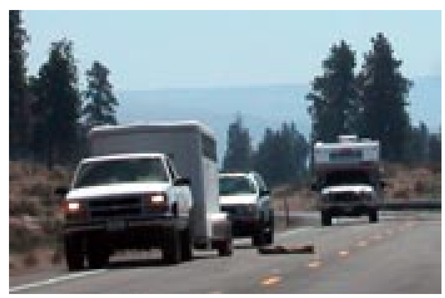
The safety impact of

VEHICLE-RELATED ROAD DEBRIS



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SI* (Modern Metric) Conversion Factors

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	***When you know***	***Multiply by***	***To find***	***Symbol***	***Symbol***	***When you know***	***Multiply by***	***To find***	***Symbol***
		LENGTH					**LENGTH**		
in	inches	25.4	millimeters	mm	mm	millimeters	0.039	inches	in
ft	feet	0.305	meters	m	m	meters	3.28	feet	ft
yd	yards	0.914	meters	m	m	meters	1.09	yards	yd
mi	miles	1.61	kilometers	km	km	kilometers	0.621	miles	mi
		AREA					**AREA**		
in^2	sq inches	645.2	sq millimeters	mm^2	mm^2	sq millimeters	0.0016	sq inches	in^2
ft^2	sq feet	0.093	sq meters	m^2	m^2	sq meters	10.764	sq feet	ft^2
yd^2	sq yards	0.836	sq meters	m^2	m^2	sq meters	1.195	sq yards	yd^2
ac	acres	0.405	hectares	ha	ha	hectares	2.47	acres	ac
mi^2	sq miles	2.59	sq kilometers	km^2	km^2	sq kilometers	0.386	sq miles	mi^2
		VOLUME					**VOLUME**		
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.034	fluid ounces	fl oz
gal	gallons	3.785	liters	L	L	liters	0.264	gallons	gal
ft^3	cubic feet	0.028	cubic meters	m^3	m^3	cubic meters	35.315	cubic feet	ft^3
yd^3	cubic yards	0.765	cubic meters	m^3	m^3	cubic meters	1.308	cubic yards	yd^3
	Note: Volumes greater than 1000L shall be shown in m^3					Note: Volumes greater than 1000L shall be shown in m^3			
		MASS					**MASS**		
oz	ounces	28.35	grams	g	g	grams	0.035	ounces	oz
lb	pounds	0.454	kilograms	kg	kg	kilograms	2.205	pounds	lb
T	short tons (2000lb)	0.907	megagrams (or "metric ton")	mg (or "t")	mg (or "t")	megagrams (or "metric ton")	1.102	short tons (2000lb)	T
		TEMPERATURE (exact)					**TEMPERATURE (exact)**		
°F	Fahrenheit	(5/9)*(F-32)	Celsius	°C	°C	Celsius	((9/5)*C)+32	Fahrenheit	°F
		ILLUMINATION					**ILLUMINATION**		
fc	footcandles	10.76	lux	lx	lx	lux	0.0929	footcandles	fc
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2	cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE AND PRESSURE OR STRESS					**FORCE AND PRESSURE OR STRESS**		
lbf	poundforce	4.45	newtons	N	N	newtons	0.225	poundforce	lbf
lbf/in^2	poundforce per sq in	6.89	kilopascals	kPa	kPa	kilopascals	0.145	poundforce per sq in	lbf/in^2

**Systeme International*

FOREWORD

This study was funded by the AAA Foundation for Traffic Safety, a not-for-profit, publicly supported charitable research and educational organization dedicated to saving lives and reducing injuries by preventing traffic crashes. The Foundation, founded in 1947, is supported by contributions from motor clubs associated with the American Automobile Association and the Canadian Automobile Association, individual AAA club members, insurance companies, and other individuals and groups.

This peer-reviewed report documents the magnitude and characteristics of the safety issues presented by vehicle-related road debris. It should be of interest to legislators, licensing agencies, law enforcement agencies, road maintenance personnel, and anyone with an interest in road safety. It is available in published paper format and as an electronic file on the AAA Foundation for Traffic Safety's Web site at www.aaafoundation.org.

Funding for this study was provided by voluntary contributions from the AAA and its affiliated motor clubs, from individual AAA members, and from AAA club–affiliated insurance companies.

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The AAA Auto Club South is recognized for identifying the need for this research and bringing it to the attention of the Foundation.

My sincere thanks go to Mr. Barry Warhoftig and Mrs. Marsha Mays, of the West Virginia Department of Transportation, who were most helpful in providing access to sanitized crash report forms for this study.

Similarly, I appreciate the effort that various personnel at state and provincial departments of transportation, public safety, and motor vehicles put forth to provide information, respond to surveys, and discuss vehicle-related road debris with the research team.

Executive Summary

When cargo or a vehicle part dislodges from a moving vehicle and falls onto the road, it becomes a serious hazard for road users. Even a small item may be dangerous when it is discharged at highway speed prompting erratic avoidance maneuvers, and causing a crash. Vehicle-related road debris (VRRD) is material—vehicle parts or cargo—that has been unintentionally discharged from a vehicle onto the roadway. This study examines the safety impact of VRRD on North American roads.

The objectives of the study are to determine the scope and magnitude of the VRRD safety problem—that is, the frequency and severity of VRRD crashes—and to identify potential countermeasures to reduce VRRD, the incidence of crashes, and/or to reduce VRRD crash severity.

The study's methods included a critical review of the literature, identification and analysis of available crash data, and a survey of current state and provincial practices for preventing and removing VRRD.

A limited number of studies have been conducted that contain information on the safety impact of VRRD. These studies either address the safety impact of “nonfixed objects” on the road (of which VRRD is a component) or deal with only one type of VRRD, such as fallen cargo or wheel separations.

The literature review produced mixed but generally consistent results. Three studies of objects on the road were identified, all of which found that debris-related crashes constitute a very small proportion of all crashes, ranging from 0.1 percent to 0.5 percent. A fourth study that examined objects on the roadway limited its scope specifically to objects on highway bridges in a metropolitan area. The study found that debris-related crashes constituted 10 percent of all crashes on the bridges, although two of the bridges had no debris-related crashes. The literature review identified seven studies that estimated crash rates for specific types of VRRD. Three of these determined that tire debris was the cause of less than 1 percent of all crashes. Two examined wheel separation crashes and determined that they constitute 0.3 percent and 1 percent, respectively, of all crashes. The other two studies, which examined lost-load crashes, found rates of 0.5 percent and 21 percent of all crashes; the higher proportion, however, is suspect.

A close examination of several crash databases, in some cases including a review of individual crash reports, was conducted to estimate VRRD crash frequency and severity. The crash data assembled and analyzed in this study consistently indicate that VRRD is a causative factor in less than 1 percent of all crashes. The data sets that were given the most thorough review provide the best estimate of the VRRD crash rate, about 0.4 percent of all crashes. All of the data sets suggest that the severity of VRRD crashes is less than that of other crashes; moreover, this finding is supported by a lower fatal VRRD crash rate (0.2 percent) yielded by data from the Fatality Analysis Reporting System.

If the VRRD crash rates of 0.2 percent for fatal crashes and 0.4 percent for all other crashes are applied to North American crash statistics for 2001, VRRD can be estimated to cause over 25,000 crashes per year, claiming 81 to 90 lives.

In order to determine the state of the practice in VRRD prevention and removal, two surveys, one focusing on VRRD prevention and the other on road maintenance, were developed for this study and distributed to transportation agencies in the United States and Canada in 2003. The purpose of the prevention survey was to determine what regulations, education, ordinances, legislation, and enforcement programs states and provinces have in place for VRRD prevention. The purpose of the maintenance survey was to determine what programs road authorities have in place to mitigate the impact of VRRD. Responses from the 38 organizations that returned maintenance questionnaires indicate that over 70 percent of these jurisdictions remove VRRD from their roads on a daily basis. In general, the road authorities' maintenance personnel remove debris manually as soon as practical after they have been notified of the debris.

Although the incidence and severity of VRRD crashes are relatively low, VRRD crashes occur, and transportation agencies should consider low-cost approaches to reducing the incidence. The recommended measures are targeted education and enforcement programs, as follows:

- Educating fleet maintenance personnel on preventing wheel separations
- Training enforcement officials in vehicle safety and load securement
- Training commercial vehicle drivers to periodically inspect their vehicles and cargo
- Educating motorists on load securement and reporting unsafe vehicles, unsecured loads, and road debris
- Enacting stricter laws on load securement
- Targeting specific groups for enforcement (e.g., waste haulers, landscapers)
- Educating the public on defensive driving, especially around trucks

Introduction

Anecdotal evidence from around North America suggests that road debris may be a serious highway safety problem. Fatal collisions involving fallen cargo, wheel separations, and other highway debris figure prominently in news headlines. One of the most publicized debris-related crash occurred in November 1998, when film director Alan J. Pakula was killed on the Long Island Expressway by a pipe that had dropped from a truck and been propelled through his windshield.

The public concern about road debris is manifest in a survey conducted by the AAA Auto Club South (Bly, 1999), which revealed that 76 percent of the club's members believe that road debris is a problem on Florida's roads. In an Internet poll conducted by the AAA Foundation for Traffic Safety (2002), over 90 percent of respondents indicated that they consider VRRD to be a somewhat serious or very serious road safety problem (see Table 1).

Road debris includes substances, materials, and objects that are foreign to the normal roadway environment. Debris may be produced by vehicular or nonvehicular sources, but in all cases it is considered litter. In fact, VRRD is recognized as a major form of litter on North American roads. A Washington state litter study (2000), for example, reported that tires constitute the largest category of litter on interstate highways, at nearly 25 percent; metal and plastic automotive parts make up over 8 percent of the litter on interstates, and items associated with motor vehicles or hauling uncovered loads (tires, wood products, other metal and composites, automotive parts, and organic material, such as yard debris, stumps, firewood, branches, and prunings) together make up almost 40 percent of roadside litter.

Vehicle-related road debris (VRRD) can originate from any class of vehicle. For example, VRRD may come from passenger vehicles when drivers inadequately secure excess cargo to the roof, such as mattresses, home furnishings, and building materials. Light, medium, and heavy-duty trucks present additional risk when they have open cargo areas that provide little protection against the loss of payload.

Table 1. Results of AAA Foundation for Traffic Safety Internet Poll on VRRD

Response*	Number of Respondents	Percentage
Very serious	377	61.5
Somewhat serious	185	30.2
Not serious	31	5.1
Not a problem	16	2.6
No opinion	4	0.7
Total	613	100.0

* The question was: “Vehicle-related road debris is material that is unintentionally deposited on the roadway from a vehicle, either from a part of the vehicle or from some cargo (i.e., tire treads, wheels, furniture, ladders, etc.). How serious of a safety problem is vehicle-related road debris?”

VRRD also occurs in the form of vehicle parts that fall or tear off. All vehicles are subject to having parts or equipment break loose. Such debris may be deposited on the road and run over or may bounce off the pavement and strike another vehicle. Blown tires, tire treads, drive shafts, bumpers, hoods, leaf springs, and brake parts have all contributed to serious crashes. At highway speeds, even small debris can be deadly. Items such as hand tools, spare tires, tarps, and tie-down straps can pose a serious danger if they land on a congested highway.

Debris that is deposited on the traveled portion of a roadway temporarily restricts traffic flow and presents a hazard to road users. The transportation community has long recognized these effects of road debris, but it has seriously studied only the congestion and delay effects: the safety impact of debris on North American roadways has not been extensively studied. The paucity of information on the subject was the impetus for this study.

Methods

OBJECTIVES

The goals of this study were to determine the scope and magnitude of the VRRD safety problem, to identify the programs road authorities are using to reduce VRRD and the incidence of VRRD crashes, and to identify additional potential countermeasures. The research focused exclusively on the safety impact of VRRD (i.e., crash occurrence and crash severity), and did not address traffic delay or maintenance issues. The debris investigated was limited to VRRD, defined as material that is unintentionally discharged from a vehicle.

The study was conducted in four parts: a literature review, collection and analysis of safety data, a survey of practices by state and provincial road authorities, and identification of appropriate countermeasures.

The literature review sought to define the current knowledge about the effects of road debris on highway safety and to determine what countermeasures, regulations, and legislation have been enacted or proposed. Crash databases were reviewed to identify those most suitable for the project, and available crash data were compiled and analyzed to determine the magnitude and characteristics of the VRRD safety problem. In addition, two surveys of states and provinces were conducted to identify current practices in the prevention and removal of VRRD from North American highways. On the basis of findings from the research, countermeasures that are appropriate to addressing the VRRD safety problem are recommended.

LITERATURE REVIEW

An exhaustive literature search was conducted to identify studies of the safety impact of VRRD that might help in establishing the magnitude of the problem. Although the literature search focused on the most recent research, it included any reports produced in the past 10 years. Both printed matter and digital information were included. Computer searches of key transportation databases as well as Internet searches using keywords were conducted.

The literature search was begun with broad searches for "road debris," "litter," and "cargo securement." More specific search terms were also used, such as "wheel separation," "tire debris," "flying wheels," and "unsecured loads." The material found was sorted according to safety effects and potential countermeasures.

Few studies that address VRRD and highway safety have been published. Those that have generally fall into one of two categories. In the first category are studies that address the safety effects of "nonfixed objects" on the road and might identify VRRD or some of its components as prevalent types of nonfixed objects. In the second category are studies that were conducted in response to a specifically identified or suspected safety issue and thus deal with only one type of VRRD—fallen cargo, for example.

Objects on the Road

Kahl and Fambro (1995), in research on the minimum visibility to be provided in road design, investigated the incidence of object-related crashes in two states (which were not named in the report) during a one-year period. The object-related crashes were categorized as

Table 2. Object-Related Crashes in Two States

	State 1 (1991)	State 2 (1990)
Number of crashes reported	187,024	153,796
Number of non-fixed-object crashes	523	619
Number of crashes in which evasive action was taken to avoid an object	377	164
Total number of object-related crashes	900	783
Percentage of crashes that were object-related	0.48	0.51
Percentage of non-fixed-object crashes that were in urban areas	54	70
Percentage of non-fixed-object crashes on urban freeways	79	46

animal-related and “other” crashes. The results are presented in Table 2.

The objects that were most commonly found on the roadways were tires, hay bales, car parts, poles (lights or signs fallen across the road), trees or branches, construction barrels, railroad ties, and metal debris. On urban freeways the most commonly found objects were items that had fallen from moving vehicles and poles that had fallen across the road.

Although Kahl and Fambro provide an estimate of the debris-related crash problem, they do not distinguish VRRD from other debris. Therefore, their estimate that debris-related crashes account for about 0.5 percent of all crashes may be considered an upper limit for VRRD crashes; presumably, the actual proportion would be less than that.

In an evaluation of the first object struck in crashes in Connecticut in 1995, Zuckier et al. (1999) determined that 132,918 vehicles were involved in crashes that were reported to the state Department of Transportation. In 14.4 percent of these, a nonvehicle object was reported as the first object struck, and of these, 9.3 percent were nonfixed objects (animals, construction barricades, foreign objects, and impact attenuators such as sand barrels), 9.1 percent were “other” objects, and 2.5 percent were foreign objects on pavement (a subset of the nonfixed objects).

The Zuckier et al. study excluded crashes in which VRRD was successfully avoided by a driver but nevertheless caused the crash. Foreign objects on the pavement were the first object struck by 0.35 percent of all vehicles involved in crashes in Connecticut in 1995.

Retting et al. (2000) undertook a study of motor vehicle crash patterns and contributing factors on four highway bridges in the New York City metropolitan area. The bridges varied in physical properties and operating characteristics. Crash data were collected over a 1-year period for one bridge, a 2-year period for another, and 3-year periods for the other two. The final data set included 1,381 police-reported crashes that occurred on the four bridges, of which 10 percent were debris-related crashes.

This rate is considerably higher than those reported in the Kahl and Fambro and Zuckier et al. studies. This difference may be due to the relatively small sample of bridges Retting et al. used and the variability of the data. In fact, two of the four bridges did not have any debris-related crashes. Alternatively, debris-related crashes may be more prevalent on bridges because of a greater exposure to cross-winds, less room for avoidance maneuvering, and a tendency for the bridges' roadside barriers to keep debris in the roadway. The authors of the study suggest more frequent inspections and removal of debris as potential countermeasures to reduce the incidence of such crashes.

The State of Michigan produces annual reports on motor vehicle crashes that include the number and severity of debris-related crashes (Michigan, 1997, 1998, 1999a, 2000, 2001). Debris crashes in these reports are those for which the field for "road condition" in the completed crash report form is coded as "debris." According to the instructional manual for completing motor vehicle crash report forms (Michigan, 1999b), "debris" is to be used as the road condition when it is the "one most significant condition that applies to the crash." The data on debris-related crashes for the period 1997–2001 are summarized in Table 3.

A road condition of "debris" was coded in 0.1 percent of all recorded crashes in Michigan during the study period. The data also suggest that debris crashes are more likely to result in injuries than other types of crashes in Michigan.

Table 3. Debris Crashes in Michigan, 1997–2001

Year	Number of Crashes		Percentage of Debris Crashes	Percentage of Crashes Resulting in Injuries	
	All Crashes	Debris Crashes		All Crashes	Debris Crashes
1997	425,793	257	0.1	23	30
1998	403,766	276	0.1	23	26
1999	415,675	239	0.1	21	28
2000	424,852	259	0.1	21	26
2001	400,813	265	0.1	20	23
All	2,070,899	1,296	0.1	22	27

The Michigan data do not distinguish VRRD from other types of debris. Moreover, since the estimate of debris-related crashes is based on debris reported as a prominent feature of "road condition," it is not clear whether the total includes crashes caused by VRRD that had been discharged from a vehicle and was still moving. If the VRRD has not come to rest on the road, it is not likely to be considered a 'road condition' and hence would probably not be included in the debris crash count. The instructional manual for filling out traffic crash report forms does not provide any guidance in this regard.

Specific Types of Debris

Tire Debris

Causes. The prevalence of tire debris on North American highways has initiated at least two studies of the causes of such debris. In 1995 and 1998, the Maintenance Council of the American Trucking Associations surveyed tire debris found along 13 roads in nine states to determine the causes of the tire failures. Researchers gathered tire debris, examined it, and determined its source and the probable cause of the failure (Strawhorn, 1999). Their findings include the following:

- 64 percent of the tires were truck tires
- 87 percent of the failed truck tires were retreaded, but retreaded tires were not overrepresented

- 7 percent of the tires examined failed because of a retread problem
- 90 percent of the tire failures examined were caused by underinflation

The Virginia State Police (2000) reported on the causes of tire debris from 27 tires that were recovered from interstate highways and examined by a qualified professional. The researchers found that eight of the tire failures were due to punctures, three were due to underinflation, one was due to the deterioration of age, one was damaged by the dual tire next to it going flat, one failed because of faulty manufacturing, and one failed in a heat-generated blowout; for 12 of the tires, the cause of the failure could not be determined.

Bareket et al. (2000), in a study of tire failures in commercial vehicles, identified maintenance issues as the major causes of tire blowouts—underinflation, overloading, tire mismatching, excessive wear, inadequate inspections, and associated matters leading to increased heat and tire operating temperatures. The researchers also identified road hazards as a contributing factor in tire blowout.

Thus, the literature consistently identifies poor tire maintenance, and in particular underinflation, as the largest single cause of tire debris on North American roads.

Crashes. The number of crashes caused by tire debris has also been investigated. The Florida Center for Solid and Hazardous Waste Management (1998), as part of its annual litter study, identified vehicle and tire debris as the most common litter item on Florida roadsides from 1994 to 1997. The Center also reported that the number of crashes caused by tire debris in Florida rose from 648 in 1993 to 931 in 1996. The source of the crash data is not provided, however.

According to statistics issued by the Florida Department of Highway Safety and Motor Vehicles (1996), the numbers of crashes reported in 1993 and 1996 were 199,039 and 241,377, respectively. Combining the above unconfirmed tire debris crash data with the state crash statistics yields an estimated tire debris crash rate of less than 1 percent of all crashes. If the number of tire debris crashes is normalized for vehicle-miles of travel, the tire debris crash rate is estimated to have increased from 0.5 to 0.7 crashes per 100 million vehicle miles of travel between 1993 and 1996.

In 1999 the Arizona Department of Transportation, in cooperation with the Governor's Office of Highway Safety, sponsored research on the impact of tire debris on highway safety. The final report concluded:

> Tire debris is not a significant safety hazard in Maricopa County or Arizona as a whole. From 1991 to 1998, an annual average of 79 traffic accidents were caused by debris of any kind on Arizona highways. This count represents only 0.07 percent of all Arizona accidents recorded for this period. Traffic accidents attributable to road debris averaged 0.02 percent of all traffic accidents in Maricopa County. Accidents attributable to debris also tend to have lower rates of injuries and fatalities than nearly all other types of traffic accidents. There were no deaths recorded in Maricopa County traffic accidents due to road debris from 1991 to 1998 (Carey, 1999).

Bareket et al. (2000), in part of a study on blowout-resistant tires, attempted to determine the number of crashes that result from tire debris on the highways. The Fatality Analysis Reporting System (FARS) and General Estimates System (GES) databases were examined, along with individual state data from Michigan, Texas, North Carolina, and Washington. The authors found that the data collected could not be used to identify crashes caused by tire debris.

However, in three years of FARS data (1995–1997), 181 fatal crashes were identified in which a driver was "avoiding or swerving due to debris or objects in the road." This figure represents 0.16 percent of the 111,853 fatal crashes that occurred during that period. In their study, however, Bareket et al. did not examine collisions in which a vehicle struck a nonfixed object.

The GES data set includes a variable that indicates whether an object on the road was an immediate cause of the crash. From 1995 to 1997, an estimated 0.53 percent of traffic crashes were caused by an object in the road (no confidence intervals or standard errors were reported). Given that "object in the road" in the GES data set includes all objects, including those thrown or blown onto the road, this estimate can be considered an upper bound for VRRD crashes.

Wheel Separations

Wheel separation is the term used to describe a wheel coming off of the vehicle to which it belongs. Wheel separations are distinct from tire tread incidents in that the tire and the hub break loose from the vehicle rather than just tire material. Truck wheels in particular have been the focus of attention in separation incidents, in part because the mass of truck wheels enable them to cause a great deal of damage.

Causes. The causes of wheel separation have been extensively researched. The Society of Operations Engineers (n.d.) in the United Kingdom investigated wheel separations and concluded that the underlying problem of wheel separations is wheel design. Hagelthorn (1992) determined that the main factor that initiates, contributes to, and causes wheel separations on tractor-trailer combination vehicles in the United States is inappropriate wheel bearing adjustments. Finally, both the National Transportation Safety Board (NTSB) (1992) and the Ontario Ministry of Transportation (Woodrooffe and Warren, 2001) concluded that the primary cause of wheel separations is poor wheel maintenance.

Incidence. The incidence of wheel separations has also been investigated. In a study commissioned by Disc-Lock Europe Ltd. to determine the statistics on heavy vehicle wheel-separation incidents in the United Kingdom, Wright (1992) found that no precise national records existed on such incidents. The only source of data he could find was a set of police records kept for three years on a 43 mile (69 kilometer) section of roadway.

Using extrapolation and various unsubstantiated assumptions, Wright estimated that the number of wheel-separation incidents in the United Kingdom in 1991 falls in the range of 2,100 to 3,200, many of which would be unreported. On the basis of newspaper reports, Wright estimated that the annual number of fatalities from wheel separations is 5 to 10. Given that 236,000 motor vehicle crashes occurred in United Kingdom in 1991, wheel-separation crashes are estimated to be about 1 percent of all crashes. Of these, it is unknown what proportion could be considered VRRD crashes, in which one or more other vehicles crashed as a result of a separated wheel in the roadway.

The purpose of the 1992 NTSB study mentioned above was to study the incidence of medium and heavy truck wheel separations and identify countermeasures. The study was undertaken in response to three wheel-separation crashes in the United States that resulted in five fatalities. The NTSB determined that wheel-separation crashes number 750 to 1,050 annually (0.2 percent to 0.3 percent of all truck crashes).

Countermeasures. Despite its finding that the incidence of wheel separations is low, the NTSB deemed it appropriate to make a number of recommendations to reduce the number further:

- To the American Trucking Associations, in cooperation with the National Wheel and Rim Association, the Motor Vehicle Manufacturers Association of the United States, Truck Trailer Manufacturers Association, and the Society of Automotive Engineers:
  – Develop and disseminate model guidelines for the inspection and maintenance of all types of medium/heavy truck wheels.
  – Develop uniform recommended practices that specify how often truck wheel bearings should be examined.
  – Promote an educational program on proper wheel tightening procedures through carriers, manufacturers, and government.
  – Encourage manufacturers to provide a label on trucks that indicates the recommended torque for wheel fasteners, proper tightening sequence, and recommended frequency for retorquing fasteners.

- To the Federal Highway Administration, in cooperation with the American Trucking Associations, the National Wheel and Rim Association, the Motor Vehicle Manufacturers Association of the United States, the Truck Trailer Manufacturers Association, and the Society of Automotive Engineers:
  – Support the development of an educational program on proper wheel tightening procedures by the carriers and manufacturers.

- To the Department of Transportation:
  - Encourage the states to separate wheel defects from tire defects in future accident data collection efforts (NTSB, 1992).

In 1995 a spate of tractor-trailer wheel-separation crashes in Ontario prompted the Professional Engineers of Ontario (1995) to prepare a brief on this topic. One of the group's main conclusions was that there is a lack of data on wheel-separation crashes, which hindered the investigation. As a result, no attempt was made to quantify the wheel-separation problem. The brief is mainly a collection of expert opinion on wheel separations, with an emphasis on identifying the causes. The group concluded that the main problems associated with wheel separations are rooted in a wide range of arenas, including legislation, maintenance, enforcement and inspection, and mechanical design. Eleven recommendations were offered to reduce the incidence of wheel separations:

1. Statistical and technical data should be made available on request to organizations and individuals with a mandate for public safety.

2. All available wheel-separation accident data should be examined for a correlation between wheel separation and vehicle design issues. Statistics on hub-piloted wheels should be compiled and analyzed.

3. Stud-piloted wheels require a preventive maintenance program and guidelines associated with qualified inspection.

4. Standards of training for maintenance and inspection of heavy-duty vehicles need to be established, upgraded regularly, and regulated. This is particularly true for tire mechanics.

5. Mechanics and inspectors should attend original equipment manufacturer (OEM) and after-market parts manufacturers seminars and study groups, and should pursue other training opportunities.

6. Means of mitigating the effects of corrosion on wheel systems should be developed.

7. Vertical and lateral wheel loads should be estimated on the basis of Ontario weight and dimension regulations; the effect of these loads on trailer performance and highway deterioration should be evaluated.

8. A permanent log book documenting every trailer's service and maintenance history should be mandatory. Failure to maintain and produce such a log should be a punishable offense.

9. There should be a continuing search for substandard, gray market, and counterfeit parts in Ontario—an effort to which the trailer log book will make a significant contribution.

10. Penalties for those identified as having attempted to circumvent maintenance and safety requirements for either tractors or trailers must be sufficiently severe to provide a deterrent.

11. Quality control procedures should be implemented by OEMs and aftermarket parts manufacturers (Professional Engineers of Ontario, 1995).

Unsecured Loads

Burns (1981) examined the effect of road roughness on lost-load crashes on a 9.5 mile section of six-lane interstate highway in Arizona. In a five-year "before" period, Burns found, lost-load crashes were increasing disproportionately with traffic volume and that an increase in road roughness was the cause. Furthermore, the peak times for lost-load crashes were around 11:00 A.M. and 9:00 P.M., when traffic is moderate and speeds relatively high.

A one-mile section of the interstate was smoothed by grinding the pavement, and the number of lost-load crashes in the treated section was then compared with that in a one-mile control section that was matched on pavement roughness, crash record, and traffic volume and with that in the 9.5 mile section, which included the treated section. The analysis used two years of "before" and two years of "after" crash data. The results of the analysis are summarized in Table 4.

Table 4. Lost-Load Crashes on an Interstate Highway in Arizona Before and After Pavement Smoothing

Section of Highway	Lost-Load Crashes			Lost-Load Crash Rate (crashes per million vehicle miles)		
	Before	After	Change (%)	Before	After	Change (%)
Control section (1 mile)	4	72	1,700	0.09	1.25	1,289
Smoothed section (1 mile)	4	35	775	0.07	0.55	686
Study section (9.5 miles)	32	381	1,091	0.06	0.65	983

Burns explained that the markedly higher number of lost-load crashes in the "after" periods of all sites is partly due to an increase in traffic as well as to an increase in the reporting of such crashes because of their costs to motorists and the need to substantiate losses to insurance companies. Despite the limited data available for analysis, Burns concluded that smoothing the pavement reduced the lost-load crash rate by 51 percent.

The magnitude of the lost-load crash problem on this section of interstate highway is illustrated in Table 5. The "before" and "after" percentages of lost-load crashes are well above those identified in other lost-load and VRRD research. Given this differential, along with the substantial increase in the number

Table 5. Percentage of Lost-Load Crashes on an Interstate Highway in Arizona Before and After Pavement Smoothing

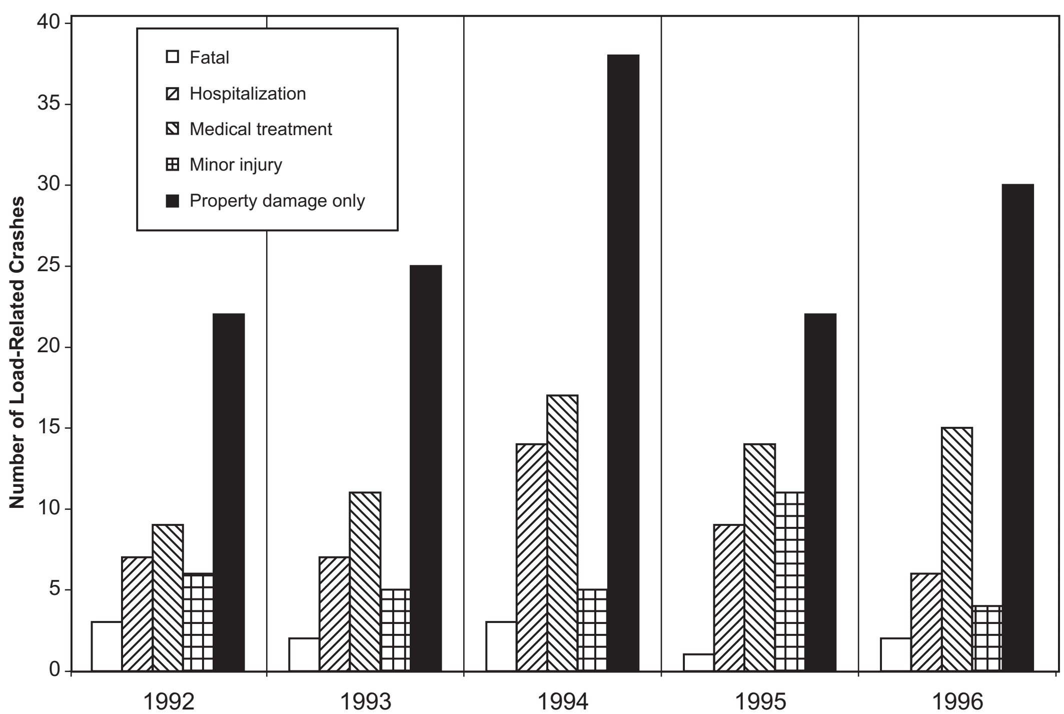
Section of Highway	Lost-Load Crashes		All Crashes		Percentage of Crashes that are Lost-Load	
	Before	After	Before	After	Before	After
Control section (1 mile)	4	72	170	296	2	24
Smoothed section (1 mile)	4	35	84	278	5	13
Study section (9.5 miles)	32	381	876	1,846	4	21

of lost-load crashes from the “before” to the “after” period, the results of the Burns study are suspect.

The Parliamentary Travelsafe Committee of the Legislative Assembly of Queensland, Australia, conducted an inquiry into unsecured loads because of concern over injuries and collisions involving lost and shifted loads (Queensland, 1997). The Committee studied the nature and extent of road safety problems caused by unsecured and improperly secured loads and reviewed the applicable regulations, including compliance and enforcement provisions.

Data on load-related crashes in Queensland, drawn from Queensland Transport’s Road Crash Database, are summarized in Figure 1. Overall, 14,810 crashes occurred in Queensland in 1994 (the year when the incidence of unsecured load crashes was the highest), and 422 of these were fatal. Thus, 0.7 percent of fatal crashes and 0.5 percent of all crashes were load related.

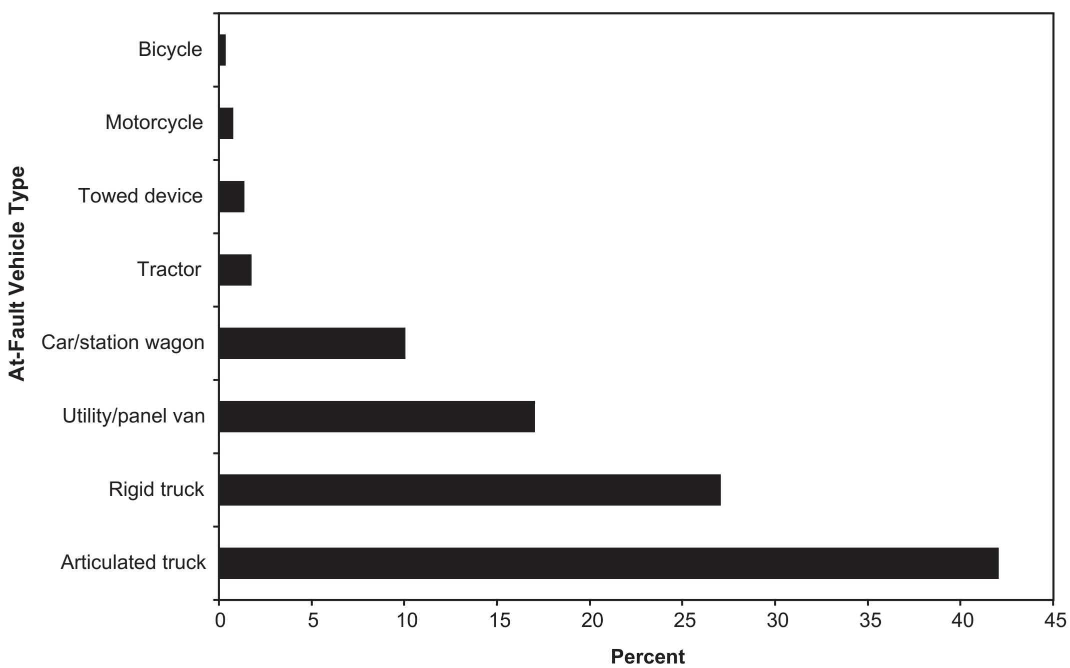
Figure 1. Number of Load-Related Crashes in Queensland



The Queensland study also found that during the study period, 183 casualties resulted from load-related crashes: 11 people were killed, 59 were hospitalized, 76 received medical treatment, and 37 sustained minor injuries. Thus, the number of fatalities was 0.5 percent of all road fatalities, and the total number of casualties was 0.25 percent of all crash casualties.

Figure 2 shows the distribution of types of vehicles that were at fault in load-related crashes during the study period. Trucks and utility vans are overrepresented compared with total vehicle registrations. For instance, trucks account for about 3 percent of the registered vehicles in Queensland but 69 percent of the load-related crashes. This should not be surprising, since these vehicles are intended to carry loads and typically undergo more miles of travel per year than other vehicles.

Figure 2. At-Fault Vehicles in Load-Related Crashes in Queensland



The crash database does not include information on the type of load. However, submissions made to the inquiry by different individuals and groups highlighted the following concerns:

- Loads of sand, gravel, soil, and building debris drew the most criticism.

- Loads being carried on short trips are of particular concern, because the time required to properly secure a load for what is perceived to be a short, low-speed trip becomes a significant proportion of the transport task.

- Incorrect loading of heavy goods, such as steel girders and pipes, is especially dangerous for the vehicle occupants, as load shift can catapult a load forward onto the cabin.

The authors of the Queensland report note that the safety implications of load shifting and load loss are not entirely clear because of underreporting. The complex nature of collisions and the general lack of experience among first-on-scene investigators in dealing with load-related issues contribute to the underreporting. In particular, determining whether a load shift caused or was a consequence of a collision may be difficult to ascertain.

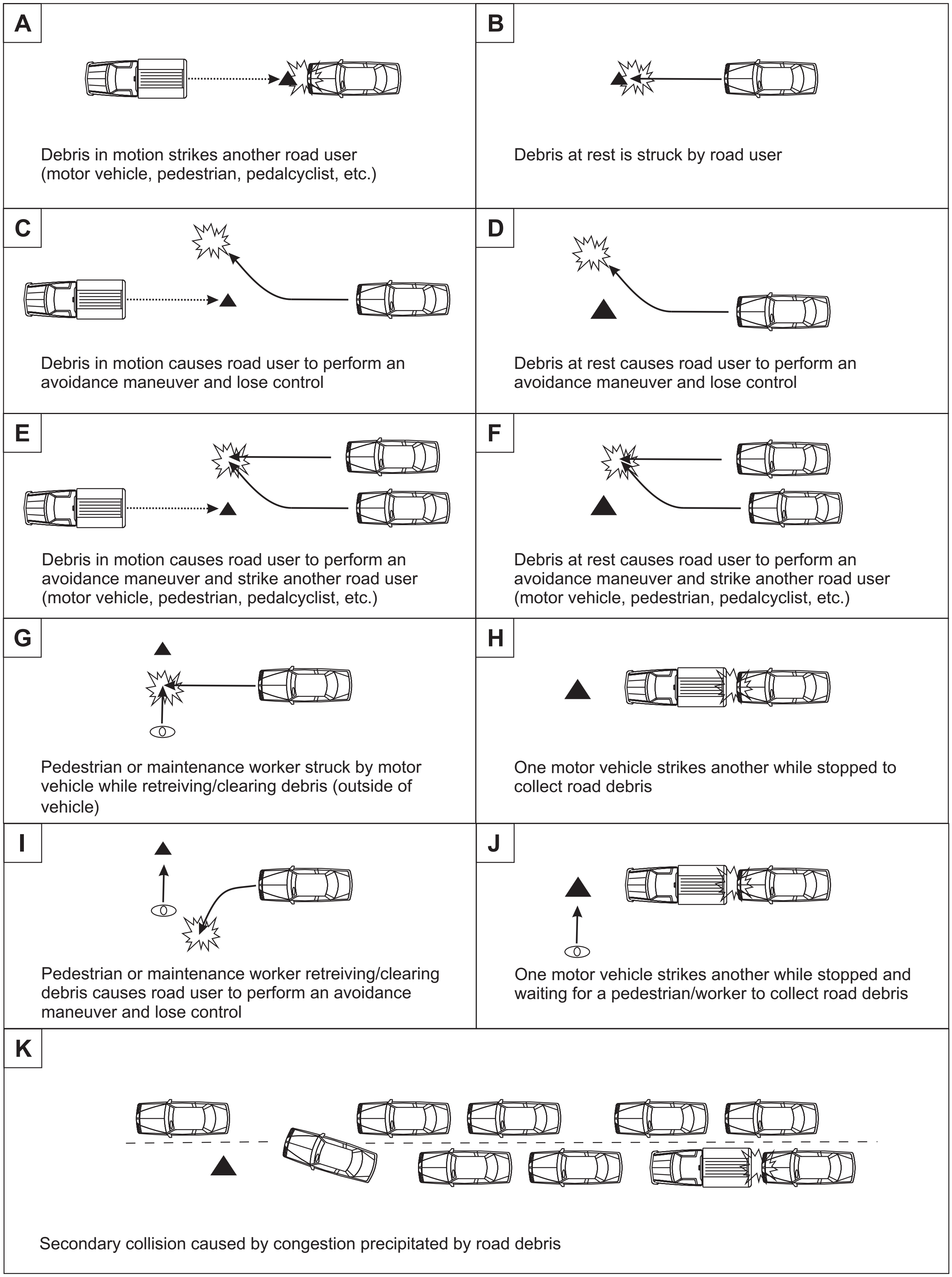
Results

In this section, the crash databases to which the research team was able to gain access are described, and the data they contained on debris-related crashes are analyzed. Next, the findings from two original surveys, one investigating prevention measures and the other maintenance practices, are presented. With the development of countermeasures in mind, supplemental incident data from two jurisdictions are examined.

CRASH DATA

Vehicle-related road debris (VRRD) crashes are crashes in which a vehicle strikes or is struck by VRRD, and crashes in which a vehicle successfully maneuvers to avoid VRRD but the avoidance maneuver results in a crash. The many possible configurations of VRRD crashes are listed in Figure 3. All of the VRRD crash types may be identified through a careful query of crash databases and subsequent review of crash report forms, with the exception of secondary crashes. Because secondary crashes are usually spatially or temporally remote from the VRRD, the VRRD usually is not identified and recorded in the crash investigation.

Figure 3. VRRD Crash Types



VRRD Crashes

The primary databases used to quantify and detail the safety impact of VRRD were national and state or provincial crash databases. Because the scope of research included determining the magnitude of the problem in the United States and Canada, national databases were the primary focus, with state and provincial databases providing supporting information. Insurance claims databases were considered as a possible source of information on debris-related crashes. However, contacts with auto insurers revealed that claims databases do not include crash details that would permit a meaningful analysis.

It became evident early in the study that crash databases generally do not contain data on the source of road debris and obstacles on the road,[1] and therefore VRRD crashes cannot be identified without a review of the narrative, crash diagram, or witness statements. Given this limitation, the research team focused on crash databases for which the database administrators could make the crash narratives available to the researchers.

On a national level, this approach directed the research team to the National Automotive Sampling System Crashworthiness Data Set (NASS-CDS). Despite the lack of information on the source of debris, fatal crash data from the U.S. Fatality Analysis Reporting System (FARS) and the Canadian Traffic Accident Information Database (TRAID) were also pursued because of their national significance.

On the state and provincial levels, inquiries were made of all jurisdictions about gaining access to state- or province-wide crash databases and to individual crash reports as necessary. Maryland and West Virginia were the only jurisdictions that responded positively to the request, and crash data from these jurisdictions were used in the analysis. The motor vehicle crash databases for Alabama and New Jersey are available online and were also used. With the assistance of AAA Michigan, the researchers were also provided with access to a limited amount of crash data from the City of Detroit that proved useful.

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[1] The crash database for the State of Alabama is the only one the researchers encountered that included information on the source of debris.

In summary, the following crash databases were used in determining the magnitude of the VRRD safety problem:

- NASS-CDS (1997–2001)
- U.S. FARS (1999–2001)
- Canadian TRAID (1999–2001)
- States of Alabama (1998–2001), Maryland (1996–2000), New Jersey (2001 and 2002), and West Virginia (1998–2001)
- City of Detroit, Michigan (2001)

Except in the cases of the Alabama, Maryland, and New Jersey data, the VRRD crashes were identified through a review of the description or narrative, the diagram on the individual crash report form, and the witnesses' statements (if available). If the data sources contained conflicting information, the investigating officer's narrative was taken as the primary source of information. When VRRD was identified as a causative factor in a crash, it was classified as cargo or mechanical (a vehicle part including the trailer but not the load) VRRD to assist with the development of countermeasures. Objects for which no source was identified were considered VRRD and were classified as unknown type.

The following subsections include brief descriptions of the crash databases used in this study. For each of the databases, the main finding reported is the number of crashes caused by VRRD and the proportion VRRD crashes are of all crashes. The discussions that follow also cover significant characteristics of VRRD crashes and address the limitations of the analysis.

NASS-CDS

The NASS-CDS is a nationwide crash data collection program that maintains a detailed database of a representative random sample of thousands of tow-away crashes. Field research teams across the United States study 4,000 to 5,000 crashes a year involving passenger cars, light trucks, vans, and utility vehicles. Trained crash investigators visit the crash sites, locate and analyze the vehicles involved, interview crash victims, and review medical records to provide a detailed record of the sampled crashes. Appendix A contains a more detailed description of the CDS program.

For this study, the CDS databases for 1997 to 2001 were queried to determine whether crashes involved a vehicle that struck or was struck by a nonfixed object or whether a nonfixed object was a critical precrash event—as occurs, for example, when a road user successfully avoids an object but crashes immediately afterward as a result of taking evasive action. For cases that met the query criteria, the crash diagram and narrative were reviewed to determine whether the nonfixed object involved was VRRD. Detailed descriptions of the CDS queries are included in Appendix A.

As Table 6 shows, over the five years analyzed, 66 crashes in the CDS database were identified as VRRD crashes, or 0.31 percent of the total number of crashes. Moreover, the number and proportion of VRRD crashes are fairly consistent from year to year.

Table 6. VRRD Tow-Away Crashes in CDS Database, 1997–2001 (Raw Data)

Year	Total Number of Tow-Away Crashes	Observed Number of VRRD Crashes	Percentage of Crashes that involve VRRD
1997	4,376	12	0.27
1998	4,387	13	0.30
1999	4,274	13	0.30
2000	4,307	17	0.39
2001	4,090	11	0.27
All	21,434	66	0.31

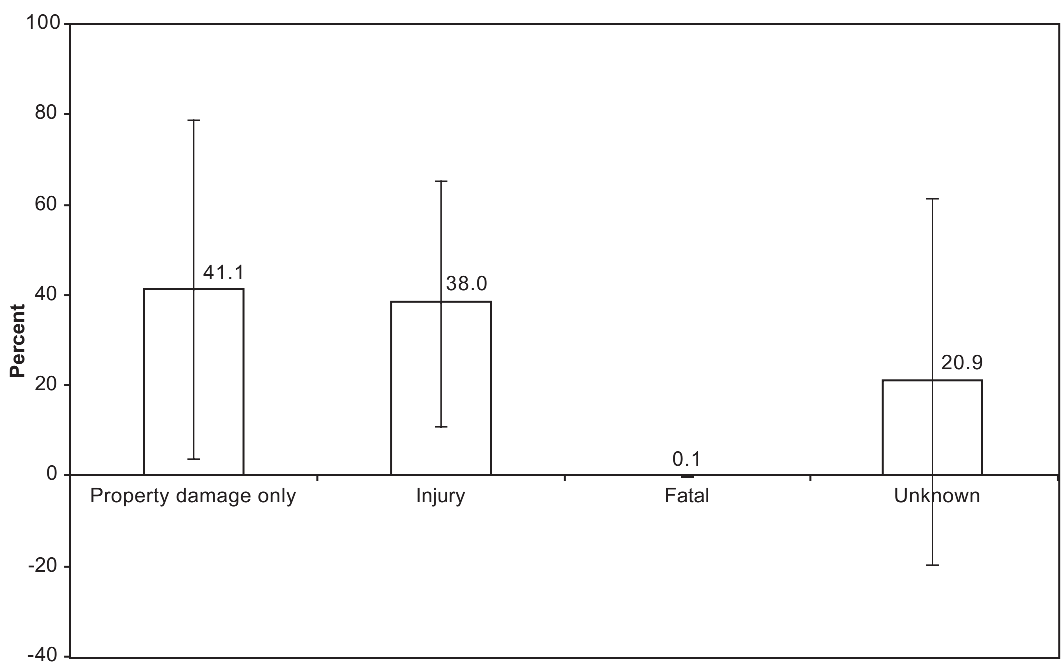
Table 7 presents the same data but this time using weighting factors supplied by the National Highway Traffic Safety Administration's (NHTSA) National Center for Statistics and Analysis. (The weighting factors reflect the probability of a crash's being sampled.) Here, instead of the 4,000 to 4,500 crashes sampled annually, these data reflect the approximately 2.5 million tow-away crashes involving one or more passenger vehicles that occur in the United States annually. The standard errors (SE) were calculated using WesVarPC, a statistical software package designed for data collected using complex sample designs, including multistage, stratified, and unequal probability samples (Westat Inc., 1997). Multiplying the SE by 1.96 and then adding and subtracting this number from the estimate yields the 95 percent confidence limits for each estimate.

Table 7. Estimated VRRD Tow-Away Crashes in the United States, based on CDS Database, 1997–2001 (Weighted Data)

Year	Total Number of Crashes (millions)	Estimated Number of VRRD Crashes	Standard Error	Percentage of Crashes that involve VRRD
1997	2.8	24,985	13,062	0.89
1998	2.6	5,438	2,897	0.21
1999	2.6	2,873	1,302	0.11
2000	2.5	14,128	6,033	0.57
2001	2.5	12,096	8,049	0.48
All	13.0	59,520	17,196	0.46

With the weighted data, the average proportion of VRRD crashes is 0.46 percent, which translates into almost 12,000 tow-away crashes involving VRRD annually. Further analysis of the weighted data indicated that, of these, an estimated 47 are fatal crashes, and 22,616 involve personal injuries. Figure 4 presents the estimated percentages of VRRD crashes by severity.

Figure 4. VRRD Crash Severity from CDS Data with 95% Confidence Intervals, 1997–2001 (Weighted Data)



On the basis of the weighted CDS data, it is estimated that in 21.5 percent (SE=7.0) of the VRRD crashes, the motorist successfully avoided the VRRD only to crash immediately after taking evasive action. In the remaining

78.5 percent (SE=7.0), the VRRD was struck by or struck the road user. The crash narratives reviewed suggest that in the weighted data, 62.6 percent (SE=16.8) of the VRRD crashes involved stationary VRRD and 35.3 percent (SE=16.6) involved VRRD that was still in motion after being discharged; in the remaining 2.2 percent (SE=2.2), it was unclear whether the VRRD was stationary or moving.

It is interesting to note the involved VRRD struck or was struck in 95.3 percent (SE=10.1) of the estimated crashes in which the VRRD was still in motion, and in 68.3 percent (SE=12.8) of the estimated crashes in which the VRRD was stationary.

The weighted data indicate that 44.9 percent (SE=21.0) of the VRRD crashes were caused by fallen cargo, 33.3 percent (SE=17.6) by mechanical debris, and 21.7 percent (SE=8.7) by VRRD of unknown type.

The terms used to describe the VRRD in the crash narratives of the 66 cases identified in the CDS database are as follows:

- Furniture: bed, chair, and a dresser drawer (3)
- Tires: spare tire, tire, tire and rim, tire tread, or wheel (21)
- Trailers: trailer, towed unit, or trailer hitch (5)
- Metal: metal, metal pipe, metal plate, and pipe (4)
- Vehicle part: mud flap, brake drum, and drive shaft (3)
- Other materials: basketball, blanket, boat, box, concrete, forklift, garbage can, oil and sand, rock, toolbox, or wood (12)
- Unknown objects (18)

FARS Data

The FARS database "contains data on a census of fatal traffic crashes within the 50 states, the District of Columbia, and Puerto Rico. To be included in FARS, a crash must involve a motor vehicle traveling on a facility customarily open to the public, and must result in the death of an occupant of a vehicle or a nonmotorist within 30 days of the crash" (NHTSA, 1999). For a more detailed description of FARS, see Appendix B.

Although the FARS database contains nationwide data, the crash reports themselves are available only from the individual state-level jurisdictions. In many cases, this would mean a significant volunteer effort by state staff to retrieve the crash reports. Hence, in an effort to balance the burden on state staff with the collection of a significant crash database, the FARS database was queried only for three years of crash data (1999–2001). After possible VRRD crashes were identified in the database, the appropriate state-level departments were contacted with requests for access to the individual crash reports.[2]

The database was queried to determine whether crashes involved a vehicle that struck or was struck by a nonfixed object or whether a maneuver to avoid a nonfixed object was a critical precrash event, such as when a motorist successfully avoids an object but then crashes. Detailed descriptions of the FARS queries are listed in Appendix B.

The FARS database query identified 1,164 crashes that might have been caused by VRRD in all 50 states, the District of Columbia, and Puerto Rico. Each state-level jurisdiction was contacted and asked to provide the crash report forms for the identified crashes, to extract and provide the narrative from the crash report form, or to review the narrative or description and indicate what debris, if any, was involved in the crash and what its source was. If the source of the debris was not mentioned, the debris was assumed to be VRRD unless it was an animal carcass or a work zone traffic control device.

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[2] Initially, the National Highway and Traffic Safety Administration (NHTSA) was contacted to coordinate efforts to assemble FARS data. Because of other priorities and staff shortages in some states, however, NHTSA could not formally support this study but did not object to the research team's pursuing this data by contacting the individual states.

Table 8. VRRD Crashes in FARS Database, 1999–2001 (Data from 31 Jurisdictions)

State	Number of Fatal Crashes	Number of Fatal VRRD Crashes	Percentage of VRRD Crashes
AK	239	1	0.4
AZ	2,733	5	0.2
CT*	603	0	0.0
DE	324	0	0.0
DC	144	0	0.0
FL	8,076	17	0.2
HI	337	0	0.0
ID	711	2	0.3
IN	2,499	3	0.1
IA	1,207	2	0.2
KS	1,294	1	0.1
LA	2,537	4	0.2
ME	495	1	0.2
MD	1,694	5	0.3
MI*	2,443	2	0.1
MN	1,632	1	0.1
MO	2,928	13	0.4
MT	598	1	0.2
NE	712	0	0.0
NJ*	1,344	0	0.0
NM	1,186	1	0.1
ND	268	0	0.0
OK	1,779	6	0.3
OR	1,202	2	0.2
SD	440	1	0.2
TX	9,662	33	0.3
UT	895	0	0.0
VA	2,501	6	0.2
WV	1,062	1	0.1
WI	2,074	3	0.1
WY	449	1	0.2
Total	54,068	112	0.2

* These states did not have 1999 crash report forms available for review.

A total of 30 states and the District of Columbia responded positively to the request for access to, or a review of, the individual crash report forms,[3] providing information on 496 of the 1,164 potential VRRD crashes (43 percent).

[3] Three of the 30 jurisdictions did not provide crash data for 1999.

A review of these report forms indicated that 112 of the fatal crashes in the 31 jurisdictions over the three-year study period were caused by VRRD. As Table 8 shows, the incidence of fatal VRRD crashes is highly variable: more than half of all fatal crashes in the 31 jurisdictions occurred in three states, and about 70 percent of the jurisdictions had zero or one fatal VRRD crash per year. Overall, crashes caused by VRRD constituted 0.21 percent of the fatal crashes in these jurisdictions.

Thirty-eight percent of the VRRD was identified in the crash reports as lost cargo and 38 percent as dislodged vehicle parts (including trailers that separated from towing units); 24 percent of the debris was not described in sufficient detail to determine the source. The VRRD types that caused the largest number of fatal crashes were as follows:

- Unknown debris or objects (22 percent)
- Separated trailers (15 percent)
- Wheels or tires (13 percent)
- Tire treads (7 percent)
- Metal (6 percent)

Of the 213 vehicles involved in the fatal VRRD crashes, no driver-related factors were listed in the crash reports for 111 drivers. Of the remaining 102 drivers, the driver-related factors that were mentioned five or more times are listed in Table 9.

Table 9. Driver-Related Factors in Fatal VRRD Crashes

Factor	**Percentage of Drivers**
Avoiding, swerving, or sliding because of debris or objects in road	45
Failure to keep in proper lane or running off road	38
Overloading or improper loading of vehicle with passengers or cargo	12
Driving too fast for conditions or in excess of posted speed limit	11
Other non-moving traffic violations	7
Hit and run	7
Inattentive (talking, eating, etc.)	6
Operating without the required equipment	6
Operating vehicle in an erratic, reckless, careless, or negligent manner, or operating at erratic or suddenly changing speeds	6

The chi-square test was used to identify crash elements that were significantly different at a 95 percent confidence level in fatal VRRD crashes as compared with other fatal crashes. The following environmental factors were overrepresented in fatal VRRD crashes:

- Speed limit: 27 percent of all fatal crashes occurred on roads where the speed limit was greater than 55 mph, compared with 63 percent of fatal VRRD crashes.

- Time of day: 50 percent of all fatal crashes occurred between 6:00 A.M. and 6:00 P.M., compared with 69 percent of fatal VRRD crashes.

- Road type: 53 percent of all fatal crashes occurred on arterial roads, compared with 81 percent of fatal VRRD crashes.

- Trucks: Heavy or medium trucks constituted 9 percent of vehicles involved in all fatal crashes, compared with 27 percent of vehicles involved in fatal VRRD crashes.

Canadian Fatal Crash Data

National crash data for Canada are collected and maintained in the Traffic Accident Information Database (TRAID). On contacting Transport Canada to discuss the use and suitability of TRAID for this study, the research team learned that, like FARS in the United States, the Canadian national database is insufficient by itself to identify VRRD crashes. Furthermore, data elements that might serve as good indicators of VRRD crashes (e.g., road condition coded as “obstruction”) are not collected by all Canadian jurisdictions. Given the shortcomings of the national database, the researchers contacted each province and territory individually, much as they did in the FARS search. See Appendix C for a brief description of TRAID.

Each jurisdiction’s crash report form was reviewed, and crash database queries were developed for each jurisdiction. Every Canadian province and territory was then asked to use the database queries to identify potential fatal VRRD crashes that occurred between 1999 and 2001. All jurisdictions complied with the request for crash data except the province of Newfoundland and Labrador.

Jurisdictions whose crash databases contained potential VRRD crashes were asked to provide the individual crash report forms related to the potential VRRD crashes, to extract and provide the narrative from the crash report form, or to review the narrative or description and indicate what debris, if any, was involved in the crash and what its source was.

Ontario and Quebec queried their databases but did not provide reviews of the narratives. The database queries in Alberta and British Columbia identified several potential VRRD crashes, but some of these did not have an associated crash narrative, which made it impossible to determine whether they were VRRD crashes. In all cases, a potential VRRD crash was considered to be a VRRD crash if the narrative was unavailable to verify the source of the debris.

Table 10 provides the best estimate of fatal VRRD crashes in Canada from 1999 to 2001, given the available information.

Table 10. Fatal VRRD Crashes in Canada, 1999–2001

Province or Territory	VRRD Crashes
Alberta	5
British Columbia	2
Manitoba	0
New Brunswick	0
Newfoundland and Labrador	Unknown
Northwest Territories	0
Nova Scotia	3
Nunavut	0
Ontario	13
Price Edward Island	0
Quebec	7
Saskatchewan	0
Yukon	0
Total	30

During the three-year study period, 7,635 fatal crashes occurred in Canada. Taking into account the missing information from Newfoundland and Labrador, VRRD crashes are estimated to constitute 0.39 percent of the fatal crashes in Canada. Because more specific information could not be obtained on the potential VRRD crashes in Ontario and Quebec, this percentage is considered to be high.

State of Alabama

In Alabama, the source of material on the roadway that is instrumental in a crash is routinely recorded by the investigating officers. The Alabama Uniform Traffic Accident Report Form includes a field that specifies whether material on the road was a contributing factor in the crash, and a second field identifies the source of the material, if known. For both fields, the possible responses officers can use are specified. For instance, the permissible responses for material in the road are: None, Rocks, Trees/limbs, Dirt, Gravel, Oil/petrol, and Other. The permissible responses for the source of material in the road are: Not applicable, Natural environment, Dropped from vehicle, Already in road but fell from vehicle, Other, and Unknown. Although the crash report form manual does not define the distinction between "dropped from a vehicle" and "already in the road," the first very likely indicates that the material had just been discharged and is still in motion, and the second refers to material that had come to rest before being struck.

The Alabama data set is accessible through the Critical Analysis Reporting Environment (CARE), which was designed to give decision makers in the traffic and aviation safety communities "direct access to accident and incident information" (Alabama, 2003). CARE was developed by the Department of Computer Science at the University of Alabama in response to the problem-identification needs of the Traffic Safety Section of the Alabama Department of Economic and Community Affairs. The desktop module of CARE, version 7.0, was used in conjunction with Alabama crash data from 1998 to 2001.

Database queries (see Appendix D) were used to identify VRRD crashes on the basis of accident-level and vehicle- or unit-level data for the four-year study period. Table 11 summarizes the findings.

Table 11. VRRD Crashes in Alabama, 1998–2001

Year	Number of Crashes	Number of VRRD Crashes	Percentage of all crashes that are VRRD Crashes
1998	138,400	1,341	0.97
1999	137,723	1,244	0.90
2000	132,626	1,310	0.99
2001	133,739	1,283	0.96
All	542,488	5,178	0.95

VRRD crashes in Alabama from 1998 to 2001 have consistently constituted about 1 percent of all crashes. This proportion is markedly higher than the 0.2 percent and 0.5 percent determined in the analyses of the FARS and CDS data, respectively. The likely reason for this difference is that the "material in roadway" field is associated with each vehicle, so both crash debris and material intentionally thrown from a vehicle are included in the Alabama VRRD data. For example, if a crash involving two vehicles results in the detachment of a vehicle part that is then struck by a third vehicle, the third vehicle will be recorded as having struck "other" material in the road that fell from a vehicle. This type of debris is a consequence of an earlier crash and not the cause of a crash, and is hence "crash debris" and not VRRD. Without a review of the crash report form, these extraneous crashes cannot be identified and removed from the VRRD crash set.

Because the Alabama data set is a census of all reported crashes rather than a sample of crashes with certain characteristics (a limitation of the FARS and CDS data), the crash severity distribution of VRRD crashes was analyzed. As Table 12 shows, VRRD crashes are generally less likely than others to produce personal injuries.

Table 12. VRRD Crash Severity in Alabama, 1998–2001

Crash Severity	VRRD Crashes N (%)	Other Crashes N (%)
Property damage only	4,786 (92.4)	414,524 (76.4)
Injury	382 (7.4)	124,202 (22.9)
Fatal	10 (0.2)	3,762 (0.7)

Selected characteristics of VRRD crashes were compared with those of non-VRRD crashes in Alabama to develop some understanding of the people and vehicles involved and the environmental conditions under which VRRD crashes occur. Chi-square testing was used to determine the statistical significance (at a 95 percent confidence level) of any differences.

Four distinct characteristics of the driving environment were overrepresented in the VRRD crash group:

- 61 percent of the VRRD crashes took place in rural areas, compared with 29 percent of non-VRRD crashes

- 73 percent of VRRD crashes occurred during clear weather, compared with 63 percent of non-VRRD crashes

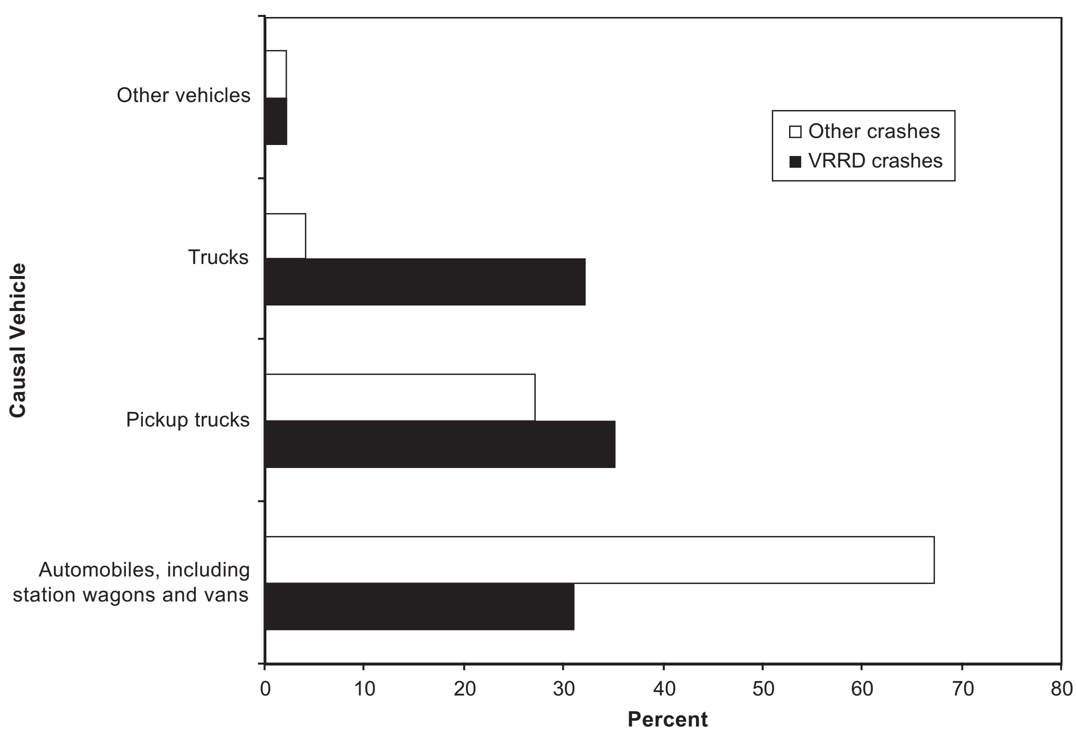
- 47 percent of VRRD crashes occurred on interstate highways, compared with 8 percent of non-VRRD crashes

- 70 percent of VRRD crashes took place in “open country,” compared with 29 percent of non-VRRD crashes

It is likely that clear weather is overrepresented in VRRD crashes because the transport of uncovered cargo, which is more susceptible to being discharged, generally takes place during favorable weather.

In the Alabama data, a causal vehicle is identified for each crash. As Figure 5 shows, trucks and pickup trucks were more likely to be the causal vehicle in VRRD crashes than in other crashes.

Figure 5. Causal Vehicle in Alabama Crashes, 1998–2001



The driver of the causal vehicle in VRRD crashes was more likely to be a male (79 percent of the VRRD crashes, compared with 59 percent of non-VRRD crashes). The age distributions for the VRRD crashes were similar to those of non-VRRD crashes.

As noted, the Alabama VRRD crash data distinguish between material that has been dropped from a vehicle and material that was already in the road but fell from a vehicle. Of the vehicles involved in crashes in which VRRD was recorded as having a role, 54.8 percent encountered material that was dropped from a vehicle, and 45.2 percent encountered material that was in the road but fell from a vehicle.

State of West Virginia

The West Virginia Department of Transportation made available crash data from 1998 to 2001, along with sanitized crash report form narratives. The West Virginia crash database was queried for crashes in which "other nonfixed object" was cited in the sequence of events or as the most harmful event. The identified records were then reviewed to determine whether the crash was caused by VRRD. Debris for which the source could not be determined was included in the VRRD data set.

The review identified 740 VRRD crashes over the four-year period (see Table 13). If a single piece of VRRD was a cause of multiple crashes, each crash was counted separately. Overall, VRRD crashes accounted for 0.38 percent of all crashes that occurred in West Virginia during the study period, averaging 185 VRRD crashes annually.

Table 13. VRRD Crashes in West Virginia, 1998–2001

Year	Total Number of Crashes	Number of VRRD Crashes	Percentage of Crashes that are VRRD
1998	47,460	120	0.25
1999	49,364	203	0.41
2000	51,305	221	0.43
2001	48,881	196	0.40
All	197,010	740	0.38

The 740 VRRD crashes were further examined to identify any salient characteristics and trends. First, the severity distribution of the VRRD crashes was compared with that of all crashes in West Virginia in 2000.[4] The results, shown in Table 14, indicate that VRRD crashes tend to be less severe than other crashes in West Virginia.

Of the VRRD crashes for which the narrative was available for review, 51 percent involved cargo debris, 40 percent involved mechanical debris, and 9 percent involved debris whose source could not be identified but that likely dropped from a vehicle. One of the weaknesses of this analysis is that the debris is sometimes identified only through witness statements (particularly on the property-damage-only crashes). Involved parties may, for example, erroneously classify lost cargo as vehicle parts or make other errors in describing the debris.

Table 14. VRRD Crash Severity in West Virginia, 1998–2001

Crash Severity	Percentage of Crashes	
	VRRD Crashes	All Crashes
Property damage only	87.0	65.9
Injury	12.9	33.4
Fatal	0.1	0.7

In the West Virginia data set the VRRD crashes are overrepresented on interstate highways: 54 percent occur on interstates, compared with 9 percent of all crashes.

State of Maryland

The State of Maryland responded to the request for crash data with limited but useful information. In Maryland's crash report form, four fields for each involved vehicle are available to record circumstances that contributed to the crash. "Debris or obstruction" is one of the codes that may be used in these

[4] The 2000 data were the only data readily available for comparison purposes.

fields. The Maryland Office of Traffic and Safety queried the database for crashes that occurred in the 1996–2000 period in which this code was listed as the first or second contributing circumstance. The results are summarized in Table 15.

Table 15. Debris Crashes in Maryland, 1996–2000

Year	Number of Crashes		Percentage of Debris Crashes	Percentage of Crashes Resulting in Injuries	
	All Crashes	Debris Crashes		All Crashes	Debris Crashes
1996	99,348	461	0.46	43	34
1997	96,121	375	0.39	42	32
1998	94,039	379	0.40	41	34
1999	97,012	435	0.45	40	35
2000	99,302	407	0.41	39	37
All	485,822	2,057	0.42	41	34

Once again, this information does not separate VRRD from other types of debris and thus can only serve as an upper limit to an estimate of the extent of VRRD crashes. Nonetheless, the fact that debris-related crashes are less than 1 percent of all crashes and that debris crashes tend to be less severe than other crashes is consistent with the results from elsewhere.

Some trends could be discerned in the Maryland data:

- Debris crashes are overrepresented on interstate highways: 33 percent of debris crashes occur on interstate highways, compared with 8 percent of all crashes.

- Debris crashes are more likely to involve male drivers: 65 percent for debris crashes, compared with 53 percent for all crashes.

State of New Jersey

The State of New Jersey maintains a crash database on the Internet that can be accessed and used for basic research purposes. The New Jersey crash database includes a field for each involved vehicle in which a contributing circumstance can be recorded. “Obstruction/debris on road” is one of the codes that may be used in this field. The 2001 and 2002 databases were queried for crashes in which this code was listed as a contributing circumstance. The results, shown in Table 16, indicate that 0.66 percent of crashes involved at least one vehicle for which a contributing factor of the crash was debris on the road. In addition, the debris-related crashes tended to produce fewer personal injury crashes than other crashes in New Jersey.

Table 16. Debris Crashes in New Jersey, 2001 and 2002

Year	Number of Crashes		Percentage of Debris Crashes	Percentage of Crashes Resulting in Injuries	
	All Crashes	Debris Crashes		All Crashes	Debris Crashes
2001	312,697	2,102	0.67	26	21
2002	319,980	2,068	0.65	26	19
All	632,677	4,170	0.66	26	20

As in the case of Maryland, the New Jersey data do not distinguish VRRD from other types of debris and thus can only serve as an upper limit to an estimate of the extent of VRRD crashes. The data indicate that debris crashes are overrepresented on roads with a posted speed limit greater than 50 mph (41 percent of debris crashes, compared with 10 percent of all crashes).

City of Detroit

Crash data from the State of Michigan were made available to the research team through AAA Michigan, with permission from the Michigan State Police. Databases containing all crashes that occurred in Michigan between 1998 and 2001 were made available. However, only crashes within the City of Detroit in 2001 that were investigated by the City of Detroit Police Services were used, because only these came with ready access to the individual crash reports. Appendix E contains the database queries used.

A total of 29,492 crashes were reported to the Detroit Police in 2001. Only eight of these were identified as having been caused by VRRD, and for four of the crashes, the source of the debris was unknown. Thus, including the debris of unknown source in the VRRD crashes, 0.04 percent of crashes in Detroit in 2001 were caused by VRRD.

The frequency of VRRD crashes in Detroit is considerably lower than in the other databases investigated, probably because VRRD crashes, according to other crash data, are more likely to occur on interstate highways. Although the City of Detroit Police are permitted to respond to crashes on interstate highways, they are more likely to respond to crashes on the municipal street system, while the Michigan State Police report the majority of those on the interstate roads.

Secondary Crashes

It has been well documented that disruptions in the normal flow of traffic increase the risk of crashes upstream of the disruption (Minnesota [1982], Volpe [1995]). It follows, then, that when VRRD is deposited on the roadway, there is an indirect safety impact upstream. Crashes that occur upstream immediately after an incident (such as VRRD being deposited on the roadway) are termed secondary crashes. In determining the safety impact of VRRD, the potential for a VRRD incident[5] to cause a remote upstream or secondary crash must be considered.

The incidence of secondary crashes is difficult to measure directly, because the precipitating event may be distant from the secondary crash or may have been stabilized before the secondary crash occurred. Unless the primary and secondary events are close in both distance and time, it is unlikely that the investigating agency will associate the secondary crash with a downstream incident. Thus, secondary crashes caused by VRRD cannot be identified by examining crash reports and databases, and the number of secondary crashes caused by VRRD must be estimated indirectly.

Although it is well known that secondary crashes result from roadway incidents, research on the rate of secondary crash occurrence has been limited. A review of the literature on secondary crashes revealed that the indirect estimates that have been made have all used a similar methodology. In these stud-

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[5] An incident is any non-recurrent event that causes a reduction of roadway capacity or an abnormal increase in demand. Incidents may be predictable (e.g., a scheduled maintenance activity) or unpredictable (e.g., lost cargo). Major incidents are those that last longer than 30 minutes and block one or more travel lanes.

ies, crashes are deemed to be secondary crashes when they are spatially and temporally linked to a primary event. For example, a crash might be categorized as a secondary crash if it occurs upstream of the primary event, is within 1 mile of the primary event, and occurs after the primary event but no later than 15 minutes after the primary event has been cleared. With some variations in the spatial and temporal parameters used, researchers estimate that secondary crash rates range from 5.7 percent to 35 percent of all crashes (Table 17).

Table 17. Secondary Crash Rates

Study	Secondary Crash Rate
Owens (1978)	17 percent of crashes related to an earlier incident
Raub (1997)	15.5 percent of crashes are secondary crashes
Sinha et al. (1998)	35 percent of crashes are secondary crashes, and 2 percent of all incidents are secondary crashes
Ran et al. (2000)	9.4 percent of crashes are secondary to a downstream crash
Comsis (1996)	5.7 percent of crashes are secondary to a downstream crash

These results are subject to some limitations. All of the research cited focused on freeways and arterial roads. The Owens and Raub studies included observation periods of less than 30 days and thus may not be representative of the entire range of seasons and operating conditions. The majority of the research has linked secondary crashes to primary crashes, and not to incidents. VRRD that causes a traffic backup (an incident), but does not cause a *primary* crash may still cause a secondary crash within the traffic queue. In the Sinha et al. study, the authors estimated that 2 percent of freeway incidents cause secondary crashes.

Secondary crashes were not accounted for in the VRRD Crashes section above. Because national estimates of VRRD incidents are not available, there is no reliable way of estimating the number of crashes that are secondary to a VRRD incident. However, available data suggest that the incidence of non-crash-producing VRRD incidents is significantly greater than the incidence of VRRD crashes, so these secondary crashes are a significant but unaccounted component of the safety impact of VRRD.

For example, in a study of freeway service patrols in the United States, Fenno and Ogden (1998) identified 6,592 annual debris incidents on five freeway systems in metropolitan areas (Table 18). The authors did not identify the source of debris and hence did not differentiate VRRD from other types of debris. However, since only vehicular traffic is permitted on freeways, the debris encountered will generally be from a vehicular source. If Sinha et al.'s estimated 2 percent is applied to this limited data, we can estimate that about 132 secondary crashes might be caused by the 6,592 annual incidents on the five roadways examined the Fenno and Ogden study.

Table 18. Incidence of Debris Incidents on U.S. Freeways

Location	Length of Road Patrolled, km (miles)	Time of Operation (hrs/day)	Annual Number of Incidents	Percentage of Incidents that are Debris	Annual Number of Debris Incidents
Chicago, IL	127 (80)	24	100,000	5	5,000
Detroit, MI	68 (42)	10	7,080	3	212
Fresno, CA	35 (22)	4	1,650	3	50
Houston, TX	270 (168)	16	33,500	2	670
Pittsburgh, PA	42 (26)	6	6,000	11	660
Total			148,230		6,592

The implication is that VRRD incidents that do not cause an immediate crash may produce a significant number of secondary crashes. However, because these secondary crashes are temporally and spatially remote from the debris incident, they are not likely to be recorded as having been caused by VRRD. Based on the limited data from five monitored sections of U.S. freeways, it is likely that the number of secondary crashes caused by VRRD incidents is sizable.

Crash Data Discussion

It is difficult to determine precisely the proportion of crashes that are caused by VRRD, because the source of nonfixed objects on the road typically is not recorded on crash report forms. Nevertheless, the crash data assembled and analyzed in this study, which we believe is the most extensive data collected on the subject, consistently indicate that VRRD is a causative factor in less than 1 percent of all crashes. This proportion is consistent with the findings gleaned from the literature review. Table 19 lists the best estimates of VRRD crash rates

Table 19. VRRD Crash Rates in the Literature and in This Study

Source	VRRD Crash Rate (% of all crashes)	Comments
Other Studies		
Kahl and Fambro, 1995	0.5	Includes all debris
Zuckier et al., 1999	0.35	Includes all debris
Retting et al., 2000	10.0	Limited data set from four bridge locations
Michigan (1997–2001)	0.1	Includes all debris, but probably does not include VRRD that has not come to rest
Data Analyzed in This Study		
CDS Data (1997–2001)	0.46	Tow-away crashes involving at least one passenger vehicle
FARS Data (1999–2001)	0.21	Fatal crash data only
TRAID Data (1999–2001)	0.39	Fatal crash data only
Alabama (1998–2001)	0.95	Includes crash debris and debris intentionally thrown from vehicles
West Virginia (1998–2001)	0.38	No comments
Maryland (1996–2000)	0.42	Includes all debris
New Jersey (2001 and 2002)	0.66	Includes all debris
Detroit, MI (2001)	0.04	Does not include high-speed roads, where VRRD crashes are overrepresented

from other research and from the data sets analyzed in this study.

The CDS and West Virginia data sets, which were given the most thorough review, provide the best estimates of the VRRD crash rate. On the basis of these estimates, VRRD crashes in North America can be estimated to constitute about 0.4 percent of all crashes.

The lower VRRD crash rate of 0.21 percent calculated from the fatal crash data in the FARS database is not unexpected, as the analyzed data also suggest that VRRD crashes tend to be less severe than other crashes. In the Michigan data, an exception to this trend, VRRD crashes were generally more severe than other crashes. The reason for the Michigan anomaly is uncertain, but it may be because the Michigan VRRD crashes are identified through road conditions, and many of the less severe, single-vehicle VRRD crashes are unreported.

The safety impact of VRRD on Canadian highways can only be estimated from some limited fatal crash data at 0.39 percent of all crashes. This estimate is higher than that derived from the U.S. FARS data, but because of the small number of fatal VRRD crashes in Canada (30 over 3 years), the Canadian estimate is not considered reliable.

National VRRD Crash Estimates

According to NHTSA (2002) and Transport Canada (2003) statistics, in 2001 there were over 6.3 million motor vehicle crashes in the United States, and 154,000 fatal and injury-producing crashes in Canada. Using the above estimates of 0.4 percent of nonfatal crashes and 0.2 percent of fatal crashes caused by VRRD, the 2001 national VRRD crash totals can be estimated at 25,217 crashes in the United States and 612 casualty crashes in Canada (see Table 20).

Table 20. Estimated National Statistics for VRRD Crashes in 2001

Crash Type	Percentage of VRRD Crashes	United States		Canada	
		2001 Totals	Number of VRRD Crashes	2001 Total	Number of VRRD Crashes
Fatal	0.2	37,795	76	2,433	5
Injury	0.4	2,003,000	8,012	151,835	607
Property damage only	0.4	4,282,205	17,129	—	—
All		6,323,000	25,217	154,268	612

These national estimates do not take into account secondary crashes that may have been caused by VRRD. While previous research has produced estimates in the range of 6 percent to 35 percent for the proportion of freeway crashes that are secondary to a downstream crash, it has also determined that some 2 percent of freeway incidents precipitate secondary crashes. There are no national estimates for VRRD incidents from which to reliably estimate the number of secondary crashes caused by VRRD incidents. Nonetheless, it is known that VRRD incidents are common on urban freeways, and the data suggest that crashes that are secondary to non-crash-producing VRRD incidents are a significant part of the safety impact of VRRD.

VRRD causes far fewer crashes than many other causative factors, such as speeding and impaired driving, and hence it may not be a significant road safety issue. However, the fact that VRRD likely causes over 25,000 crashes per year and on average claims 80 to 90 lives per year[6] is reason enough to examine the circumstances surrounding VRRD crashes and to determine whether they can be effectively addressed through commensurate countermeasures.

PREVENTION AND MAINTENANCE PRACTICES

In order to determine current practices related to VRRD prevention and removal, two surveys were developed and distributed in 2003. The first survey

was sent to legislators and enforcement personnel to determine what VRRD prevention strategies were in place (the prevention survey); the second was sent to maintenance personnel to determine what VRRD removal practices were being used (the maintenance survey). Both surveys will be helpful in the development of VRRD crash countermeasures.

The prevention survey was distributed to all 50 states, the District of Co-

[6] According to U.S. national crash statistics (NHTSA, 2002), a fatal crash results in an average of 1.11 fatalities.

lumbia, Puerto Rico, and the 10 Provinces and three Territories of Canada. The maintenance survey was distributed to the above-mentioned road authorities as well as metropolitan planning organizations, counties, and municipal road authorities through the American Public Works Association, the U.S. Department of Transportation, and the Institute of Transportation Engineers electronic mailing lists.

When the surveys were originally distributed in February 2003, they included questions on the perceived safety impact of VRRD and the programs and measures that are in place to mitigate the impact. The response rate was extremely low, however. A follow-up investigation revealed that some nonresponding agencies did not collect crash data specific to VRRD; the individuals who might have completed the questionnaire were uncomfortable about providing an opinion on the safety impact of VRRD and therefore chose not to respond.

To increase the response rate, the perceived safety impact questions were removed, and both surveys were redistributed to the nonresponding states, provinces, and territories in August 2003.

Twenty-five completed prevention surveys were received from the state or provincial agencies (16 from U.S. agencies and nine from Canadian agencies).

Thirty-eight completed maintenance surveys were received, 30 of which were completed by state or provincial agencies; 27 surveys of these were from U.S. agencies, and three were from Canadian agencies. Eight surveys were completed by local government road authorities—four each from U.S. and Canadian jurisdictions.

This section presents the major findings from the two surveys.

Prevention Survey

The purpose of the prevention survey was to determine what regulations, ordinances, legislation, and education and enforcement programs states and provinces have in place for VRRD prevention. The questionnaire is reproduced in Appendix F. Responses were received from 25 transportation agencies (see Appendix G), yielding a response rate of 38 percent. The survey responses are summarized in a series of tables in this section and are presented in more detail in Appendix G.

Of the prevention survey respondents, 11 were from state police, 11 were from departments of transportation, and 3 were from other agencies. The jurisdictions that responded ranged in population from 30,000 to 16,713,000, with a mean of 4,339,453 and a median of 2,700,000. Three respondents did not provide population information.

Programs

Some form of an education program on vehicle safety or load securement is offered by 68 percent of the responding jurisdictions. Vehicle inspection and cargo securement training for commercial drivers are the most popular education programs among respondents, although only 40 percent offer such programs. Flyers and public service announcements are the next most popular education programs, offered by 32 percent and 20 percent of the respondents, respectively.

Two respondents indicated that they have an employer-based incentive program, citing enforcement and carrier safety ratings. However, enforcement and safety ratings cannot really be considered “incentive” programs, since they punish poor behavior rather than reward good behavior. Therefore, none of the responding jurisdictions provide an employer-based incentive program.

Industry-sponsored education programs for VRRD are offered in half of the responding jurisdictions. These typically take the form of vehicle safety programs and load securement programs offered by the trucking association.

Enforcement

Respondents were asked to specify the amount of monetary fines, if any, that their jurisdictions have established for unsecured loads, unsafe vehicles, and littering. The range and average fines for each offense are listed in Table 21. The average fines in U.S. and Canadian jurisdictions are substantially similar for all three violations. It is interesting to note that among the U.S. respondents, the fine for littering is much larger than the fine for an unsafe vehicle and

Table 21. Fines for VRRD Offenses

Violation	USA (N=14)			Canada (N=9)		
	Low	High	Average	Low	High	Average
Unsecured load	0	500	161	0	575	189
Unsafe vehicle	0	1,020	171	0	700	167
Littering	0	1,000	219	60	500	172

an unsecured load. In at least three of the jurisdictions the fine is highly variable, depending on the specifics of the offense. For example, in one of the Canadian jurisdictions, fines for unsafe vehicles range from CA$200 to CA$20,000.

Forty to 45 percent of responding jurisdictions have established the violations of unsecured loads, unsafe vehicles, and littering as absolute-liability offenses—stong message that in these jurisdictions, vehicle and load safety is clearly the operator's responsibility.[7]

Twenty-three respondents indicated that there is a driver demerit point system in their jurisdiction. On average, U.S. jurisdictions require 12 demerit points for a license suspension but do not assess any demerit points against a driver for an unsecured load, an unsafe vehicle, or littering. In Canadian jurisdictions, typically 14 demerit points yield a license suspension; unsecured load

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[7] Absolute liability, also known as strict liability, is liability for injury to others without regard to fault or negligence. It is generally applied to inherently dangerous activities. In the case of VRRD, some jurisdictions—among them Ontario—have implemented absolute liability for wheel separation incidents. Under absolute liability, if a wheel separation occurs, the operator of the vehicle is guilty of an offense regardless of fault or cause. In other words, under the law the sole question is whether a wheel separated from the vehicle. Although some may think this approach unfair, it imposes a responsibility on each operator to ensure that loads are secured and vehicles are maintained in good condition. Without such liability, an operator could avoid any penalty for VRRD by merely claiming that he or she was unaware of the problem. Absolute liability places an affirmative duty on the operator to maintain vehicles and their loads and protect public safety. It is a generally accepted legal concept in both U.S. and Canadian courts.

and unsafe vehicle violations each draw two demerit points, and littering draws none.

For commercial vehicles, carrier safety ratings and facility safety audits, which monitor and assess corporations instead of individual drivers, are prevalent. Eighty-eight percent of respondents have a carrier safety rating program, and 92 percent of respondents conduct facility safety audits.

Periodic vehicle safety inspections are mandatory for private and commercial vehicles in 33 percent and 71 percent, respectively, of the jurisdictions. Mandatory inspections for private vehicles are usually conducted annually or when ownership changes. For mandatory commercial vehicle inspections, the frequency generally varies between six months and two years. One responding jurisdiction also has a mileage limit, whereby commercial vehicles must be inspected every year or every 25,000 miles, whichever comes first.

Some respondents indicated that the inspection interval depends on the vehicle characteristics. In one case, for example, interjurisdictional commercial vehicles must be inspected twice a year, whereas single-jurisdiction trucks do not require an inspection. In another case, the powered unit of the truck requires inspection twice a year, and the trailer portion once a year.

All of the responding jurisdictions provide some form of vehicle and load inspections, with 76 percent using police for this purpose and 64 percent using government inspectors. Furthermore, 92 percent of the jurisdictions employ permanent roadside inspection stations for commercial vehicles on some of their roads.

The frequency of specific enforcement actions for unsecured loads and vehicle safety is highly variable, ranging from “never” to “daily”:

- Enforcement specifically for unsecured loads is conducted up to 12 times a year in the responding jurisdictions, with three respondents indicating that it is never conducted and four respondents indicating that it is a daily activity.

- Enforcement specifically for unsafe vehicles is conducted between one and 69 times per year, with three respondents indicating that it is a daily activity.

- In both categories several respondents indicated that enforcement as described is a "regular," "continuous," or "ongoing" activity or is conducted "as we see it."

Jurisdictions were asked to provide data on the number and outcome of vehicles stopped for inspections in 2002. The results are summarized in Table 22. The average number of vehicles stopped for inspection is 27 percent higher in the U.S. jurisdictions than in the Canadian jurisdictions. However, normalizing the number of inspections for population reveals that the Canadian jurisdictions conduct more inspections per 1,000 persons than the U.S. jurisdictions.

Table 22. Commercial Vehicle Inspection Outcome, 2002

	USA				Canada			
	Number of Agencies	High	Low	Average	Number of Agencies	High	Low	Average
Number stopped	13	115,884	4,379	44,110	8	122,000	250	34,862
Stops per 1,000 population	13	39	3	13	8	34	6	14
Out-of-service rate*	15	51	4	24	9	38	5	21
Safety:load ratio	11	15:1	2:1	8:1	5	56:1	1:3	19:1

* The out-of-service rate is the percentage of vehicles placed out of service in relation to the number of vehicles stopped for inspection. A vehicle is placed out of service if it is not equipped and operated according to the state or provincial requirements. Criteria used for placing vehicles and drivers out of service are the North American Uniform Out-of-Service Criteria adopted by the Commercial Vehicle Safety Alliance and the U.S. Department of Transportation.

The proportion of vehicles that are taken out of service or impounded for critical deficiencies on inspection is higher in the United States than in Canada—24 percent and 21 percent, respectively. These numbers are consistent with the 22.1 percent reported out-of-service rate in other research [Commercial Vehicle Safety Alliance, 2002].

Although not all respondents provided a breakdown of the numbers of vehicles placed out of service for unsecured loads and for safety defects, a ratio was calculated for those that did. In the United States, for every vehicle that is placed out of service for load securement, eight vehicles are placed out of service for safety defects. In Canada, for every vehicle that is placed out of service for load securement, 19 vehicles are placed out of service for safety defects. It is not possible to determine whether these numbers represent the true rates, as they are highly dependent on how inspectors decide which vehicles to inspect and what the inspectors are trained to look for. These results may merely indicate that inspectors look more intently for safety defects and give less attention to load securement.

Other

Additional information was sought from respondents about research on VRRD prevention, other regulations not mentioned, and suggestions for better VRRD prevention. None of the respondents are conducting research on VRRD prevention. One respondent indicated that in addition to the federal load securement regulations, the jurisdiction has local trip inspection regulations and tarping regulations to further prevent VRRD.

Respondents' suggestions for VRRD prevention included the following:

- Have enforcement personnel advise maintenance personnel of debris on the road, or grant enforcement personnel permission to remove debris.

- Require tarps and tailgates for gravel trucks.

- Use roadside signs and public service announcements to alert and educate motorists.

- Collect better information on the type and source of VRRD.

- Enact better regulations and standards for retreaded tires.

- Establish uniform training for transportation industry and enforcement personnel.

Maintenance Survey

The purpose of the maintenance survey was to determine what programs road authorities in the United States and Canada have in place to mitigate the impact of VRRD. The questionnaire is reproduced in Appendix H. Responses were received from 38 transportation agencies (listed in Appendix I). The survey responses are summarized in tables in this section and are presented in more detail in Appendix I.

Thirty of the maintenance survey respondents were from states, provinces, or territories, and eight were from municipal governments. The response rate from state, provincial, and territorial jurisdictions was 46 percent; the response rate for municipal governments cannot be determined, as the survey was distributed via electronic mailing lists and the number of survey recipients is unknown.

Respondents were first asked to specify the population, the proportion of two-lane roads, and the number of lane-miles of road in their jurisdiction. Their responses are summarized in Table 23.

Table 23. Information on Populations and Roadways from Maintenance Survey Respondents

		State/Province Agency (N=30)	**Local Agency (N=8)**
Population	Mean	6,134,590	469,329
	Median	3,500,000	375,000
	Range	144,000 to 34,500,000	61,828 to 1,000,000
Percentage of two-lane roads	Mean	67	77
	Median	75	85
	Range	8 to 98	10 to 98
Lane-miles	Mean	39,524	2,220
	Median	17,724	1,688
	Range	1,077 to 180,000	1,000 to 5,044

Two respondents did not provide information on population, five did not provide information on the proportion of two-lane roads, and two did not provide the number of lane-miles of road in their jurisdiction.

VRRD Occurrence and Impact

Most road authorities reported removing VRRD from their roads on a daily basis. Seventy-one percent of the respondents remove VRRD from two-lane roads daily, 77 percent remove VRRD from multilane roads daily, and 20 percent remove VRRD from their two-lane and multilane roads weekly. The top five types of VRRD that maintenance staff cited when asked which were the most prevalent in their jurisdictions are the following:

- Tire treads (84 percent of respondents)
- Garbage from waste haulers (50 percent of respondents)
- Lumber and construction materials (39 percent of respondents)
- Gravel, soil, and tree limbs that were being transported (32 percent of respondents)
- Mufflers and exhaust parts (26 percent of respondents)

Of 36 jurisdictions that responded, 27 (75 percent) reported that commercial vehicles are responsible for depositing the most VRRD on the roads.

The respondents' view of the extent of the safety problem presented by VRRD was sought by asking them to rank it on a 1 to 10 scale, on which 10 indicates that it is a significant safety problem and 1 indicates that it is not a safety problem. The average rank was 4, which indicates that maintenance personnel feel that VRRD is a moderate safety problem.

Programs

More than half (55 percent) of the responding jurisdictions offer at least one type of informational or educational program to remind motorists of the importance of vehicle safety and load securement. When the results are broken down by type of respondent, 12 percent of municipal governments have information programs, whereas 67 percent of state or provincial jurisdictions have programs. This differential may be an indication that municipal governments consider these programs a state responsibility. Of the programs used, public service announcements and flyers are the most popular.

VRRD Identification and Removal

All of the responding agencies indicated that the jurisdiction's department of transportation or its contractor is responsible for removing debris from the traveled way. Police and tow truck operators were also cited, by 24 percent and 18 percent of respondents, respectively. The main method of removing small debris from the traveled way is to do so manually (97 percent of respondents), and the main method for large debris is to push it to the side of the road with a vehicle and then collect it (67 percent of respondents).

Respondents were queried about their standards on the maximum time for removal of debris on two-lane and multilane roads. Municipal respondents indicated that the maximum time for removal of debris on all roads varied from 30 minutes to 4 hours. State and provincial respondents indicated that the maximum time for removal of debris on two-lane roads varied from 20 minutes to days, and on multilane roads, from 20 minutes to hours. Twenty percent of the respondents indicated that the maximum time for any debris removal on any road is as soon as practical after notification is received. Of the respondents who have a standard for debris removal, 76 to 80 percent have the same standard for two-lane and multilane roads. Finally, about 30 percent of respondents indicated that they did not have a standard for debris removal.

The following measures are used on at least some of the facilities in state-level jurisdictions to assist in debris identification and removal:

- Roadside assistance patrols (59 percent)
- Video surveillance (49 percent)
- Traffic flow sensors and incident detection software (32 percent)
- Licensed/authorized tow trucks (32 percent)

Twenty-two percent of the agencies use only routine road patrols for debris detection. States are more likely than municipalities to use all of the above-mentioned detection methods.

If VRRD cannot be removed from the traveled way immediately (e.g., a spilled load of lumber), then state-level agencies use various methods to warn motorists:

- Media releases (67 percent)
- Changeable message signs (83 percent)
- Traveler information systems (47 percent)
- Real-time traffic information on the World Wide Web (47 percent)

However, 13 percent of the state-level agencies do not use any methods to warn motorists of debris in the traveled lanes. One agency respondent commented that their routine procedure concerning debris that cannot be removed immediately is to close the road until all debris can be moved from the traveled lanes. Municipal respondents are much less likely to use any of the above-mentioned methods, with 50 percent indicating that they employ none of the listed methods.

Respondents were queried about their standards for the maximum time between road patrols on two-lane and multilane roads. Municipal respondents indicated that the time between patrols on two-lane roads varied from every 4 hours to once a month, and on multilane roads from every 4 hours to every 4 days. State and provincial respondents indicated that the time between patrols on two-lane roads varied from every 4 hours to once every 8 days, and on multilane roads, from every 3 hours to once a day. Overall, two-lane roads are patrolled less frequently than multilane roads, and about 38 percent of respondents indicated that they do not have a standard for road patrol frequency.

Other

Additional information was sought from respondents on research in VRRD identification and removal, other methods and programs not mentioned, and suggestions for better VRRD removal practices. One of the state respondents indicated that they are conducting some limited research on VRRD at selected problem locations. Methods currently employed by respondents that have not been mentioned included:

- Adopt-a-highway and sponsor-a-highway programs
- Public comments
- Mechanical removal of gravel and concrete spills
- Inclusion of VRRD removal as part of normal daily operations
- Use of magnets to remove some metal material

The following suggestions were made by respondents to enhance debris detection and removal:

- Maintenance crews could remove debris while en route to other activities
- Promote better vehicle design
- Focus on prevention
- Increase staff levels
- Improve enforcement and levy fines

INCIDENT DATA

To supplement crash data, the research team contacted several North American freeway service patrols for detailed information on types of debris. Data were provided by the Ohio Department of Transportation's (ODOT) Freeway Incident Response Service Team (FIRST) and the Ministry of Transportation of Ontario's (MTO) Burlington COMPASS system.

The officials who manage freeway incidents have agreed on a system for classifying incidents by type. One of the classifications is "debris in road." When responding to incidents concerning debris in the roadway, incident responders generally maintain records of the general nature of the incident (i.e., "debris in road") and the time of detection or notification, dispatch, arrival on site, and clearance. It is rare that a freeway service patrol maintains a record of the type of debris involved. However, the ODOT FIRST responders and the MTO Burlington COMPASS patrollers maintain incident databases that include optional comments in addition to "debris in road."

"FIRST was created in 2001 to help detect and clear highway incidents faster. FIRST's primary focus is detecting and responding to minor incidents, such as property damage accidents, flat tires, stalled cars, and debris in the roadway" (Ohio Department of Transportation, 2003). FIRST patrols Interstates 270, 670, 71, and 70 within the outer belt, as well as State Route 315. Two shifts operate each weekday, providing service from 5:00 A.M. to 8:00 P.M. Crews also work on weekends during special events.

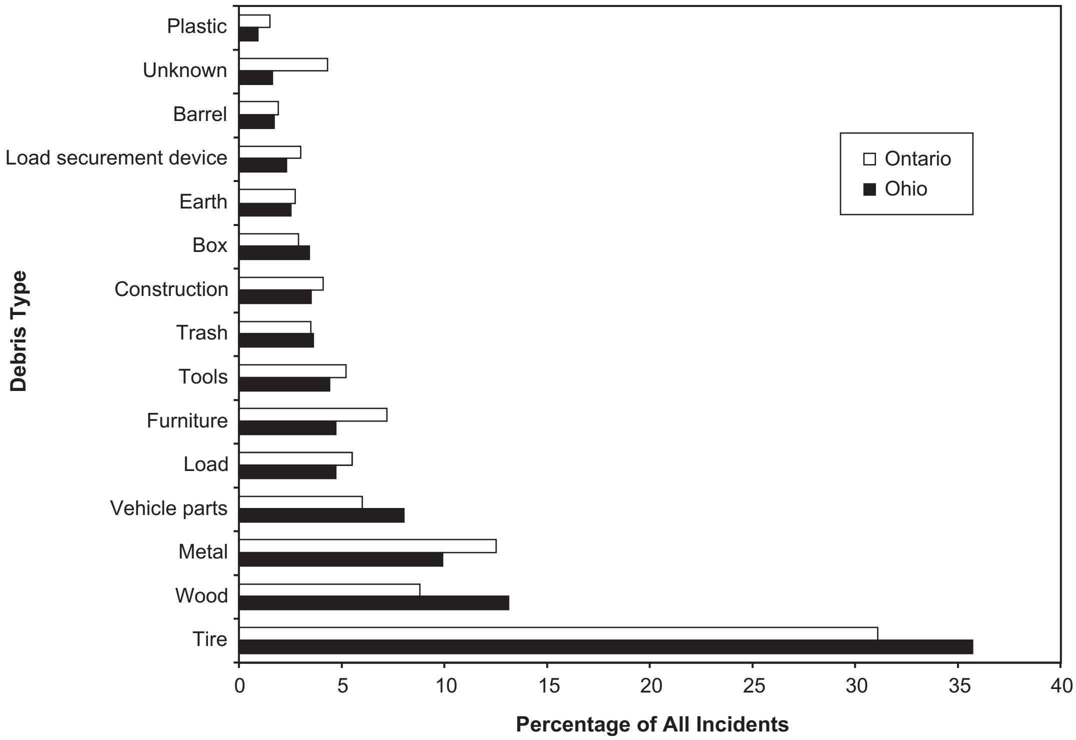
The Burlington Ontario COMPASS System was installed in 1986 to help alleviate "traffic congestion, particularly during construction and peak traffic times on the Burlington Bay Skyway" (MTO, 2003). The system is in place along the Queen Elizabeth Way from Burlington Street to the Gardiner Expressway (about 45 km [28 miles] of mostly six-lane freeway), using 42 closed-circuit television cameras and maintenance contractors who patrol the roadways continually.

Data from the Ohio and Ontario systems were examined and categorized, whenever possible, by debris type, according to the coding rules listed in Appendix J.

From June 19, 2001, to May 9, 2003, FIRST responded to 1,787 reports of debris in the road. Of these reports, the responders recorded a description of the type of debris for 1,157 debris incidents. For the period of August 13, 2002, to September 8, 2003, the Burlington COMPASS database contains 2,801 debris-related incidents, most of which include a description of the debris. Debris incidents that were considered to be crash (vehicle debris that resulted from a crash) debris or environmental (debris that was thrown or blown onto the highway) debris were removed from the database, leaving 2,367 VRRD incidents. The findings from the Ohio and Ontario data are summarized in Figure 6.

As the figure shows, tire debris is undoubtedly the most prevalent type of VRRD, constituting nearly one-third of all debris incidents logged in both jurisdictions. Wood and metal are the second and third most prevalent debris, together accounting for more than 20 percent of all debris incidents recorded. The top seven types of debris are the same in both jurisdictions, with some minor differences in ordering. If the categories are collapsed to cargo debris and mechanical debris (with the "metal" and "other" categories excluded), cargo debris constitutes 50 to 55 percent of the VRRD, and mechanical debris 45 to 50 percent.

Figure 6. Incidence of Debris on Ohio and Ontario Highways



Several limitations of these data must be kept in mind:

- The source of the debris is not known. However, given that the patrolled roadways are controlled-access facilities, it is almost certain that any debris encountered will be from a motor vehicle crash; cargo, parts, or other material from a moving vehicle; or an animal that strayed onto the road.

- The description of the debris may be inaccurate. Sometimes the material is described only by a motorist who saw it while passing by at high speed and later contacted the call center.

- If a motorist strikes VRRD before the debris is reported to the road authority, then the incident might be coded as an "accident" and not "debris" (although this is not necessarily the case). These debris-related incidents would not be contained in the data.

- The VRRD that the research team identified in the database comments and classified for Figure 6 were not necessarily deposited in the travel lanes of the highway. VRRD that comes to rest on the side of the road, off of the traveled way, is not likely to cause a crash but will still be reported to the incident management team.

Despite these limitations, the incident data are helpful in determining the prevalence of the different types of road debris, and they shed some light on the safety impact of VRRD. For instance, tire debris constitutes about one-third of the VRRD reports and, as noted earlier, caused almost one-third of the VRRD crashes identified in the CDS data and about 20 percent of those in the FARS data. Thus, the crash risk posed by tire debris, which is by far the largest category of VRRD, is commensurate with its prevalence. The incident data also indicate that cargo and mechanical VRRD contribute to the road debris problem in roughly equal proportions, which suggests that countermeasures should be aimed at both types of VRRD.

The data suggest that VRRD is much more prevalent on North American highways than the crash data would indicate. The fact that relatively few crashes are identified as having been caused by VRRD brings up several points. First, as noted, VRRD crashes are not always identified as such. The presence of VRRD is not always appreciated or reported, and when VRRD is recognized, the question of whether it was already present or resulted from the crash itself may be impossible to resolve. The problem of connecting VRRD to a crash is all the more intractable in the case of secondary crashes. Second, not all VRRD carries the same risk of causing crashes. For example, VRRD in motion may be more likely to cause a crash than stationary VRRD. Finally, the incident data suggest that, at least in some jurisdictions, maintenance personnel are fairly efficient in detecting and removing VRRD, minimizing the crash risk.

Discussion: Safety Countermeasures

The key to developing countermeasures to prevent VRRD crashes is to understand the characteristics of the VRRD being deposited on the roadway and the circumstances that might contribute to the occurrence of VRRD. Based on the crash data analysis in the previous section, several points emerge as relevant to the development and selection of countermeasures:

- Much of the debris deposited on highways is of unknown origin; however, there is a roughly equal split between the crashes caused by lost cargo and lost vehicle parts.
- Wheels, tires, and tire treads cause the most VRRD crashes.
- VRRD crashes are more likely to occur on the interstate highway system and on roads with posted speed limits in excess of 55 mph.
- Trucks and pickup trucks are overrepresented in VRRD crashes.
- VRRD crashes are more likely than non-VRRD crashes to result only in property damage.

- Although the number of secondary crashes caused by VRRD is unknown, available evidence suggests that such crashes are a significant part of VRRD's toll.

COUNTERMEASURE SELECTION PRINCIPLES

In selecting crash countermeasures, it is important to consider not only the effectiveness of the individual countermeasure but also the cost and feasibility of implementing it. While countermeasures should reduce crash frequency or severity, they should also be affordable and acceptable to the affected stakeholders. Typically, countermeasures that have been shown to be effective in crash mitigation are benchmarked against local safety management policy and an economic analysis to determine which are appropriate in a given setting.

Although the incidence and severity of VRRD crashes are relatively low, they do occur, and therefore transportation agencies should consider some low-cost solutions to the problem, such as targeted education and enforcement programs. High-cost countermeasures such as vehicle modifications and infrastructure improvements would be difficult for policymakers to justify solely on the basis of attempting to reduce the number of VRRD crashes. However, in more far-reaching policy, such countermeasures could be easier to justify, because they would also reduce other types of crashes as well as road congestion. Furthermore, the databases reviewed in this study suggest that the incidence of VRRD is substantially higher than that of VRRD crashes. Thus, although VRRD may be a relatively minor safety issue, it is a significant maintenance issue, and countermeasures designed to reduce its incidence may yield sizable benefits to road authorities by reducing the need for clearance activities.

Countermeasures designed to reduce the incidence of VRRD crashes can be placed into two general categories: those intended to prevent debris from occurring and those intended to prevent or mitigate crashes involving debris. Specific countermeasures for each category are discussed in the following subsections. Within each category, measures are identified that are commensurate with the VRRD problem, and suggestions are made regarding measures that may be considered in reducing the incidence of VRRD crashes but would have to be justified on the basis of additional benefits.

PREVENTING VRRD

Low-Cost Options: Education and Enforcement

Given the magnitude of the VRRD safety problem, the recommended prevention countermeasures are education and enforcement initiatives. Below are specific prevention initiatives that have been identified through the survey of practices or through the literature search and are commensurate with the VRRD safety problem.

Education

Educate fleet maintenance personnel on the methods of preventing wheel separations. The Society of Operating Engineers in the United Kingdom developed a guide to wheel security that it distributes to fleet maintenance personnel (see Appendix K).

Train enforcement officials in vehicle safety and load securement. Enforcement officials need to be aware of the fact that both cargo and mechanical debris cause VRRD crashes, and they need to know what to look for during inspections.

Train commercial vehicle drivers to periodically inspect their vehicles and cargo. Pre-trip inspections similar to those recommended by the Utah Department of Transportation (see Appendix L), as well as specific load securement training can be used (see Appendix M).

Educate private motor vehicle operators on load securement requirements, littering laws, and the associated penalties. People who periodically transport goods and large items need to be aware of the consequences and penalties associated with cargo that is discharged on the highway. (Appendix N contains a brochure developed by the State of Georgia for this purpose.)

Washington State initiated an anti-litter campaign in 2002, called “Litter and it will hurt,” which includes targeting vehicles with unsecured loads (MacDonald, 2002). The campaign uses media announcements, 138 new road signs, and a toll-free telephone number to report litter law violators. An example of an advertisement focusing on unsecured loads is shown in Appendix O.

Advise the driving public on how to report unsafe vehicles and unsecured loads. All road users share in the responsibility of reporting unsecured loads and unsafe vehicles. Transportation agencies should educate motorists and other road users on whom to contact and how to do so when they observe a vehicle that appears to be an imminent cause of VRRD.

For example, the North Carolina Department of Transportation has a program for reporting vehicles with loose and uncovered loads. State authorities publicize the use of "*HP" on the cellular telephone network to contact the State Highway Patrol to report emergency situations. Owners of vehicles that are reported to the Highway Patrol are sent notices designed to raise awareness.

Florida has one of the most well-developed educational program for VRRD. The "No Debris Saves You and Me" campaign includes reminders to properly secure and cover cargo and provides advice on how to avoid collisions with road debris and how to deal with road debris. Motorists are reminded to maintain a proper following distance and to stay alert (see Appendix P).

Enforcement

Increase fines and demerit points for unsecured loads. Penalize waste haulers with unsecured loads by increasing their tipping fee at the landfill. For instance, Santa Cruz County, Arizona, doubles the tipping fees for uncovered or unsecured loads, for both residential waste haulers and commercial waste haulers (Santa Cruz County, 2002).

An escalating fee structure may also be appropriate. For example, in Ohio anything hauled in a motor vehicle must be securely attached to the vehicle; violations are misdemeanors, with each succeeding one considered a more serious offense (Ohio, 2003).

The survey of practices indicates that in many jurisdictions the minimum fines for littering often exceed the minimum fines for unsecured loads, and that demerit points are not issued for either offense.

Make VRRD incidents and crashes an absolute-liability offense. Some road authorities have made discharged vehicle parts and lost loads absolute-liability offenses. The survey of practices indicates that 45 percent of responding jurisdictions already employ this countermeasure.

Absolute liability, also known as strict liability, is liability for injury to others without regard to fault or negligence. Some jurisdictions, Ontario among them, have implemented absolute liability for wheel-separation incidents. Under absolute liability, if a wheel separation occurs, the operator of the vehicle is guilty of an offense regardless of fault or cause.

Targeted enforcement of specific groups or VRRD causes. A multistate initiative targeting waste haulers has been established to increase the safe transport of waste materials (Mid-Atlantic States, 1999). TRASHNET is a weeklong vehicle inspection event during which trash haulers are subject to detailed roadside inspections for safety and environmental checks. The event is coordinated in eight states and the District of Columbia. The TRASHNET concept originated as a result of negative publicity in the wake of crashes involving trucks transporting waste and the implied lack of safety inspections. The TRASHNET events are usually scheduled twice a year.

Enact legislation requiring that loads be covered, or use anti-littering legislation to penalize offenders. A number of states have such legislation in effect.

Higher-Cost Options

Below are additional countermeasures that would address VRRD crashes but would be considered too expensive to justify on the basis of VRRD crash reduction alone.

Safety fitness ratings. Safety ratings are a means of ranking motor carriers according to the risk they pose to highway safety. These programs are generally designed to reduce the incidence of crashes involving poorly maintained commercial vehicles, such as those involving loss of control because of tire failures and inadequately maintained braking systems. Because such programs address vehicle condition, they can lead to the identification of loose or worn parts that could become detached and result in VRRD. According to the survey of practices, most jurisdictions currently employ a safety fitness rating system.

Private motor vehicle safety inspections. Many states require motorists to keep their motor vehicles in safe operating condition whenever they drive on a public street or roadway. In New York State, for example, each vehicle must pass inspection every 12 months and whenever there is a change of ownership or registration. Inspections must be performed by a certified motor vehicle inspector. The inspection requirements focus on ensuring that the vehicle may be operated safely (i.e., condition of brakes, steering, etc.) but also specifically include inspection of some items that may lead to VRRD, such as the condition of the wheel fasteners, tire defects, and so forth (New York State, 2003).

Remote vehicle diagnostics (RVD). RVD is the monitoring of vehicle condition during operation with direct feedback to the operator. RVD includes such measures as tire pressure monitoring equipment and rollover stability systems.

Better vehicle standards. Wheel-separation crashes have been a concern in many jurisdictions and several studies have been conducted to uncover the causes. Some cite a lack of standardization in the design of wheel fastening systems and point to disadvantages of specific systems.

Smooth road surfaces. Rough and irregular road surfaces may cause vehicle parts or cargo to shake loose. Smoothing the surface will not only decrease the potential for VRRD but also reduce loss-of-control crashes and decrease maintenance costs.

REMOVAL AND MITIGATION

By providing public thoroughfares, road authorities have assumed a responsibility whereby they owe the road user a “duty of care” in providing for reasonably safe passage. Road users who incur an injury or loss when using the public highway system are generally permitted to seek compensation for damages from the road authority—that is, the road authority is legally liable. The premise that a duty of care is owed to road users and that damages that result from a breach of the duty are recoverable is a basis for both design and maintenance decisions by road authorities. Good roadway design, inspection, and maintenance practices by road authorities very likely have had a role in keeping the incidence of VRRD crashes low.

Road authorities design highways such that they provide adequate visibility of stationary objects in the roadway to motorists traveling at highway speeds. The "Policy on Sight Distance for Highways," published in 1940 by the American Association of State Highway Officials, states that the stationary object that must be visible may be "a very low object such as merchandise dropped from a truck" (American Association of State Highway Officials, 1940). While the dimensions of this hypothetical object in the road have changed slightly over time, the principle of providing adequate visibility has not, and this may be a primary reason for the low incidence of VRRD crashes.

Regular road inspection and timely debris removal are critical components of maintenance. While VRRD may be rare and occur at random, road authorities must proactively seek VRRD and other hazardous conditions through timely road inspections. If VRRD remains on the highway for a significant amount of time and causes a crash, the road authority may be liable even though it was not aware of the VRRD. In such instances the road authority should have known of the debris's existence and has a duty to remove it. This principle, which is called "constructive notice," places an obligation on the road authority to routinely inspect the condition of its highways in a meaningful way.

The exposure to legal liability through constructive notice has spawned a culture among highway authorities in which routine inspection of their highways is considered an essential function. In fact, since at least 1983, guidelines for maintenance personnel have included a need to "conduct field reviews of the condition of roadway facilities on a reasonable periodic basis" (Lewis, 1983).

Below are two examples of highway maintenance programs that address road debris issues:

- The North Carolina Maintenance Operations Manual, chapter 7, "General Maintenance Activities," states, "All Division of Highways employees, including supervisory personnel, shall immediately remove from the traveled portion of the road, dead animals or any object that they find on the highways or killed on the highways that endangers safe travel" (North Carolina, 2002).

- The Province of Ontario (2001) has established maintenance standards for roads that specify the minimum frequency for routine patrolling of highways, as set out below.

Class of Highway	Patrol Frequency
1	3 times every 7 days
2	2 times every 7 days
3	Once every 7 days
4	Once every 14 days
5	Once every 30 days

Routine patrolling denotes either driving on or electronically monitoring the highway to check for hazardous conditions. The class of highway is determined by the road's traffic volume and speed limit, with the class number increasing as the road's speed and volume decrease.

The Ontario maintenance standards include the following: "If there is debris on a roadway, the minimum standard is to deploy resources, as soon as practicable after becoming aware of the fact, to remove the debris" (Province of Ontario, 2001).

In this context "debris" means any material or object on a roadway that is not an integral part of the roadway or has not been intentionally placed on the roadway by a municipality, and that is reasonably likely to cause damage to a motor vehicle or to injure a person in a motor vehicle.

Despite the apparently good maintenance practices already in place in most jurisdictions, additional measures could be considered in addressing the VRRD safety problem. Again, because of the low incidence of VRRD crashes, low-cost countermeasures such as education and minor improvements to maintenance activities are the most likely choices. The subsections below list specific prevention initiatives that have been identified through the survey of practices or the literature search and are commensurate with the VRRD safety problem.

Low-Cost Options: Education and Maintenance

Education

Highway Watch. "Highway Watch is a national American Trucking Associations (ATA) supported, driver-led, state-organized set of efforts focused on providing truck drivers with the expertise, tools, and recognition they need to make a positive difference in their neighborhoods and on America's roadways" (American Trucking Associations, 2003). The program trains truck drivers on how to correctly report incidents and how to identify unsafe drivers and road conditions. The program is currently active in 24 states.

Education of the driving public on whom to call and how to report road debris. In a review of 11 jurisdictions that have implemented some form of incident management program, the Federal Highway Administration (2000) established the cellular telephone call as the predominant method of incident detection. These incident management programs were primarily used on urban freeways, with cellular telephone calls being the method used to detect 20 to 90 percent of all incidents.

Providing and promoting toll-free telephone numbers to report VRRD incidents is an important VRRD crash countermeasure. Reminding motorists of the telephone number to call and what characteristics of the debris to report will help in reducing the incidence of VRRD crashes.

Defensive Driving Education. Motorists can avoid crashes with VRRD if they exercise due care and attention to the driving task. In addition to maintaining an appropriate distance from the vehicle ahead and complying with speed limits, drivers need to stay alert and practice defensive driving.

Defensive driving is founded on the well-proven three-part standard crash prevention formula:

- *Recognize the hazard:* Think about what is going to happen or what might happen as far ahead of encountering the situation as possible. Never assume everything will be all right.

- *Understand the defense:* Know what to do on encountering VRRD so you can take appropriate action when the need arises.

- *Act in time:* Once you've seen the hazard and you understand the defense against it, act! Never take a "wait and see" attitude (adapted from Alfa Drivers Training, "A Preventable Collision," http://www.alfa.20m.com/html/pervention.html).

Maintenance

Increasing freeway service patrols. The crash data indicate that VRRD crashes occur more frequently on the interstate highway system and on roads with speed limits over 55 mph. Increasing patrols on these roads to detect and remove VRRD is a potentially viable countermeasure. In addition, increasing service patrols on any road or section of road that has been identified as having a disproportionate number of VRRD crashes would likely be beneficial.

The Nebraska State Highway Patrol supplements its regular staff with 32 volunteers to offer the Nebraska Motor Assist Program (NeMAP). In 2002, NeMAP volunteers provided more than 5,000 services to travelers, including clearing debris from the roadway. The volunteers are trained by the State Highway Patrol and must be prepared to volunteer at least 4 hours per week. The program is funded by donations (Nebraska, 2003).

Open Roads Policy. An Open Roads Policy is an interagency agreement between incident management stakeholders to cooperate and ensure the quick and efficient removal of debris and other incidents from the traveled way. The State of Florida has implemented such a policy (see Appendix Q).

Higher-Cost Options

Below are additional countermeasures that would address VRRD crashes but are likely to be considered too expensive to justify on the basis of the VRRD safety problem and would require further analysis and consideration of other benefits.

Forward crash warning systems (FCWS). FCWS are devices designed to alert drivers to potential crash situations and help them avoid striking moving or stationary objects ahead. Such devices could yield safety benefits for any crash configuration with a frontal impact, including rear-end and head-on crashes.

Freeway service patrols (FSP). FSPs are roaming patrols that monitor operations of key transportation facilities to ensure smooth traffic flow by assisting disabled vehicles, removing debris, and clearing other incidents. Additional benefits of such patrols would include congestion mitigation, air quality improvements, and crash prevention.

Incident management. A variety of policies, activities, programs, and equipment can be combined and used to detect and respond to highway incidents. The emphasis is on early detection and clearing of incidents, VRRD, and other debris. For instance, closed-circuit television cameras can be placed on high-volume roads to monitor and detect VRRD, stalled vehicles, and other incidents. As for additional benefits, because nonrecurring conditions (such as VRRD) disrupt the normal flow of traffic and create safety concerns, incident management techniques can be used to reduce VRRD crashes as well as many other types of crashes.

Summary

The crash data gathered and analyzed in this study consistently indicate that VRRD is a causative factor in less than 1 percent of all crashes. The CDS and West Virginia data sets were given the most thorough review and provide the best estimates of the VRRD crash rate, placing it around 0.4 percent of all crashes. All of the data sets indicated that VRRD crash severity tends to be lower than that of other crashes, a finding supported by the lower rate of fatal VRRD crashes (0.2 percent) computed from the FARS data. Applying these rates to North American crash statistics for 2001, it can be estimated that VRRD causes over 25,000 crashes per year and claims 81 to 90 lives per year.

These estimates do not include secondary crashes—crashes that occur upstream and soon after an incident (such as VRRD) and may not be known to be related to the prior incident. However, given that the incidence of non-crash-producing VRRD incidents is significantly greater than the incidence of VRRD crashes, secondary crashes are probably a significant but unaccounted component of the safety impact of VRRD.

The incidence and severity of VRRD crashes are relatively low. Nonetheless, VRRD crashes occur, and transportation agencies should consider some low-cost approaches to reducing the incidence. The recommended measures are targeted education and enforcement programs, as follows:

- Educating fleet maintenance personnel on preventing wheel separations
- Training enforcement officials in vehicle safety and load securement
- Training commercial vehicle drivers to periodically inspect their vehicles and cargo
- Educating motorists on load securement and reporting unsafe vehicles and unsecured loads
- Enacting stricter laws on load securement
- Targeting specific groups for enforcement (e.g., waste haulers, landscapers)
- Implementing programs that train frequent road users to identify and accurately report unsafe vehicles, unsecured loads, and road debris
- Educating the public on defensive driving, especially around trucks

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APPENDIX A

NASS CDS Database Search, Crash Data 1997–2001

The User's Manual describes National Automotive Sampling System Crashworthiness Data System as follows:

> The National Automotive Sampling System (NASS) Crashworthiness Data System (CDS) is a nationwide crash data collection program sponsored by the U.S. Department of Transportation. It is operated by the National Center for Statistics and Analysis (NCSA) of the National Highway Traffic Safety Administration (NHTSA).
>
> The NASS CDS provides an automated, comprehensive national traffic crash data base. Data collection began in 1979 in 10 geographic sites, called Primary Sampling Units (PSU's). The 2000 NASS CDS file contains data from 24 PSU's. These data are weighted to represent all police reported motor vehicle crashes occurring in the USA during the year involving passenger cars, light trucks and vans that were towed due to damage.
>
> The NASS program was re-evaluated in the mid-1980's. This re-evaluation resulted in changes which were implemented by NHTSA in January 1988. NASS now has two major operating components: the General Estimates System (GES) which collects data on a sample of police traffic crash reports; and the Crashworthiness Data System (CDS) which collects additional detailed information on a sample of police reported traffic crashes.
>
> Comparing the 1988-2000 files with files from years prior to 1988 is not recommended. The principal attributes of the NASS CDS 1988-2000 files include: focusing on crashes involving automobiles and automobile derivatives, light trucks and vans with gross vehicle weight less than 10,000 pounds (4,537 kg); giving special consideration to late model year vehicles (the five most recent model years [four, beginning in 1996]); emphasizing the more serious injury crashes; eliminating the pedestrian and

non-motorist record, the driver record and vehicle registration information. A revised set of data collection forms was designed in 1988 for the crashworthiness data system. Some features are: the introduction of an Accident Event Record to capture all events in the crash; the creation of three new vehicle records (General Vehicle, Exterior Vehicle, Interior Vehicle); and the separation of occupant records into an Occupant Assessment Record and an Occupant Injury Record, wherein all injuries are coded (National Highway Traffic Safety Administration, 2000).

The system is summarized by the National Center for Statistics and Analysis:

NASS CDS has detailed data on a representative, random sample of thousands of minor, serious, and fatal crashes. Field research teams located at Primary Sampling Units (PSU's) across the country study about 5,000 crashes a year involving passenger cars, light trucks, vans, and utility vehicles. Trained crash investigators obtain data from crash sites, studying evidence such as skid marks, fluid spills, broken glass, and bent guard rails. They locate the vehicles involved, photograph them, measure the crash damage, and identify interior locations that were struck by the occupants. These researchers follow up on their on-site investigations by interviewing crash victims and reviewing medical records to determine the nature and severity of injuries (http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/TextVer/CDS.html).

There are generally two types of collisions that involve VRRD. The first is a crash in which the VRRD is struck or strikes a road user at some time during the crash event. The second is a crash in which VRRD is a contributing factor in a crash but is not struck and does not strike a road user during the crash event.

To identify VRRD crashes of the first type, the database was queried using the Accident Event Record Variable "Object Contacted." VRRD is classified as a nonfixed object, of which the following variable codes are permitted (National Highway Traffic Safety Administration, 2000b):

Collision with Nonfixed Object

- Passenger car, light truck, van, or other vehicle not in-transport

- Medium/heavy truck or bus not in-transport
- Pedestrian
- Cyclist or cycle
- Other nonmotorist or conveyance (specify)
- Vehicle occupant
- Animal
- Train
- Trailer, disconnected in transport
- Object fell from vehicle in-transport
- Other nonfixed object (specify)
- Unknown nonfixed object
- Other Event (specify)

Trailer, disconnected in transport

Used when the vehicle is contacted by or contacts a trailer which has become detached from its towing unit while the towing unit was in-transport. The type of trailer is not of interest; the only factors to consider are the detachment of the trailer and the transport status of the towing unit.

Object fell from vehicle in-transport

Used when the vehicle is contacted by or contacts an object that was being carried by or was attached to a vehicle in-transport but fell from or became detached from that vehicle. For example, a detached side mirror, spare tire, cargo, etc. Detached trailers are entered under trailer, disconnected in transport.

Other nonfixed object

Refers to any moveable object that is either readily moveable or is moving and is not specifically named above. Examples include trash cans, grocery carts, unoccupied pedalcycles, small boulders, sheared poles, etc.

Unknown event or object

Used whenever the object contacted is not known or if an unknown event occurs and the researcher cannot determine what the event consisted of and how to enter it.

To identify VRRD crashes of the second type, involving debris that contributed to the crash but did strike and was not struck by a vehicle, the database was queried using the General Vehicle Record Variable "Critical Precrash Event." The critical precrash event is determined by asking, "What action by this vehicle, another vehicle, person, animal, or nonfixed object was critical to this vehicle's crash?" To determine the precrash event, the following procedure is used by analysts who are coding the CDS data (National Highway Traffic Safety Administration, 2000b):

> Proceed through the following questions as they apply to the crash under research and stop when the answer to the questions is "Yes". This is the Critical Precrash Category.
>
> 1. Did the vehicle exhibit a control loss?
> 2. Does the evidence suggest that the vehicle was in an environmentally dangerous position?
> 3. Was another vehicle "in" this vehicle's lane?
> 4. Was another vehicle entering into this vehicle's lane?
> 5. Was a pedestrian, pedalcyclist, or other nonmotorist in or approaching this vehicle's path?
> 6. Was an animal in or approaching this vehicle's path or was an object in this vehicle's path?

Analysts are also encouraged to use the "BUT FOR" test. For example, "'But for" Vehicle # going left-of-center, this vehicle would not have been involved in this crash; or 'But for' having entered into the intersection, this vehicle would not have been involved in this crash."

The following variable codes are permitted for Precrash Event (National Highway Traffic Safety Administration, 2000b):

> This Vehicle Loss of Control Due To:
>
> - Blowout or flat tire
> - Stalled engine
> - Disabling vehicle failure (e.g., wheel fell off)
> - Non-disabling vehicle problem (e.g., hood flew up)

- Poor road conditions (puddle, pot hole, ice, etc.)
- Traveling too fast for conditions
- Other cause of control loss (specify)
- Unknown cause of control loss

This Vehicle Traveling

- Over the lane line on left side of travel lane
- Over the lane line on right side of travel lane
- Off the edge of the road on the left side
- Off the edge of the road on the right side
- End departure
- Turning left at intersection
- Turning right at intersection
- Crossing over (passing through) intersection
- This vehicle decelerating
- Unknown travel direction

Other Motor Vehicle in Lane

- Other vehicle stopped
- Traveling in same direction with lower steady speed
- Traveling in same direction while decelerating
- Traveling in same direction with higher speed
- Traveling in opposite direction
- In crossover
- Backing
- Unknown travel direction of other motor vehicle in lane

Other Motor Vehicle Encroaching Into Lane

- From adjacent lane (same direction)—over left lane line
- From adjacent lane (same direction)—over right lane line
- From opposite direction—over left lane line
- From opposite direction—over right lane line
- From parking lane
- From crossing street, turning into same direction
- From crossing street, across path
- From crossing street, turning into opposite direction

- From crossing street, intended path not known
- From driveway, turning into same direction
- From driveway, across path
- From driveway, turning into opposite direction
- From driveway, intended path not known
- From entrance to limited access highway
- Encroachment by other vehicle—details unknown

Pedestrian or Pedalcyclist, or Other Nonmotorist

- Pedestrian in roadway
- Pedestrian approaching roadway
- Pedestrian—unknown location
- Pedalcyclist or other nonmotorist in roadway
- Pedalcyclist or other nonmotorist approaching roadway
- Pedalcyclist or other nonmotorist—unknown location

Object or Animal

- Animal in roadway
- Animal approaching roadway
- Animal—unknown location
- Object in roadway
- Object approaching roadway
- Object—unknown location

Other (specify)

- Other critical precrash event (specify)
- Unknown

Of interest when researching the second type of VRRD crash is when the precrash event is coded as an object in or approaching the roadway, or an object with an unknown location.

For this study, the 1997 to 2001 NASS CDS databases were queried to identify the two types of VRRD crashes. For records that satisfied either query, the collision diagram and narrative were retrieved and reviewed to determine whether the object involved or contributing to the crash was VRRD.

APPENDIX B

FARS Database Search, Crash Data 1999–2001

The National Highway Traffic Safety Administration (2002) describes the Fatality Analysis Reporting System as follows:

> FARS, which became operational in 1975, contains data on a census of fatal traffic crashes within the 50 states, the District of Columbia, and Puerto Rico. To be included in FARS, a crash must involve a motor vehicle traveling on a trafficway customarily open to the public, and must result in the death of an occupant of a vehicle or a nonmotorist within 30 days of the crash.
>
> NHTSA has a cooperative agreement with an agency in each state's government to provide information on all qualifying fatal crashes in the state. These agreements are managed by Regional Contracting Officer's Technical Representatives located in the 10 NHTSA Regional Offices. Trained state employees, called "FARS Analysts," are responsible for gathering, translating, and transmitting their state's data to NCSA in a standard format. The number of analysts varies by state, depending on the number of fatal crashes and the ease of obtaining data.
>
> FARS data are obtained solely from the state's existing documents:
>
> - Police Accident Reports
> - Death Certificates
> - State Vehicle Registration Files
> - Coroner/Medical Examiner Reports
> - State Driver Licensing Files
> - Hospital Medical Reports
> - State Highway Department Data
> - Emergency Medical Service Reports
> - Vital Statistics
> - Other State Records

From these documents, the analysts code more than 100 FARS data elements. The specific data elements may be modified slightly each year to conform to changing user needs, vehicle characteristics, and highway safety emphasis areas. The data collected within FARS do not include any personal identifying information, such as names, addresses, or social security numbers. Thus, any data kept in FARS files and made available to the public fully conform to the Privacy Act.

In the coding of debris for the FARS data set, a distinction is made between debris that is in motion (the unstable event is continuing), and debris that is at rest (an unstable event has stabilized, and the crash is a new unstable event). The following queries were developed to identify all potential VRRD crashes:

Crash Type A: Debris in Motion Strikes other road user

(A86) First Harmful Event = 12 or 13 Motor vehicle in transport (in other roadway)

AND

(A121,A123,A125) Related Factor =14 or 15 Motor vehicle in transport struck by falling cargo, or something that came loose from or something that was set in motion by a vehicle; or Nonoccupant struck by falling cargo, or something that came loose from or something that was set in motion by a vehicle

AND

(A121,A123,A125) Related Factor <> 19 Recent/previous accident scene nearby

Crash Type B: Debris at Rest Struck by road user

(A86) First Harmful Event = 18 Other Object (not fixed)

AND

(A91) Relation to Roadway = 01 On roadway

If the collision with the object was off road, then a previous event or occurrence caused the vehicle to leave the road

AND

(A121,A123,A125) Related Factor <> 3 Other construction created condition
(A121,A123,A125) Related Factor <> 19 Recent/previous accident scene nearby

Do not use A86 = 16 “Thrown or falling object” because if it was discharged from a motor vehicle (i.e., vehicle debris) it is coded as A86=12 or 13 (Motor vehicle) with (A121, A123, A125) Related Factor = 14 or 15 “Falling cargo, or something came loose from, or set in motion by a motor vehicle.”

Crash Types C, D, E, F, and H: Debris in Motion or at rest avoided by other road user but results in a crash

(V84) Vehicle Maneuver = 09 Maneuvering to avoid an animal, pedestrian, object, other vehicle, etc.

AND

(D61,D63,D65,D67) Related Factors, Driver Level = 81 Debris or objects in road
Does not include live animals, vehicles, pedestrians, cyclists, sand, dirt, oil, leaves, etc.

AND

(A121,A123,A125) Related Factor <> 19 Recent/previous accident scene nearby

APPENDIX C

TRAID Database Search, Fatal Crash Data 1999–2001

"In Canada, data on motor vehicle collisions are contained in the Traffic Accident Information Database (TRAID). This database is a census of all collisions reported in Canada" (Boucher, 2003). Reported collisions meaning that the collision occurred on a public road, and that they incurred bodily harm and/or property damage exceeding a stipulated dollar threshold (the threshold is determined independently for each provincial and territorial jurisdiction).

> The data are collected by the various police forces on their respective accident report forms. The forms are then submitted to the appropriate Provincial/Territorial Government (jurisdictions) where the data are ultimately entered into a database; each of these jurisdictions has its own database system.
>
> Once the data for a given calendar year are finalized, they are provided to Transport Canada for collating and generation of national statistics on motor vehicle collisions. Transport Canada has no authority over the type of data being collected nor does it provide funding to the various jurisdictions for activities related to data collection and quality control (Boucher, 2003).

The police reporting forms are not uniform across jurisdicions, and some jurisdictions do not supply all the information in the database.

Data collection started in 1984 and TRAID is maintained by Transport Canada. The TRAID file consists of 55 data elements that can be divided into accident-level, vehicle-level, and person-level data.

The TRAID data set contains several elements that could be used to identify potential VRRD crashes. However, not all of them are reported by all of the jurisdictions. For instance, data element no. 14, Accident Type, includes a value of "Motor Vehicle Hit Object," but 6 of the 13 jurisdictions do not report this data element. Because of this shortcoming in the data set, the research team contacted individual jurisdictions to seek fatal crash data directly.

APPENDIX D

CARES Database Search, Alabama Crash Data 1997–2001

There are generally two types of collisions that involve VRRD. The first is a crash in which the VRRD is struck or strikes a road user at some time during the crash event. The second is a crash in which VRRD is a contributing factor in a crash but is not struck and does not strike a road user during the crash event.

The following queries were used with the CARES database to identify VRRD crashes:

1. First Harmful Event = 05 (Spill), 08 (Parts/Cargo fell from moving vehicle), or 09 (Trailer hitch came loose)

OR

2. Prime Contributing Circumstance = 29 (Parts/Cargo from Vehicle)

OR

3. First Harmful Event = 90 (Foreign material in road); and Material Source for any involved unit = 03 (Dropped from vehicle) or 04 (Already in road but fell from vehicle)

OR

4. Prime Contributing Circumstance = 07 (Avoid object/person/vehicle) or 08 (Unseen object/person/vehicle) or 16 (Defective equipment) or 19 (Improper load/size) or 20 (Improper attachment) or 26 (Load shift); and Material Source for any involved unit = 03 (Dropped from vehicle) or 04 (Already in road but fell from vehicle)

If the crash matched any of these four queries, it was classified as a VRRD crash.

APPENDIX E

City of Detroit Database Search, Crash Data for 2000

Crash data for the State of Michigan was made available by AAA Michigan with permission from the state authorities. Although crash databases that included all crashes in Michigan from 1998 to 2001 were available, only the 2001 data on crashes in the City of Detroit were used in this study because of ready access to the individual collision reports. The ability to review the narrative and collision diagram is essential in distinguishing VRRD crashes from many other types of debris and non-fixed-object crashes.

There are generally two types of collisions that involve VRRD. The first is a crash in which the VRRD is struck or strikes a road user at some time during the crash event. The second is a crash in which VRRD is a contributing factor in a crash but is not struck and does not strike a road user during the crash event.

The following queries were used with the City of Detroit data to identify VRRD crashes:

1. Road Condition = 7 (Debris)

OR

2. Prior Action = 18 (Avoiding object)

OR

3. First Event (for any unit) = 07 (Separation of units) or 12 (Cargo shift/ loss), or 21 (Collision with other nonfixed object)

If the crash matched any of these four queries, it was classified as a VRRD crash.

In Query 2, “avoiding object” precludes avoiding pedestrians, parked and moving vehicles, and animals, as these items have separate and unique codes.

In Query 3, “collision with other nonfixed object” precludes pedestrians, bicyclists, motor vehicles, trains, and animals, as these items have separate and unique codes.

APPENDIX F

Legislation and Enforcement Survey, Survey Instrument

AAA Foundation for Traffic Safety, Vehicle-related Road Debris Study

NORTH AMERICAN SURVEY OF STATE & PROVINCIAL VEHICLE SAFETY & LOAD SECUREMENT ENFORCEMENT PRACTICES

Vehicle-related road debris (VRRD) is considered to be a serious safety concern on North American roads but the magnitude of the problem is unclear. We know that road debris is prevalent and that road authorities invest significant resources in removing debris from the right-of-way. What we do not know is how often VRRD is a contributing factor in a motor vehicle crash. The AAA Foundation for Traffic Safety has commissioned Intus Road Safety Engineering Inc. to establish the magnitude of the VRRD safety problem and to review practices related to VRRD prevention and removal.

For the purposes of this study, VRRD is defined as lost or spilled cargo (e.g., lumber or furniture), and vehicle parts (e.g., tire treads or mufflers) that have been unintentionally deposited on the traveled way. It does not include vehicle parts and cargo deposited on the road as a result of a motor vehicle crash.

The purpose of this survey is to determine what regulations, ordinances, legislation, and enforcement programs States and Provinces have in place for VRRD prevention.

This survey should be completed by the person(s) in your jurisdiction that is most familiar with the regulations for, and enforcement of vehicle safety, and load securement. It will take approximately 15 minutes to complete. This survey is being conducted for research purposes only. All responses will be included in a final study report. However, your contact information will not be shared with anyone except the study team.

Please return the completed survey and any supporting documentation by **August 31, 2003** to:

Gerry Forbes
Intus Road Safety Engineering Inc.
4261 Price Court, Burlington, ON L7M 4X3 Canada
Fax: 905-332-9777.

If you have any questions about this study, please contact Mr. Gerry Forbes, President, Intus Road Safety Engineering Inc., (gerry@intus.ca or 905-332-9470) – or – Dr. Scott Osberg, Director of Research, AAA Foundation for Traffic Safety, (sosberg@aaafoundation.org or 202-638-5944 Ext 6.)

Thank you for your time.

PART I: GENERAL INFORMATION

1. Name:

2. Job title:

3. Email address:

4. Telephone No.:

5. Employer:

6. Type of Employer:
   - ❏ Department of Motor Vehicles
   - ❏ Department of Transportation
   - ❏ Department of Public Safety
   - ❏ State/Provincial Police
   - ❏ Other (Specify) ______________________________

7. Population of jurisdiction: ____

PART II: PROGRAMS

Education

8. Does your State/Province provide any of the following VRRD education programs? *[Check all that apply]*

   - ❏ Vehicle inspection training for commercial drivers
   - ❏ Cargo securement training for commercial drivers
   - ❏ Public service announcements
   - ❏ Flyers or brochures
   - ❏ Advertisements in trade magazines, and newsletters
   - ❏ Roadside signs/billboards
   - ❏ Other (Specify) ____
   - ❏ None of the above

9. Do you have any employer-incentive programs to encourage vehicle safety and cargo securement (e.g., reduced fee for license renewal if no vehicle safety violations in previous year)? *[Check one only]*

   - ❏ No
   - ❏ Yes (Specify) ____

10. Does your jurisdiction have any trucking association, or automobile association sponsored education programs related to VRRD?
[Check all that apply]

❏ No
❏ Yes, trucking association program for vehicle safety
❏ Yes, trucking association program for load securement
❏ Yes, automobile association program for vehicle safety
❏ Yes, automobile association program for load securement

Enforcement

11. What are the monetary fines for the following violations?
[Record the set fine or "N/A" if you do not have the regulation]

Unsecured load	$_______	❏ USD	❏ CAD
Unsafe vehicle	$_______	❏ USD	❏ CAD
Littering on a public road	$_______	❏ USD	❏ CAD

12. Which of the following are "absolute liability" offenses in your jurisdiction?
[Check all that apply]

❏ Unsecured load
❏ Unsafe vehicle
❏ Littering on a public road
❏ None of the above

13. How many demerit points are associated with the following offenses?
[Record points or "N/A" if you do not have the regulation]

Unsecured load	________ points
Unsafe vehicle	________ points
Littering on a public road	________ points

14. What is the minimum number of demerit points required for a driver's license suspension? ________ points

15. Does your jurisdiction have "Carrier Safety Ratings", "Safety Fitness Rating" or a similar program that pertains to an entire corporation rather than the individual vehicle? *[Check one only]*

❏ No
❏ Yes

16. Does your jurisdiction conduct “Facility Safety Audits” or safety audits of commercial vehicle companies? *[Check one only]*

❏ No
❏ Yes

17. Do you have mandatory vehicle safety inspections for private vehicles (e.g., a vehicle safety check is required once per year for vehicle license plate renewal)? *[Check one only]*

❏ No
❏ Yes (How often) ____________________________ (e.g., once per year)

18. Do you have mandatory vehicle safety inspections for commercial vehicles (e.g., a vehicle safety check is required once per year for vehicle license plate renewal)? *[Check one only]*

❏ No
❏ Yes (How often) ____________________________ (e.g., once per year)

19. Do you have any other legislation respecting VRRD? *[Check one only]*

❏ No
❏ Yes (Specify) ____

20. Who provides vehicle and load inspections? *[Check all that apply]*

❏ We do not perform inspections
❏ State/Provincial Police
❏ Government inspectors

21. Do you have permanent roadside inspection stations on some or all of your roads where vehicle safety and load securement inspections are routinely conducted? *[Check one only]*

❏ No
❏ Yes

22. On average, how many times per year do you conduct specific enforcement campaigns for:

a. Unsecured loads _____________
b. Unsafe vehicles _____________

23. In 2002, how many vehicles were:

a. Stopped for inspections? _______
b. Placed out-of-service or impounded for unsecured loads? _______
c. Placed out-of-service or impounded for safety defects? _______

PART III: OTHER

24. Are you doing any research regarding VRRD prevention? *[Check one only]*

❏ No
❏ Yes (Specify)_______________________________________

25. Are there any other methods of preventing VRRD that are employed by your agency that have not been previously mentioned? *[Check one only]*

❏ No
❏ Yes (Specify)_______________________________________

26. Do you have any suggestions how VRRD prevention could be improved? *[Check one only]*

❏ No
❏ Yes (Specify)_______________________________________

27. May we contact you for further information? *[Check one only]*

❏ No
❏ Yes

Thank you for your time.

Please return the completed survey by **August 31, 2003** to:

Gerry Forbes
Intus Road Safety Engineering Inc.
4261 Price Court
Burlington, ON L7M 4X3
Canada
Fax: 905-332-9777

APPENDIX G

Legislation and Enforcement Survey, Summary of Survey Responses

This appendix provides a detailed review of the responses to the survey reprinted in Appendix F, with tables indicating for each response option of each question the number of respondents who checked the boxes indicating positive responses.

Not all questions received a significant number of responses or, in some cases, meaningful responses. Some questions were not answered, and despite an effort to make the survey instrument as comprehensible as possible, it is clear that some questions were not well understood by some respondents. As a result, the number of responses does not always add up to the total number of respondents.

Overall, the responses were of high quality and provide valuable information on practices in VRRD prevention.

GENERAL INFORMATION

Respondents were asked to provide the type of agency, and the population of their jurisdiction.

Respondent	Type of Employer	Population
Alabama Department of Public Safety	State Police	NR
Alaska Department of Transportation and Public Facilities, Division of Measurement Standards and Commercial Vehicle Safety	DOT	650,000
Florida Department of Transportation, Motor Carrier Compliance Office	DOT	16,713,000
Indiana State Police	State Police	6,080,485
Kansas Highway Patrol	State Police	2,700,000
Kentucky Transportation Cabinet, Department of Vehicle Regulation	DOT	NR
Maryland State Police	State Police	NR
Michigan State Police	State Police	10,050,446
Minnesota Department of Public Safety	State Police	4,500,000
Pennsylvania State Police	State Police	12,281,000
Rhode Island State Police	State Police	1,000,000
South Dakota Department of Public Safety	State Police	700,000
Utah Department of Public Safety	State Police	2,100,000
Washington State Patrol	State Police	5,894,121
West Virginia Public Service Commission, Motor Carrier Enforcement	Public Service Commission	1,790,000
Wisconsin State Patrol	DOT	5,363,675
Alberta Transportation, Inspection Services	DOT	2,994,387
Manitoba Transportation and Government Services, Compliance Branch	DOT	NR
New Brunswick Department of Public Safety, Compliance Head Office	Department of Public Safety	750,000
Northwest Territories Department of Transportation, Road Licensing and Safety Division	DOT	41,400
Ontario Ministry of Transportation, Carrier Safety Policy Office	DOT	9,000,000
Prince Edward Island Transportation and Public Works, Highway Safety Division	DOT	140,000
Quebec Societe de l'Assurance Automobile du Quebec (SAAQ)	Public Insurance Agency	7,400,000
Saskatchewan Highways and Transportation	DOT	950,000
Yukon Department of Transportation	DOT	30,000

DOT, Department of Transportation; NR, No response

PART II: PROGRAMS

Education

8. Does your State/Province provide any of the following VRRD education programs? *[Check all that apply]*

Education Program	**USA (N=15)**		**Canada (N=8)**		**All (N=23)**	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
Vehicle inspection training for commercial drivers	8	53	2	25	10	43
Cargo securement training for commercial drivers	8	53	2	25	10	43
Public service announcements	3	20	2	25	5	22
Flyers or brochures	5	33	3	38	8	35
Advertisements in trade magazines and newsletters	2	13	1	13	3	13
Roadside signs/billboards	0	0	2	25	2	9
Other	2	13	1	13	3	13
None of the above	5	33	3	38	8	35

This table shows that education programs are not extensively used in North America. As many as 35 percent of responding agencies do not provide any VRRD education programs. However, when such programs are offered, they tend to focus on commercial vehicle training and information flyers or brochures.

The education programs mentioned in the "Other" category included miscellaneous safety programs that are carried out at the carrier's request as well as booths set up at truck shows, agriculture exhibits, and industry forums.

9. Do you have any employer-incentive programs to encourage vehicle safety and cargo securement (e.g., reduced fee for license renewal if no vehicle safety violations in previous year)? *[Check one only]*

Employer-Based Incentive Program	USA (N=15)		Canada (N=8)		All (N=23)	
	Number of Responses	%	Number of Responses	%	Number of Responses	%
No	14	93	7	88	21	91
Yes	1	7	1	12	2	9

This table shows that responding North American road authorities do not offer any employer-incentive programs. The affirmative responses cited "enforcement" and "carrier safety ratings" as the incentive programs, which are not really incentive based.

10. Does your jurisdiction have any trucking association, or automobile association sponsored education programs related to VRRD? *[Check all that apply]*

Industry-Sponsored Programs	USA (N=14)		Canada (N=8)		All (N=22)	
	Number of Responses	%	Number of Responses	%	Number of Responses	%
Trucking association program for vehicle safety	8	57	3	38	11	50
Trucking association program for load securement	7	50	2	25	9	41
Automobile association program for vehicle safety	1	7	0	0	1	5
Automobile association program for load securement	0	0	0	0	0	0
None of the above	6	43	5	63	11	50

This table shows that half of the responding agencies have no private-sector-sponsored education programs. Of those with programs, the primary provider is the trucking association.

Enforcement

11. What are the monetary fines for the following violations?
    [Record the set fine or "N/A" if you do not have the regulation]

Minimum set fines	**USA (N=14)**			**Canada (N=9)**		
	Low	**High**	**Average**	**Low**	**High**	**Average**
Unsecured load	0	500	161	0	575	189
Unsafe vehicle	0	1,020	171	0	700	167
Littering	0	1,000	219	60	500	172

The average fines established for these three violations are similar, although the average set fine for littering is higher than that for an unsafe vehicle in both U.S. and Canadian jurisdictions.

In some instances, the respondent indicated that the fine was variable depending on the specifics of the offense. For example, one jurisdiction responded that the set fines for all offenses are in the range of CA$200 to CA$20,000; another indicated that all offenses are misdemeanors with fines ranging from zero to US$500; and a third specified that the fines for three offenses are determined by the presiding magistrate.

12. Which of the following are "absolute liability" offenses in your jurisdiction?
    [Check all that apply]

	USA (N=12)		**Canada (N=8)**		**All (N=20)**	
Offense	**Number of Responses**	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
Unsecured load	5	42	3	38	8	40
Unsafe vehicle	5	42	4	50	9	45
Littering	4	33	4	50	8	40
None of the above	5	42	4	50	9	45

This table shows that the principle of absolute liability is being used for at least one of the three offenses in just over 50 percent of the jurisdictions.

13. How many demerit points are associated with the following offenses? *[Record points or "N/A" if you do not have the regulation]*

14. What is the minimum number of demerit points required for a driver's license suspension?

Demerit points	USA (N=14)			Canada (N=9)		
	Low	High	Average	Low	High	Average
Unsecured load	0	2	0	0	6	2
Unsafe vehicle	0	1	0	0	6	2
Littering	0	0	0	0	3	0
Suspension	6	17	12	9	20	14

None of these offenses garner many demerit points. On average, Canadian jurisdictions issue more demerit points per offense than their U.S. counterparts. Considering the number of points that are required for a license suspension, none of the above offenses are considered to be terribly serious.

In some instances, the respondent indicated that the number of demerit points is variable, depending on the specifics of the offense. For example, one jurisdiction indicated that the demerit points assessed for any of the three offenses are determined by the presiding magistrate.

15. Does your jurisdiction have "Carrier Safety Ratings," "Safety Fitness Rating" or a similar program that pertains to an entire corporation rather than the individual vehicle? *[Check one only]*

16. Does your jurisdiction conduct "Facility Safety Audits" or safety audits of commercial vehicle companies? *[Check one only]*

	USA (N=16)		Canada (N=9)		All (N=25)	
	Number of Responses	%	Number of Responses	%	Number of Responses	%
Carrier safety ratings						
Yes	13	81	9	100	22	88
No	3	19	0	0	3	12
Facility safety audits						
Yes	15	94	8	89	23	92
No	1	6	1	11	2	8

This table shows that both carrier safety ratings and facility safety audits are well used by North American road authorities.

17. Do you have mandatory vehicle safety inspections for private vehicles (e.g., a vehicle safety check is required once per year for vehicle license plate renewal)? *[Check one only]*

18. Do you have mandatory vehicle safety inspections for commercial vehicles (e.g., a vehicle safety check is required once per year for vehicle license plate renewal)? *[Check one only]*

	USA (N=16)		**Canada (N=8)**		**All (N=24)**	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
Private vehicles						
Yes	5	31	3	38	8	33
No	11	69	5	62	16	67
Commercial vehicles						
Yes	9	56	8	100	17	71
No	7	44	0	0	7	29

This table shows that mandatory vehicle safety inspections are more prevalent for commercial vehicles than for private vehicles. When commercial vehicle inspections are required, the frequency generally varies between once every six months to once every two years. One respondent indicated that a mileage limit was also in place, commercial vehicles must be inspected every year or every 25,000 miles, whichever comes first. Some of the respondents indicated that the inspection interval depends on the vehicle characteristics. For example, in one instance, commercial vehicles that are interjurisdictional require inspections twice a year, whereas single-jurisdiction trucks do not require an inspection; in another, the powered unit of the truck requires inspection twice a year, and the trailer portion, once a year.

19. Do you have any other legislation respecting VRRD? *[Check one only]*

	USA (N=14)		**Canada (N=9)**		**All (N=23)**	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
No	13	93	5	56	18	78
Yes	1	7	4	44	5	22

The affirmative responses included citations for "large vehicle control regulations," "Dangerous Goods Act," and basic state laws governing load securement.

20. Who provides vehicle and load inspections? *[Check all that apply]*

Enforcement providers	USA (N=16)		Canada (N=9)		All (N=25)	
	Number of Responses	%	Number of Responses	%	Number of Responses	%
Police	14	88	5	56	19	76
Government inspectors	7	44	9	100	16	64
Do not inspect	0	0	0	0	0	0

Vehicle and load inspections are carried out in all of the responding jurisdictions. In the United States, the inspections are most often conducted by the police, and in Canada by government inspectors.

21. Do you have permanent roadside inspection stations on some or all of your roads where vehicle safety and load securement inspections are routinely conducted? *[Check one only]*

Roadside inspection stations	USA (N=16)		Canada (N=9)		All (N=25)	
	Number of Responses	%	Number of Responses	%	Number of Responses	%
Yes	14	88	9	100	23	92
No	2	12	0	0	2	8

22. On average, how many times per year do you conduct specific enforcement campaigns for:
    a. Unsecured loads?
    b. Unsafe vehicles?

Enforcement specifically for unsecured loads is generally conducted between zero and 12 times a year; and four respondents indicated that this is a daily activity.

Enforcement specifically for unsafe vehicles is generally conducted between 1 and 69 times per year; three respondents indicated that this is a daily activity.

In both categories, several respondents indicated that enforcement as described is a "regular," "continuous," or "ongoing" activity, or conducted "as we see it."

23. In 2002, how many vehicles were:
    a. Stopped for inspections?
    b. Placed out-of-service or impounded for unsecured loads?
    c. Placed out-of-service or impounded for safety defects?

	USA				Canada			
	N	**High**	**Low**	**Average**	**N**	**High**	**Low**	**Average**
Number stopped	13	115,884	4,379	44,110	8	122,000	250	34,862
Out-of-service rate for all offenses (%)	15	51	4	24	9	38	5	21
Safety: load ratio for out-of-service vehicles	11	15:1	2:1	8:1	5	56:1	1:3	19:1

This table shows that one of every four or five vehicles stopped for inspection in the United States and Canada, respectively, are placed out of service for an unsecured load or a safety defect. In general, vehicles placed out of service for safety defects greatly outnumber those placed out of service for unsecured loads.

PART III: OTHER

24. Are you doing any research regarding VRRD prevention? *[Check one only]*

	USA (N=15)		Canada (N=8)		All (N=23)	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
No	13	87	8	100	21	91
Yes	2	13	0	0	2	9

One state indicated that it was tracking tire debris crashes with a view to determining whether retreaded tires are a safety hazard. On follow-up with several agencies in that state, the research team determined that no formal research project on retreaded tires was under way.

25. Are there any other methods of preventing VRRD that are employed by your agency that have not been previously mentioned? *[Check one only]*

	USA (N=15)		Canada (N=8)		All (N=23)	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
No	15	100	6	75	21	91
Yes	0	0	2	25	2	9

The two affirmative responses were: "Working with CCMTA on load securement regulations"; and "Tarping regulations and Trip inspection regulations."

26. Do you have any suggestions how VRRD prevention could be improved? *[Check one only]*

	USA (N=15)		Canada (N=7)		All (N=22)	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
No	11	73	4	57	15	68
Yes	4	27	3	43	7	32

The questionnaire prompted respondents who checked the Yes box to specify. The suggestions included the following:

- *Have enforcement personnel advise maintenance personnel if debris is on the road, or grant enforcement personnel permission to remove the debris*
- *Require tarps and tailgates for gravel trucks*
- *Use roadside signs and public service announcements*
- *Collect better information on the type and source of VRRD*
- *Enact better regulations and standards regarding retreaded tires*
- *Use uniform training for transportation industry and enforcement personnel*

27. May we contact you for further information? *[Check one only]*

	USA (N=15)		Canada (N=9)		All (N=24)	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
No	0	0	1	11	1	4
Yes	15	100	8	89	23	96

APPENDIX H

Roadway Maintenance Survey, Survey Instrument

AAA Foundation for Traffic Safety Vehicle-related Road Debris Study

NORTH AMERICAN SURVEY OF ROAD DEBRIS REMOVAL PRACTICES

Vehicle-related road debris (VRRD) is considered to be a serious safety concern on North American roads but the magnitude of the problem is unclear. We know that road debris is prevalent and that road authorities invest significant resources in removing debris from the right-of-way. What we do not know is how often VRRD is a contributing factor in a motor vehicle crash. The AAA Foundation for Traffic Safety has commissioned Intus Road Safety Engineering Inc. to establish the magnitude of the VRRD safety problem and to review practices related to VRRD prevention and removal.

For the purposes of this study, VRRD is defined as lost or spilled cargo (e.g., lumber or furniture), and vehicle parts (e.g., tire treads or mufflers) that have been unintentionally deposited on the traveled way. It does not include vehicle parts and cargo deposited on the road as a result of a motor vehicle crash.

The purpose of this survey is to estimate the safety impacts of VRRD, and to determine what maintenance programs road authorities in the United States and Canada have in place to mitigate the impacts of VRRD.

This survey should be completed by the person(s) most familiar with the removal of VRRD from roads in your jurisdiction. It will take approximately 15 minutes to complete. This survey is being conducted for research purposes only. All responses will be included in a final study report. However, your contact information will not be shared with anyone except the study team.

Please return the completed survey and any supporting documentation by **August 31, 2003** to:

Gerry Forbes
Intus Road Safety Engineering Inc.
4261 Price Court, Burlington, ON L7M 4X3 Canada
Fax: 905-332-9777.

If you have any questions about this study, please contact Mr. Gerry Forbes, President, Intus Road Safety Engineering Inc., (gerry@intus.ca or 905-332-9470) – or – Dr. Scott Osberg, Director of Research, AAA Foundation for Traffic Safety, (sosberg@aaafoundation.org or 202-638-5944 Ext 6.)

Thank you for your time.

PART I: GENERAL INFORMATION

1. Name:

2. Job title:

3. Email address:

4. Telephone No.:

5. Employer:

6. Type of Employer: ❑ State/Province
   ❑ MPO
   ❑ County/Region
   ❑ City/Town/Local government
   ❑ Other (Specify) ______________________________

7. Population of jurisdiction: ____

8. Approximately what proportion of your roads are two-lane roads?
   [Record to 100] _______ %

9. Approximately how many lane-miles/kilometres of road are in your jurisdiction?

   ________ lane-miles OR ______ lane-kilometres

PART II: VRRD OCCURRENCE & IMPACTS

If you do not know the answer to a question in PART II, please provide your best estimate.

10. How often is VRRD removed from the roads within your jurisdiction?
    [One check mark per row]

	Do not have these roads	Daily	Weekly	Monthly	Quarterly	Twice a year	Once a year or less
a. Two-lane	❑	❑	❑	❑	❑	❑	❑
b. Multi-lane	❑	❑	❑	❑	❑	❑	❑

11. What three types of VRRD are deposited most frequently on your roads? *[Check three boxes only]*

❑ Tire treads	❑ Furniture (including mattresses)
❑ Wheels and wheel assemblies	❑ Cardboard boxes
❑ Brake parts	❑ Gravel, soil, tree limbs being transported
❑ Mufflers and exhaust parts	❑ Appliances (stoves, washing machines, etc.)
❑ Transmission parts	❑ Ladders, wheelbarrows, and tools
❑ Hubcaps	❑ Other (Specify) ______________________
❑ Lumber and construction materials	❑ Other (Specify) ______________________
❑ Garbage from waste haulers	❑ Other (Specify) ______________________

12. Which type of vehicle deposits the most VRRD on your roads? *[Check one only]*

❑ Commercial vehicles
❑ Private automobiles
❑ No significant difference between commercial and private vehicles
❑ Don't know

13. On a scale of 1 to 10, where 10 is a significant safety problem and 1 is not a safety problem, how much of a safety problem would you say VRRD is on your roads? [Record a number from 1 to 10 or "N/A" if you do not have that type of road]

a. Two-lane roads ______________
b. Multi-lane roads ______________

PART III: PROGRAMS

For PART III, small debris is an object such as a tire tread, large debris is an object such as a steel beam.

14. Does your jurisdiction have any of the following information programs in place to remind motorists of the importance of vehicle safety and/or load securement? *[Check all that apply]*

❑ Public service announcements
❑ Flyers or brochures
❑ Roadside signs/billboards
❑ Other (Specify) ____
❑ We have no information programs

15. Who is responsible for removing VRRD from the traveled lanes? *[Check all that apply]*

	Police	DOT/Roads Department, or their contractor	Tow truck operators	Other (Specify) ________
a. Two-lane roads	❏	❏	❏	❏
b. Multi-lane roads	❏	❏	❏	❏

16a. How is small VRRD (e.g., a tire tread) typically removed from the traveled lanes? *[Check one per row]*

	By hand	Pushed to side of road with vehicle, and then collected	Robotic or remote retrieval	Other (Specify) ________
a. Two-lane roads	❏	❏	❏	❏
b. Multi-lane roads	❏	❏	❏	❏

16b. How is large VRRD (e.g., a steel beam) typically removed from the traveled lanes? *[Check one per row]*

	By hand	Pushed to side of road with vehicle, and then collected	Robotic or remote retrieval	Other (Specify) ________
a. Two-lane roads	❏	❏	❏	❏
b. Multi-lane roads	❏	❏	❏	❏

17. According to your maintenance standards, what is the maximum time allowed from the time of notification to the time that the VRRD is removed from the traveled way? *[Enter the time or "N/A" if you do not have that road type, or a maintenance standard]*

Small debris on a two-lane road	____	❏ minutes	❏ hours	❏ days
Large debris on a two-lane road	____	❏ minutes	❏ hours	❏ days
Small debris on a multi-lane road	____	❏ minutes	❏ hours	❏ days
Large debris on a multi-lane road	____	❏ minutes	❏ hours	❏ days

18. Does your jurisdiction have any of the following on all or some of your roads to assist in VRRD identification and removal? *[Check all that apply]*

❏ Roadside assistance patrol
❏ Video surveillance of roadway
❏ Traffic flow sensors and incident detection software
❏ Licensed or authorized tow trucks

❑ Other (Specify) ____
❑ None of the above

19. Does your jurisdiction employ any of the following methods to warn motorists of VRRD that may not be removed from the travel lanes immediately (e.g., a spilled load of lumber)? *[Check all that apply]*

❑ Media contacts/releases
❑ Changeable message signs
❑ Traveler information systems (including 511)
❑ Real-time traffic information on the World Wide Web
❑ Other (Specify) ____
❑ None of the above

20. According to your maintenance standards, what is the maximum time between road patrols on a road section? *[Record the time or "N/A" if you do not have that road type, or a maintenance standard]*

a. Two-lane roads	______	❑ hours	❑ days	❑ months
b. Multi-lane roads	______	❑ hours	❑ days	❑ months

21. Are you doing any research regarding the identification and removal of VRRD from the road allowance? *[Check one only]*

❑ No
❑ Yes (Specify) ____

22. Are there any other methods of identifying and removing VRRD that are employed by your agency that have not been previously mentioned? *[Check one only]*

❑ No
❑ Yes (Specify) ____

23. Do you have any other suggestions how VRRD identification and removal could be improved? *[Check one only]*

❑ No
❑ Yes (Specify) ____

24. May we contact you for further information? *[Check one only]*

❑ No
❑ Yes

Thank you for your time.

Please return the completed survey by **August 31, 2003** to:

Gerry Forbes
Intus Road Safety Engineering Inc.
4261 Price Court, Burlington, ON L7M 4X3
Canada
Fax: 905-332-9777

APPENDIX I

Roadway Maintenance Survey, Summary of Survey Responses

This appendix provides a detailed review of the responses to the survey reprinted in Appendix H.

Not all questions received a significant number of responses or, in some cases, meaningful responses. Some questions were not answered, and despite an effort to make the survey instrument as comprehensible as possible, it is clear that some questions were not well understood by some respondents. As a result, the number of responses does not always add up to the total number of respondents.

Overall, the responses were of high quality and provide valuable information on practices in VRRD prevention.

PART I: GENERAL INFORMATION

Respondents were asked to specify the population of their jurisdiction, the proportion of their roads that are two-lane facilities, and the number of lane-miles or lane-kilometers of road under their jurisdiction.

Respondent	Type of Employer	Population	Proportion of Roads that are Two-Lane	Lane-Miles of Road
Alabama Department of Transportation	State	144,000	60	1,077
Alaska Department of Transportation and Public Facilities	State	635,000	83	10,680
Alberta Transportation	Province	3,000,000	85	64,000++
California Department of Transportation	State	34,500,000	59	50,891
City of Edmonton, Alberta	City	675,000	90	8,070++
City of Grand Rapids, Michigan	City	197,800	85	1,550
City of Ottawa, Ontario	City	800,000		5,798++
City of Wichita, Kansas	City	300,000	80	1,800
Florida Department of Transportation	State	16,700,000	NR	40,700
Georgia Department of Transportation	State	8,800,000	75	45,000
Hawaii Department of Transportation	State	1,000,000	70	2,437
Idaho Department of Transportation	State	1,320,000	NR	4,979
Kentucky Department of Highways	State	4,041,769	82	61,695
Louisiana Department of Transportation and Development	State	4,500,000	86	38,491
Maine Department of Transportation	State	1,200,000	95	16,000
Milwaukee County, Wisconsin	County	1,000,000	10	1,575
Minnesota Department of Transportation	State	2,500,000	NR	3,950
Missouri Department of Transportation	State	5,672,579	81	71,400
Montcalm County, Michigan	County	61,828	98	2,000
Nebraska Department of Roads	State	300,000	30	51
Nevada Department of Transportation	State	2,000,000	85	13,312
New Jersey Department of Transportation	State	8,414,350	41	10,735
New York State Department of Transportation	State	16,000,000	> 50	15,000
North Carolina Department of Transportation	State	8,188,008	94	169,018
Nova Scotia Transportation and Public Works	Province	940,000	98	23,300++

(continued)

Respondent	Type of Employer	Population	Proportion of Roads That Are Two-Lane	Lane-Miles of Road
Ohio Department of Transportation	State	11,373,541	71	48,526
Pennsylvania Department of Transportation	State	NR	75	41,000
Prince Edward Island Transportation and Public Works	Province	NR	8	28,000++
Region of Waterloo, Ontario	County	450,000	75	1,600++
Simcoe County, Ontario	County	270,000	98	1,670++
South Carolina Department of Transportation	State	4,000,000	75	90,000
South Dakota Department of Transportation	State	730,000	88	17,947
Tennessee Department of Transportation	State	5,750,000	NR	NR
Texas Department of Transportation	State	20,000,000	90	180,000
Utah Department of Transportation	State	2,300,000	27	15,962
Vermont Agency of Transportation	State	800,000	80	3,700
Washington State Department of Transportation	State	6,000,000	20	80,986+
Wisconsin Department of Transportation	State	959,275	10	1,126

NR, no response
+ Centerline miles
++ Lane-kilometers

PART II: VRRD OCCURRENCE AND IMPACTS

10. How often is VRRD removed from the roads within your jurisdiction? *[One check mark per row]*

Frequency of Removal	Two-Lane Roads (N=35)		Multi-lane Roads (N=35)	
	Number of Responses	%	Number of Responses	%
Daily	25	71	27	77
Weekly	7	20	7	20
Monthly	3	9	0	0
Quarterly	0	0	0	0
Twice a year	0	0	0	0
Once a year or less	0	0	0	0
Do not have these roads	0	0	1	3

This table shows that in the responding jurisdictions, VRRD is collected from over 70 percent of all roads on a daily basis and over 90 percent of all roads on at least a weekly basis.

11. What three types of VRRD are deposited most frequently on your roads? *[Check three boxes only]*

Number of Mentions	VRRD
32	Tire treads
19	Garbage from waste haulers
15	Lumber and construction materials
12	Gravel, soil, tree limbs being transported
10	Mufflers and exhaust parts
6	Cardboard boxes
5	Hubcaps
5	Other (specify)
1	Furniture (including mattresses)
0	Wheels and wheel assemblies
0	Brake parts
0	Transmission parts
0	Appliances (stoves, washing machines, etc.)
0	Ladders, wheelbarrows, and tools

This table shows that tire treads are the most common type of debris collected from North American roads. If these responses are categorized as cargo, mechanical debris, and other, 53 mentions are cargo, 47 are mechanical debris, and 5 are other.

Other debris specified included "dead animals," "paper products," "garbage not from waste haulers," "material falling off trucks," and a "mixture of all."

12. Which type of vehicle deposits the most VRRD on your roads? *[Check one only]*

	State/Provincial (N=29)		Municipal (N=7)		All (N=36)	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
Commercial vehicles	22	76	5	71	27	75
Private automobiles	1	3	0	0	1	3
No significant difference between commercial and private	2	7	2	29	4	11
Don't know	4	14	0	0	4	11

This table shows that respondents in both U.S. and Canadian jurisdictions indicate that commercial vehicles are responsible for the majority of VRRD on their roads.

13. On a scale of 1 to 10, where 10 is a significant safety problem and 1 is not a safety problem, how much of a safety problem would you say VRRD is on your roads? *[Record a number from 1 to 10 or "N/A" if you do not have that type of road]*

	State/Provincial Agencies (N=27)		Local Agencies (N=5)	
	Two-lane Roads	**Multi-lane Roads**	**Two-lane Roads**	**Multi-lane Roads**
Median	4	5	3	4
Mean	4	5	4	4
Standard Deviation	1.7	1.9	1.8	2.7
Range	1 to 8	3 to 10	2 to 6	1 to 8

PART III: PROGRAMS

14. Does your jurisdiction have any of the following information programs in place to remind motorists of the importance of vehicle safety and/or load securement? *[Check all that apply]*

	State/Provincial (N=30)		Municipal (N=8)		All (N=38)	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
Public service announcements	13	43	1	13	14	37
Flyers or brochures	11	37	1	13	12	32
Roadside signs and billboards	7	23	0	0	7	18
Other	8	27	0	0	8	21
None of the above	10	33	7	88	17	45

This table shows that information programs are common at the state and provincial level. Two-thirds of responding jurisdictions offer some program, with public service announcements and flyers being the most common. At the municipal level, 88 percent of respondents offer no information programs.

The responses in the "other" category were education programs:

- *Announcements on the World Wide Web*
- *Bumper stickers*
- *Adopt-a-highway and Sponsor-a-highway programs*
- *Selected enforcement of waste haulers*
- *A litter prevention program led by the Department of Ecology*
- *511 National Traveller Information Number*
- *A computerized road condition reporting system*

15. Who is responsible for removing VRRD from the traveled lanes? *[Check all that apply]*

	State/Provincial Agencies (N=30)		Local Agencies (N=8)	
	Two-lane Roads	**Multi-lane Roads**	**Two-lane Roads**	**Multi-lane Roads**
Police	9	9	1	1
DOT/Roads Department, or their contractor	30	30	8	7
Tow truck operators	7	7	3	2
Others	1	1	0	0

In the responding jurisdictions, the departments of transportation and their contractors are the primary agencies responsible for clearing VRRD from the roads.

16a. How is small VRRD (e.g., a tire tread) typically removed from the traveled lanes? *[Check one per row]*

16b. How is large VRRD (e.g., a steel beam) typically removed from the traveled lanes? *[Check one per row]*

	State/Provincial Agencies (N=30)		Local Agencies (N=8)	
	Two-Lane Roads	**Multi-lane Roads**	**Two-Lane Roads**	**Multi-lane Roads**
Small Debris				
By hand	29	29	8	7
Pushed to side of road	1	1	0	0
Robotics or remote retrieval	0	0	0	0
Other	0	0	0	0
Large Debris				
By hand	7	7	1	1
Pushed to side of road	19	19	4	4
Robotics or remote retrieval	2	2	1	1
Other	1	1	1	1

This table shows that almost all of the debris found on the roads in these jurisdictions is removed manually either by direct collection or by pushing larger items to the side of the road and collecting it manually.

17. According to your maintenance standards, what is the maximum time allowed from the time of notification to the time that the VRRD is removed from the traveled way? *[Enter the time or "N/A" if you do not have that road type, or a maintenance standard]*

- *Municipal respondents who provided a time frame indicated that the maximum time for removal of debris on all roads varied from 30 minutes to 4 hours.*

- *State/provincial respondents who provided a time frame indicated that the maximum time for removal of debris on two-lane roads varied from 20 minutes to days, and on multilane roads, from 20 minutes to hours.*

- *Twenty percent of the respondents indicated that the standard for debris removal is as soon as practical after notification is received, for all types of debris on all types of roads.*

- *Of the respondents who have a standard for debris removal, 76 to 80 percent have the same standard for two-lane and multilane roads.*

- *About 30 percent of respondents indicated that they did not have a standard for debris removal.*

18. Does your jurisdiction have any of the following on all or some of your roads to assist in VRRD identification and removal? *[Check all that apply]*

	State/Provincial (N=29)		**Municipal (N=8)**		**All (N=37)**	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
Roadside assistance patrols	20	69	2	25	22	59
Video surveillance of roadway	16	55	2	25	18	49
Traffic flow sensors and incident detection software	11	38	1	13	12	32
Licensed or authorized tow trucks	10	34	2	25	12	32
Other	6	21	2	25	8	22
None of the above	5	17	3	38	8	22

This table shows that the state and provincial jurisdictions employ more methods to identify and remove debris than the municipal road authorities. Roadside assistance patrols and video surveillance are the most commonly used methods. This does not imply that these methods are used on all roads under an agency's authority but that they are used at least in critical locations.

The methods specified in the "other" category included:

- *Citizen inquiries*
- *24-hour call center*
- *Regular road patrol*
- *Portable and fixed changeable message signs*
- *Inmate litter patrols*
- *Traffic management centers to handle calls and coordinate responses*

19. Does your jurisdiction employ any of the following methods to warn motorists of VRRD that may not be removed from the travel lanes immediately (e.g., a spilled load of lumber)? *[Check all that apply]*

	State/Provincial (N=30)		Municipal (N=8)		All (N=38)	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
Media contacts/releases	20	67	1	13	21	55
Changeable message signs	25	83	3	38	25	66
Traveler information systems (including 511)	14	47	0	0	14	37
Real-time traffic information on the World Wide Web	14	47	0	0	14	37
Other	2	7	2	25	4	11
None of the above	4	13	4	50	8	21

This table shows that the state and provincial agencies are more likely to employ warning measures than the municipal agencies. Changeable message signs and media releases are the most common type of warning employed.

The methods specified in the "other" category included:

- *Signs, closures, and detour routes*
- *Flag people, police assistance, and department spokesperson*
- *Highway advisory radio*

One jurisdiction noted that in most instances when the debris could not be removed immediately, the highway would be closed to traffic and reopened only after the debris had been cleared.

20. According to your maintenance standards, what is the maximum time between road patrols on a road section? *[Record the time or "N/A" if you do not have that road type, or a maintenance standard]*

- *Municipal respondents indicated that the time between patrols on two-lane roads varied from every 4 hours to once a month, and on multilane roads every 4 hours to every 4 days.*
- *State/provincial respondents indicated that the time between patrols on two-lane roads varied from every 4 hours to once every 8 days, and on multilane roads, from every 3 hours to once a day.*
- *Two-lane roads are patrolled less frequently than multilane roads.*
- *About 38 percent of respondents indicated that they did not have a standard for road patrol frequency.*

21. Are you doing any research regarding the identification and removal of VRRD from the road allowance? *[Check one only]*

	State/Provincial (N=30)		**Municipal (N=8)**		**All (N=38)**	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
No	29	97	7	88	36	95
Yes	1	3	1	12	2	5

22. Are there any other methods of identifying and removing VRRD that are employed by your agency that have not been previously mentioned? *[Check one only]*

	State/Provincial (N=30)		**Municipal (N=7)**		**All (N=37)**	
	Number of Responses	**%**	**Number of Responses**	**%**	**Number of Responses**	**%**
No	20	67	4	57	24	65
Yes	10	33	3	43	13	35

- *Adopt-a-highway*
- *Public comments*
- *Mechanical removal of gravel and concrete spills*
- *VRRD removal is a part of normal daily operations*
- *Magnets are employed to remove some metal material*
- *Video surveillance*

23. Do you have any other suggestions how VRRD identification and removal could be improved? *[Check one only]*

	State/Provincial (N=30)		Municipal (N=8)		All (N=38)	
	Number of Responses	%	Number of Responses	%	Number of Responses	%
No	25	83	6	75	31	82
Yes	5	17	2	25	7	18

Suggestions included:

- *Maintenance crews could remove debris while en route to other activities*
- *Promote better vehicle design*
- *Focus on prevention*
- *Increase staff levels*
- *Improve enforcement and levy fines*

24. May we contact you for further information? *[Check one only]*

	State/Provincial (N=30)		Municipal (N=8)		All (N=38)	
	Number of Responses	%	Number of Responses	%	Number of Responses	%
No	0	0	2	25	2	5
Yes	30	100	6	75	36	95

APPENDIX J

Coding Rules for Incidents

The Ohio and Ontario incident databases were reviewed to determine what types of VRRD are most frequently deposited on North American freeways. The databases contain a great variety of debris types, so for ease of presentation and analysis, the debris was categorized according to the taxonomy shown in the table below.

The categories are somewhat arbitrary and were developed by the research team while considering the main types of debris encountered during the early phases of the study.

The following coding rules were used in reviewing and categorizing the incident data:

- If there is a discrepancy in what was reported to the call center and what was collected, the item that was collected was taken as correct.
- If debris was reported but none was found, the item that was reported was coded, under the assumption that it was moved before the removal crew arrived.
- All incidents without a description beyond “debris” were culled from the database.
- Debris that was identified as cones, pylons, or construction barrels was assumed to be work-zone debris.
- Debris that was labeled as a “sign,” “sign post,” or “light pole” was assumed to be environmental or crash debris unless specific mention was made that it fell from a vehicle.
- Any debris that was clearly identified as debris resulting from a crash was removed from the database.
- Any debris that involved an animal was assumed to be environmental debris unless specific mention was made that it fell from a vehicle.

VRRD Categories for Incident Databases

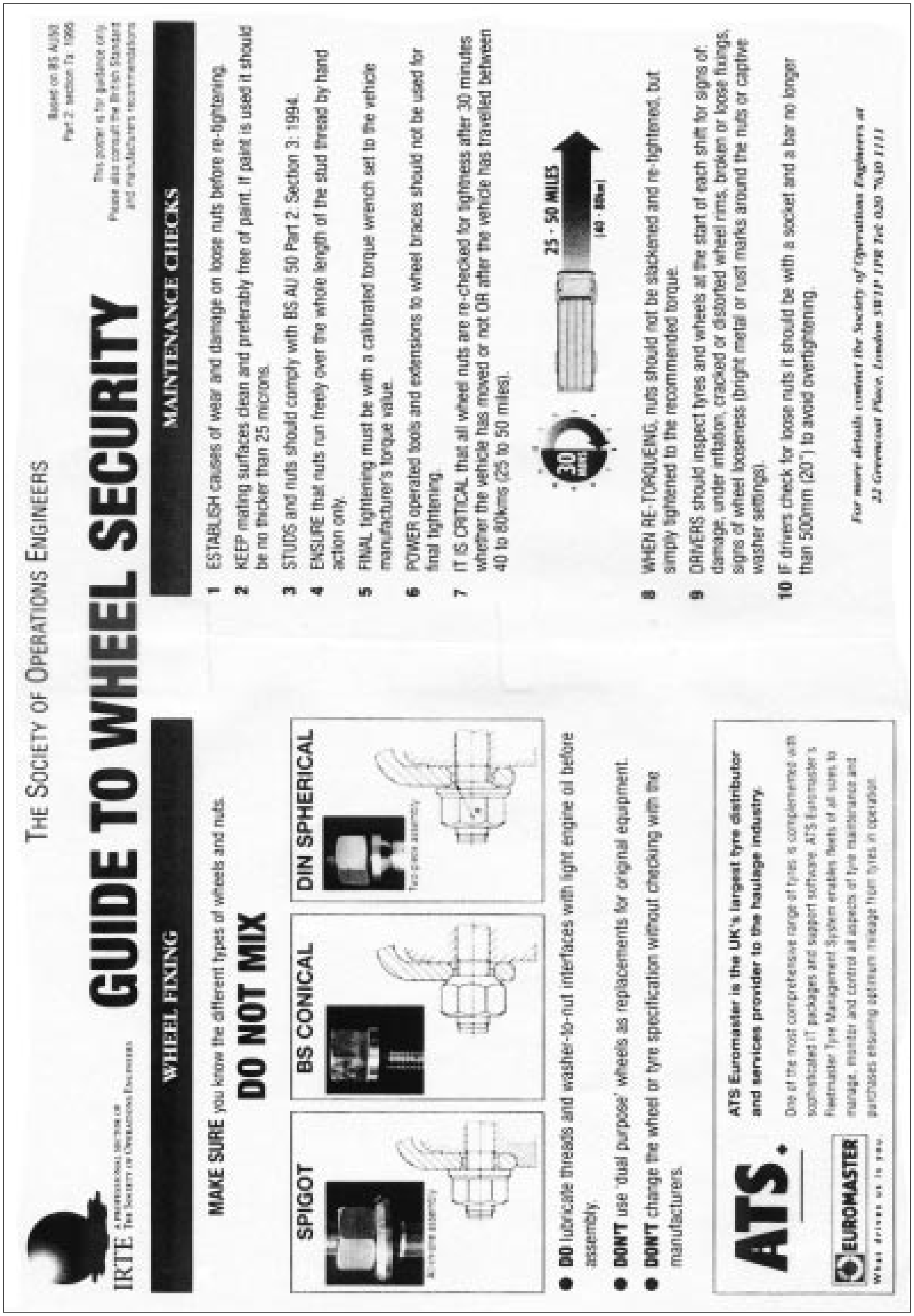
Category of Debris	Items	
Barrels	Barrel Bin Bucket	Container Drum Pail
Box	Box Cardboard	Crate
Construction	Bricks Cable Concrete Drywall Fiberglass Insulation Orange plastic fencing	Pallet Paneling Shingles Siding Skids Snow fencing Styrofoam
Earth	Branches Earth Grass Gravel Tree limbs	Mulch Rocks Soil Trees [Natural material]
Furniture	Appliance Bench Box springs Carpets or carpeting Chair Couch	Desk drawer Desk Filing cabinet Mattress Sofa
Load	Bag Barbecue or grill Bathtub Bicycle Boat trailer, entire Christmas tree Cooler Fire extinguisher Furnace Gas can Gas tank General cargo Hot tub Hula hoops	Kayak Kiddie pool Luggage Phone book Piece of machinery Plastic hooks Roll of canvas Sink Sleeping bag Snowplow Suitcase Tent Workbench
Load Securement	Chains Straps Tarps	Tie-downs [Any material that may have been used to secure a load]
Metal	Aluminum Coils of steel Metal	Steel Steel plate
Other	Blanket Clothing Glass Granular material	Hose Oil, no source indicated Towel

(continued)

Category of Debris	Items *(continued)*	
Plastic	Plastic pipe	[Any mention of plastic in the generic sense]
Tire	Rubber Tire Tread	Wheel [Any mention of a tire part]
Tools	Broom Equipment Fire hose Ladder	Tools Trolley Wheelbarrow
Trash	Garbage Garbage bag Garbage can	Trash Trash bag Waste
Vehicle part	Truck bed liner Brake parts Bumper Car seat Center caps Drive axle Drive shaft Engine oil Exhaust system parts	Fender Hubcap Leaf spring Mirror Mud flap Muffler Tailpipe Trailer hitch
Wood	2 x 4 4 x 4 Logs	Lumber Plywood Wood

APPENDIX K

The Society of Operations Engineers, "Guide to Wheel Security"



THE SOCIETY OF OPERATIONS ENGINEERS

IRTE

GUIDE TO WHEEL SECURITY

Based on BS AU50 Part 2: section 7a: 1995

This poster is for guidance only. Please also consult the British Standard and manufacturers recommendations

WHEEL FIXING

MAKE SURE you know the different types of wheels and nuts.

DO NOT MIX

SPIGOT — All-in-one assembly

BS CONICAL

DIN SPHERICAL — Two-piece assembly

- **DO** lubricate threads and washer-to-nut interfaces with light engine oil before assembly.
- **DON'T** use 'dual purpose' wheels as replacements for original equipment.
- **DON'T** change the wheel or tyre specification without checking with the manufacturers.

ATS Euromaster is the UK's largest tyre distributor and services provider to the haulage industry.

One of the most comprehensive range of tyres is complemented with sophisticated IT packages and support software. ATS Euromaster's Fleetmaster Tyre Management System enables fleets of all sizes to manage, monitor and control all aspects of tyre maintenance and purchases ensuring optimum mileage from tyres in operation.

ATS. EUROMASTER What drives us is you.

MAINTENANCE CHECKS

1. ESTABLISH causes of wear and damage on loose nuts before re-tightening.
2. KEEP mating surfaces clean and preferably free of paint. If paint is used it should be no thicker than 25 microns.
3. STUDS and nuts should comply with BS AU 50 Part 2: Section 3: 1994.
4. ENSURE that nuts run freely over the whole length of the stud thread by hand action only.
5. FINAL tightening must be with a calibrated torque wrench set to the vehicle manufacturer's torque value.
6. POWER operated tools and extensions to wheel braces should not be used for final tightening.
7. IT IS CRITICAL that all wheel nuts are re-checked for tightness after 30 minutes whether the vehicle has moved or not OR after the vehicle has travelled between 40 to 80kms (25 to 50 miles).

30 MINS — 25 - 50 MILES (40 - 80km)

8. WHEN RE-TORQUEING, nuts should not be slackened and re-tightened, but simply tightened to the recommended torque.
9. DRIVERS should inspect tyres and wheels at the start of each shift for signs of: damage, under inflation, cracked or distorted wheel rims, broken or loose fixings, signs of wheel looseness (bright metal or rust marks around the nuts or captive washer settings).
10. IF drivers check for loose nuts it should be with a socket and a bar no longer than 500mm (20") to avoid overtightening.

For more details contact the Society of Operations Engineers at 22 Greencoat Place, London SW1P 1PR Tel: 020 7630 1111

APPENDIX L

Utah Department of Transportation, Vehicle Pre-Trip Inspection

V.I.N. (Last four digits)__________ Date___________ Time_______ am pm
Inspector Signature____________________ Job Title____________________

Before starting engine—observe and correct as necessary:

Component Cond./Operation

Good	Needs Repair/ Replcmnt	N/A		
❏	❏	❏	1.	All lights operable (headlamps, park and marker, brake, turn signal, tail, hazard, interior).
❏	❏	❏	2.	Body and bumper damage - loose or protruding parts.
❏	❏	❏	3.	Wheels - bent, loose, or missing lug nuts.
❏	❏	❏	4.	Tires - inflation, damage, and tread depth (incl. spare).
❏	❏	❏	5.	Jack, jack handle, and lug wrench.
❏	❏	❏	6.	Flares, fire extinguisher, and first aid kit.
❏	❏	❏	7.	Windows and mirrors (clean and properly adjusted).
❏	❏	❏	8.	Doors' operation (include emergency exit).
❏	❏	❏	9.	Clean (steps, step wells, floor, seats, and handrails).
❏	❏	❏	10.	Seats and wheelchair locks' condition, proper operation, securely anchored.
❏	❏	❏	11.	Fluid levels (radiator, engine oil, power steering, battery electrolyte and windshield washer solution.
❏	❏	❏	12.	Drive belts condition and tension.
❏	❏	❏	13.	Visible wiring condition.
❏	❏	❏	14.	Wiper blades and arms condition.

Start engine and observe for proper operation—correct as necessary:

❏	❏	❏	1.	Instruments/warning lights (amperage/voltage, temp., fuel, oil, brakes, signal, emergency flasher).
❏	❏	❏	2.	Abnormal drive-train noise.
❏	❏	❏	3.	Windshield wiper and washer.
❏	❏	❏	4.	Heater, defrosting, ventilator, and air conditioner.
❏	❏	❏	5.	Wheelchair lift/ramp.
❏	❏	❏	6.	Radio and public address systems.
❏	❏	❏	7.	Service and parking brakes.
❏	❏	❏	8.	Fuel level gauge.
❏	❏	❏	9.	Observe under-carriage and ground surface under vehicle for visible fluid leakage.
❏	❏	❏	10.	Steering (loose, binding).
❏	❏	❏	11.	Mirror adjustment.
❏	❏	❏	12.	Transmission shift lever.
❏	❏	❏	13.	Transmission shift points.
❏	❏	❏	14.	Clutch (standard transmission).

Page 2 — Utah Department of Transportation, Vehicle Pre-Trip Inspection

TIME (Hour, Min.)	OCCURRENCES IN/ABOUT VEHICLE DESCRIBE

Checklist can be found at http://www.dot.state.ut.us/progdev/transit/AA%20Pre%20Trip%20Inspection.PDF

APPENDIX M

Wingfield Waste Management Centre, "Cover Your Load"

Page 2 — Wingfield Waste Management Centre, "Cover Your Load"

Moving a Load?

It's not only hard work loading, securing, transporting and unloading, it's a big responsibility. Think about your load habits!

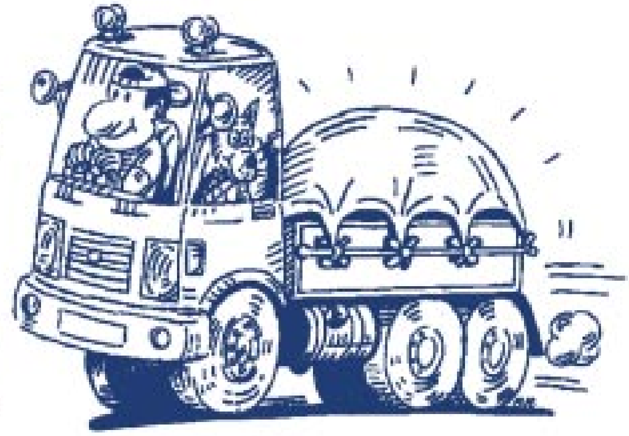
Best Practice Tips for commercial operators and householders

Do you...

- Wear gloves to protect your hands from sharp objects when loading?
- Consider what you have to load and plan to spread the weight?
- Divide your load into groups for ease of unloading and separation, eg. green waste, bottles, cans, household items?
- Dampen soil or sand before transporting to minimise dust?
- Cover and secure your load with ratchet straps or rope tied with firm knots?
- Cover mini skips and roll-on, roll-off bins with a tarpaulin?
- Check commercial bins after emptying and ensure lids are closed?
- Carry a broom to sweep your trailer after unloading?

Do you...

- Keep the load within the tray dimensions and make sure there are no protruding objects?
- Maintain your trailer or truck in good condition?
- Check your rear lights and indicators once loaded?
- Check your load regularly when travelling long distances?
- Always unload at authorised places?
- Wash mud from tyres and clean tray top so nothing remains which can blow out after emptying?
- Keep a bin or bag in your vehicle for disposal of personal rubbish?
- Wash your car, trailer or truck in designated 'washdown' areas so that harsh detergents do not run into waterways?
- Ensure your vehicle does not leak oil or petrol on roads or in trailer parks?



- Check manufacturers' instructions for safe transportation of liquid and hazardous waste?

IT'S A FACT

There are significant penalties for littering and poor waste management practices.

APPENDIX N

Georgia Department of Community Affairs,

“Keep it in Your Bed . . . Secure Your Load”

Georgia Department of Community Affairs

Keep it in Your Bed...Secure Your Load

Georgia taxpayers spend millions of dollars every year to remove trash that blows from truck beds. Transporting unsecured loads isn't just scandalous, it's illegal!

LITTER. It costs you

Georgia Department of Community Affairs
Office of Environmental Management
60 Executive Park South, N.E.
Atlanta, Ga. 30329
404-679-4940
www.dca.state.ga.us

Printed on Recycled Paper

LITTER. It costs you

Tarp it, or Get Ticketed

Careless drivers could wind up picking up their own litter…wearing an orange jump suit. It's a misdemeanor under Georgia law to haul an improperly secured load. Penalties may reach one year in prison, a $1,000 fine, or both.

OCGA 40-6-254: No person shall operate any motor vehicle with a load on or in such vehicle unless the load… is adequately secured to prevent the dropping or shifting of the load onto the roadway. Any person who operates a vehicle in violation of this Code section shall be guilty of a misdemeanor.

A survey conducted by the Georgia Department of Transportation, Department of Community Affairs, and Keep Georgia Beautiful found 18% of the 'littering' tickets authorities wrote in 2000 were under the unsecured loads law. When surveyed by Georgia DOT, 77% of Georgia motorists said they have seen something blow out of a vehicle onto the road.

Do Your Part….Secure Your Load

Page 2 — Georgia Department of Community Affairs,
"Keep it in Your Bed . . . Secure Your Load"

Put a lid on it!

Trucks carrying unsecured loads send litter onto the Peach State's roads every day. The Georgia Department of Transportation has spent $11 million in a single year picking up roadside litter and those costs continue to rise. We've all seen trash blowing from the back of garbage trucks, but private pickup truck owners are also partly to blame. Truck owners often use their truck beds as mobile garbage cans. Sure it's handy, but the trash doesn't always stay put. At highway speeds, with vehicles passing and bumpy roads, empty containers and other bits of trash easily become airborne and turn into litter. Weekend warriors hauling unsecured loads of construction debris also contribute to our litter problem.

Driving with an unsecured load can destroy more than scenery. The Governor's Office of Highway Safety reports that in 2000, roadway debris was a contributing factor in five motorist deaths. Perhaps this is why officers reported that three out of four tickets they issue for unsecured loads are issued with motorist safety in mind.

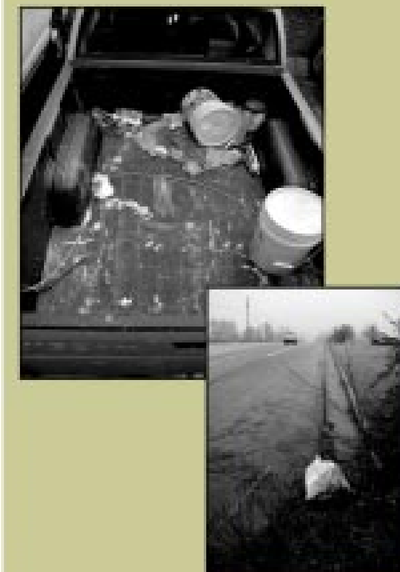
Lock That Load!

All of us share a responsibility to Keep Georgia Beautiful. You may not intentionally litter, but if you're not securing the items in your pickup truck, they could easily become litter. Take the time to secure your load.

- Don't rely on the weight of items to keep them in your truck. Bumps, turns and sudden stops can dislodge even heavy items like furniture, tools, and equipment.
- Consider buying a cover if you don't often haul large bulky items in your truck. Not only do covers improve fuel economy and keep your goods dry, they keep material in the bed, keep thieves out, and look good doing it.
- All trash or recyclables should be in sturdy bags and covered by a strong tarp or cargo netting. If you often throw trash into your truck bed, secure a 5-gallon bucket with a lid in a corner of the bed, as a trash can. Or, throw trash into the tool box.

It doesn't take much time, effort, or money to make sure your load is properly secured.

If You Throw it Here,



You're Throwing it Here.

Commercial garbage and recycling haulers aren't to blame for all of the trash that turns into litter. In fact, most in the industry say the small haulers, especially weekend warriors cleaning out the garage or hauling home remodeling debris share the responsibility. It doesn't take long to secure a tarp or cargo netting over a pickup truck bed and tarps can be bought for under $20, including tie-downs, at most home improvement or automotive stores.

APPENDIX O

State of Washington, "Cover Your Load"

APPENDIX P

Florida Department of Transportation, "No Debris Saves You & Me"

FLORIDA'S TURNPIKE Florida's Main Street

Roadway Debris Awareness Brochure

MyFlorida.com

Search MyFlorida.com Go contact us | what's new | FAQ's | links

Safe Roads

are

No Accident

SECURE LOADS. Whether you drive a dump truck or a pick-up truck, make sure the bed is covered and secured. We've all seen tarps flapping in the wind with debris blowing out from underneath them. It takes only a small piece of metal, wood or concrete to create a dangerous situation for other motorists.

REPORT DEBRIS. If you see hazardous debris (in lanes of traffic, not on the roadside) - don't stop and pick it up. Call *FHP.

DON'T LITTER. Make it a rule that nothing gets tossed from the windows of your car. In this age of drive-through everything, it's easy to accumulate litter in your vehicle. Use litter bags, one in front and one in back. Every convenience store, gas station and rest stop has trash containers. Use them.

ADOPT A HIGHWAY. Join an organization or group that adopts a portion of roadway and donates time or resources to keep it clean. Contact the local Florida Department of Transportation Maintenance Office and ask for the Adopt A Highway Program Coordinator.

DRIVE DEFENSIVELY. Maintain a safe following distance. It's hard to avoid debris blown from a truck or kicked up by a tire if you don't have time to see it and room to react safely.

BUCKLE UP. Always wear your seatbelt and keep both hands hands on the wheel. You might have to swerve to miss a hazard on the road.

STAY ALERT. Concentrate on your driving. Safety experts advise not to talk on cell phones, eat or use the radio dials when driving. Road debris can appear within seconds.

Injury prevention tips should your vehicle become disabled due to a collision with road debris:

1. Try to move your vehicle off the roadway.

2. Use flashers.

3. Raise the hood.

4. Call for help or wait for assistance. Motorists aid call boxes are located every mile along Florida's Turnpike.

5. Stay in your vehicle unless it's unsafe.

6. Avoid standing in front of or behind the vehicle.

Check out our Road Ranger crews in action !

E-mail questions regarding the Florida's Turnpike here.

or call 1-800-749-7453

Learn more about the Florida's Turnpike.

APPENDIX Q

State of Florida, "Open Roads Policy"

State of Florida

"OPEN ROADS POLICY"

Quick Clearance for Safety and Mobility

This agreement by and between the Florida Highway Patrol (FHP) and the Florida Department of Transportation (FDOT) establishes a policy for FHP and FDOT personnel to expedite the removal of vehicles, cargo, and debris from roadways on the State Highway System to restore, in an URGENT MANNER the safe and orderly flow of traffic following a motor vehicle crash or incident on Florida's roadways.

Whereas: Public safety is the highest priority and must be maintained especially when injuries or hazardous materials are involved. The quality of life in the State of Florida is heavily dependent upon the free movement of people, vehicles, and commerce. The FHP and FDOT share the responsibility for achieving and maintaining the degree of order necessary to make this free movement possible. Agencies have the responsibility to do whatever is reasonable to reduce the risk to responders, secondary crashes, and delays associated with incidents, crashes, roadway maintenance, construction, and enforcement activities.

The following operating standards are based on the philosophy that the State Highway System will not be closed or restricted any longer than is absolutely necessary.

Be it resolved: Roadways will be cleared of damaged vehicles, spilled cargo, and debris as soon as it is safe to do so. It is understood that damage to vehicles or cargo may occur as a result of clearing the roadway on an urgent basis. While reasonable attempts to avoid such damage shall be taken, the highest priority is restoring traffic to normal conditions. Incident caused congestion has an enormous cost to society.

Florida Highway Patrol Responsibilities

Members of FHP who respond to the scene of traffic incidents will make clearing the travel portion of the roadway a high priority. When an investigation is required, it will be conducted in as expedient a manner as possible considering the severity of the collision. Non-critical portions of the investigation may be delayed until lighter traffic conditions allow completion of those tasks. The FHP will close only those lanes absolutely necessary to safely conduct the investigation. The FHP will coordinate with FDOT representatives to set up appropriate traffic control, establish alternate routes, expedite the safe movement of traffic at the scene, and restore the roadway to normal conditions as soon as possible.

Whenever practical, damaged vehicles on access controlled roadways will be removed to off ramps, accident investigation sites, or other safe areas for completion of investigations to reduce the delays associated with motorists slowing to "gawk." Tow trucks will be requested as soon as it is evident that they will be needed to clear the roadway. FHP will assure that all authorized tow operators have met established competency levels and that the equipment is of appropriate size, capacity, and design to meet all standards of the State of Florida.

The FHP will not unnecessarily cause any delay in reopening all or part of a roadway to allow a company to dispatch its own equipment to off-load cargo or recover a vehicle or load that is impacting traffic during peak traffic hours or creating a hazard to the public. The FHP and FDOT will cooperate in planning and implementing clearance operations in the most safe and expeditious manner.

Florida Department of Transportations Responsibilities

When requested by FHP or other emergency agency, FDOT will respond and deploy resources to major traffic incidents 24 hours a day, 7 days per week. Each FDOT District will develop and implement response procedures to meet the goal of providing initial traffic control within **30 minutes** of notification during the assigned working hours of each maintenance yard, and **60 minutes** after hours.

The FDOT, in coordination with FHP, will upgrade traffic controls, determine detour routes, and discuss clearance strategies. When requested, FDOT will provide temporary traffic controls to ensure a safe work zone for all responders and the motoring public.

The FDOT, in cooperation with the FHP, will determine and deploy the necessary heavy equipment and manpower to reopen the roadway if there is a delay in clearing the travel lanes, or if the task is beyond the capabilities of the wrecker service on scene. If cargo or spilled loads [non-hazardous] are involved, FDOT will make every effort to assist in the relocation of the materials in the shortest possible time, using whatever equipment necessary. All such materials or any vehicles relocated by FDOT will be moved the minimum possible distance to eliminate traffic hazards.

FDOT personnel will document all hours and equipment used for traffic control, roadway clearance, and debris clean up. FDOT will place traffic control devices at the scene should any damaged vehicles or cargo remain on the shoulder adjacent to the travel lanes for removal at a later time.

The FDOT and FHP will continually work together to ensure that the needs of motorists on state roadways are being met in the most professional, safe, and efficient manner.

Therefore, it is agreed as follows:

The FHP and the FDOT will evaluate and continually update and modify their operating policies, procedures, rules, and standards to assure they are consistent with this **"OPEN ROADS POLICY"** agreement.

FHP, together with FDOT, will research, evaluate, and conduct training in the most advanced technologies, equipment, and approved methods for the documentation and investigation of crash or incident scenes. FHP, using these techniques, will prioritize the investigative tasks and reopen travel lanes upon completion of tasks that must be conducted, without the impediment of traffic flowing.

Roadways will be cleared as soon as possible. It is the goal of all agencies that **all incidents be cleared from the roadway within 90 minutes of the arrival of the first responding officer.** This goal being made with the understanding that more complex scenarios may require additional time for complete clearance.

It is further agreed that:

FHP and FDOT will actively solicit and enlist other state, county, and local agencies, political subdivisions, industry groups, and professional associations to endorse and become party to this **"OPEN ROADS PHILOSOPHY"** for the State of Florida.

In witness whereof, each party hereto has caused this document to be executed in its name and on its behalf by its duly authorized Chief Executive.

By: ______________________
Thomas F. Barry, Jr., P.E.
Secretary
Florida Department of Transportation

Date: 10/30/02

By: ______________________
Col. Christopher Knight
Director
Florida Highway Patrol

Date: 11-1-02

Reviewed By:

____
Agency's General Counsel Office

______________________ 10/31/02
Agency's General Counsel Office