, increased its use. Today there are about 250 miles of cable median barrier in Missouri. Based on the experience of MoDOT, the 33-inch-high low-tension cable median barrier was the only cable median barrier specifically mentioned in the 1996 American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide.[4]

In 1991 the state of California examined and ultimately revised its median barrier policy in response to numerous cross-median crashes.

Caltrans's reexamination of median crossover crashes prompted several other states to reconsider median barrier policies, as cross-median crashes were becoming a problem in a number of urban areas. In the 1990s several states began pilot installations of cable median barrier, including Washington in 1995, Oregon in 1996, North Carolina in 1998, and Arizona in 1999, with many states following thereafter. These early-adopting states experienced very good results: The frequency of cross-median fatalities were generally reduced by about 50 percent and the cable median barriers prevented vehicles from penetrating or crossing over the median in about 95 percent of the crashes.

State transportation departments have been surveyed several times about the use of cable median barrier. The first survey was performed in 1997 by Ray and McGinnis and documented in National Cooperative Highway Research Program (NCHRP) Synthesis 244.[5] Low-tension cable median barriers were used at that time in North Carolina, Washington, South Dakota, and Missouri. By 2004 at least 14 states reported using some type of cable median barriers, according to a survey conducted by Penn State. They include Alabama, Arizona, Iowa, Mississippi, Missouri, Nebraska, Nevada, New York, North Carolina, South Carolina, Washington, and Wisconsin.[6] In another 2004 study, New Jersey and Minnesota also indicated occasional use of three kinds of cable median barriers.[7] Most recently in 2006, an ongoing NCHRP research study found that about 25 states are using at least some cable median barriers.[8]

Figure 2 is a graphical representation of the information from all the sources listed in Table 3 as well as the information collected and discussed in the rest of the report. Any state that was listed in one of the surveys in Table 3 is shown on the map. Where possible, the mileage of cable median barrier was determined from news releases or press reports. States with over 100 miles of cable median barrier were colored red whereas those with less than 100 miles were colored blue. States where cable median barrier is known to be used but the mileage is unknown were colored green. States where there is no indication that cable median barrier has been used are colored yellow. As the map shows, seven states have more than 100 miles of cable median barrier installed, some with as much as 600 miles. Only 14 states have not used cable median barrier so over 70 percent of the states have some experience with using cable median barriers.

These types of surveys are ambiguous. States that may occasionally use cable median barrier to address a particular crossover problem are grouped with other states that have a very specific policy on the use and placement of cable median barrier. This report will attempt to discuss both groups of states, those that have formally included cable median barrier into their design standards and policies and those that use cable median barrier for specific projects but do not necessarily have formal standards. As shown in Figure 2, however, several states have a great deal of experience with cable median barrier since they have used them for over a decade and have hundreds of miles of the system installed.

Table 1. States using cable median barrier.

Year	No.	States reporting cable median barrier use	Ref.
1997	4	North Carolina, Washington, South Dakota, Missouri	6
2004	12	Alabama, Arizona, Iowa, Mississippi, Missouri, Nebraska, Nevada, New York, North Carolina, South Carolina, Washington, Wisconsin	7
2004	14	Alabama, Arizona, Iowa, Mississippi, Missouri, Nebraska, Nevada, New York, North Carolina, South Carolina, Washington, Wisconsin, New Jersey, Minnesota	8
2006	25	Maine, Pennsylvania, Virginia, North Carolina, Georgia, Florida, Alabama, Ohio, Indiana, Illinois, Wisconsin, Iowa, Missouri, Arkansas, Texas, Oklahoma, North Dakota, Montana, Idaho, Washington, Oregon, Nevada, Utah, Colorado, Arizona	9

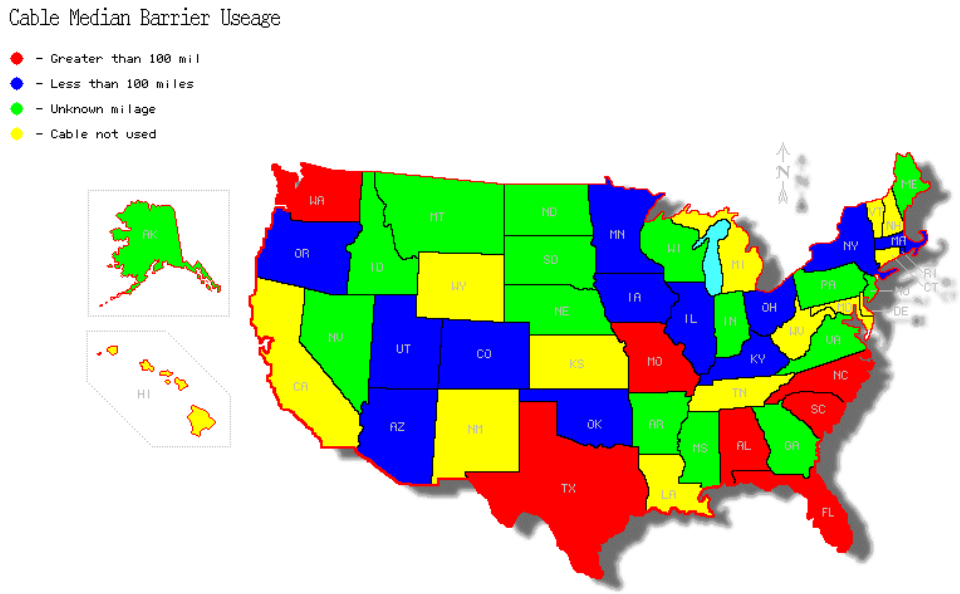

Figure 2. States reporting use of cable median barrier in 2006.

Table 2 shows an estimate of the amount of cable median barrier installed by state and year, compiled from available research reports, new reports, and press releases from around the country. As shown in Table 2, there are over 2,600 miles of cable median barrier already installed as of the end of 2006 and many states report that they are either initiating or in the midst of major programs to install additional cable median barrier. All of this mileage has been installed in the last decade and much of it in just the past few years. States across the nation are clearly adopting cable median barrier as a means of reducing cross-median crashes.

HISTORY OF CABLE MEDIAN BARRIERS

Apparently, the first use of cable barriers in a median was in California in the 1960's. At the time there were no crash guidelines but CALTRANS performed a test of a two-cable median barrier, shown in Figure 2, in the mid-1960's. It is believed that these very early barriers were meant more to prevent intentional cross-overs (i.e., drivers wanting to reverse direction) than as a safety barrier. The system was included in the 1977 AASHTO Barrier Guide as system MB1. CALTRANS has not installed any of this type of barrier since the late 1970s and it is thought that they are removing it in favor of more modern crash tested median barriers.[9] California has never used any of the more modern low-tension or high-tension cable median barriers to any large degree.

Figure 2. The obsolete MB-1 two-cable median barrier in California.

The modern crash tested cable guardrail and median barrier systems were developed and crash tested by New York DOT in the 1960's.[10] These first systems were low-tension three cable barriers with bottom cable heights of 21 inches and top cable height of 27 inches. A typical low-tension cable median barrier is shown in Figure 3. Low-tension cable median barriers have been tested with large and small passenger cars and more recently with pickup trucks. The maximum deflection of the cables in the pickup truck test are generally around 12 feet so it is usually necessary to ensure that there is at least 12 feet of free space behind the barrier. New York DOT changed cable heights at various times in the past four decades, generally in response to particular crash problems observed in the field. While the bottom cable height has always been at 21 inches, the top cable has been positioned variously at 27, 30 and 33 inches.

Figure 3. Typical low-tension cable median barrier.

Over the years, the height of the top cable has varied in response to the changing vehicle fleet. Generally, 27-inch tall barriers were used on the roadside but a higher top cable height was used in medians because installations in the median generally involve traversing some sloped terrain. A higher top-cable height makes the system more forgiving of changes in bumper height. As large passenger cars disappeared and were replaced by pickup trucks and SUVs,

the height was again raised in order to provide protection for these vehicles with higher bumpers.

Missouri DOT is thought to be the first State to widely adopt the 33-inch high low tension cable median barrier which is considered a crashworthy test level three barrier by FHWA.[11 12 13] When North Carolina began to install cable median barrier in the mid-1990's, the only available alternative was the 33-inch high cable median barrier so they adopted it in their first installations. At about the same time (i.e., the mid-1990's), Washington DOT sponsored full-scale crash tests of a 30-inch high low-tension cable median barrier based on the tried-and-true New York designs.[14] The tests, which involved a small car and a pickup truck, were both successful and many States began to adopt the WSDOT version of the low-tension cable median barrier based on the fact that it was included in the 2002 RDG.

State	Miles	Year
AL	118	2006
AZ	89	2006
CO	40	2005
FL	187	2005
IA	64	2007
IL	70	2005
KY	13	2006
MA	1.5	2006
MN	6.3	2003
MO	250	2006
NC	600	2007
NY	5	1989
OH	27.5	2006
OK	23	2005
OR	23	2005
RI	1.4	2005
SC	470	2005
TX	500	2006
UT	16.4	2003
WA	135	2006
Total	2640	

Table 2. Cable median barrier mileage estimate.

In 2001, the British company Brifen received approval from the FHWA to begin marketing and installing a four-cable high-tension wire-rope safety fence as a cable median barrier in the U.S.[15] Unlike the low-tension cable median barriers, the Brifen system uses cables with a tension of between 2500 and 8100 lbs and four cables that are interweaved through the posts. The dynamic deflection in the pickup truck test for high-tension cable median barriers is generally less, on the order of eight to ten feet depending on the post spacing, so they can be positioned closer to a hazard. The Brifen system was developed and tested in the UK and had been used there for many years prior to its FHWA approval in the US. Since the Brifen system was approved, a number of other high-tension systems have been approved for use including the Safence, a system from Blue Systems AB in Sweden, CASS by Trinity Industries, the Gibraltar System and the Saferoads Cable Barrier System by Nucor.[16 17 18 19] Coon *et al* has written a review of cable barrier testing from the early days until the present that provides details on several of these systems and full details can be obtained in the cited approval letters.[20] The Brifen, CASS and Gibralter systems are also available in test level four configurations that can redirect a 18,000-lb single-unit truck striking the barrier at 50 mi/hr at a 15 degree angle.[21] There are, therefore, a variety of crash tested and approved cable median barrier systems available that meet the requirements for both test level three and four. WSDOT has played an important role in this: sponsoring crash tests of the 30-inch low-tension system and examining the various high-tension systems. While a successful full-scale crash test is not a guarantee of satisfactory performance in every real-world crash, it is the best available method for judging the impact performance of roadside safety hardware today. The cable median barrier options available today have been tested and evaluated as thoroughly as any roadside safety hardware appurtenance.

DEVELOPMENT OF MEDIAN BARRIER GUIDELINES

Roadside policy in general and median barrier policy in particular is developed through a consensus building process involving a variety of groups. AASHTO is an umbrella organization composed of the chief engineers of all the state departments of transportation. It has numerous technical committees and subcommittees whose purpose is to develop policy recommendations based on sound research and practical implementation.

AASHTO sponsors the Technical Committee on Roadside Safety (TCRS) (formerly the Task Force for Roadside Safety). One of the primary functions of the TCRS is to periodically update and review the AASHTO Roadside Design Guide (RDG).[22] The RDG has evolved over the past several decades; the first version was published in 1989, with updates in 1996, 2002, and 2006.[10,23,24] The TCRS is made up of state department of transportation engineers who are actively involved in roadside safety in their states and several members of the Federal Highway Administration (FHWA) who deal exclusively with roadside design issues. The TCRS monitors research sponsored by a variety of organizations, including the NCHRP, the FHWA, individual states, and private industry. The TCRS reviews current research and attempts to reach consensus on new policy. If research indicates a change is appropriate in the RDG, TCRS members consult with the researchers, other experts in roadside safety, and other roadside safety groups to reach a consensus policy.

Since the RDG is developed through a consensus process involving experts in the field of roadside safety, practitioners in the states, the various state transportation departments, and FHWA, most states adopt the recommendations of the RDG and incorporate them into their own state standards. States sometimes, however, adopt policies that are more stringent than the RDG in an effort to provide a higher level of safety and address specific local concerns.

The Federal Highway Administration (FHWA) is the branch of the U.S. Department of Transportation charged with the construction, operation, and maintenance of highways. Since most highways in the National Highway System (NHS) use some federal funds, the FHWA has a role in establishing standards for most highways. Generally, the FHWA field office in each state works with the department of transportation to approve its standard plans for projects with federal funding. For example, a change in median barrier policy involving the placement of the barrier would be submitted to the Washington State FHWA Division Office for review and approval.

Two general approaches have been developed to aid in the placement and selection of barriers: installation guidelines and cost-effectiveness. Using installation guidelines is when "certain geometric and operational characteristics of a site are examined to determine if it is appropriate to place a guardrail in a particular location."[10] Guidelines for installing barriers began with HRB SR 81 in 1964; later updated in NCHRP Reports 36, 54 and 118; and then revised and published as the 1977 AASHTO Barrier Guide.[5] The Barrier Guide was superseded by the 1989, 1996, 2002, and 2006 Roadside Design Guides. Cost-effectiveness procedures have also been included in these guides, providing methods for allocating funding based on the benefit-cost effectiveness of projects.

The 1977 Barrier Guide suggested installation guidelines for median barriers based on traffic volume (ADT) and median width.[5] These guidelines were applicable to "high-speed, controlled access roadways which have relatively flat, unobstructed medians."[5] They were based on a report by the Traffic Department of the state of California in 1968 ("Median Barrier Warrants"), Research Report 140-8 by TTI in 1974 ("Warrants for Median Barriers in Texas"), and the judgment of the AASHTO Task Force for Traffic Barrier Systems, the predecessor to today's TCRS.[25,26] For all ADTs, median barriers were optional for median widths of 30 feet or more. For medians wider than 50 feet, barriers were generally not necessary, "unless there is an adverse history of across-the-median accidents."[13] Where median barriers were installed, the guide suggested using a rigid or semirigid barrier in medians up to 18 feet wide; any type of barrier except the 2-cable MB-1 in medians 18 to 30

feet wide; and semirigid or flexible barrier in medians 30 to 50 feet wide. The guide also provided guidelines for placement of barriers on median slopes.

Caltrans reinvestigated its median barrier policy in the late 1980s and early 1990s and revised its guidelines in 1991 after becoming concerned that median cross-over crashes were an emerging problem.[27] The median barrier guidelines for freeways used by Caltrans in 1991 took into account the number of cross-median accidents, traffic volume, and median width. The report stated, "a rate of 0.50 cross-median accidents per mile per year of any severity or 0.12 fatal cross-median accidents involving opposing vehicles justifies further analysis to determine the advisability of a barrier" (see Section 7-02.3 in the Caltrans Traffic Manual). These crash rates were first included in the Caltrans Traffic Manual in 1978. The authors noted that these rates provide "slim statistical evidence" and that "locations where conditions may be conducive to cross-median accidents need to be separated from those with random occurrences."[15] The point, as noted in some of the studies to be discussed later, is that median crossover crashes occur more or less randomly in the highway network. Cross-median crashes most often occur as a result of conflict between vehicles on the road rather than as a result of a characteristic of the road or roadside (e.g., a sharp curve or super elevation). It is, therefore, difficult to predict where cross-median crashes will occur.
The 1991 California recommendations also stated that a barrier should be considered if the median was 45 feet wide or narrower and met the minimum traffic volume criteria. In 1991, concrete barriers were installed in medians up to 36 feet wide, and thrie beam barriers were used in wider medians. While the California study and change of policy did not address cable median barrier per se, it did open up the discussion on the national level about using median barriers in medians where they had previously been considered unnecessary.

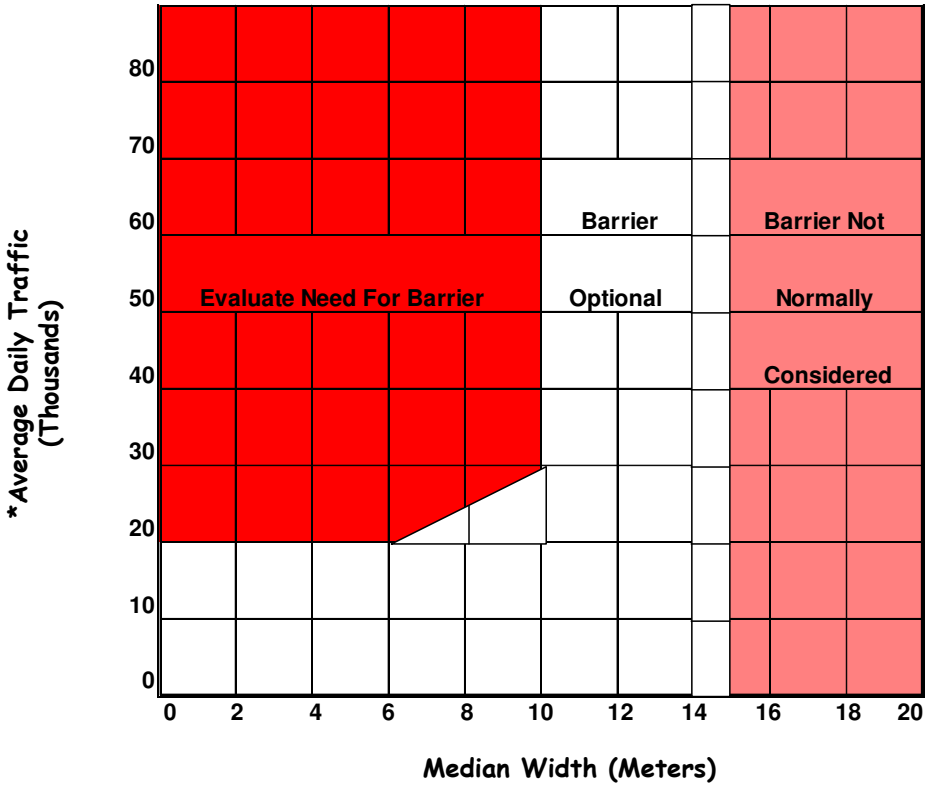

Figure 3. Median barrier installation guidelines from the 1996 AASHTO Roadside Design

The 1996 version of the AASHTO RDG median barrier guidelines indicated that barriers were "not normally considered" on 50-foot (i.e., 15 meter) or wider medians as shown in Figure 3.[10] They were optional for median widths of 30 to 50 feet (i.e., 10 to 15 meters). The 2002 version of the AASHTO RDG median barrier guidelines are identical to the 1996 RDG, with the minor exception that it provides installation and placement guidelines in U.S. Customary Units (USCU, i.e., inches and feet) and SI units (i.e., meters).[12] In 2006 a revision was published for the Median Barrier chapter of the Roadside Design Guide (see Figure 4). In this revision, the "Barrier Optional" area between 30 to 50 feet (10 to 15 meters) was changed to "Barrier Considered." The intent of this change was to encourage more use of the median barrier.

North Carolina began examining its median barrier policy in the early 1990s after recognizing a significant number of cross-median crashes occurring on the highway system, especially on high-volume, high-speed urban highways. This is shown graphically in Figure 5 where crashes are plotted on the typical RDG installation guideline shown in Figure 3. Clearly, there were numerous cross-median crashes even in wide medians where the RDG did not normally recommend median barriers. Other plots, similar to Figure 5, have been developed for New Jersey, California, Pennsylvania, and Ohio with identical results.[8]

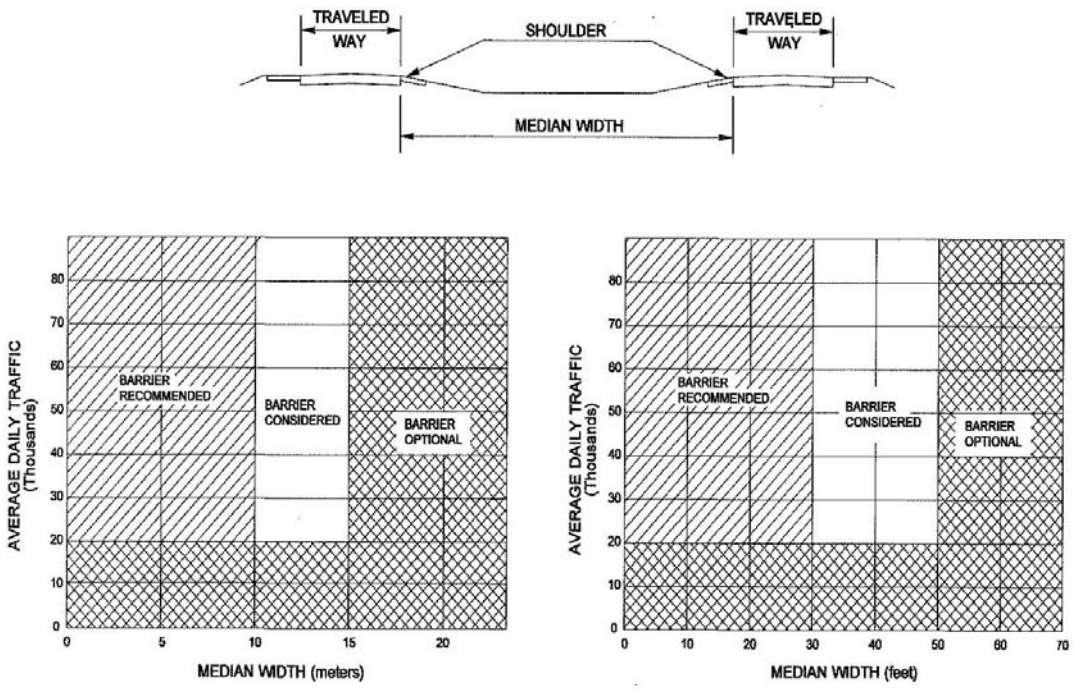

Figure 6.1 Guidelines for median barriers on high-speed, fully controlled-access roadways

Figure 4. 2006 AASHTO Roadside Design Guide – Guidelines for Median Barrier.

Results such as these caused some roadside safety engineers to question whether the RDG guidelines were still appropriate for more modern, high-volume, high-speed conditions. As will be discussed in a later section, North Carolina began installing test sections of cable median barrier in about 1991 and kept careful track of all median crashes in the study areas.[28] As a result, North Carolina changed its median barrier location policy such that all medians less than 70 feet wide should have median barriers. For very narrow medians, a concrete

median barrier is necessary, but when there is sufficient room for lateral deflection, the cable median barrier is the preferred solution because it is more flexible and forgiving. While the research described above has convinced many states that the current AASHTO policy was not doing enough to prevent cross-median crashes, the national consensus in the roadside safety community (as documented in the RDG) is still that median barriers are optional in medians wider than 30 feet. As will be shown in the next section, however, many states have opted to provide additional protection by adopting median barrier policies that recommend the use of barriers in medians wider than 30 feet.

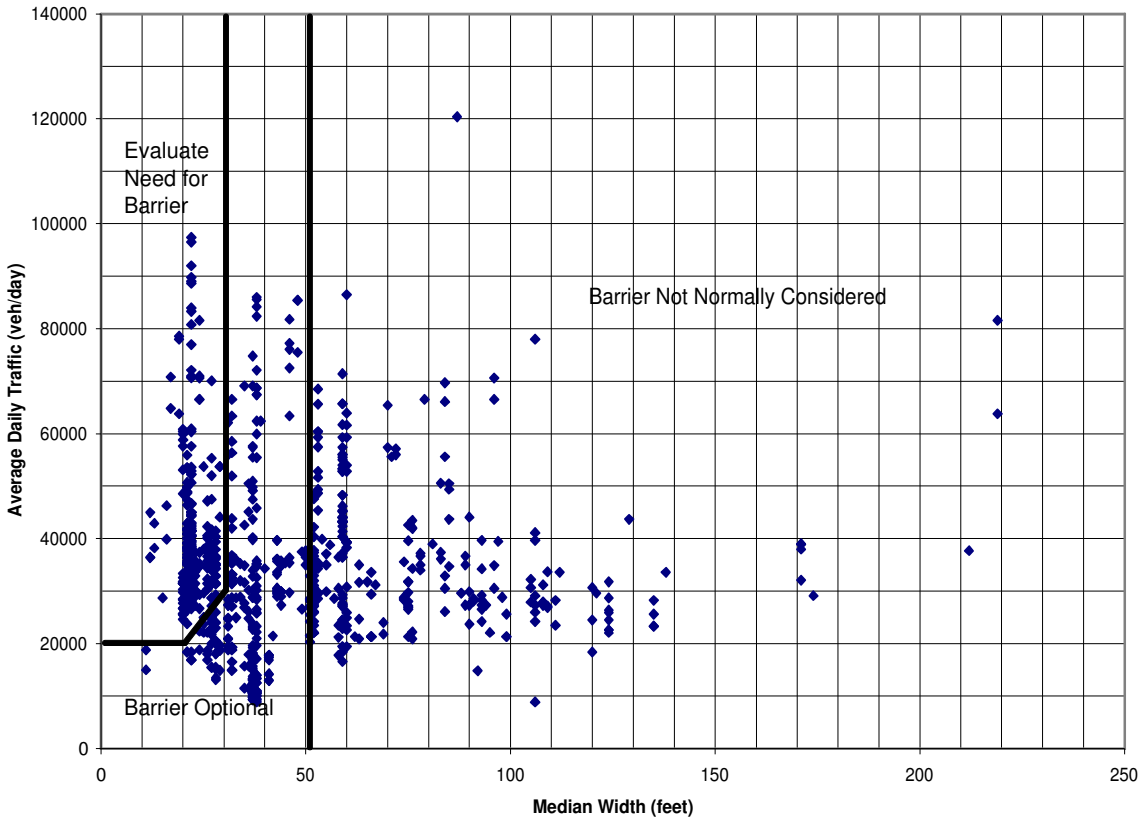

Figure 5. Cross-median crashes in North Carolina compared to the RDG design chart.

PERFORMANCE

The field performance of cable roadside and median barriers has been studied perhaps more than any other guardrail system. The earliest studies were performed almost three decades ago in New York State and the most recent studies are ongoing efforts in states like North Carolina, Arizona, Washington, and South Carolina.

The performance of both low- and high-tension cable median barriers has been examined to some degree in at least ten states. Table 3 shows a list of states that report using cable median barrier to some degree, along with a comparison of before and after cross-median crashes. As shown in Table 3, most states have observed very high reductions in the number of cross-median crashes. While most of the states reporting 100 percent reductions have either relatively small inventories of the barrier or have not been installing cable median barriers for very long, many states with long histories of using cable median barriers report cross-median crash reductions of more than 90 percent. Missouri, for example, has used low-tension cable median barriers for nearly 20 years on a large portion of its divided highway system and it reports a 92 percent reduction in cross-median crashes. The values in Table 3 are most likely underestimates since they do not account for the growth in traffic. In Arizona, for example, traffic was increasing at almost 30 percent each year on the highways where cable median barriers were installed, so the actual performance is much better than the 59 percent reduction shown in Table 3 suggests.

Table 3. Performance of cable median barriers in various states: reduction in cross-median crashes.

State	Annual Before	Annual After	Reduction
	(No.)	(No.)	(%)
Fatal Cross-Median Crashes			
AL	47.5	27	43
AZ	1.7	0.7	59
MO	24	2	92
NC	2.1	0	100
OH	40	0	100
OK	0.5	0	100
OR	0.6	0	100
TX	30	1	97
UT	15	0	100
WA	4.4	0.4	91
Cross-Median Crashes			
FL	--	--	70
NC	25.4	1	96
OH	371	27.5	93
UT	114	55	52
WA	42.4	11.2	74

Table 3 demonstrates that cable median barriers do in fact reduce the number of fatal cross-median crashes. Every state that has used cable median barrier and studied its performance has reported a reduction of at least 40 percent and usually closer to 95 percent. While a 95 percent reduction of these types of crashes is a significant achievement, cable median barriers are not 100 percent effective. Unfortunately, no traffic barrier system is.

Table 4. Performance of cable median barriers in various states: effectiveness.

State	Collisions	Penetrations	Effectiveness
	(No.)	(No.)	(%)
AR	490	25	94.9
IA	20	0	100.0
NC	71	5	93.0
NY	99	4	96.0
OH	372	4	98.9
OK	400	1	99.8
OR	53	3	94.3
RI	22	0	100
SC	2500	10	99.6
UT	18	2	88.9
WA	774	41	94.7

Several states have also reported the effectiveness of cable median barriers in terms of the percentage of crashes that were contained by the barrier. If the barrier prevented the vehicle from crossing to the opposing lanes of traffic, the cable median barrier can be considered to have been effective. As with Table 3, some of the data in Table 4 represents fairly limited data collection, but several of the states have been collecting cable median barrier crash data for nearly a decade. In general, it appears that the vehicle is prevented from crossing over into the opposing lanes of traffic in about 95 percent of the cases. As with Table 3, all the states in Table 4 that have used cable median barriers and studied their effectiveness have found that approximately 95 percent of all crashes are contained by the barrier. Generally, these containment crashes are not severe, and many times the vehicle can be driven away.

Tables 3 and 4 show that the experience of states that have used cable median barrier has been overwhelmingly good. Most states have experienced crossover crash reductions of about 95 percent and have observed that the cable median barriers contain the vehicle in about 95 percent of crashes. Only one of the at least 25 states that have performed a pilot study with cable median barrier has chosen not to continue using it (New Jersey). States are finding cable median barrier to be an effective treatment for highways where cross-median crashes occur.

STATE POLICIES

A median barrier policy consists of making recommendations regarding the following questions:

- In what range of median widths should median barriers be used?
- What types of median barriers should be used?
- What median cross-sections are allowable (i.e., what slopes and ditch configurations)?
- Where in the median should the barrier be located?

As shown in the last section, many states use cable median barrier, but relatively few have incorporated details into their design standards or standard plans. At this point in time, most states treat cable median barrier on a case-by-case basis and develop project plans

accordingly. Table 5 shows states that have incorporated cable median barriers into their standard plans and drawings, and summarizes their policies.

As shown in Table 5, most states use cable median barriers beginning with median widths in the range of 30 to 50 feet, most often 36 feet. Medians narrower than 30 feet are not wide enough to allow the cable median barrier enough room to deflect laterally during an impact without encroaching into the opposing lanes. Cable median barriers should be about 12 feet from the edge of the lane to prevent a vehicle crossing from the other side from entering the opposing lanes. Since divided highway shoulders are generally 8 feet wide, the median barrier in this case would be 4 feet from the edge of the shoulder and 12 feet from the edge of the lane. Using this logic, the smallest median where a cable median barrier could be used would be about 24 feet.

There are a variety of maximum median widths in use in the different states. Some states use cable median barrier on all urban highways with medians wider than 30 feet regardless of the width. Many other states use cable median barrier in medians as wide as 75 feet.

Table 5. States with cable median barrier policies in their standards.

State	Installation Guidelines				Max. Slope	Cable Barrier Type	Location
	Median Width		Min. Traffic Volume	Crash Rate			
	Min.	Max.					
	(ft)	(ft)	(veh/day)		(H:V)		
AZ	30	75	All Urban		6:1	LT33	CM
DL	50	--					
VA	--	40					
OH	--	76	36,000		6:1	HT	GT8BD
NC	36	70			6:1	LT	SDR/SSR/CM
OR	30	--					
MO	36	60	20,000	0.8 cross-median crashes /100MVMT	6:1	LT30 HT	CM/GT14S/ SDR
NY	36	72	20,000		6:1	LT30	CM/SSR/SDR
NY	36	72	20,000		10:1	HT	CM
KY				0.12 fatal crashes/mi/yr			
WA	30	50			6:1	LT30 HT	CM/GT8BD

CM = Center of median
GT8BD = Greater than 8 feet from the bottom of the ditch
HT = High-tension cable median barrier
LT = Low-tension cable median barrier
LT30 = 30-inch low-tension cable barrier
LT33 = 33-inch low-tension cable barrier
SDR = Shoulder double run
SSR = Shoulder single run
GT14S = Greater than 14 feet from the edge of the nearest shoulder

Two states use crash rates, at least in part, to establish the need for cable median barriers. Missouri uses a crash rate of 0.8 cross median crashes/100 MVMT to identify sites where cable median barriers should be used. Kentucky uses a crash rate of 0.12 fatal crashes/mile/year to locate sites for cable median barriers.

Some states have a minimum traffic volume for the use of cable median barriers, whereas others specify them for use on all urban highways. The net effect is probably much the same, since urban highways will generally have higher traffic volumes than rural highways.

Nearly all the states allow the use of cable median barriers on approach slopes as steep as 6:1, although one state (New York) limits the use of high-tension cable median barrier to approach slopes of 10:1. If the slopes are greater than 6:1, most states locate cable median barrier on each of the median shoulders in a so-called double run configuration.

There is a considerable diversity of thought regarding the placement of cable median barrier within the median cross section for depressed medians with 6:1 or flatter slopes. Some states always put the barrier essentially in the center of the median (i.e., CM), which generally corresponds to the centerline of the ditch in a depressed median. Other states place the barrier at least 8 feet from the centerline of the ditch (i.e., GT8DB) since it has been demonstrated in one crash test that the bumper height may be too low in this area after the vehicle has crossed the ditch bottom. Additional research needs to be performed to determine where cable median barriers should be placed when they are located on slopes, especially on slopes approaching 6:1.

STATE-BY-STATE SUMMARIES

Alabama

In 2003 the state of Alabama erected 52 miles of cable median barrier in locations where cross-median crashes were historically a problem.[29] The installation of cable median barrier is credited with reducing the number of cross-median fatalities by half. In 2003, prior to the installation of cable median barriers, 49 people were fatally injured in cross-median crashes whereas in 2004, after the installation of cable median barriers, 24 people died. Today, 118 miles of cable median barrier have been installed along Alabama's nearly 1,000 miles of divided interstate highways.[30]

Arizona

Arizona first adopted cable median barriers in 1999 following a well-publicized cross-median crash in the Phoenix area. According to a 1999 report by ADOT, there were 103 crossover crashes and 18 fatal cross-median crashes in Arizona in the five-year period from January 1994 through December 1998.[31] During the same period, traffic volume, especially in urban areas, was increasing and new multilane highway facilities were being constructed and opened. In general, these cross-median crashes occurred on highways with no median barriers. ADOT personnel, concerned with the growing perception that there was a median cross-over problem on high-volume, high-speed highways in the state initiated a study to determine if ADOT's policy on median barriers should be modified. The ADOT team surveyed other state transportation departments, examined police crash records of median crossover crashes in Arizona, examined the relevant crash tests, and consulted with experts, academics, and researchers to develop a new policy that would provide a high level of safety on Arizona highways. The result of this examination was a report issued by ADOT in 1999 outlining a new median barrier policy where 33-inch high low-tension cable median barriers were used on all urban highways with medians between 30- and 75-feet wide.[32]

ADOT has examined its cable median barrier crashes as documented in police crash reports.[33] During a 3.5-year period between July 2000 and March 2004, a total of 1,829 police-reported crashes involved Arizona cable median barrier. A total of 2,857 cable repairs were performed in the same period indicating that at least 35 percent of the cable median barrier crashes were not serious enough to contact the police or require towing. As shown in

Table 6, 1,677 of the 1,829 vehicles (i.e., almost 92 percent) were contained by the cable median barrier and did not cross the barrier line. Of those that were contained on the correct side of the barrier, none reentered the roadway or became involved with impacts with following traffic. About 8 percent of the vehicles (i.e., 152) penetrated the cable median barrier in some manner: by rolling over, penetrating through or over the barrier, or under-riding the barrier. As shown in Table 6, under-riding the barrier in the locations where Arizona uses cable median barrier (i.e., in the center of a 6:1-6:1 depressed median) is extremely rare; only one in 305 cable median barrier crashes resulted in an under-ride. Overall, the ADOT cable median barrier policy appears to be effective since more than 90 percent of police-reported crashes do not result in a median crossover.

Table 6. Median crash data on Arizona highways from 1999–2003.

Vehicle Response	Annual Fatal Crashes		Annual Total Crashes
	(No.)	(%)	(No.)
Contained	13	0.8	1677
Penetrated			
Rolled over	2	4.0	50
Through or over	4	4.0	96
Under-rode	0	0.0	6
Total Penetrations	6	4.0	152

It is preferable to examine crash rates rather than percentages because percentages can hide the effect of barrier length and changes in traffic volume. A study is currently underway by Exponent to match police-reported crash records with traffic volume and barrier length data in order to calculate crash rates.[34] The study was performed by examining cable maintenance repair records for 1999 through 2005, as well as construction documents for the same period. These maintenance and construction records were matched to police-reported crashes in 1991 through 2003 crash data. Single-vehicle crashes involving cable median barriers resulted in fatal or severe injuries (i.e., A+K) in less than 2 percent of the cases. The study found that the number of cross-median crashes and cross-median fatalities were cut in half after the installation of cable median barriers, even though the amount of traffic was increasing.

In an in-service evaluation of the low-tension cable median barrier in Arizona, Mak found that 25 percent of the crashes were not reported and were only observed by maintenance crews when barriers had to be replaced.[35] Clearly, many crashes occur on cable median barriers that are very minor and allow the vehicle and its occupants to leave the scene, while they may have crossed the median and been involved in a serious collision had the median barrier not been there.

Today, ADOT's median barrier policy is to use a 33-inch-high low-tension cable median barrier on all urban highways with medians 50 feet or less and in medians of 75 feet or less on all divided highways with three or more travel lanes in each direction.[36] Generally, the cable median barrier is placed at the center of a depressed median and median slopes must be 6:1 or flatter.

Unfortunately, the cable median barriers have not been 100 percent effective since some penetrations and cross-median crashes have continued to occur, especially on the loop 101 around Phoenix.[37] Many of these crashes involve vehicles that have sloped front ends or are spinning and sliding prior to impact, an impact scenario that cable median barriers, like all post-and-beam barriers, have difficulty accommodating. When the vehicle is spinning or sliding sideways, the front of the vehicle can compress on the suspension, causing the bumper to get under the lower cable. On the other hand, cable median barriers have effectively stopped many errant vehicles. In one case, a man driving a stolen car struck the

barrier at nearly 100 miles per hour. The vehicle was contained and safely stopped. The driver was struck by a truck while fleeing on foot across the opposite lanes of travel.[38,39]

Colorado

Colorado is a fairly recent adopter of cable median barriers. In 2002 two roughly 1,000-foot-long installations of the Brifen high-tension cable median barrier were installed on US 285 in Windy Point. As of 2004, the system had only been hit four times.[40] Three of the crashes were so minor the vehicles left the scene, and in the fourth the crash was reported but there were no injuries. In recent years, CDOT has expanded the amount of cable median barrier further.[41]

Florida

In 2005 the Florida Turnpike instituted a "Mainline Safety Program" aimed at reducing the number of fatal crashes on the Florida Turnpike. The program has a number of components, but one of them is to install median barriers through the entire length of the Turnpike's 187-mile length within 15 months.[42] According to a commander in Florida's Highway Patrol, "there are a number of people still alive as a result of these guardrail installations." The Turnpike Authority has observed a 70 percent reduction in crossover crashes since installing the high-tension cable median barriers. Typical of many reports from drivers, cross-median crashes generally start as traffic conflicts between vehicles. For example, a driver in Florida said, "people don't pay attention to what's in front of them and what's behind them and change lanes and just lose control."[43] It appears that the high-tension cable median barriers on the Florida Turnpike are generally installed about 12 feet from the edge of pavement in an asphalt strip in relatively flat medians about 60 feet wide.

Illinois

In 1996 Lou Holtzman lost his wife and daughter in a cross-median crash where there was no median barrier.[44] Holtzman was convinced a cable median barrier would have prevented his personal tragedy, so he established a nonprofit organization called "Citizens for Median Safety" to promote and lobby for the use of cable median barriers in Illinois.

In another case, a 15-passenger van owned by the Salvation Army was transporting ten people on a trip to visit family members in a correctional institution in January of 2002. The vehicle lost control, probably due to black ice, and entered an unprotected 40-foot-wide median. The van completely crossed the median and collided with a tractor trailer truck traveling in the opposing lanes. All ten passengers in the van and the van's driver were ejected and fatally injured in the crash.[45]

Crashes like these prompted IDOT to install a 3.5-mile-long section of high-tension cable median barrier on I-55 in 2006.[46] Apparently, IDOT has used low-tension cable median barrier in some locations for years, but they are now installing high-tension cable median barriers more aggressively. The Illinois Tollway installed 70 miles of high-tension cable median barrier in a single construction season in 2005.[47]

Indiana

In April of 2006 a tractor trailer truck driver fell asleep and crossed an unprotected median on I-69 in Indiana and then collided with a van. Five people died as a result of the crash.[48,49] In response to horrific crashes like this, INDOT has been installing experimental evaluation sections of high-tension cable median barrier since 2005. INDOT is still evaluating the performance of its test installations, which are just a little over a year old.

Iowa
Cable guardrails have been used for many years in Iowa. IADOT investigated the performance of low-tension three-cable guardrails in the 1970s and documented the results in a report.[50] According to the author, the report "presents the results of a brief survey of the performance of Iowa's light post cable guardrail through the use of available accident statistics." Data came from reported collisions in 1977 and 1978. In approximately 32 percent of the 31 collisions with cable guardrail, the vehicle penetrated the barrier. One of the penetrations involved four injuries and one fatality. The rest of the collisions were fairly minor, with only six injuries in the other 30 collisions.

While Iowa has used cable guardrail for many years, they have only recently (i.e., 2002) installed a 3.5-mile test section of high-tension cable median barrier near Ankeny[51] The test section was installed in an area where cross-median crashes had been a problem. The high-tension barrier was installed at the edge of the shoulder of one direction of travel. The median was a depressed median with intersecting 6:1 slopes. About 18 months after the installation of the barrier, there were 20 police-reported crashes, none of which resulted in any type of injuries or penetrations of the barrier. The statement of a witness to a January 2004 crash is typical: "The SUV was traveling northbound and crossed the median. It impacted the barrier hard enough that the front corner panel tore off and three or four of the metal barriers posts either bent over or broke off. The SUV was disabled and ended up 30 to 50 feet north of the point of impact. There is no doubt there would have been several injuries and potential fatalities if this fence would not have been there. The accident occurred during rush hour traffic, and there would have been no way for anyone to avoid a collision."

After evaluating the performance of the test section for several years, IADOT has decided to expand its use of cable median barriers to include another 61 miles on I-80.[52] IADOT was not only pleased with the safety performance of the barrier, they were also quite pleased with the winter maintenance aspects of the cable median barrier since it did not obstruct snow-plowing operations.

Kentucky
In February 2003, Sarah Nichter was traveling on I-71 in Jefferson County, when another car cut her off. She swerved to avoid the collision and lost control of her vehicle entering the median. The median did not have any barriers, so she traveled completely across the median and struck a car in the opposing lane head on. The driver of the other vehicle was killed. Nichter thinks cable median barriers might have prevented her from crossing over into the opposing lanes and causing a fatal crash.[53]

Between 2000 and 2005, there were 467 cross-median crashes in Kentucky, resulting in 177 fatalities and 562 injuries.[54] While median crossover crashes account for only 3 percent of total fatalities in Kentucky, cross-median crashes are often dramatic multiple-fatality events that close highways and create large traffic disturbances. For example, a crash in Kentucky was initiated when a tire blew out on a passenger car. The vehicle crossed the median and collided with opposing traffic, resulting in the deaths of three college students. The state of Kentucky initiated a program in 2005 to install two pilot sections of four-strand high-tension cable barrier in Jefferson County. The barriers were installed in the 2006 construction season.

The high-tension cable median barriers are credited with preventing a cross-median crash on I-71 in September 2006. An SUV lost control, struck a truck, overturned, and entered the

median, where the cable barrier prevented the SUV from entering the opposing lanes. A police officer at the scene stated, "obviously, they saved the SUV from crossing over…it prevented her from going over into the opposing lanes."[55]

Governor Ernie Fletcher promised that the state would begin installing cable median barriers. "Median cable barriers have proven effective on Interstates 64 and 71 by preventing more than 30 crossover crashes," Fletcher said. "We are now ready to move forward with this installation on the Gene Snyder Freeway in an effort to further reduce the number of highway crashes and fatalities in the Louisville Metro area."[56,57] The new project will result in another 13 miles of cable median barrier in the Louisville area.

Massachusetts

A 1.5-mile section of Route 123 in Methuen was the site of seven fatalities in a ten-year period. As an example of the dramatic crashes in this area a report states, "Methuen Fire Captain Mike Buote recalled a 2000 crash in which a westbound car rolled across the median near Exit 4, ejected its driver into oncoming traffic, and rolled over an oncoming vehicle in the eastbound lanes. The ejected driver was decapitated, and a Methuen man in the eastbound car was crushed to death."[58] The local police, fire, and rescue personnel contacted local political leaders to find a solution to the crash problem on this section of Route 123. In response, a cable median barrier was installed in 2006.

Minnesota

MNDOT is experimenting with several methods of preventing cross-median crashes. One method is to use a "swamp-like area filled with cattails" in the median and the other is using a four-strand high-tension cable median barrier.[59] A 2.3-mile-long test installation was installed on I-94 sometime in 2003. Encouraged by the results of the first installation, MNDOT is installing another 4-mile section of cable median barrier on I-69 near New Hope. A year prior to the installation of the cable median barrier in this area, five cross-median fatalities occurred.[60]

Missouri

Missouri began using cable median barrier sometime in the late 1980s in response to a series of cross-median crashes.[61] Cable median barriers were at first used near interchanges and specific problem locations, but MoDOT soon found that it was difficult to predict the precise locations where cross-median crashes would be most likely, so they began installing cable median barrier on all high-volume urban divided highways with wide medians. In 2002, MoDOT decided to expand the use of cable median barrier system-wide.

Table 7. Reduction of cross-median fatalities with increasing mileage of cable median barrier.

Year	Total Miles of Cable Median Barrier Installed	Cross-Median Fatalities
1999	0	22
2000	9	13
2001	15	18
2002	18	24
2003	20	23
2004	323	14
2005	144	6
2006	179	2

Prior to 2000, there were about 20 cross-median fatalities per year on I-70 in Missouri. Each year since about 2000, MoDOT has installed more miles of cable median barrier and the cross-median fatal crashes have reduced proportionally. This has been reflected in the crash data such that today, with more traffic volume on the road, there are about two cross-median fatalities with 250 miles of cable guard median barrier installed and another 250 miles planned for construction in the next several years.[62] The system-wide crash statistics indicate

that the cable median barrier contains 95 percent of the vehicles that strike it, and cable median barriers have been responsible for a 92 percent reduction in cross-median crashes. In one particular instance, a cable median barrier was installed at a location where 14 people were fatally injured during a two-year period. After the installation of the cable median barrier, no crossover or fatal crashes occurred, even though the cable median barriers were struck more than 200 times.[63] Cable median barriers have even been reported to have stopped tractor trailer trucks, a type of vehicle the cable median barrier is not normally expected to contain.[64]

MoDOT performed an in-service evaluation of its cable median barriers in 2005.[65] Data analysis from 1999 to 2005 yielded 1,402 crashes involving cable median barriers. Successful performance was defined as "the vehicle does not make it to the opposing travel lanes," whereas failure indicated that the vehicle penetrated the barrier and entered the opposing lanes. By this definition, 95.2 percent of the cable median barrier crashes were considered successful in that they prevented a cross-median event. The data were further segregated to examine all the cable median crashes on I-44 to ascertain the possible influence of median slope on barrier performance. Field surveys of 140 crash sites provided data for 225 crashes along I-44 with slopes ranging from as flat as 24:1 to as steep as 2.7:1. When the data were examined with respect to slope, the result was that the cable median barrier actually seemed to perform better on the steeper slopes. The success rate was 93.2 percent for slopes steeper than 6:1 and 91.8 percent for slopes flatter than 6:1. The difference is statistically not significant, so the conclusion was that cable median barrier performs as well on all slopes, at least up to 5:1 (the data were sparse for the steeper slopes). The same study also looked at vehicle type and there was no strong relationship between success, failure, vehicle type, and slope, although passenger cars tended to have a lower success rate. Cars experienced a higher success rate on steeper slopes (92.5 versus 87.8 percent), whereas trucks and SUVs performed better on the flatter slopes (97.8 versus 92.5 percent). The results of this study seem to indicate that cable median barrier is unusually tolerant of slope conditions and a variety of vehicle types.

Initially, MoDOT used a 33-inch-high cable median barrier, but at some point changed to the 30-inch-high low-tension cable median barrier crash tested by WSDOT. Presumably the change from 33- to 30-inches was made to conform to the recommendations in the RDG – the 1989 RDG used the 33-inch system but the 2002 RDG switched to the 30-inch high system. In recent years, MoDOT has also begun to use the proprietary high-tension cable median barriers as well. MoDOT recommends cable median barriers on divided highways where the median is between 36 and 60 feet wide, the radius of horizontal curves is greater than 2,000 feet, and the traffic volume is greater than 20,000.[66] In depressed medians, MoDOT recommends placing the cable median barrier 2 feet from the edge of both shoulders if the slopes are greater than 5:1 (i.e., a "double run" of cable median barrier), and in the center of the median if the slopes are 6:1 or flatter. For stepped medians, the cable median barrier should be placed at least 14 feet from the edge of the nearest traveled way on a 6:1 or flatter slope.

Even as MoDOT installs more cable median barrier, media attention has been focused on locations where median barriers have not yet been installed. For example, a fatal crash on I-44 near Rolla in October 2005 was cited as an example where a cable median barrier would have prevented the tragic result of the crash.[67] In another example, a family skidded off I-70 in August 2005 striking a tractor trailer truck in an area where median barriers had not yet been installed. A cable median barrier would likely have prevented the crash from becoming a fatal crash.[68]

Nevada
A dramatic increase in traffic and crashes on Highway 395 between Minden and Carson City created public concern with safety such that the Nevada Department of Transportation called a meeting to hear the public's concerns.[69] One of the options suggested was to install cable median barriers to prevent crossover crashes. Nevada has a comprehensive plan for reducing head-on and cross-median crashes that is expected to reduce the number of fatal crashes from 51 to fewer than 34 per year. There were 254 fatal head-on crashes in Nevada in 2002, 70 of which were cross-median related (i.e., 28 percent).[70] One component to addressing the problem is the use of cable median barriers.

New Jersey
On November 20, 2002, a tractor trailer truck traveling on I-78 experienced a tire blow-out causing the truck to lose control, enter and cross a 50-foot-wide unprotected median into the opposing lanes of traffic, and strike a car and another tractor trailer truck. The result was one fatality, two serious injuries, and a complete shutdown of the highway for three hours.[71] Engineers at NJDOT decided to examine what other states were doing with respect to protecting wide medians that do not normally need median barriers based on the RDG guidelines.

New Jersey standards recommend the optional use of a "dual-faced guide rail" for all medians greater than 26 feet with traffic volumes greater than 20,000 vehicles per day and traversable slopes flatter than 10:1.[72] NJDOT installed a one-mile test section of cable median barrier and in 2004 installed several more long sections of cable median barrier in order to evaluate the system and compare it to the dual-faced, thrie beam barrier that has been in NJDOT standards. An in-service evaluation was performed to compare the performance of two different median barrier treatments. During a one-year evaluation of the site, the cable median barrier experienced ten crashes, only one of which was reported to the police, and none penetrated the barrier. Subsequent to the completion of the study, however, there were four instances of a vehicle penetrating the barrier, resulting in two fatal crashes and eight injuries. New Jersey decided that cable median barrier was not a cost-effective solution for the type of conditions in New Jersey, so they elected to retain the dual-faced thrie beam as their standard median treatment.

New Jersey is the only state to have rejected the use of cable median barrier. The decision seems to be partly in response to the number of penetrations and partly in response to the amount of maintenance and repair required, which is difficult on the type of very heavily traveled highways typical in New Jersey.

New York
As discussed above, the three-cable low-tension guardrail and median barrier were initially developed in New York and a 27-inch cable system was included in the NYDOT standards in 1968. Since the low-tension three-cable guardrail was originally developed and tested in New York, it is not surprising that the field performance of cable barriers has been examined in New York several times. Much of the literature on cable guardrail and median barrier performance was summarized by Ray, Weir, and Hopp in NCHRP Report 490.[85] VanZweden and Bryden examined all barrier-related crashes in a two-year period on the New York highway system and found 4,213 cases involving a wide variety of barriers.[73] Police crash reports for 217 midsection cable guardrails crashes were identified (i.e., crashes not involving the end of the barrier). The results indicated that about 1 percent of the cable guardrail crashes involved fatal injuries and about 17 percent of the police-reported cases

involved a penetration of the cable guardrail. This relatively high percentage of penetrations prompted further study, which revealed that the penetrations were due to (1) a poor cable splice detail and (2) inadequate top-cable height. The splice detail was improved and the top-cable height was moved to 33 inches to reduce the chance of over-rides.

Carlson studied all types of barrier crashes on all New York highways in 1972-1975 and found that there were no disabling or fatal crashes involving cable median barriers (e.g., guide rail and median barrier) although the penetration rate was 33 percent (note: penetration in this context means that the vehicle got past the barrier line but it did not necessarily cross over the median).[74]

NYDOT had installed some cable median barrier as early as 1978. An in-service performance evaluation was conducted by Tyrell, Ashley, and Bryden on about 5 miles of cable median barrier installed in 1984 at 15 sites on the Palisades Parkway. Based on 99 police crash reports, the barrier contained the vehicle in 96 percent of the police-reported collisions.[75] Four of the 99 vehicles penetrated the barrier; two involved vehicles that impacted a tree improperly located behind the barrier. The police crash reports are unclear as to whether the vehicle actually penetrated the barrier or if it deflected enough to allow the tree impact. The other two penetrations were reported as under-rides; one was a medium-sized car and one was a small station wagon.

In the above study, no fatal collisions occurred and 76 percent of the collisions resulted in no injuries to vehicle occupants. The authors concluded that "the performance of cable median barrier on this facility [was] unquestionably good." To address concerns about the two vehicles that apparently under-rode the barrier, the authors suggested that the top-cable mounting height of this median barrier be reduced to 27 inches, like cable guardrail used on the roadside (i.e., nonmedian). NYDOT has performed research on crash testing cable median barriers, improving splice details, examining the appropriate limits for degree of curvature, and tension requirements.[76]

One interesting feature of these early New York studies is the issue of the height of the cable barriers. Cable median barriers in New York have been installed with top cables at 27, 30, and 33 inches at various periods. Generally, the top cable heights have been modified to address the changing characteristics of the vehicle fleet and different placement details. The 27-inch barrier, for example, is generally used on the roadside where it is positioned close to the shoulder and terrain is less likely to affect bumper trajectory. The 30- and 33-inch high versions were used in the median where the barrier is generally placed farther from the edge of the traveled way in locations where traversing the median terrain may affect the location of the bumper at impact.

NYDOT recently revised its cable median barrier standards in light of all the recent research and operational experience in other states. It is recommending cable median barriers on divided highways with more than 20,000 vpd in medians between 36 and 50 feet and encouraging their use in medians up to 72 feet wide.[77] The new policy allows the use of both the 30-inch-high low-tension cable median barrier and any of the high-tension cable median barriers, although the high-tension cable median barriers can only be used on slopes of 1:9 or flatter.[78] According to the NYDOT Highway Design Manual, cable median barrier should be placed in the center of the median essentially on the ditch line if the approach slopes from both sides are 10:1 or flatter. For slopes up to 6:1, NYDOT recommends placing the cable median barrier adjacent to one of the shoulders, but at least 12 feet from the edge of the

nearest traveled way. On slopes steeper than 6:1, NYDOT recommends using a cable median barrier placed on both shoulders (i.e., a double run of cable median barrier).[79]

Even with NYDOT's long history of use of cable guardrails and median barriers, there has been some additional pressure from the public to install even more cable median barriers in response to crossover crashes. For example, an article from the Ottaway News Service indicates local officials have asked the state to install additional cable median barriers after six people were fatally injured in a 15-month period on a particular stretch of roadway.[80] Presumably, the road did not need median barriers under the policy described above, yet crossover crashes remain a problem.

NYDOT has a long history of use of cable guardrails and median barriers. It developed the basic low-tension system 40 years ago and has studied its performance numerous times over the years. NYDOT has continued to improve and modify its installation guidelines and policies in response both to local conditions and in light of national research and the experience of other states.

North Carolina

North Carolina has been investigating cross-median crashes and developing new median barrier policy since the early 1990s when cross-median crashes on high-volume, high-speed urban facilities began to be perceived as a problem. Between 1988 and 1991, 105 people were fatally injured in cross-median crashes. NCDOT analyzed cross-median accident data from April 1988 through October 1991 and used the results to identify locations for installation of median barrier.[81] During the 3.5-year study, there were 751 cross-median crashes at locations with no median barrier, of which 71 involved at least one fatality. This type of accident represents only 3 percent of all interstate accidents but 32 percent of interstate fatalities. Cross-median accidents resulted in serious or fatal injuries 40 percent of the time. Crashes occurred most frequently at sections with a median width of 20 to 39 feet. Median barriers were recommended on 24 sections of interstate, but at the time it was unclear what the best median barrier for this application might be, so research continued.

The Highway Safety Research Center (HSRC) at the University of North Carolina evaluated the performance of an installation of three-cable median barrier on a segment of I-40.[82,83] The cable median barriers on this highway segment had been installed as an experiment to determine if cable median barriers would provide an effective treatment for the cross-median crash problem discussed in the previous paragraph. The particular segments of I-40 where the barrier was installed had experienced a history of cross-median head-on collisions. On the 8.5-mile segment, 6.8 miles of double-run median barrier (i.e., one roadside barrier on each side of the median) and 1 mile of single-run barrier (i.e., one median barrier in the center of the median) were installed. The posted speed limit was 65 mph, and the AADT ranged from 106,000 to 119,000 vehicles per day over the segment. In addition, data were collected for a 4-mile section of single-run barrier (i.e., cable median barrier in the center of the median) on I-40 and a 3-mile section of double-run cable barrier on US 1. The top cables were mounted at a nominal height of 27 inches. During four years of monitoring, there were 71 collisions with the barriers, resulting in no fatalities and only one serious injury. Almost 90 percent involved passenger cars. Table 1 in the report shows the "final resting position" of the vehicles after the collisions. Of the 18 collisions involving a single run of cable median barrier (i.e., one cable in the center of the median), three (17 percent) of the vehicles passed through or across to the opposite travel lanes. Before and after crash data and comparison site crash data from the Highway Safety Information System (HSIS) were also used to develop regression models for estimating the effects of cable median barriers on various crash rates.

The models "showed improved overall safety due to fewer serious and fatal crashes, as well as fewer head-on crashes" after installation of cable median barriers.

The use of cable median barriers in 30- to 50-foot wide medians in North Carolina has been estimated to have saved between 25 and 30 lives per year since the barriers began to be installed a decade ago. The new median barrier policy has been shown by police crash reports to be responsible for a 90 percent reduction in cross-median crashes.

Table 8 summarizes the before and after data and demonstrates some very interesting results. On the one hand, the percentage of fatalities was reduced even though the traffic was increasing on the section. The number of crashes probably increased for two related reasons. First, before the installation of the cable median barriers, there was nothing for a vehicle to strike prior to entering the opposing lanes of traffic. Second, many of the median barriers were so-called double-run barriers where the cable median barrier was installed at the shoulder of the median, close to traffic. Since the barrier was close to the traveled way, vehicles that once might have left the road and returned now struck a barrier.

Table 8. Cable median crossover crashes in North Carolina.

Crash Type	Annual Crashes	Annual Fatal Crashes	
	No.	No.	%
Before crossovers	4.6	0.3	6.5
After crossovers	0.8	0.1	12.5
After cable barrier	67.0	0.6	0.8
Total after crashes	67.8	0.7	1.0

Ray et al. performed an in-service performance evaluation of four types of post-and-beam guardrail in Iowa, Connecticut, and North Carolina, including the three-cable guardrail.[84,85] Data were collected from 1997 to 1999 and analyzed in terms of collision characteristics, occupant injury, and barrier damage. The focus of the paper was on unreported collisions, but there is also discussion of reported collisions. Data were collected from 127 collisions with cable guardrail. Three of the collisions (2 percent) resulted in severe or fatal injuries, 12 (23 percent) resulted in moderate injuries, and the majority (75 percent) resulted in only property damage. The study also showed that for every three-cable guardrail crash reported to the police in Iowa, another crash was repaired by maintenance personnel but not reported to the police. In other words, at least 25 percent of the crashes were not reported to the police. In fact, however, the number is likely even higher because there are crashes that are neither reported to the police nor repaired by maintenance. The same study examined police-reported versus maintenance-reported crashes in North Carolina where the ratio was very similar. This suggests that fatality percentages like those reported in Tables 2 through 4 probably overstate the severity of cable median barrier crashes due to the fact that there are a large number of such crashes that go unreported because the barrier (1) prevented the vehicle from crossing the median and (2) did so without injuring vehicle occupants or seriously damaging the vehicle (presumably the vehicle was able to drive off after the collision if the collision was not reported to the police).

NCDOT policy has used both the 33-inch and 30-inch low-tension cable median barrier. However, they currently recommend only the 30-inch version and it is believed they are also using some high-tension cable median barrier.[86] Current policy recommends cable median barriers for medians up to 70 feet wide.

North Carolina has been a leader in the development of median crossover protection policy. NCDOT believes that its adoption of cable median barriers has prevented nearly 60 cross-median crashes and saved nearly 100 lives.[87]

Ohio

There were 11 fatal crossover crashes in Ohio between October 2000 and December 2001. As is common for crossover crashes, there were no apparent common contributing factors that might explain the reason vehicles were crossing the median.[88]

While ODOT had some low-tension cable median barrier in place since the early 1990s, it did not generally use cable median barrier to any great extent. ODOT decided to install 14.5 miles of Brifen high-tension cable median barrier in an attempt to reduce the frequency of cross-median crashes. The barrier was installed 14 feet from the edge of travel of one of the lanes in depressed medians that were generally about 60 feet wide with 10:1 slopes. ODOT performed a three-year in-service evaluation to determine the performance of the system as well as document any installation and maintenance issues. Approximately four crashes per year resulted in a penetration of the cable median barrier. At least one of these penetrations involved a tractor trailer truck. In the period prior to the cable median barrier installation, the road segment experienced about seven fatalities per year whereas after, it was one fatality per year and none of those fatalities have involved a crossover related to the cable median barrier.

In 2006, ODOT decided to install another 13 miles of cable median barrier on I-70 and I-270 near Cleveland. This area had experienced about six crossover crashes and one fatality per year.[89] In general, ODOT has been installing the high-tension cable median barrier on 60-foot-wide medians with 6:1 or flatter slopes. The barrier is placed 10 feet from the bottom of the ditch to avoid drainage issues. ODOT places a high priority on placing cable median barriers in medians up to 76 feet wide with traffic volumes over 36,000 vehicles per day. Additionally, they recommend installing cable median barriers in medians between 76 and 84 feet with traffic volumes over 26,000 vehicles per day if there is a crash history problem.

Oklahoma

The Lake Hefner Parkway is a six-lane highway with 36- to 42-foot-wide medians located in the northwestern portion of Oklahoma City. The Parkway was opened in 1991 and began to experience a high number of crossover crashes. Between June 1997 and May 2000, 11 median crossover crashes occurred, resulting in four fatalities. ODOT wanted to find a way of minimizing crossover crashes while protecting the scenic character of the parkway, which has views of Lake Hefner.

ODOT researched alternatives and selected the Brifen high-tension cable system for use on the Hefner Parkway. This installation is notable because it was the first use of the Brifen system in the U.S. Two experimental sections were installed in 2000 amounting to 1,000 feet of barrier, and the performance was examined in a 2003 report.[90] The amount of barrier was increased to 7 miles the next year. The test sections of the Parkway experienced six reported serious median collisions prior to the installation of the Brifen system that resulted in one fatality. In the year after the Brifen high-tension system was installed, there were 126 impacts to the cable median barrier, 43 of which were considered potential crossover events. None of the 126 impacts resulted in a penetration of the cable median barrier and there were no crossover events in the barrier section. After five years of installation on the Hefner Parkway, the cable median barrier was struck 400 times with only one fatality, which resulted from a crash involving a tractor trailer.[91,92]

ODOT was pleased with the results on the Hefner Parkway and began expanding its use of cable median barriers throughout the state. Cable median barriers were installed on I-35 in Cleveland and McClain Counties in 2004, and public input to the process resulted in ODOT installing more cable median barrier than had originally been planned.[93] The Swedish cable median barrier marketed as Safence in the U.S. was installed in 2004 on I-35.[94] A single installation near Purcell was struck four times in one day as a result of a strong rainstorm, but the cable median barrier prevented any of the vehicles from crossing the median.[95] All the crashes were precipitated by drivers operating too fast for conditions, losing control, and entering the median. Of course, cross-median crashes continue to occur at locations without cable median barrier, so ODOT is continuing its expansion of the use of cable median barriers such that ODOT plans to install 277 miles of cable median barriers during the next eight years.[96,97]

Oregon

A crossover crash in August 1996 captured public interest in crossover median crashes in Oregon. Between 1987 and 1996, six fatal and 14 injury cross-median crashes occurred. In response, ODOT investigated options for providing crossover protection and ultimately recommended the use of the 33-inch-high low-tension cable median barrier, which it installed on I-5 in December 1996.[98] ODOT also installed a 33-inch-high three-cable low-tension median barrier on I-5 in 1996 on a 50-foot-wide median. At about the same time, the 1996 RDG included a drawing of a 33-inch-high three-cable low-tension median barrier.

Sposito et al. investigated the effectiveness of three-cable median barriers in preventing median crossover crashes on I-5 in Oregon. Based on the results of the study, the cable median barrier system proved to be cost-effective when compared to the concrete median barrier system and the system performed well, decreasing crossover accidents in the area. The authors concluded that "the cable median barrier system worked well in medians with a minimum width of 7 meters [i.e., 23 feet], where it is used to prevent the infrequent potentially catastrophic cross-median accidents." In an 18-month review of crashes, Sposito found that the barrier had been stuck 53 times, 21 potential crossover events. In two cases, vehicles under-rode the barrier, although they did not enter the opposing lanes. A tractor trailer struck and penetrated the barrier on September 23, 1997. The truck entered the opposing lanes of travel striking an SUV, but none of the occupants was seriously injured. There were no fatal crashes associated with the cable median barrier during the evaluation period, although there were five injury crashes.

Early in 2005 there were two under-rides of the low-tension cable median barrier.[99] These under-rides prompted ODOT engineers to investigate why vehicles might be under-riding the cable median barrier. Several factors were apparent from the crash reports. Three of the vehicles were low-profile vehicles with low bumpers and sloping hoods that might make it easier to get under the bottom cable. The other common factor in at least two of the crashes was preimpact yawing or spinning. Photographs of the crash sites showed significant "plowing" of the soil, indicating the vehicles were spinning and sliding prior to impact. Sliding sideways can cause the leading corner of the bumper to drop lower, possibly promoting an under-ride. In these cases, the cable median barrier was essentially at the bottom of the ditch in the depressed median and the medians were characterized as "flat." In general, Oregon's experience with cable median barrier has been quite positive, but these recent under-rides and penetrations point out cable median barriers are not 100 percent effective and there are crash scenarios that may be more prone to cable median barrier penetrations.

Rhode Island
A 1.4-mile long section of high-tension cable median barrier was installed in 2004.[100] After about one year of service, the barrier had been struck 20 times. Seven of those crashes were so minor the crash was not reported to the police and was only revealed by the need to repair the barrier. None of the other 13 crashes resulted in a median cross-over or an injury crash.

South Carolina
In 2000 a number of cross-median crashes occurred in South Carolina on relatively wide unprotected medians.[101] Median crossover crashes killed 13 people in three months on just one 10-mile section of highway.[102] SCDOT identified sites on interstates that needed median barriers and chose the cable median barrier because "it is the safest for motorists, has the lowest initial cost, and can be installed in medians at least 7.3 meters wide and on 6:1 slopes."[103] By January 2003, 400 installations of three-strand median cable had been installed. Through July 2003, "only 15 vehicles, less than 1 percent of those that hit the median barrier, penetrated the cable system, resulting in eight median crossover fatalities." South Carolina received an FHWA Roadway Safety Award in 2003 for its safety practices program, including the use of some 400 installations of cable median barriers, which were credited with saving 148 lives in three years and reducing fatalities by 30 percent.[104] South Carolina has integrated the use of cable median barriers into its overall strategy for reducing highway fatalities in the state.

Texas
More than 500 miles of cable median barrier have been installed in recent years. One district in Texas has reported that "they have gone from 30 fatal crashes to one since installing the barrier on a section of I-10."[105]

The guidance for the use of high-tension cable median barriers in Texas is that they are installed about 14 feet from the edge of the traveled way. Typically, median shoulders are 6 feet wide and the typical median width is 48 feet. Median slopes range from a typical of 12:1 to a maximum of 6:1.[106]

Utah
Between 1996 and 2003, there were 203 serious injuries and 41 fatalities related to crossover crashes on a particular 16-mile-long segment of I-15. The crossover crashes on this section of I-15 account for 10 percent of all the highway-related fatalities in Utah. In 2002 UDOT investigated the option of installing high-tension cable median barriers.[107] In 2003, 1.7 miles of the Brifen high-tension cable median barrier was installed. The following year, 14.7 miles of the CASS high-tension cable median barrier were installed.[108]

As of May 2004, the two systems had been struck 18 times. In two of these cases the vehicles penetrated the barrier, although the vehicles did not cross the median into the opposing lanes. Interestingly, both penetrating crashes happened on systems that had been struck and not yet repaired. The number of serious injury cross-median crashes in the segment decreased by 92 percent and there were no fatal crashes. The highway segment is reported as averaging six cross-median fatalities prior to the installation of cable median barriers but there have been no cross-median fatalities since the barriers have been installed.[109]

As a result of the penetrating crashes, UDOT personnel and representatives of the manufacturer discussed the failures. One of the crashes involved a nearly 90-degree impact, which is well outside the capability of the system. The second involved a median barrier

installed in the centerline of the depressed median. UDOT personnel decided that moving the barrier to the "high side" of the median near the shoulder would be a better location for the barrier. In the opinion of one motorist, "if the cable barrier hadn't been there, that car would have passed through the median and hit me."

In 2005 UDOT issued a "special provision" for the use of high-tension cable median barriers.[110] The Utah draft specifications call for installation of high-tension cable median barrier 12 feet from the edge of the higher elevation traveled lane on a depressed median slope of 8:1 or flatter. UDOT has plans for installing another 22 miles of cable median barrier in the near future.[111]

Washington State

Washington State installed a 2-mile-long pilot installation of cable median barrier in 1995. WSDOT has been one of the leaders in cable median barrier research and policy development since the early 1990s. It sponsored crash tests of a 30-inch-high low-tension cable median barrier in 1996; this barrier has been adopted by a number of states and was also included in the 2002 RDG.[112] WSDOT also examined its median barrier policy in a 2002 research study, which resulted in a reexamination of the median barrier installation guidelines.[113] The results of the study and WSDOT's policy were the basis of many of the policies in other states. As will be discussed below, WSDOT has also examined cable median barrier performance several times in the past decade, providing valuable evidence about the effectiveness of cable median barriers. (Note: The studies reviewed in this section do not include the most recent evaluation performed for the Governor in the spring of 2007.)

The policy in Washington State has developed as understanding about cable median barrier performance has increased. WSDOT's policy allows for the use of both the 30-inch low-tension cable median barrier and the newer proprietary high-tension systems. The policy recommends that median barriers, including cable median barrier, be placed at least 8 feet from the edge of the nearest traveled lane.[114] In depressed medians with relatively flat slopes (e.g., 10:1 or flatter), the median barriers should be placed in the center of the median to minimize the chance of collisions with vehicles. Cable median barriers are recommended for medians 30 and 50 feet wide and can be used in depressed medians as steep as 6:1. In depressed medians, the cable median barrier should be placed either within 1 foot of the centerline of the median or ditch or at least 8 feet away from the centerline of the ditch. This recommendation comes from a crash test where vehicles were able to under-ride vehicle's positions 4 feet from the centerline on a 6:1 slope.

McClannahan et al. examined the in-service performance of the cable median barrier by analyzing its initial installation cost, maintenance costs, maintenance experiences, and accident history before and after installation.[115] The report is based on accident and maintenance report data associated with 24.4 total miles of cable median barrier located in three distinct locations along I-5. The data are summarized in Table 9. One of the unique and important aspects of the Washington data is that crashes were linked to the traffic volume on each roadway such that crash rates could be developed. A crash rate provides the number of crashes per vehicle passing the location rather than the number of crashes in a period of time. When they can be calculated, crash rates are much more informative than the usual time-based crash statistics because the effects of traffic growth and barrier inventory are incorporated. For example, Table 9 shows that before cable median barriers were installed, on average 2.12 crashes occurred for every 100 million vehicles that passed through a 1-mile segment of the highway. Reporting crashes in this way eliminates confusion due to the change in traffic volume during data collection and the growth of traffic. For example, if one

crash was observed one year and the next year two were observed, the difference could simply be due to the increase in traffic rather than any intrinsic characteristic of the site.

The data in Table 9 show several very interesting features. First, installing the cable barrier caused the total number of crashes in the median to go up from 2.12 crashes/100 million vehicle miles traveled (100 mvmt) to 4.61 crash/100 mvmt, twice the pre-cable median barrier rate. However, the fatal crash rate (i.e., the number of fatal collisions per 100 million vehicles passing through a 1-mile section) decreased from 0.21 fatalities/100 mvmt to 0.02 fatalities/100 mvmt after the cable barrier was installed. This is a tenfold decrease in fatalities even though the number of crashes more than doubled. This dramatically illustrates an important point in median barrier design: Installing a median barrier will increase the number of crashes since there will be something in the median to hit. When designing a median, the least harmful barrier possible should be installed in order to minimize the potential for injuring vehicle occupants. When a median is unprotected, there are fewer cross-median events, but they tend to be very severe. When a barrier is installed, especially a very forgiving barrier like a cable median barrier, the number of crashes increases, but the fatalities drop dramatically—by a factor of 10 in the Washington data.

Table 9. Performance of cable median barrier in Washington State.

Crash Type	Annual Crashes		Annual Disabling Injury Crashes			Annual Fatal Crashes		
	No.	Rate†	No.	Rate†	%	No.	Rate†	%
Before crossovers	16.0	2.12	2.2	0.29	13.8	1.6	0.21	10.0
After crossovers	3.8	0.51	0.3	0.04	7.9	0.0	0.0	0.0
Total after crashes	58.6	4.1	0.9	0.06	1.5	0.3	0.02	0.5

† Crash rates are reported as crashes/100 MVMT

The performance of cable median barriers was again examined in 2006 in response to public concerns about a portion of I-5 in Maryville.[116,117] While cable median barriers appear to be doing a very effective job of reducing cross-median crashes in Washington State in general, the portions of I-5 in Marysville still seem to experience crossover events even with the addition of cable median barriers. A review of crashes in Marysville indicated that 92.4 percent of the vehicles that struck the cable median barrier were contained; somewhat lower than the 95 percent statewide average, but not radically different. There were 18 collisions in Marysville that penetrated the barrier and crossed over to the other side, with 3 resulting in fatalities. Interestingly, 83 percent of the cable median barrier penetrations occurred with vehicles initially traveling southbound even though only 46 percent of cable median barrier collision in the same area involved southbound vehicles.

One placement detail that was discovered was that many of the collisions involved cable median barriers placed 5 feet from the bottom of the ditch. A series of crash tests performed by the FHWA in 2004 showed that cable median barriers placed 4 feet up the backslope beyond the ditch bottom under-rode the barrier. The crash test and the experience in Marysville convinced WSDOT to change its policy to include a zone from 1 to 8 feet from the bottom of the ditch where cable median barrier should not be placed. Traffic conditions also appeared to play a role since that segment of I-5 was characterized by high speed, congestion, and a transition from rural to urban commuting traffic. All these traffic features

are indicative of an increase in traffic conflicts, which are most often the source of cross-median crashes. In response, WSDOT installed a second cable median barrier on the other side of the median creating a "double run" of cable median barrier.[118] It also increased speed enforcement in the area to try to reduce speed and traffic conflicts. WSDOT elected to continue using cable median barrier because of its good record in other parts of the state, as well as the lower impact severity of cable collisions in general. Marysville, however, has continued to be a problematic site with a fatal crash occurring in February 2007.[119,120]

AWARDS

A number of states and other organizations have received awards for implementing cable median barrier policies or using cable median barriers. In 2000 DMJM, the design consultant for the Arizona Department of Transportation's SR 101 project, received a "Merit Award" from the Arizona Consulting Engineering Association for its use of cable median barrier in the design of SR 101 near Phoenix. In 2003 the South Carolina Department of Transportation received the FHWA 2003 National Roadway Safety Award for using cable median barrier and in so doing reducing fatalities by 30 percent.

AASHTO's Technology Implementation Group (TIG) was so impressed by the results of installing cable median barriers in North Carolina and other states that they designated the use of cable median barriers a Focus Technology in 2005.[121] Designation as a TIG Focus Technology means that AASHTO actively promotes the use of cable median barriers by providing presentations, implementation materials, demonstration workshops, and other training and information dissemination activities aimed at promoting the technology. AASHTO, the national leader in developing transportation policy, is clearly backing the use of cable median barrier in wide medians because AASHTO believes that it provides a safer roadway network where cross-median crashes are reduced.

CONCLUSIONS

The use of cable median barrier has expanded rapidly in a very short period of time. Two decades ago, cable median barriers were uncommon, whereas today there are over 2500 miles of cable median barrier installed more than 25 states with hundreds more planned each year. In most of the states discussed above, public concern over cross-median crashes was the initial motivation for using cable median barriers. In several states, the public, political establishments, and citizen groups have lobbied aggressively for cable median barriers. Transportation departments have installed cable median barriers in response to this public concern.

As described in the previous sections, most states have experienced significant cross-median fatal crash reductions and high levels of effectiveness when using cable median barriers. Typical cross-median crash reductions have been on the order of 95 percent. Only one state (New Jersey) elected not to continue using cable median barrier after performing a field evaluation. Using cable median barrier does result in more low-severity and nuisance crashes that require maintenance and repair, but the low cost of the cable median barrier allows states to protect many more miles of highway than would be possible with other types of median barriers. While the performance has been universally good on a system-wide basis, tragic and dramatic cross-median crashes have continued in states that have used cable median barriers for a while. While the total number has been reduced by a factor of 10, the occasional fatal crossover crash that penetrates a cable median barrier still demands attention.

Most states are using cable median barriers in medians with widths between 36 and 75 feet. These medians are typically depressed medians and most states allow the cable barrier to be

used as long as the slope is flatter than 6:1. There is a wide variety of opinion on the placement of median barriers. Some states prefer the center of the median; others prefer a single run 12 to 14 feet from the edge of one of the inside edges of the pavement. Some states allow cable median barriers to be placed on the slopes, whereas others have areas on the slope where cable median barrier can not be placed.

The early-adopting states all started by using one of the low-tension cable median barriers since at the time there were no high-tension systems available. Most of the states that have begun using cable median barrier in more recent years have opted for the high-tension system and many of the early adopters are transitioning away from the low-tension systems.

The reports in the news media regarding cable median barrier have generally been very positive. Most accounts stress the need for median barriers to prevent crossover crashes. In some states, like Arizona and Washington, where cable median barriers have been used for a longer time, there have been negative reports about the occasional failures of cable median barriers. Unfortunately, one of the characteristics of crossover median crashes is that they are often very dramatic, involving multiple vehicles and often multiple fatalities, and they are very disruptive. When a cross-median crash occurs where a cable median barrier is installed, it is natural to question why it did not work this time, even if it has been effective in many previous collisions.

All the states discussed above had very positive experiences with cable median barriers. Most are using it to treat specific sites prone to cross-median crashes, but it is likely that guidelines for using cable median barriers will become a more typical feature of state standards in the coming years.

I hope that the foregoing analysis has helped to answer some of your questions about the use and performance of cable median barriers in other states. If you should have any questions or comments, please contact me. I appreciate the opportunity to be of service to the WSDOT and the people of the State of Washington.

Sincerely,

Malcolm H. Ray, P.E., Ph.D.

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Appendix B2: Newspaper coverage in other states

WSDOT searched newspaper archives using ProQuest, LexisNexus and newspaper Web sites and found 27 articles and editorials about cable median barrier published outside of Washington state from Dec. 2004 to March 2007. The vast majority of newspaper articles focused on cable median barrier's ability to reduce the severity of collisions and prevent deadly crossover collisions. Additionally, several articles stated cable median barrier was a cheaper solution than concrete or guardrail. Three articles focused on the controversy surrounding an old version of cable median barrier in California, which uses a single steel cable instead of the three cables used in modern designs. Most of the old cable median barrier was replaced with concrete barrier by late 2005. Following are excerpts from all 27 articles and editorials.

West Virginia

Officials mistrust barriers for I-81

Although a new median barrier designed to prevent deadly vehicle accidents on Interstate 64 in Cabell County has shown promising results, Berkeley County officials say the same type of barrier placed along Interstate 81 is not doing its job and they want it replaced.

Berkeley County Commission President Howard Strauss wants the cable barrier system along a six-mile stretch of I-81 near Martinsburg to be replaced with a concrete barrier, which he says would be safer. ...

"No barrier system is perfect, but I think this is the safest one we could have asked for," Braley said. "If you drive into it, you most likely will scratch the paint on your car and walk away."

The Herald-Dispatch (Huntington), Jan. 21, 2003

Missouri

Median cable barriers raise hopes for highway safety; MoDOT plans to install the barriers along 437 miles of interstate by 2007.

... Humphrey, of Springfield, believes a cable barrier in the median would have prevented the car from crossing over and colliding with her family's minivan. The safety feature -- known for its relatively low cost and proven ability to reduce serious crashes -- would likely have saved the young Oklahoma woman's life, she said.

The Missouri Department of Transportation plans to install such barriers along 437 miles of interstate median by 2007...

Springfield News-Leader, May 3, 2005

West Virginia

I-81 cable barriers worry some officials

West Virginia transportation officials are re-examining the decision to install steel cables as a cost-effective alternative to concrete barriers on Interstate 81 after several accidents. ...

The Associated Press State & Local Wire, Aug. 10, 2005

Arizona

Damaged cable barriers a symptom of bad driving; Our stand: Dressing up restraints fails to solve real problem on loop 101: Speed

Check out the eye-catching yellow covers on some median cable barriers on Loop 101.

The long metallic cords are now dressed up so drivers can see them better.

It seems that the Arizona Department of Transportation is looking to reduce the $1.4 million the state pays each year to fix the barriers, which vehicles strike an incredible 75 to 80 times each month. ...

Speed likely is more of a factor in the cable hits than bad eyesight. ...

The state needs to go beyond treating the symptom and find a cure, which likely is either a greater DPS officer presence on the freeway, photo enforcement or a combination of the two. ...

The Arizona Republic (Phoenix), Aug. 17, 2005

Kansas

First lines of defense; Missouri will string cable barriers along 165 miles of I-70 median

... Missouri, hoping to reduce such accidents, is stringing steel cables on 165 miles of I-70 between Kansas City and St. Louis in one of the most extensive uses of such barriers nationwide. ...

The cable barriers are not without drawbacks and critics. The barriers are expensive to maintain and repair, do not always prevent crossovers, damage vehicles that slide into them in relatively minor incidents and limit the ability of police and emergency vehicles to cross medians. ...

The department did a study of barriers used on I-435 in Kansas City and on I-44 in St. Louis ...

Briggs said the study found that fatalities from crossover wrecks dropped by two-thirds to three-fourths, although wrecks doubled because of collisions with the barriers.

The Kansas City Star, Aug. 26, 2005

West Virginia

DOH finally pursuing life-saving cable barriers around state

It took a while, but the West Virginia Division of Highways has gotten religion on the subject of cable barriers in the medians of interstate highways. ...

Approximately 60 miles of interstate should be equipped with the barriers within the next year as the state attempts to reduce the number of vehicles going into or through the median, ...

The Herald-Dispatch (Huntington), Sept. 22, 2005

Missouri

Cables stretch to guard motorists

... Wire barriers are designed to prevent crossovers into oncoming traffic. The devices stop cars about 90 percent of the time. ...

The devices became a reality thanks to a campaign led by Warren County Coroner Roger Mauzy, who saw 34 people die in crossover accidents in his county over a 10-year period. Since the cables have gone up, no more fatalities have occurred on I-70 in Warren County, and only one motorist who struck the devices suffered any injury. ....

work is steadily progressing on the highway department's plan announced six months ago to install 437 more miles of the cable barriers along interstates 70, 44 and 29, he said.

Investment questioned

... "I'm not saying it isn't an excellent idea to have cable barriers that prevent deaths or serious injuries or even accidents, but I believe if you look more broadly at traffic safety and deaths on the road, a dollar spent on driver education would go a lot further toward reducing death and injury than putting up physical barriers," he said.

Other commuters disagree with Allen's assessment. ...

"That road is tremendously dangerous anyway, and it's not going to get any better by itself," he said. "So adding those wires is probably one of the only things you can do at such an affordable price that actually adds some decent safety to the road."

St. Louis Post-Dispatch, Oct. 23, 2005

Kentucky

Keeping traffic in line; State to install cable barriers

... "It's such an easy fix to prevent these type of accidents," said Robinson, who was thrilled to learn yesterday that the state plans by summer to install cable median barriers along two stretches of Interstates 64 and 71.

The barriers, ... will be the first of their kind installed in Kentucky...

The Courier-Journal (Louisville), Jan. 21, 2006

Ohio

Cable barriers may prevent some fatal crashes;

BEAVERCREEK - Barbara Frantz of West Milton can't drive past the spot where her brother died in one of two fatal cross-over crashes last year on U.S. 35 in Beavercreek. ...

Last May, Christopher A. Paulson, 25, of Kettering was reaching for something in his car when he swerved to avoid a vehicle and drove across the median into the path of an eastbound semitrailer. ...

"Something's got to be done," Frantz said. ...

Frantz said she learned the state plans to install barriers in 2007 on U.S. 35 between Steve Whalen Boulevard and I-675.

Since 2003, when Ohio's first cable barriers were installed along I-75, the cement barriers and guardrails have been installed along about 100 miles of state roadway, mostly around Dayton, Cincinnati and Columbus - costing about $8 million. There have been no fatal cross-over crashes where the barriers were installed, the state said.

Dayton Daily News, April 5, 2006

Colorado

Lifesaving cable median to get test along C-470

A series of new cable median barriers will be installed along a 5-mile stretch of C-470 this summer as part of a project aimed at saving lives and cutting down serious injuries.

The Colorado Department of Transportation has installed cable barriers across the state where there have been deadly accidents, but the test areas will systematically use five different cable systems and track to weigh effectiveness. ...

Cable barriers are safer because they are more forgiving than traditional, solid metallic guardrails and concrete barriers, experts say.

High-speed vehicles tend to bounce off concrete barriers and can careen back into traffic. Traditional metal guardrails can either collapse or repel vehicles, depending on the speed, force and angle of crashing cars. But steel cables are designed to catch cars and trucks like a net; the barrier lassos vehicles and coaxes them to a safe stop. ...

The Denver Post, April 17, 2006

Tennessee

Low-cost cables offer barrier to road deaths;

Easy to install yet strong enough to halt a hurtling SUV, a cable-barrier system recently strung along Interstate 40 in North Memphis shows promise as a flexible, cost-effective way to prevent deadly median-crossover crashes, transportation officials say.

The Tennessee Department of Transportation is testing the effectiveness of cable barriers along a 3.6-mile stretch of the I-40/240 north loop. Variations on the concept are undergoing demonstrations in Chattanooga, Knoxville and Nashville, TDOT spokesman Pamela Marshall said. ...

Marshall said the Tennessee highway sections where the barriers are being tested all have been prone to crossover accidents.

The Commercial Appeal (Memphis), April 15, 2006

Oklahoma

One dead, one hurt in wreck; Truck crashes through barrier dividing lanes of city highway.

One person died and another was injured after a truck drove into oncoming traffic Tuesday on Hefner Parkway in northwest Oklahoma City, authorities said.

The southbound truck ran off the left side of the road and drove through cable barriers in the highway median.

It was the first time an automobile has crossed the median since the cable barriers were installed in 2001, officials said. ...

The Oklahoman (Oklahoma City), May 24, 2006

Missouri

These strands of braided cable may not look like much. But they can save your life. Wires grab and stop vehicles to prevent crossover crashes -- and they cost less, too.

... "All of a sudden, we hit black ice and started spinning," Floyd Atkinson recalled last week. "There was nothing you could do about it."

Out of control, the Atkinsons' three-quarter-ton Dodge van flew against the cable median barrier just west of Warrenton. The crash totaled the van, but the cables stopped it from crossing the median and into oncoming traffic. ...

A new report shows that the barriers have halted nearly all instances in which vehicles crossed the median and collided with vehicles in the opposite lanes. Of 378 accidents last year in which vehicles hit cable barriers on Interstate 70, vehicles got through in only 6 percent of the crashes, the transportation department said.

Between 1996 and 2005, crossover accidents killed more than 400 people and injured more than 2,400 on Interstates 44, 55 and 70 in Missouri. There were six fatalities last year, after most of the state's median cables had been installed. The state said four of the fatal crashes were in spots that still lacked the barriers. ...

St. Louis Post-Dispatch, June 25, 2006

Colorado

Cable barriers going up on E-470 Key locations getting the median installations include the site of a double fatality in November.

Cable barriers will be installed in the median of E-470 along the site of a double-fatality accident, toll road officials said Thursday.

In November, a road-rage accident between South Parker and Gartrell roads caused a Toyota 4Runner to tumble across the median and land on a Ford Explorer in the opposite lanes, killing the drivers of both vehicles. ...

The Denver Post, July 14, 2006

Missouri

Lives saved as highways get cable; New barriers much cheaper than concrete or steel beams

SPRINGFIELD, Mo. -- A relatively low-cost safety device -- steel cable strung in highway medians -- is proving phenomenally effective at saving lives, perhaps more so than steel-beam or concrete barriers.

Steel-beam, concrete and cable barriers all cut down on accidents in which cars cross over into oncoming traffic.

Cable, however, also cuts down on the number of rebound accidents, in which a vehicle hits a barrier and bounces back into traffic. ...

USA TODAY, July 20, 2006

Alabama

Cables put up along risky roads

Alabama transportation workers are installing cable median barriers along Alabama interstates and divided four-lane highways to prevent the kind of crossover traffic accidents that kill 250 people in the United States each year.

Research shows the barriers -- steel cable strung like a fence and held by a series of concrete posts -- are more forgiving than traditional concrete and metal beam barriers and can be effective when installed on sloping terrain.

During the past three years, 118 miles of cable median barriers have been installed along the state's 907-mile interstate system at a cost of $14.5 million. ...

Montgomery Advertiser, Aug. 13, 2006

States try cable barriers, distance dots to make roads safer

A hornet sting caused trucker Christopher Adams to lose control of his semitrailer at 70 mph. Three cables might have saved his life.

A steel-cable barrier that Missouri had installed a few weeks earlier snagged his truck in the median of Interstate 44, keeping it from barreling into oncoming vehicles or ricocheting back into traffic.

"If the cables wouldn't have been there, I would have gone clear across the interstate," said Adams, 58, of Payette, Idaho. "No one got hurt. That was amazing." ...

The Associated Press State & Local Wire, Nov. 5, 2006

Georgia

Median barriers have been lifesavers

Police and emergency responders might not like them, but state transportation officials are all in favor of the cable barriers in the medians of interstate highways.

It has taken about five years for the state to install about 470 miles of the safety cables. ...

In 2000, 27 people died in crossover crashes on South Carolina interstates. In 2005, there was just one such fatality. ...

The drop in crossover crash fatalities means that South Carolina's cable barriers are 99 percent effective, according to the agency.

The Augusta Chronicle, Nov. 12, 2006

Oklahoma

Cable barrier in works for treacherous ramp

It will be the first of its kind in the Tulsa area.

The Tulsa area's first highway cable barrier will be installed along a ramp where 30 vehicles crashed within two years as part of a highway safety improvement project that will begin in the next few months. ...

Tulsa World, Dec. 19, 2006

Alberta, Canada

Post-and-cable barrier on its way to Deerfoot: Installation expected to begin on Jan. 9

A revolutionary highway median barrier praised in some jurisdictions as a life-saver -- but criticized as a killer in others -- will be installed along 10 kilometers of Deerfoot Trail, a section of road where four people have died in the past 18 months.

The province will begin work on installing the post-and-cable barrier in the Deerfoot median from 16th Avenue N.E. to Country Hills Boulevard on Jan. 9. That's several months after the date originally promised.

It will be the first stretch of road in Alberta to feature the cable barrier system, and one of the first in the country to utilize the relatively new technology. ...

The Calgary Herald, Dec. 20, 2006

Wisconsin

New cable barriers aimed at reducing Highway 41 fatalities

... Following her son's death, Bruss, formerly of Mayville and now of Illinois, spoke to legislators, wrote letters to the Department of Transportation and circulated petitions advocating cable-guard barriers and other safety improvements on 41.

In November, part of Bruss's wish for the highway became a reality after the installation of nearly 35,600 feet of cable guard in the median from the Dodge County line to Highway 151 was completed an $11.1 million project.

The Reporter (Fond du Lac), Dec. 21, 2006

Oklahoma

Wired for safety; ODOT commits to median barriers

... Drivers on Lake Hefner Parkway are already familiar with cable barriers. A 1,000-foot stretch of the road was the first site in the United States to employ a technology that was already in widespread use in Europe, the Middle East and Australia.

It's a cheaper and more aesthetic alternative to concrete barriers. An eight-year ODOT program will result in installation of 277 miles of barriers, some concrete and some cable. ...

Now that the Legislature has opened the purse strings for ODOT, barrier building will begin in earnest. Oklahoma was a pioneer in embracing cable technology; since the Hefner Parkway "experiment," the technology has been used in at least 20 other states. Although cable barriers are cheaper than concrete barriers, the latter generally don't need repair when struck by a vehicle. Repairs to cable barriers are necessary but not too costly.

In a safer world, wide medians wouldn't need barriers. But that's not the world we drive in. We applaud ODOT for making median barriers a priority.

The Oklahoman (Oklahoma City), Feb. 21, 2007

Iowa

Iowa to add more cable barriers on highways as safety measure.

Iowa Department of Transportation officials say an experiment with metal cable barriers on Interstate 35 was so successful during winter storms that they plan to use them elsewhere. The cables were on a three–mile stretch of I–35 near Ankeny. They kept cars and trucks that went out of control from crossing the median and colliding with oncoming traffic. Traffic safety engineer Tom Welch says the posts were all knocked down, but the cable was still effective in stopping the vehicles. The DOT plans to install at least another 61 miles of barriers, mostly on Interstate 80 in eastern Iowa, over the next five to ten years. The cost of installing metal cable median barriers in Iowa is about $170,000 a mile. An analysis by the Federal Highway Administration estimates the overall benefits of the barriers are $420,000 a mile –– based on reductions in crashes causing deaths or serious injuries.

KCRG-TV, April 16, 2007

California

Deadly collision, troubling question. A stronger barrier might have prevented I-80 crash, victim's family contends.

Amanda Chatigny had a cold that September morning. The 26-year-old Vacaville woman thought about calling in sick to work. Instead, she grabbed a can of Orangina, drove onto Interstate 80 and joined the freeway commute. ...

Ironically, as California struggles to replace its cable barriers, other states are starting to install more cable barriers, mainly because they are inexpensive. Those, however, are new designs that employ three or four cables, unlike the single- cable barriers still used in California. ...

The Sacramento Bee, Jan. 11, 2004

I-80 stretch: 21 miles and 8 fatalities

One year and one day after four people died in a fiery crash on Interstate 80 in Solano County, a man died and his wife and two daughters were injured Thursday after a nearly identical crash.

What did both crashes have in common? A car vaulted a cable barrier and slammed head-on into another. In less than two years, the death toll has risen to eight in strikingly similar accidents on a 21-mile strip of highway from Dixon to Fairfield. ...

The Sacramento Bee, May 28, 2005

Traffic fixes often come only with a squeaky wheel

... For years, only a thin cable barrier has separated eastbound and westbound traffic on I-80 near Dixon.

Tom and three others were killed in May 2004, when a Jeep Cherokee hurtled past the cable barrier and oleander bushes in the center divide, colliding with Tom's vehicle just miles from the exit to his parents home. ...

Times-Herald (Vallejo), July 1, 2005