The Minnesota Comprehensive Highway Safety Plan (CHSP) was created in a coordinated effort between the Minnesota Departments of Transportation and Public Safety to reduce the number of traffic fatalities and serious injuries on Minnesota's roadway. Using a systematic, data and information driven process and the guidance of the State's safety partners, five critical emphasis areas (CEAs) and 15 critical strategies have been identified as having the greatest potential to reduce the number of related fatalities and serious injuries. These strategies are comprehensive in nature and address enforcement, education and emergency services in addition to the more traditional engineering improvement (the "Four Safety Es"). The strategies and partnerships identified in this CHSP present the State of Minnesota the opportunity to achieve the aggressive goal of reducing traffic fatalities to fewer than 500 by 2008 and to take the initial steps in moving Towards Zero Deaths.

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16. Abstract (Limit: 200 words)

The Minnesota Comprehensive Highway Safety Plan (CHSP) was created using a data driven, comprehensive, systematic process. In development of the CHSP, Minnesota's Safety Partners first met to discuss and prioritize AASHTO's 22 key emphasis areas in the Strategic Highway Safety Plan. From this process, the five Critical Emphasis Areas were identified: (1) Reducing Impaired Driving and Increasing Seat Belt Use, (2) Improving the Design and Operation of Highway Intersections, (3) Addressing Young Drivers Over Involvement & Curbing Aggressive Driving, (4) Reducing Head-On and Across-Median Crashes, Keeping Vehicles on the Roadway & Minimizing the Consequences of Leaving the Road, and (5) Increasing Driver Safety Awareness & Improving Information Systems.

For these CEAs, the State's Safety Partners met again to discuss the safety strategies associated with each of these areas. This effort resulted in 15 Critical Strategies that are believed to have the greatest potential of reducing the number of traffic fatalities in Minnesota. A detailed action plan was developed for each Critical Strategy, along with an Effectiveness Spreadsheet that estimates the cost and number of lives saved for a given deployment of each strategy. To assist local agencies address traffic safety issues, Appendix III (CHSP Safety Toolbox) was developed to assist local agencies and organizations identify countermeasures.

17. Document Analysis/Descriptors Comprehensive, "Four Safety Es", Fatal and Serious Injury Crashes, Alcohol Related Crashes, Unbelted Vehicle Occupants, Intersection Crashes, Young Drivers, Aggressive Drivers, Lane Departure Crashes, Driver Safety Awareness, Information Systems		18. Availability Statement No restrictions.	
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Executive Summary

From a peak in the 1970s, there have been significant reductions in the number of traffic related fatalities in Minnesota which led to noticeable decreases in the fatal crash rate. However, after 1980 there has been an increasing trend in the number of traffic fatalities while the trend in the fatal crash rate has flattened. The pattern in Minnesota's traffic fatalities has paralleled what has been occurring at the national level. This lack of progress on reducing fatalities led the American Association of State Highway and Transportation Official's (AASHTO) to create the Strategic Highway Safety Plan (SHSP). The SHSP acknowledged the need for the states to look at traffic safety in a new way and identified 22 emphasis areas where the greatest number of lives can be saved. In Minnesota, a review of the fatal crash data revealed that some of the key contributing factors (young drivers, impaired drivers, aggressive drivers, unbelted vehicle occupants, lane departure crashes, and intersection crashes) are directly related to the original 22 emphasis areas.

The key principles for a state CHSP are to: be data driven; be inclusive of the four safety "Es"; address local roadway system needs; be comprehensive...; and be more strategic…

The National Cooperative Highway Research Program (NCHRP) has published a set of guides based on the SHSP to assist state and local agencies identify and implement strategies in many of the emphasis areas. FHWA has also encouraged state transportation agencies to develop their own Comprehensive Highway Safety Plan (CHSP). The key principles for a state CHSP are to: be data driven; be inclusive of the four safety "Es"; address local roadway system needs; be comprehensive by reaching out to and coordinating with the state's safety partners; and be more strategic by addressing traffic safety in both a proactive and reactive manner.

Minnesota's CHSP Development Process

Since the previous approach to traffic safety has not continued to decrease the number of traffic fatalities, the Minnesota Department of Transportation (Mn/DOT) and Department of Public Safety (DPS) have partnered to address the State's traffic safety issues in a coordinated, integrated, and systematic approach by preparing the Minnesota CHSP. The purpose of the CHSP is to address the crash problems in Minnesota by focusing on the number of lives lost, as opposed to the fatal crash rate. The goal of the Minnesota CHSP is to reduce the number of traffic fatalities to 500 or less per year by 2008, from a current level of approximately 650 traffic fatalities per year.

The Minnesota plan is being built upon AASHTO's SHSP and the NCHRP Series 500 Implementation Guides. The approach has actively involved the State's safety partners through two workshops and a self-assessment survey. The two workshops had a combined attendance of over 100 persons, with attendees from a wide diversity of agencies and organizations, including: Minnesota Supreme Court, Minnesota State Patrol, local law enforcement, DPS, Driver & Vehicle Services, metropolitan and greater Minnesota EMS,

driver education, universities, FHWA, National Highway Traffic Safety Administration, Federal Motor Carrier Safety Administration, Mn/DOT, county and city engineering departments, consulting firms, and safety organizations (i.e., Safe Communities of Wright County, MADD, and AAA). By providing the safety partners a forum to voice their concerns and ideas, it has resulted in the Minnesota plan addressing the State's needs in the "Four Es."

The Minnesota CHSP

From AASHTO's original 22 emphasis areas, Mn/DOT, DPS and their safety partners identified the 10 emphasis areas that were the most important to Minnesota. These emphasis areas were grouped into five Critical Emphasis Areas (CEAs) based upon similarities and relationships in the challenges facing each.

CEA 1 – Reducing Impaired Driving & Increasing Seat Belt Use
CEA 2 – Improving the Design and Operation of Highway Intersections
CEA 3 – Addressing Young Drivers Over Involvement & Curbing Aggressive Driving
CEA 4 – Reducing Head-On and Across-Median Crashes, Keeping Vehicles on the Roadway & Minimizing the Consequences of Leaving the Road
CEA 5 – Increasing Driver Safety Awareness & Improving Information Systems

For the CEAs, 15 Critical Strategies were then identified (see **Table ES-1**). Based on the data driven prioritization process, Critical Strategies have the greatest ability to reduce the number of traffic fatalities and serious injuries. For each Critical Strategy, an action plan has been developed along with implementation goals for Year 1.

TABLE ES-1
Minnesota's Critical Strategies

1. Provide adequate law enforcement resources	8. Cost effective intersection improvements
2. Primary seat belt law	9. Roadway maintenance
3. Implement automated enforcement	10. Support the enforcement traffic safety laws
4. Stronger graduated driver licensing system	11. Targeted enforcement
5. Cost effective lane departure improvements	12. Enhance driver education
6. Communication and marketing task force	13. Road Safety Audits
7. High-level traffic safety panel and legislature action committee	14. Improve Data System
	15. Statewide Trauma System

It was determined that to optimize the effectiveness of the State's investment in safety projects and to meet interim goals for reduction in fatalities, implementation of the Critical Strategies must focus on addressing all four "Es". Further, at Mn/DOT there is a new focus on providing local agencies with funding, training, and technical assistance (similar to DPS) in order to address the fact that historically over 45% of fatal crashes occur on local roadways. The *CHSP Safety Toolbox* was one such tool developed for this purpose. The *CHSP Safety Toolbox* is a

...to optimize the effectiveness of the State's investment in safety projects and to meet interim goals for reduction in fatalities, implementation of the Critical Strategies must focus on addressing all four "Es".

companion document to the CHSP written with the intent of providing local agencies guidance in developing, prioritizing, and implementing safety projects in their jurisdiction.

The greatest challenge facing traffic safety professionals in Minnesota is the need to acknowledge that the effort to reduce fatal and life changing injury crashes is tied to implementing the prioritized strategies identified in this CHSP. The guiding principles suggest that the most effective implementation likely involves doing things differently from what has been the practice in recent years. This includes investing in additional enforcement, a statewide trauma system data base, being more proactive, significantly increasing the level of investment in safety improvements on local roads and actively engaging the legislature to improve our laws regarding seat belts, automated enforcement and the graduated licensing process for young drivers.

The strategies and partnerships identified in this Comprehensive Highway Safety Plan present the State of Minnesota the opportunity to achieve the aggressive goal of reducing fatalities to fewer than 500 by 2008 and to take the initial steps in moving Towards Zero Deaths.

Table of Contents

1. Background & Purpose

From a peak in the 1970s, there have been significant reductions in the number of traffic related fatalities in Minnesota which led to noticeable decreases in the fatal crash rate (see **Figures 1-1** and **1-2**) (*1*). However, after 1980 there has been a slight increasing trend in the number traffic fatalities while the fatal crash rate has flattened. The pattern in Minnesota's traffic fatalities parallels what has occurred at the national level. This led the American Association of State Highway and Transportation Official's (AASHTO) and Federal Highway Administration (FHWA) to conclude that a new focus on and approach to traffic safety would be necessary to address the alarming increases in fatal and injury crashes. Their vision for a new process is documented in the *National Cooperative Highway Research Program Report 501: Integrated Safety Management Process* (*2*). This process encourages State Highway Agencies to adopt a new safety process that is integrated with and complimentary to other agencies and organizations responsible for traffic safety. Agencies are also using the approach of focusing new efforts in target areas where the greatest number of fatalities can be prevented. This concept is illustrated by FHWA's decision to target resources in the "vital few": roadway departures, intersections, and pedestrians (*3*) (Roadway departures and intersections were also emphasis areas selected by the State of Minnesota, see **Chapter 2**).

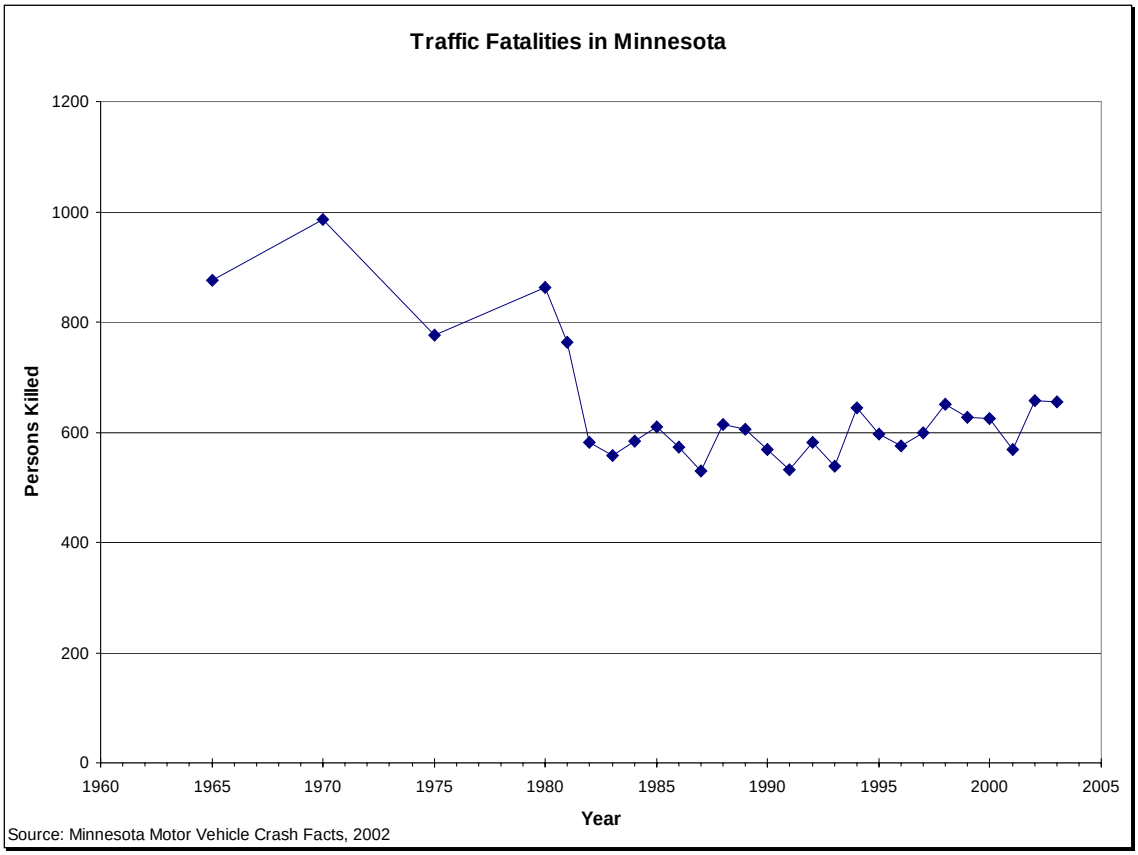

FIGURE 1-1
Historic Number of Minnesota Traffic Fatalities (*1*)

In 2002, Minnesota had 657 traffic fatalities; based on the trend from 1993 to 2002 crash data, approximately 665 traffic fatalities would be expected by 2008. Therefore, it can be concluded that the previous approach to traffic safety has not continued to work, which resulted in the Minnesota Department of Transportation (Mn/DOT) and Department of Public Safety (DPS) partnering to address the State's traffic safety issues in an integrated, systematic approach by preparing the Minnesota Comprehensive Highway Safety Plan (CHSP). The goal of the CHSP is to address the crash problems in Minnesota and reduce the number of traffic fatalities to 500 or less each year by 2008.

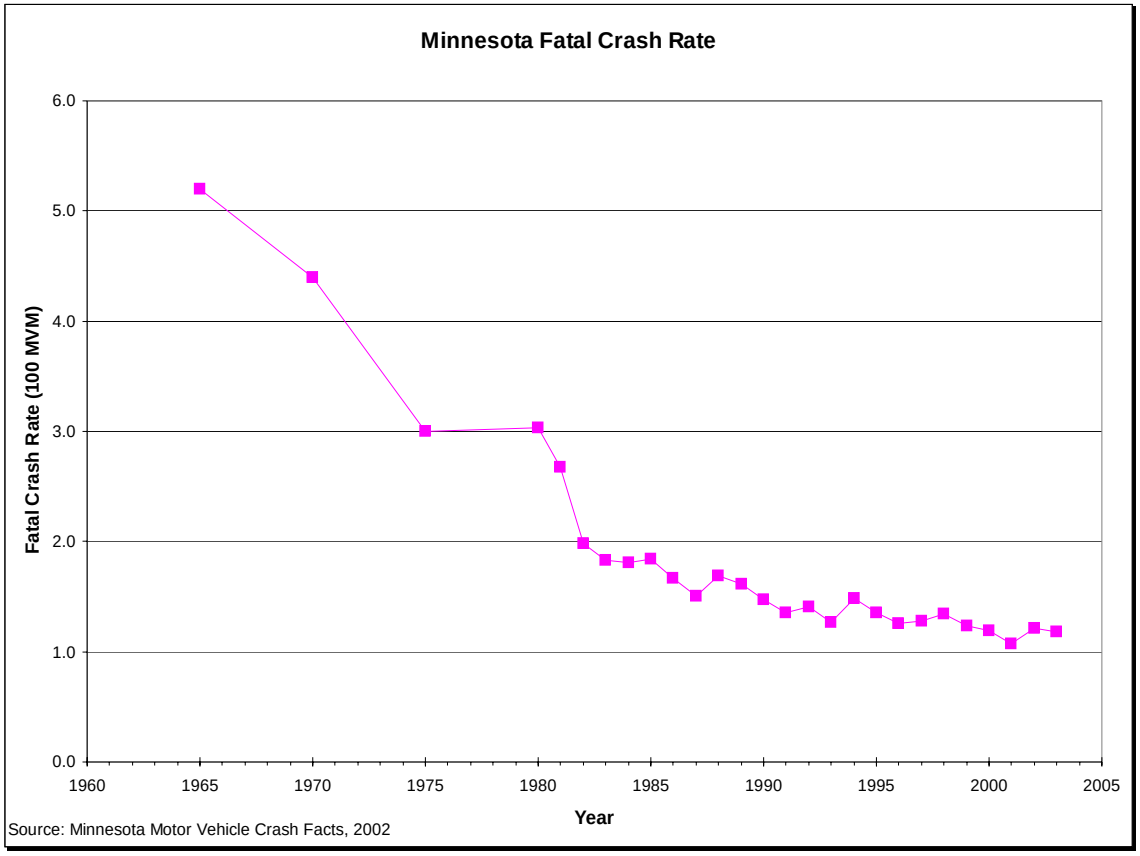

FIGURE 1-2
Historic Minnesota Fatal Crash Rate (*1*)

At the national level, there were 42,815 traffic fatalities in 2002, of which 60 percent occurred in rural areas (*4*). Of Minnesota's 657 traffic fatalities in 2002, over 70 percent occurred on rural roads (*1*). Also, the importance of the local road systems (i.e., county, township, and city streets) is made evident since 50 percent of all 2002 fatalities occurred on these roadways, despite that local roads account for only 41 percent of all vehicle miles traveled in the State. In fact, Minnesota's County Sate Aid Highways had more fatalities than any other type of roadway. Therefore, the probability of a crash occurring on a local road is 64 percent higher than a crash occurring on the state highway system for equal miles traveled (*5*). When comparing fatality rates for local and state roadways, the probability of a fatal crash is still 39 percent higher on a local road (*5*). This information makes evident the importance of

rural and local roadway systems in order to effect a substantial decrease in the number of Minnesota's fatalities. Yet, in order to be systematic and comprehensive, the problems and issues facing safety in urban areas and on the state highways must also be addressed.

Of the 657 traffic fatalities, there were a wide variation of causes or contributing factor. However, several contributing factors or crash types accounted for a large number of the fatalities. Several of the most frequent crash types and contributing factors were:

- Lane and roadway departure crashes,
- Intersection related crashes,
- Unbelted vehicle occupants,
- Impaired drivers,
- Young drivers, and
- Aggressive drivers.

The national plan to improve roadway safety is AASHTO's Strategic Highway Safety Plan (SHSP) which is based on 22 emphasis areas that broadly addresses the "four Es" – Engineering, Enforcement, Education and Emergency Medical Services (EMS) (*6*). Each emphasis area targets a distinct area where it is believed that a significant number of deaths can be prevented each year from happening on the nation's highways and includes general strategies for reducing fatalities. **Table 1-1** lists the 22 emphasis areas grouped into six parts (Drivers, Special Users, Vehicles, Highways, Emergency Medical Services, and Management) identified by AASHTO.

To put the SHSP into practice, DPS and Mn/DOT used AASHTO's 22 emphasis areas as the building blocks for the CHSP. AASHTO's 22 Emphasis Areas were screened for those that have the highest priorities for Minnesota to create a subset referred to as the Critical Emphasis Areas (CEAs). For each CEA, an analysis of the relevant crash data was performed to help identify a comprehensive list of strategies. These strategies were then screened to help identify those strategies believed to have the greatest safety benefit in Minnesota (i.e., Critical Strategies). Implementation plans for each of the critical strategies have been developed along with a year one deployment plan. This report also addresses safety needs at some of the most dangerous locations in the state and helps identify potential methods to assist local governments in safety improvements.

TABLE 1-1
AASHTO's 22 Emphasis Areas

	Emphasis Areas
Part 1: Drivers	1. Instituting Graduated Licensing for Young Drivers 2. Ensuring Drivers are Licensed and Fully Competent 3. Sustaining Proficiency in Older Drivers 4. Curbing Aggressive Driving 5. Reducing Impaired Driving 6. Keeping Drivers Alert 7. Increasing Driver Safety Awareness 8. Increasing Seat Belt Usage and Improving Airbag Effectiveness
Part 2: Special Users	9. Making Walking and Street Crossing Easier 10. Ensuring Safer Bicycle Travel
Part 3: Vehicles	11. Improving Motorcycle Safety and Increasing Motorcycle Awareness 12. Making Truck Travel Safer 13. Increasing Safety Enhancements in Vehicles
Part 4: Highways	14. Reducing Vehicle-Train Crashes 15. Keeping Vehicles on the Roadway 16. Minimizing the Consequences of Leaving the Road 17. Improving the Design and Operation of Highway Intersections 18. Reducing Head-On and Across-Median Crashes 19. Designing Safer Work Zones
Part 5: Emergency Medical Services	20. Enhancing Emergency Medical Capabilities to Increase Survivability
Part 6: Management	21. Improving Information and Decision Support Systems 22. Creating More Effective Processes and Safety Management Systems

Source: AASHTO Strategic Highway Safety Plan

2. Prioritization of the AASHTO Emphasis Areas

In order to prioritize or screen AASHTO's emphasis areas, the following three step process was used.

1. Complete of AASHTO's Self-Assessment tool, which was designed as a companion document to the SHSP.
2. Analyze five years of statewide fatal crash data (1998 – 2002) to quantify the number of traffic fatalities related to each of the emphasis areas.
3. Hold a workshop to provide Minnesota's safety partners with an opportunity to voice their opinions regarding the importance of each emphasis area.

Through this process, nine of AASHTO's original 22 emphasis area were identified as Minnesota's Critical Emphasis Areas (CEAs).

2.1 Self-Assessment Tool

The Self-Assessment tool consists of a series of statements specifically designed to evaluate an agency's progress in each emphasis area and the implementation strategies outlined in the SHSP. After completing the self-assessment, an agency should have a better understanding of where they are already implementing the SHSP and identify those areas where there is room for improvement.

The self-assessment was designed for any agency that is responsible for or involved in traffic safety. Within the self-assessment, twelve agencies or types of agencies are identified along with those questions relative to each agency. From April through the middle of May (2004), key individuals at each of the twelve agencies were asked to either complete the self-assessment as part of an interview or fill-out and return the self-assessment survey independently. The agencies and individuals that participated in the self-assessment are listed in **Table 2-1**.

When responding to each question, the respondent was allowed four choices. The four available responses and their meaning is:

- Strongly Disagree – The agency has no program (planned or in place) to address the indicated strategy.
- Disagree – The agency has some minimal action, but is not aggressively addressing the strategy.
- Agree – The agency has a program underway, but the program's effectiveness has not been evaluated.
- Strongly Agree – The agency has a comprehensive program that has proven to be effective and the agency is still working to improve the program.

TABLE 2-1
Self-Assessment Respondents

Agency	Agency Respondent(s)
Federal Highway Administration	Dave Kopacz
National Highway Traffic Safety Administration	Don McNamara, Mike Witter and George Ferris
Federal Motor Carrier Safety Administration	Dan Drexler
Governor's Highway Safety Representative	Kathy Swanson and Kathy Burke Moore
Mn/DOT	• Bob Winter • Loren Hill • Dave Engstrom - Metro District Traffic Engineer • Rob Ege – District 1 Traffic Engineer • Monty Eidem – District 2 Traffic Engineer • Tom Dumont – District 3 Traffic Engineer • Gary Dirlam – District 3 Traffic Engineer • Janelle Fowlds – District 4 Traffic Engineer • Jon Henslin – District 8 Traffic Engineer • Pierre Carpenter - Office of Freight and Commercial Vehicle Operations
Driver & Motor Vehicle Services	Joan Kopcinski
State Patrol	• Major Al Smith • Captain Ken Urquhart
County or City Highway Agency	Dick Larson, Mille Lacs County
County or City Police Department	• Jim Way, City of Ramsey Police Chief • Jim Franklin, Minnesota Sheriff Association
Emergency Medical Services	Paul Stelter, South Central Regional EMS
Traffic Court	Laurel Higgins, Minnesota Supreme Courts
State Legislative Branch	State Legislatures unable to participate since surveys were conducted near end of session.

2.1.1 Summary of Self-Assessment Responses

Responses to the self-assessment that were either strongly agree and strongly disagree represent the two areas where significant effort is already being invested or where there is room for improvement. A comprehensive summary of the of the self-assessment responses that were either strongly disagree (i.e., "Needs Improving") or strongly agree (i.e., "Working Well") is provided in **Appendix I**. To see an agency's responses to all questions, a copy of the surveys is kept by Loren Hill in the Mn/DOT Office of Traffic, Safety, and Operations.

The self-assessment survey found that the responses indicating area for improvement were generally spread across the categories. Of all responses, the following five were rated as strongly disagree by more than one agency:

- Driver fatigue,
- Graduated licensing,
- Pedestrian safety,
- Motorcycles, and
- Safety management systems.

The areas where three or more agencies identified themselves as doing well are:

- Reducing impaired driving,
- Increasing seat belt use (even without a primary seat belt law), and
- EMS safety training.

Also, several agencies may have responded with a strongly agree in an area where one or more agencies responded with strongly disagree. These instances are potential opportunities for agencies to work together in order to build off efforts and success of other agencies.

2.2 Prioritization Using Minnesota Crash Data

Similar to what was presented in the SHSP, a summary of Minnesota's fatal crashes and fatalities was compiled for each of the emphasis areas (see **Table 2-2**). This information was useful in quantifying the magnitude of the problem for each emphasis area and indicating a priority among the areas. For this analysis, the five years of crash data (1998 – 2002) were reviewed to make sure that historic trends were being identified, and not an anomaly that occurred in a single year. Based on the number of fatal crashes, the top five emphasis areas for Minnesota are:

1. Seat belt use,
2. Impaired driving,
3. Intersections,
4. Run-off the road crashes, and
5. Young drivers.

Using three years of crash records (2000 – 2003), Mn/DOT reviewed and ranked all crashes by crash types using the average crash cost, a surrogate for average crash severity (see **Table 2-3**). The cost of traffic crashes are sometimes disregarded by state and local agencies because these costs are believed not to affect their budgets. However, approximately 9% of all crash costs are paid for by a government agency, resulting in an extra $203 in taxes for every household (*7*). Using average crash cost, the most severe accidents generally are a vehicle colliding with a pedestrian, train, or bicyclists. Other top crash types include head-on crash, ran-off the road crash, and intersection related crash (right angle, left turn, right turn, and rear end). Even though crashes involving pedestrians, trains, and bicyclists have a high average crash cost (i.e., high average severity), the number of these collisions is often much lower than the other top collision types.

TABLE 2-2
Summary of Minnesota Fatal Crashes by Emphasis Areas

	Emphasis Areas	Minnesota Fatal Crashes*	Percent
Part 1: Drivers	1. Instituting Graduated Licensing for Young Drivers	705 fatal crashes involved a driver under the age of 21	25%
	2. Ensuring Drivers are Licensed and Fully Competent	-- NA --	
	3. Sustaining Proficiency in Older Drivers	254 fatal crashes involved a driver between the age of 65 and 74	9%
		340 fatal crashes involved a driver over the age of 74	12%
	4. Curbing Aggressive Driving	675 fatal crashes listed excessive speed or following too closely as a contributing factor	24%
	5. Reducing Impaired Driving	1,020 fatal crashes were alcohol related	36%
	6. Keeping Drivers Alert	623 fatal crashes listed inattentive as a contributing factor	22%
		58 fatal crashes listed asleep or fatigued as the driver's physical condition	2%
	7. Increasing Driver Safety Awareness	-- NA --	
	8. Increasing Seat Belt Usage and Improving Airbag Effectiveness	1,351 vehicle occupant fatalities (out of 2,572 vehicle occupant fatalities) were not using a restraint device	53%
Part 2: Special Users	9. Making Walking and Street Crossing Easier	244 pedestrian fatalities	8%
	10. Ensuring Safer Bicycle Travel	45 bicyclists fatalities	1%
Part 3: Vehicles	11. Improving Motorcycle Safety and Increasing Motorcycle Awareness	193 motorcyclists fatalities	6%
	12. Making Truck Travel Safer	379 fatal crashes involving heavy trucks	14%

TABLE 2-2
Summary of Minnesota Fatal Crashes by Emphasis Areas

	Emphasis Areas	Minnesota Fatal Crashes*	Percent
	13. Increasing Safety Enhancements in Vehicles	-- NA --	
Part 4: Highways	14. Reducing Vehicle-Train Crashes	31 fatal crashes involving a collision with a train	1%
	15. Keeping Vehicles on the Roadway	959 fatal run-off the road crashes	34%
	16. Minimizing the Consequences of Leaving the Road	Top 5 fatal run -off the road collisions: - Rollover (47%) - Collision with tree/shrubbery (17%) Collision with embankment/ditch/curb (10%) - Collision with bridge piers (7%) - Collision with utility poles (3%)	
	17. Improving the Design and Operation of Highway Intersections	1,013 fatal crashes at an intersection	36%
	18. Reducing Head-On and Across-Median Crashes	505 fatal head-on and across-median crashes	18%
	19. Designing Safer Work Zones	19 fatal crashes in work zones	1%
Part 5: EMS	20. Enhancing Emergency Medical Capabilities to Increase Survivability	-- NA --	
Part 6: Management	21. Improving Information and Decision Support Systems	-- NA --	
	22. Creating More Effective Processes and Safety Management Systems	-- NA --	

* Source: Minnesota Crash Database (1998 – 2002)

NOTE: Between 1998 and 2002, there were 2,797 fatal crashes and 3,126 traffic fatalities.

TABLE 2-3
Summary of Minnesota Crashes by Average Crash Cost

1. Collision with Pedestrian			$375,000	(537 crashes / 46 fatal)
2. Collision with Train			$324,000	(34 / 3 fatal)
3. Head-On Collision			$233,000	(3,451 / 203 fatal)
4. Collision with Bicycle			$137,000	(410 / 9 fatal)
5. Right Angle Collision			$66,000	(15,061 / 173 fatal)
6. Ran-Off the Road			$64,000	(12,869 / 251 fatal)
- Parking Meter	$137,000	(2 / none fatal)		
- Tree	$122,000	(1,533 / 41 fatal)		
- Culvert/Headwall	$80,000	(159 / 2 fatal)		
- Retaining Wall	$77,000	(255 / 4 fatal)		
- Rollover	$75,000	(8,958 / 121 fatal)		
- Ditch	$74,000	(1,396 / 18 fatal)		
- Bridge Pier	$58,000	(2,813 / 35 fatal)		
- Mailbox	$55,000	(261 / 3 fatal)		
- Utility Pole	$51,000	(349 / 3 fatal)		
- Light Pole	$31,000	(994 / 3 fatal)		
- Sign Pole	$24,000	(2,544 / 10 fatal)		
- Submersion	$10,000	(94 / none fatal)		
7. Left Turn Collision			$52,000	(3,931 / 29 fatal)
8. Rear End Collision			$20,000	(37,341 / 50 fatal)
9. Right Turn Collision			$15,000	(442 / none fatal)

2.3 Prioritization by Minnesota Safety Partners

On May 3, 2004; Mn/DOT and DPS hosted a workshop for many of Minnesota's Safety Partners (an agency or organization responsible for safety on Minnesota roadways). The purpose of the workshop was to educate everyone about the presence and purpose of the SHSP, provide background information about current safety strategies in each of the "four Es", share findings from the completed Self-Assessments, summarize Minnesota's fatal crashes by the emphasis areas, and allow the Safety Partners to discuss and vote for the emphasis areas they felt were most important to Minnesota and should be included as a CEA.

Attendance at the workshop included 38 Safety Partners from 16 different public and private organizations (see **Table 2-4**). Before prioritizing the emphasis areas, the Safety Partners were given presentations on existing safety strategies in each of the "four E's", safety efforts at the national level, summary of the self-assessment results, and review of Minnesota's fatal crash information. Following the presentations, participants were broken into two interdisciplinary groups to facilitate an open discussion on the relative importance of the 22 emphasis areas. Following the small group discussions, each Safety Partner was allowed to cast 10 votes for the emphasis areas they felt was of highest importance to Minnesota (see **Table 2-5**).

TALBE 2-4
May 3 Workshop Participants - Minnesota Safety Partners

Name	Agency	Name	Agency
Bernie Arseneau	Mn/DOT – Office of Traffic, Security and Operations (OTSO)	Dave Kopacz	Federal Highway Administration
Loren Hill	Mn/DOT – OTSO	Dan Drexler	Federal Motor Carrier Safety Administration
Mike Spielmann	Mn/DOT – OTSO	Jay Blanchard	ATSSA
Marc Briese	Mn/DOT – OTSO	Bob Johnson	Insurance Industry
Dan Brannan	Mn/DOT – OTSO	Gail Weinholzer	AAA
Dave Engrstrom	Mn/DOT – Metro District Traffic Engr.	Paul Stelter	South Central Regional EMS
Monty Eidem	Mn/DOT – District 2 Traffic Engr.	Bill Snokes	Allina EMS
Tom Dumont	Mn/DOT – District 3 Traffic Engr.	Nic Ward	University of MN, Human First
Peggy Reichert	Mn/DOT – Office of Investment Management	Gina Baas	University of MN, Center for Transportation Studies
Pierre Carpenter	Mn/DOT – Office of Freight and Commercial Vehicle Operations	Pat Hackman	Safe Communities of Wright County
Tim Spencer	Mn/DOT – Office of Freight and Commercial Vehicle Operations	Laurel Higgins	Minnesota Supreme Court
Jim Rosenow	Mn/DOT – Geometric Design Engineer	Major Al Smith	State Patrol
Kristie Billiar	Mn/DOT – Office of Transit	Captain Tom Fraser	State Patrol
Kathy Swanson	DPS - Office of Traffic Safety	Lieutenant Amy Stanfield	State Patrol
Kathy Burke Moore	DPS - Office of Traffic Safety	James Franklin	Minnesota Sheriff Association
Marc Dronen	DPS - Office of Traffic Safety	Bob O'Brien	Metropolitan Law Enforcement Liaison
Tina Folch	DPS - Office of Traffic Safety	Howard Preston	CH2M HILL
Denise Peterson	Driver & Vehicle Services	Tim Neuman	CH2M HILL
Joan Kopcinski	Driver & Vehicle Services	Richard Storm	CH2M HILL

Based on the group discussions, it was apparent that an overwhelming majority of the participants believed increasing seat belt use and driver safety awareness were two exceptionally important emphasis areas for Minnesota. Therefore, people were instructed not to vote for these areas because they would be considered top priorities by Mn/DOT and DPS. Of those emphasis areas voted for, the top five emphasis areas are (1) impaired driving, (2) young drivers, (3) aggressive drivers, (4) information systems, and (5) EMS.

TABLE 2-5
Prioritization of Emphasis Areas – Exercise Results

Rank	AASHTO Emphasis Areas	Voting Results
1 (Tied)	Increasing Driver Safety Awareness	*
1 (Tied)	Increasing Seat Belt Usage and Improving Airbag effectiveness	*
3	Reducing Impaired Driving	42
4	Instituting Graduated Licensing for Young Drivers	33
5	Curbing Aggressive Driving	27
6	Improving Information and Decision Support Systems	23
7	Enhancing Emergency Medical Capabilities to Increase Survivability	19
8 (Tied)	Keeping Vehicles on the Roadway	18
8 (Tied)	Reducing Head-On and Across-Median Crashes	18
10	Improving the Design and Operation of Highway Intersections	13
11	Minimizing the Consequences of Leaving the Road	12
12	Keeping Drivers Alert	11
13	Ensuring Drivers are Licensed and Fully Competent	10
14 (Tied)	Sustaining Proficiency in Older Drivers	9
14 (Tied)	Creating More Effective Processes and Safety Management Systems	9
16	Making Walking and Street Crossing Easier	7
17	Making Truck Travel Safer	6
18	Improving Motorcycle Safety and Increasing Motorcycle Awareness	5
19	Designing Safer Work Zones	4
20	Ensuring Safer Bicycle Travel	3
21	Reducing Vehicle-Train Crashes	2
22	Increasing Safety Enhancement in Vehicles	0

* Group discussions indicated these strategies were of great importance to Minnesota. Therefore, Safety Partners were instructed not to vote for these areas since their significance was already recognized.

2.4 Minnesota's Critical Emphasis Areas

Due to limited resources (both in terms of personnel and financially), the number of emphasis areas needed to be reduced from 22 down to some number appropriate for Minnesota (i.e., Critical Emphasis Areas). To identify Minnesota's CEAs, the Project Managers from Mn/DOT and DPS used the results of the self-assessment, Minnesota fatal crash summary, and voting results from the May 3 workshop. From AASHTO's original 22 emphasis areas, the nine emphasis areas chosen were:

- Reducing Impaired Driving
- Increasing Seat Belt Use
- Addressing Young Drivers Over Involvement
- Curbing Aggressive Driving
- Improving the Design and Operation of Highway Intersections
- Reducing Head-On and Across-Median Crashes
- Keeping Vehicles on the Roadway
- Minimizing the Consequences of Leaving the Road
- Increasing Driver Safety Awareness & Improving Information Systems

From these nine emphasis areas, Mn/DOT and DPS chose to group several of emphasis areas together because of similarities and/or interaction between the emphasis areas in order to form the final CEAs. The five CEAs are:

CEA 1 – Reducing Impaired Driving & Increasing Seat Belt Use

CEA 2 – Improving the Design and Operation of Highway Intersections

CEA 3 – Addressing Young Drivers Over Involvement & Curbing Aggressive Driving

CEA 4 – Reducing Head-On and Across-Median Crashes, Keeping Vehicles on the Roadway & Minimizing the Consequences of Leaving the Road

CEA 5 – Increasing Driver Safety Awareness & Improving Information Systems

These emphasis areas were identified as critical for Minnesota; however, any of AASHTO's 22 emphasis areas will likely improve safety and are considered part of this plan.

3. Analysis of Selected CEAs

Each year, there are approximately 650 traffic fatalities in Minnesota. If the trend from the past 10 years (1993-2002) continues, it is expected there will be approximately 665 traffic fatalities in 2008. In line with the State's Towards Zero Deaths initiative, Mn/DOT and DPS have established a goal to reduce the number of traffic fatalities to 500 by 2008. The key to achieving a 25% reduction in the number of traffic fatalities is implementation of new strategies and/or increased efforts of existing strategies (such as efforts to increase seat belt use and increased levels of enforcement) in each of the CEAs (see **Figure 3-1**).

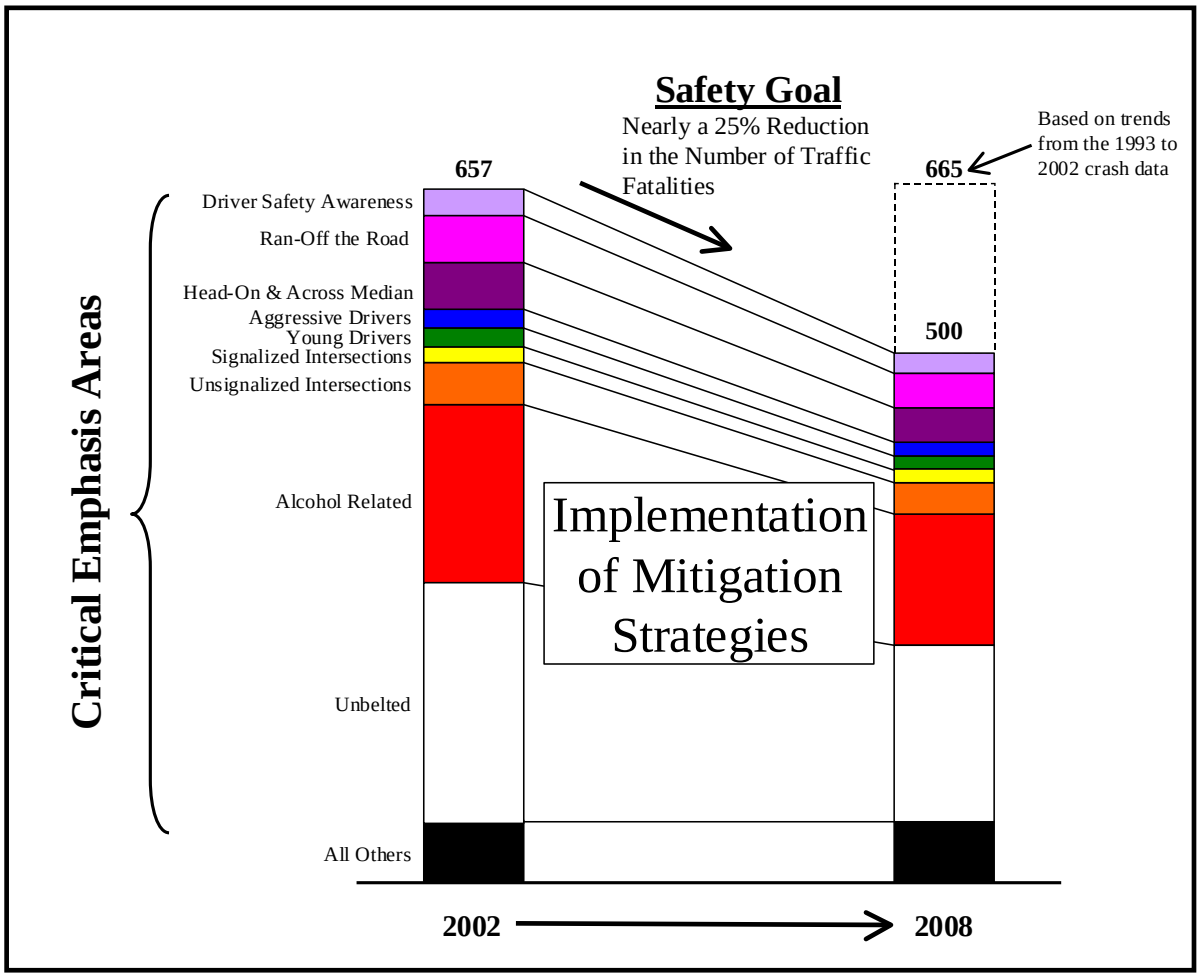

FIGURE 3-1
Needed Reduction in Fatal Crashes In Order to Meet Minnesota's 2008 Goal

Before work could begin on identifying the strategies best suited for addressing each CEA, a thorough understanding of the problem was needed. Therefore, a review of the Minnesota crash database was performed, with a focus on understanding the situation and circumstances in which the fatal crashes occurred. Following is a review of the fatal crash records for the first four CEAs and a discussion of the problems for the final CEA.

3.1 Reducing Impaired Driving & Increasing Seat Belt Use

3.1.1 Impaired Driving

How Significant is the Problem?

On Minnesota roadways, there were 1,020 fatal crashes between 1998 and 2002 in which DPS data classifies the crash as "alcohol-related." This accounts for approximately 36% of all fatal crashes during the five year period. In 2002, there were 239 alcohol-related fatalities. Of these fatalities, nearly 60% (143 of 239) were vehicle occupants that were either not using seat belts or were using them improperly. Further, 39% (397 of 1,020) fatal alcohol crashes also involved an aggressive driver (i.e., cited for excessive speeding or following too closely).

Approximately 42% (425 of 1,020) of all alcohol-related fatal crashes occurred on Mn/DOT's facilities while County level roadways (i.e., County State Aid Highways [CSAHs], county roads, and township roads) were slightly higher at 49% (500 of 1,020). Of all route types, CSAHs had the greatest number of alcohol-related fatal crashes (392 of 1020, 38%). Alcohol-related fatal crashes tended to occur on rural roadways (667 of 1020, 65%), but urban roadways still had 28% (288 of 1,020) of the fatal crashes.

A review of the roadway design revealed that 70% (712 of 1,020) of all the alcohol-related fatal crashes occurred on two-lane roadways. Approximately 10% occurred on each of freeway design (101 of 1,020) and other divided roadways (103 of 1,020).

What are the Contributing Factors?

For alcohol-related fatal crashes, the three top crash types were lane departure crashes (see following list). The fourth most frequent crash type, is an intersection crash type.

- Ran-Off Road, right (295 of 1020, 29%),
- Ran-Off Road, left (240 of 1020, 24%),
- Head-On (129 of 1020, 13%), and
- Right Angle (100 of 1020, 10%).

Approximately 29% (294 of 1,020) of the alcohol-related crashes occurred in the seven county Metro area. The five Metro counties of Hennepin, Ramsey, Dakota, Anoka, and Scott County were in Minnesota's top 10 for alcohol-related fatal crashes (see **Table 3-1**). Additionally, 25% (256 of 1,020) of fatal crashes were located at an intersection or were intersection related.

In the alcohol-related fatal crashes, there were 738 recorded "drunk" drivers and 1002 "drinking" drivers. Of these drivers, men accounted for approximately 85% (1,465 of 1,740). Nearly half (46%) of the "drunk" and "drinking" drivers were in the 21 – 34 age group (see **Table 3-2**).

Well over half of all alcohol-related fatal crashes occurred on the weekend:

- Saturday (256 of 1020, 25%)
- Sunday (216 of 1020, 21%)
- Friday (175 of 1020, 17%).

There was also a disproportionate number of crashes the occurred between 12:00 AM - 3:00 AM for all alcohol-related fatal crashes (30%) and also for those that occurred on either Saturday (31%) or Sunday (38%).

TABLE 3-1
Top Minnesota Counties for Alcohol Related Fatal Crash

Ranking	County	Number of Fatal Crashes
1	Hennepin	86
2	Ramsey	54
3	St. Louis	51
4	Dakota	45
5	Anoka	43
6	Cass	32
7	Scott	30
8	Crow Wing	28
9 (tied)	Olmsted	27
9 (tied)	Otter Tail	27
9 (tied)	Stearns	27

Source: 1998 – 2002 Minnesota crash database

TABLE 3-2
Age Distribution of Drinking and Drunk Drivers

Age Group	Drinking Driver (BAC < 0.10)	Drunk Driver (BAC ≥ 0.10)
≤ 20	15%	14%
21 – 25	23%	22%
26 - 30	13%	14%
31 – 35	10%	11%
36 - 40	13%	14%
41 – 45	9%	10%
46+	17%	15%

Source: 1998 – 2002 Minnesota crash database

3.1.2 Safety Belt Use

How Significant is the Problem?

On Minnesota roadways, there were 1,351 fatalities between 1998 and 2002 where the vehicle occupant was either unbelted or not using the safety belt properly. This accounts for approximately 43% of all traffic fatalities (3,126) and 53% of all vehicle occupant fatalities (2,572) during the five year period. In 2002, there were 298 unbelted fatalities. Of these fatalities, approximately 48% (143 of 298) were involved in an alcohol-related fatal crash. Also, nearly 32% (426 of 1,351) of the fatalities involved an aggressive driver (i.e., cited for excessive speeding or following too closely).

Just over half of unbelted fatalities occurred on Mn/DOT's facilities (691 of 1351, 51%) while County level roadways (i.e., CSAHs, county roads, and township roads) were slightly lower at 44% (591 of 1,351). Of all route types, CSAHs had the greatest number of unbelted fatalities (456 of 1351, 34%). Unbelted fatalities tended to occur on rural roadways (991 of 1351, 73%), but urban roadways still had 20% (270 of 1,351) of the fatalities.

A review of the roadway design revealed that 76% (940 of 1,351) of unbelted fatalities occurred on two-lane roadways. Approximately 13% occurred on each of freeway design (157 of 1,351) and other divided roadways (163 of 1,351).

What are the Contributing Factors?

In the fatal crashes that occurred between 1998 and 2002, unbelted vehicle occupants were found to account for 53% of all vehicle occupant fatalities. For vehicle occupants that were injured during a fatal crash, 34% were not wearing a seat belt whereas only 11% of the people involved in a fatal crash but were uninjured and not wearing a seat belt.

Of the unbelted fatalities, approximately 21% (286 of 1,351) occurred in the seven county Metro area. Of the seven Metro counties, five of the counties (Hennepin, Ramsey, Dakota, Anoka, and Scott County) were in Minnesota's top 10 for unbelted fatalities (see **Table 3-3**).

Similar to alcohol-related fatalities, a high percentage of unbelted fatalities occurred in lane departure crashes (i.e., ran-off road and head-on crashes) .

- Ran-Off Road, right (338 of 1351, 25%),
- Ran-Off Road, left (309 of 1351, 23%),
- Right Angle (269 of 1351, 20%), and
- Head-On (209 of 1351, 15%).

The three days most likely for an unbelted fatality to occur were again on the weekend:

- Saturday (267 of 1351, 20%),
- Friday (255 of 1351, 19%) and
- Sunday (216 of 1351, 16%).

Of the 1,351 unbelted fatalities, men accounted for approximately 71% (954 of 1,351). Also, those killed in a crash and were not wearing a seat belt were often young (25 years of age and younger), but there was also an increase in fatalities for those over the age of 75 (see **Table 3-4**). This information is consistent with a DPS study that measured safety belt use in June 2004. This survey found only 73.1 percent of men were observed to wear a safety belt while 84.9 percent of women wore a safety belt. Also, the 16 – 29 age group had the lowest safety belt usage at 73.0 percent. The next age group with the lowest usage (80.2 percent) was 30 – 64 year olds. These safety belt use statistics have found to be very consistent with the rest of the nation.

TABLE 3-3
Top Minnesota Counties for Unbelted Fatalities

Ranking	County	Number of Fatal Crashes
1	Hennepin	88
2	St. Louis	68
3	Ramsey	49
4	Dakota	46
5	Olmsted	44
6	Cass	37
7	Anoka	35
8	Rice	33
9	Stearns	31
10	Scott	29

Source: 1998 – 2002 Minnesota crash database

TABLE 3-4
Age Distribution by Gender for Unbelted Fatalities

Age Group	Male	Female
≤ 20	23%	28%
21 – 25	14%	12%
26 - 30	10%	8%
31 – 35	9%	7%
36 - 40	9%	10%
41 – 45	7%	6%
46 – 75	20%	19%
75+	8%	10%

Source: 1998 – 2002 Minnesota crash database

3.2 Improving the Design and Operation of Highway Intersections

3.2.1 Unsignalized Intersections

How Significant is the Problem?

On Minnesota roadways, there were 408 fatal crashes (491 fatalities) at unsignalized intersections (specifically thru-STOP intersections) between 1998 and 2002. This accounts for approximately 15% of all fatal crashes during the five year period.

Of the 408 fatal thru-STOP intersection crashes, over half occurred on Mn/DOT facilities (238 of 408, 58%) while county highways followed with 35% (142 of 408). The most common route type was CSAH roadways with 32% (131 of 408) of the fatal crashes. Approximately 66% (271 of 408) were on two lane roadways while expressways was second (99 of 408, 24%). Finally, a majority of the crashes occurred in rural locations (318 of 408, 78%).

What are the Contributing Factors?

For thru-STOP fatalities, an overwhelming majority of the crashes were right angle crashes (329 of 408, 81%). The second most frequent crash type was other (22 of 408, 5%) followed by left turn (17 of 408, 4%).

Alcohol involvement was recorded for only 21% (93 of 175) of all fatal crashes at thru-STOP intersections. Also, nearly 38% (188 of 491) of the fatalities at thru-STOP intersections were not wearing a safety belt while an aggressive driver was cited (i.e., excessive speeding or following too closely) in only 10% (47 of 491) of the fatalities. A review of the age of the drivers involved in a fatal thru-STOP crash found that the two highest involved age groups were those under the age of 21 (115 of 798, 14%) or over the age of 75 (106 of 798, 13%)

Weather was discovered not to play a significant role in these crashes since only 2% (8 of 408) were snow and ice related while 85% (348 of 408) occurred on dry pavement. Further, 69% (284 of 408) happened in daylight while crashes during dark conditions were 23% (95 of 408).

Detailed review of right angle crashes at rural, thru-STOP crashes indicates that a vast majority of right angle crashes are gap recognition related. Contrary to common opinion, intersection recognition is generally not found to be a significant problem in right angle crashes. Along rural, two-lane roads, almost 60% of right angle crashes involved vehicles that Stopped and then Pulled Out (*8*). At studied high crash rural expressway intersections, almost 90% of right angle crashes involved vehicles that Stopped and then Pulled Out (*9*).

Of the fatal crashes at thru-STOP intersections, approximately 23% (93 of 408) occurred in the seven county Metro area. Of the seven Metro counties five of the counties (Hennepin, Dakota, Scott, Washington, and Ramsey County) were in Minnesota's top 12 for thru-STOP fatal intersection crashes (see **Table 3-5**).

TABLE 3-5
Top Minnesota Counties for Fatal Crashes at Unsignalized Intersections

Ranking	County	Number of Fatal Crashes
1	Hennepin	30
2	St. Louis	18
3	Dakota	16
4	Sherburne	13
5	Kandiyohi	12
6 (tied)	Olmsted	11
6 (tied)	Scott	11
6 (tied)	Washington	11
9 (tied)	Beltrami	10
9 (tied)	Benton	10
9 (tied)	Ramsey	10
9 (tied)	Stearns	10

Source: 1998 – 2002 Minnesota crash database

3.2.2 Signalized Intersections

How Significant is the Problem?

On Minnesota roadways, there were 175 fatal crashes (188 fatalities) at signalized intersections between 1998 and 2002. This accounts for approximately 6% of all fatal crashes during the five year period.

Of the 175 fatal crashes at signalized intersections, just over half occurred at a traffic signal located on a Mn/DOT facility (90 of 175, 51%) while county highways followed with 28% (49 of 175). City streets were also found to account for a considerable number of the fatal crashes with 21% (36 of 175). The most common route type was Mn/DOT highways with 29% (50 of 175) of the fatal crashes, but was closely followed by CSAH roadways with 28% (49 of 175) and Municipal State Aid Streets with 20% (35 of 175). Approximately 50% (87 of 175) were on divided roadways while 4/6 lane undivided roadways was second (47 of 175, 27%). Finally, a majority of the crashes occurred on urban roadways (157 of 175, 90%).

What are the Contributing Factors?

For fatal crashes at signalized intersections, nearly half of the crashes were right angle crashes (72 of 175, 41%). The second most frequent crash type was left turn (25 of 175, 14%).

Alcohol involvement was recorded for only 19% (34 of 175) of all fatal crashes at signalized intersections. Also, approximately 21% (39 of 188) of the fatalities at signalized intersections were not wearing a safety belt while an aggressive driver was cited (i.e., excessive speeding or following too closely) in 13% (27 of 188) of the fatalities. A review of the age of the drivers involved in a fatal crash at a signalized intersection found that the two highest involved age

groups were those under the age of 25 (81 of 313, 26%) or over the age of 75 (41 of 313, 13%). Fatal crashes at signalized intersection were also found to have a significant involvement of pedestrians and bicyclists (51 of 175, 27%).

Weather was also not found to play a significant role in these crashes since only 3% (6 of 175) were snow and ice related while 78% (136 of 175) occurred on dry pavement. Further, 64% (112 of 175) happened in daylight while crashes during dark conditions were 32% (56 of 175).

Of the fatal crashes at signalized intersections, approximately 80% (140 of 175) occurred in the seven county Metro area. Of the seven Metro counties, six of the counties (Hennepin, Ramsey, Anoka, Dakota, Scott, and Washington County) were in Minnesota's top 9 for fatal signalized intersection crashes (see **Table 3-6**).

TABLE 3-6
Top Minnesota Counties for Fatal Crashes at Signalized Intersections

Ranking	County	Number of Fatal Crashes
1	Hennepin	58
2	Ramsey	23
3	Anoka	22
4	Olmsted	10
5	Dakota	9
6 (tied)	Benton	6
6 (tied)	Scott	6
8 (tied)	St. Louis	4
8 (tied)	Washington	4

Source: 1998 – 2002 Minnesota crash database

3.3 Addressing Young Drivers Over Involvement & Curbing Aggressive Driving

3.3.1 Young Drivers

How Significant is the Problem?

On Minnesota roadways, there were 705 fatal crashes between 1998 and 2002 in which a young driver (≤ 20) was involved. This accounts for approximately 25% of all fatal crashes during the five year period.

Approximately 44% (306 of 705) of all fatal crashes involving young drivers occurred on Mn/DOT's facilities while County level roadways (i.e., CSAHs, county roads, and township roads) were slightly higher at 47% (331 of 705). Of all route types, CSAHs had the greatest number of young driver involved fatal crashes (237 of 705, 34%). Young driver fatal crashes tended to occur on rural roadways (446 of 705, 63%), but urban roadways still had 28% (197 of 705) of the fatal crashes.

Of the fatal crashes involving young drivers, approximately 68% (478 of 705) took place on two-lane roadways. Only 10% (68 of 705) were on freeways while other divided highways accounted for just over 11% (80 of 705).

What are the Contributing Factors?

For fatal crashes in which a young driver was involved, 38% (271 of 705) occurred at an intersection or were intersection related. Also, the top crash type is intersection related followed by three lane departure crash types.

- Right Angle (169 of 705, 24%)
- Head-On (149 of 705, 21%)
- Ran-Off Road, left (102 of 705, 14%)
- Ran-Off Road, right (95 of 705, 13%)

Of the top 10 counties that had young driver involved fatal crashes, five of the counties are in the Metro area (Hennepin, Anoka, Ramsey, Dakota, and Washington County) (see **Table 3-7**). Overall, 28% (201 of 705) of the fatal crashes were in the 7 county Metro area. Wright and Sherburne County, which are adjacent to Metro counties, were also two of the top 10 counties.

Just over half of the young driver fatal crashes occurred during the weekend and were also the top three days for a this type of fatal crash.

- Saturday (144 of 705, 20%)
- Sunday (123 of 705, 17%)
- Friday (115 of 705, 16%)

When reviewing the time of crash for all 705 fatal crashes, the time distribution did not have any noticeable spikes. However, there were several observable peaks for fatal crashes that occurred on either Friday or Saturday. For the fatal crashes that occurred on Friday, one

peak occurred at the end of the typical school day (10% occurred from 3:00 PM – 4:00 PM) and another peak occurred between 10:00 PM – 12:00 AM (20%). On Saturdays, the first peak was between 8:00 PM – 9:00 PM (11%) and another peak at 12:00 AM – 1:00 AM (8%).

TABLE 3-7
Top Minnesota Counties for Fatal Crashes Involving a Young Driver

Ranking	County	Number of Fatal Crashes
1	Hennepin	62
2	Anoka	33
3	Ramsey	31
4	Dakota	27
5	St. Louis	26
6	Wright	21
7	Washington	20
8	Sherburne	19
9	Stearns	19
10	Cass	18

Source: 1998 – 2002 Minnesota crash database

Alcohol was also found to be a significant factor in young driver fatal crashes since approximately 28% (200 of 705) of the crashes were alcohol-related. Approximately 40% (295 of 743) of the young drivers were not wearing safety belts and 27% (199 of 743) were driving aggressively. Young drivers involved in a fatal crashes were also predominately male (499 of 743, 67%).

Adverse weather and light conditions were generally not reported for the fatal crashes involving a young driver. Over half of the crashes occurred during the day (375 of 705, 53%) while 38% (269 of 705) were during dark conditions. Further, a majority of the crashes took place when there was no reported precipitation (607 of 705, 86%) and therefore the pavement was reported as dry and clear of debris (538 of 705, 76%).

3.3.2 Aggressive Drivers

How Significant is the Problem?

On Minnesota roadways, there were 675 fatal crashes between 1998 and 2002 in which a aggressive driver was involved. (NOTE: An "aggressive" driver was defined as a driver cited for excessive speed or following too closely.) This accounts for approximately 24% of all fatal crashes during the five year period.

Approximately 46% (309 of 675) of all fatal crashes involving aggressive drivers occurred on Mn/DOT's facilities while County level roadways (i.e., CSAHs, county roads, and township roads) was the same at 46% (309 of 675). Of all route types, CSAHs had the greatest number

of aggressive drivers involved in fatal crashes (226 of 675, 33%). Aggressive driver fatal crashes tended to occur on rural roadways (406 of 675, 60%), but urban roadways still had 34% (227 of 675) of the fatal crashes.

Of the fatal crashes involving young drivers, approximately 62% (435 of 675) took place on two-lane roadways. Approximately 15% (109 of 675) were on freeways while other divided highways accounted for just 9% (64 of 675).

What are the Contributing Factors?

Fatal crashes that involved an aggressive behavior generally resulted in a lane departure crash. The top three crash types are:

- Ran-Off Road, right (193 of 675, 29%)
- Ran-Off Road, left (162 of 675, 24%)
- Head-On (92 of 675, 14%)

Similar to other CEAs, a weekend peak in fatal crashes involving aggressive drivers was seen. The day with the most fatal crashes involving an aggressive driver was Saturday (141 of 675, 21%), closely followed by Sunday (119 of 675, 18%) and Friday (111 of 675, 16%).

Weather was not found to play a significant role in these crashes since only 15% (101 of 675) were snow and ice related while 69% (463 of 675) occurred on dry pavement. However, only 39% (264 of 675) happened in daylight while nighttime crashes were over 50% (354 of 675, 52%) with the following distribution:

- Dark, street light on (111 of 675, 16%)
- Dark, street light off (10 of 675, 1%)
- Dark, no Street light (233 of 675, 35%)

Approximately 25% (174 of 675) of aggressive driving fatalities occurred at an intersection or were in some way intersection related. Also, 34% (231 of 675) of these fatal crashes were in the 7 county Metro area and five of the Metro counties (Hennepin, Ramsey, Dakota, Anoka and Scott County) are in the top 11 Minnesota counties (see **Table 3-8**).

The aggressive driver involved in a fatal crash (697 recorded aggressive drivers) were most often men (540 of 697, 77%) and often not wearing safety belts (399 of 697, 57%). Of all of the drivers, nearly half were under the age of 25 (323 of 697, 47%) while very few were over the age of 65 (18 of 697, 3%).

TABLE 3-8
Top Minnesota Counties for Fatal Crashes Involving an Aggressive Driver

Ranking	County	Number of Fatal Crashes
1	Hennepin	80
2	Ramsey	45
3	Dakota	34
4	St. Louis	29
5	Anoka	28
6	Stearns	24
7 (tied)	Scott	21
7 (tied)	Otter Tail	21
9	Olmsted	20
10 (tied)	Rice	16
10 (tied)	Cass	16

Source: 1998 – 2002 Minnesota crash database

3.4 Reducing Head-On and Across-Median Crashes, Keeping Vehicles on the Roadway & Minimizing the Consequences of Leaving the Road

3.4.1 Head-On and Across Median Crashes

How Significant is the Problem?

On Minnesota roadways, there were 445 fatal head-on crashes and 60 fatal sideswipe (opposite direction) crashes between 1998 and 2002 (620 combined fatalities). This accounts for approximately 18% of all fatal crashes during the five year period.

Of the 505 fatal crashes, 70 occurred on divided roadways (i.e., across median) while 428 were on undivided roadways (i.e., head-on) and 7 fatal crashes occurred on "other" roadway types. An overwhelming majority of the across median fatal crashes occur on Mn/DOT's facilities (66 of 70, 95%) and are slightly more likely to happen in an urban area (41 of 70, 59%). However, the head-on fatal crashes are distinctly rural (327 of 428, 76%); tend to occur on two-lane roadways (398 of 428, 93%); and are likely to occur on Mn/DOT (260 of 428, 61%) or county (148 of 428, 35%) facilities.

What are the Contributing Factors?

Of the fatal head-on or across median crashes, 27% were listed as being alcohol-related. Of all fatalities resulting from head-on and across median crashes, nearly 37% (228 of 620)of those were individuals not wearing a safety belt. Also, 94 of the fatalities (15%) involved an aggressive driver. For all drivers involved in fatal head-on and across median crashes, the top 7 recorded contributing factors are:

- Driving left of roadway center – not passing (243 of 505),
- Illegal or unsafe speed (109 of 505),
- Other human contributing factor (95 of 505),
- Driver inattention or distraction (90 of 505),
- Improper or unsafe lane use (73 of 505),
- Skidding (59 of 505), and
- Weather (57 of 505).

Weather was found to have little involvement since 75% of the fatal crashes occurred during clear or cloudy conditions and only 19% during rain, snow, or sleet. Furthermore, over 60% of the crashes occurred on dry pavement. Across median crashes (20%) were more likely to take place on wet pavement than a head-on crash (10%). In contrast, a head-on crash (18%) was more likely to happen on ice/snow packed roads than an across median (7%) crash.

Approximately 62% of head-on crashes occurred during the day, while across median are nearly equally distributed between daylight (37%), dark with street lights on (26%), and dark with no street lights (30%). The high percentage of across median crashes that occurred during dark conditions was seen to affect the time-of-day peaks:

- 5:00 PM – 7:00 PM = 17%
- 9:00 PM – 12:00 AM = 19%
- 12:00 AM – 3:00 AM = 13%

The time-of-day peaks for head-on crashes was slightly different with 10% between 7:00 AM – 8:00 AM and 26% from 3:00 PM to 6:00 PM.

Four of the seven Metro counties (Hennepin, Dakota, Carver, and Anoka County) were in Minnesota's top 10 for fatal head-on and across median crashes (see **Table 3-9**).

TABLE 3-9
Top Minnesota Counties for Fatal Head-On and Across Median Crashes

Ranking	County	Number of Fatal Crashes
1	Hennepin	33
2	Dakota	23
3	Crow Wing	22
4 (tied)	St. Louis	21
4 (tied)	Stearns	21
6	Rice	19
7	Cass	18
8	Olmsted	17
9	Carver	15
10	Anoka	14

Source: 1998 – 2002 Minnesota crash database

3.4.2 Run-Off the Road Crashes

How Significant is the Problem?

On Minnesota roadways, there were 959 fatal run-off the road crashes between 1998 and 2002. This accounts for approximately 34% of all fatal crashes during the five year period.

Of the 959 fatal run-off the road crashes, over half occurred on county and township roads (511 of 959, 53%) while Mn/DOT facilities were second with 41% (392 of 959). The most common route type was CSAH roadways with 40% (385 of 959) of the fatal crashes. Nearly 70% (663 of 959) were on two lane roadways while freeways was the second most frequent facility type (163 of 959, 17%). Finally, run-off the road crashes tend to be rural in nature (693 of 959, 72%).

What are the Contributing Factors?

Of all fatal run-off the road crashes, 31% were alcohol-related. Of the fatalities resulting from run-off the road crashes, nearly 63% (647 of 1,028) were individuals not wearing a safety belt.

Also, 43% (444 of 1,028) of the fatalities involved a an aggressive driver. For all drivers involved in fatal run-off the road crashes, the top 7 recorded contributing factors are:

- Illegal or unsafe speed (400 of 959),
- Other human contributing factor (319 of 959),
- Driver inattention or distraction (166 of 959),
- Skidding (104 of 959),
- Improper or unsafe lane use (72 of 959),
- Driver inexperience (70 of 959), and
- Other vehicle defects or factors (53 of 959).

The fatal crashes also tended not to be related to weather since 83% occurred during clear or cloudy conditions and only 8% were weather related (i.e., rain, snow, or sleet). Also, 76% of fatal run-off the road crashes occurred on dry pavement while 8% of the time the pavement was wet and the pavement was snow or icy only 11% of the time.

Approximately 53% of fatal run-off the road crashes occurred during dark conditions while fatal crashes during the daytime (35%) or at dawn/dusk (7%) were less frequent. Further, nearly 20% of fatal run-off the road crashes occurred between 12:00 AM – 3:00 AM.

The Top 5 recorded crash types in all fatal run-off the road crashes are:

- Overturn or rollover (450 of 959, 47%),
- Collision with tree or shrubbery (158 of 959, 16%),
- Collision with embankment, ditch, or curb (95 of 959, 10%),
- Collision with bridge piers (64 of 959, 7%), and
- Collision with utility pole (32 of 959, 3%).

The most common age group for a fatal run-off the road crash was 20 years and younger (19%), followed by the 21 – 25 age group (17%). Drivers over the age of 65 accounted for only 9% of the fatal run-off the road crashes.

Three of the seven Metro counties (Hennepin, Ramsey, and Dakota County) were in Minnesota's top 10 for fatal run-off the road crashes (see **Table 3-10**).

TABLE 3-10
Top Minnesota Counties for Fatal Run-Off Road Crashes

Ranking	County	Number of Fatal Crashes
1	Hennepin	78
2	Ramsey	47
3	St. Louis	42
4	Stearns	32
5	Olmsted	31
6	Otter Tail	30
7	Dakota	25
8 (tied)	Rice	24
8 (tied)	Itasca	24
10	Wright	23

Source: 1998 – 2002 Minnesota crash database

3.5 Increasing Driver Safety Awareness & Improving Information Systems

3.5.1 Driver Safety Awareness

What Type of Crash is being Targeted?

All crashes, not only those caused by impairment, aggressive drivers, head-on, or run-off-the road crashes; not only those that result in a fatality due to non-safety belt use, but those also involving older drivers, heavy trucks, motorcycles, work zones, and railroad crossings. If the driving public understood the role they play in making our highways and roads safer and personally decided to live that role, imagine the lives that could be saved.

How Significant is the Problem?

A close look at the 657 traffic fatalities in Minnesota in 2002 will find that the great majority of those fatalities may have been prevented if a different decision was made. Despite the loss of 657 people who were someone's family member, best friend, or trusted co-worker, the public accepts these fatalities as a normal part of life in our mobile society. How do we get society to look at fatalities and serious injuries as something they have some control over? What will it take to make people say:

- "Dad is getting lost in familiar places; we need to work to remove his driving privileges."
- "I ride my motorcycle on highways with cars and trucks; a helmet would protect me during a crash."
- "There is road construction ahead and I am already late; I better slow down anyway and accept the fact that I'll be late."

What are the Contributing Factors?

It is difficult to know exactly why some individuals have a cavalier approach to safe driving. However, some of the reasons may include:

- In the St. Paul/Minneapolis metropolitan area, the media generally does not cover crashes unless they are high profile.
- Due to media focus, tragedies that produce a large number of fatalities (airline crashes, terrorist attacks, nightclub fires) get coverage and the resulting public outcry for prevention and safety.
- Certain population groups are more likely to take risks in many areas of life, including driving. Other groups of individuals may not realize how dangerous their behavior (i.e., speeding, racing a train, and erratic behavior around trucks or motorcycles) is and the consequences of their actions.

3.5.2 Information Systems

Why are Information Systems Important?

Data and Information Systems are critical to traffic safety programs. Minnesota Statute 169.09 requires accident reports on all traffic crashes causing death, injury, or $1,000 or more in property damage. The information on these reports is used by many disciplines to reduce traffic accidents, injuries, and fatalities – not merely for insurance purposes. The data collected on accident reports is the first and most important source of information for designing safer roads and vehicles and crafting legislation and programs to bring about changes in human behavior to save lives and prevent injuries. Crash data elements can be linked with elements of other data systems to get detailed analysis of crashes.

What is the Role of Information Systems?

Crash data is used to determine the answer to this question for all types of crashes. Data and the information systems that collect it are the essential foundations to traffic safety programs. As agencies and organizations determine which traffic safety problem they are going to address - data assists in making that decision. When evaluating our programs - data and its analysis, is critical to showing that progress has been made or that resources should be directed elsewhere. When local government or the legislature is making a policy decision, they want data to assist them in assessing the situation. Maintaining and upgrading data and information systems is costly and their importance often overlooked as a vital component of preventing fatalities and serious injuries on our roadways.

Why are Information Systems Directly Related to Minnesota's Safety Goal?

Without adequate and accurate information systems, Minnesota cannot set traffic safety goals and measure progress toward them. Without data analysis, Minnesota cannot probe the details of fatal and serious injury crashes to identify what programs make a difference, which need to be modified, and which need to be discontinued. If we are to accurately measure whether the number of traffic fatalities decreased from 657 in 2002 to 500 in 2008, high-quality information systems must be in place.

What does a Good Information System Look Like?

- Data on all fatal and injury crashes has been collected and accurately accumulated.
- Data on all property damage crashes within statutory dictates has been collected and accurately accumulated.
- Opportunities for linking databases to provide diverse views of crash statistics have been sought.

4. Identification & Prioritization of the Strategies

4.1 Identification of Minnesota's High Priority Strategies

To identify the strategies best capable of achieving the 2008 safety goal (see **Figure 3-1**), a multi-step screening process was used that involved over 70 individuals representing 31 agencies, private companies and organizations (see **Figure 4-1**). To begin with, over 150 strategies were compiled using the National Cooperative Highway Research Program (NCHRP) Report 500 series. The NCHRP Report 500 series is a set of guides written to assist state and local agencies implement the strategies associated with AASHTO's 22 emphasis areas. NCHRP Report 500 implementation guides were available for each of the emphasis areas except for addressing young drivers over involvement, increasing driver safety awareness, and improving information systems. In these three emphasis areas, the Project Management Team (PMT) generated the initial strategies. The first and second steps in the screening process were completed by Minnesota's Safety Partners at a workshop held on June 10, 2004. At the June 10 workshop, participants were divided into five interdisciplinary task teams (see **Table 4-1**) to focus on the strategies for one Critical Emphasis Area (CEA).

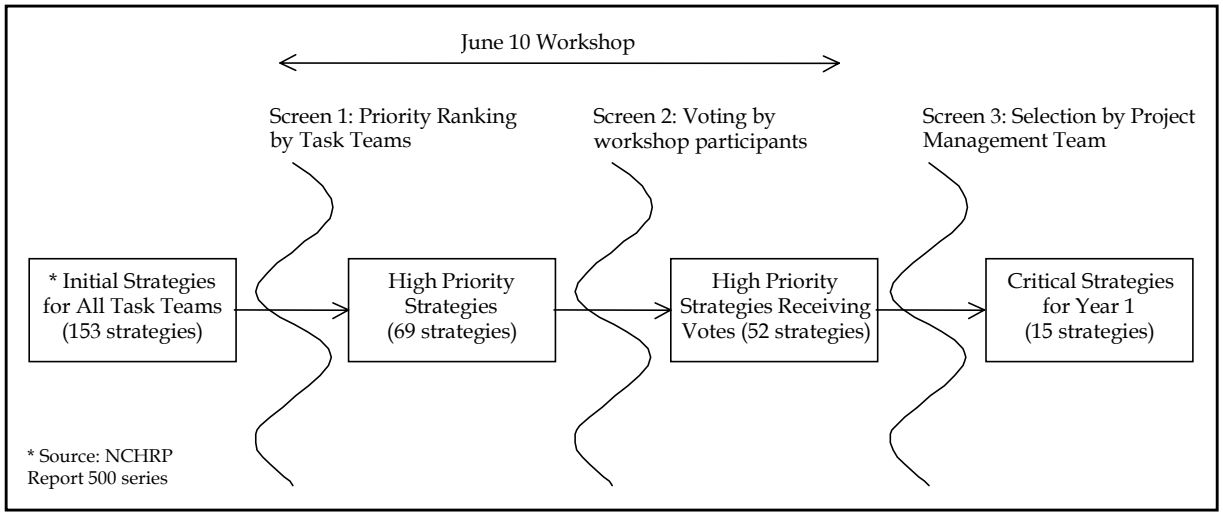

FIGURE 4-1
Critical Strategy Prioritization Process

In the morning, each task team was responsible for discussing the strategies and creating an edited list of strategies (revisions, additions, deletions) and then ranking the strategies as high, medium, or low relative to their importance in Minnesota. This step reduced the number of strategies from over 150 to 69 high priority strategies. Following the morning small group exercise, the task team leaders presented a summary of their team's discussion to all workshop participants, including the revisions and rankings. Following the presentations, the next step in the screening process had each workshop participant invest 12 votes on the strategies they felt were the most important and critical in achieving the 2008 goal. (Note: People were instructed to vote for only those strategies given a high ranking by

a task team.) After the vote, the list of high priority strategies was narrowed by removing those strategies that received no votes. The voting process resulted in a list of 52 strategies. (See **Appendix II** for the entire list of strategies considered by the five task teams including the priority rankings by task teams and voting results.) The final screen was a discussion and selection by the PMT to identify the critical strategies that should be implemented in the first year. Factors considered by the PMT included voting results, expected effectiveness, relative cost to implement and operate, and typical timeframe for implementation.

TABLE 4-1
June 10 Workshop Participants - Minnesota Safety Partners

	Name	Agency
Task Team 1: Reducing Impaired Driving & Increasing Seat Belt Use	Kathy Burke Moore (Leader)	DPS
	Dean Larson	International Idea Institute
	Rob Ege	Mn/DOT
	Monty Eidem	Mn/DOT
	Jon Jackels	Mn/DOT
	Kevin Gutknecht	Mn/DOT
	Deputy Mark Arnold	City of Waite Park Police Department
	Rick West	Otter Tail County
	Colonel Anne Beers	State Patrol
	Bonnie Labatt	MADD
	Denise Peterson	Driver Vehicle Services
	Tina Folch	DPS
	David Mancl	Federal Motor Carrier Safety Administration
	Bob Bollenbeck	TZD Committee
	Jean Ryan	DPS
	Amr Jabr	Mn/DOT
Task Team 2: Improving the Design and Operation of Highway Intersections	Loren Hill (Leader)	Mn/DOT
	Jim Beauregard	City of Morris Police Department
	Tom Dumont	Mn/DOT
	Mick Rakauskas	ITS Institute/University of Minnesota
	Bob Provost	TZD Committee
	Virginia Lockman	DPS
	Lieutenant Daniel Erspamer	State Patrol
	Ted Schoenecker	City of Bloomington
	Jim Rosenow	Mn/DOT
	Ferrol Robinson	SRF
	Kristie Billiar	Mn/DOT
	Tom Maze	CTRE/ Iowa State University
	Bill Snoke	Allina EMS
Task Team 3: Young Drivers & Curbing Aggressive Driving	Lieutenant Mark Peterson (Leader)	State Patrol
	Joseph Christensen	TZD Committee
	Chief Jim Way	City of Ramsey Police Department
	Randy Newton	City of Eden Prairie
	Gail Weinholzer	AAA
	Joan Kopcinski	Driver Vehicle Services

TABLE 4-1
June 10 Workshop Participants - Minnesota Safety Partners

	Name	Agency
	Brad Kollmann	DPS Law Enforcement Liaison
	Brad Estochen	Mn/DOT
	Jon Henslin	Mn/DOT
	Sharon Gehrman-Driscoll	Minnesotans for Safe Driving
	Mike Spielmann	Mn/DOT
	Bill Shafer	DPS
	Frank Thissen	Driver Education
Task Team 4: Reducing Head-On and Across-Median Crashes, Keeping Vehicles on the Roadway & Minimizing the Consequences of Leaving the Road	Dave Kopacz (Leader)	Federal Highway Administration
	Pierre Carpenter	Mn/DOT
	Mohammad Dehdashti	Mn/DOT
	Mike Schweyen	Mn/DOT
	Tom Kummrow	DPS Law Enforcement Liaison
	Pat Hackman	Safe Communities of Wright County
	Ban Brannan	Mn/DOT
	Sue Miller	Freeborn County
	Paul Stelter	South Central Minnesota EMS
	Dave Engstrom	Mn/DOT
	Mark Scheidel	Mn/DOT
	Captain Kevin Daly	State Patrol
	Nathan Bowie	DPS
	Gary Dirlam	Mn/DOT
	Susie Palmer	DPS
Task Team 5: Driver Safety Awareness & Improving Information Systems	Laurie McGinnis (Leader)	CTS/University of Minnesota
	Bob O'Brien	DPS Law Enforcement Liaison
	Major Al Smith	State Patrol
	Laurel Higgins	Minnesota Supreme Court
	Marc Dronen	DPS
	Janelle Fowlds	Mn/DOT
	Peggy Reichert	Mn/DOT
	Steve Lund	Mn/DOT
	Dick Larson	Mille Lacs County
	Randy Hodson	SEH Inc.
	Judy Melander	Mn/DOT
	George Ferris	NHTSA
	Marc Briese	Mn/DOT
	Patricia McCormack	DPS
Other Participants	Bob Winter	Mn/DOT
	Bernie Arseneau	Mn/DOT
	Kathy Swanson	DPS
	Howard Preston	CH2M HILL
	Richard Storm	CH2M HILL

When trying to select the Critical Strategies, it was important not to select only experimental or tried strategies because the effectiveness of these types of strategies is either unknown or not well documented. Ensuring that some proven strategies are selected was needed to balance the strategies. **Tables 4-2** through **4-6** summarize the expected effectiveness of the 52 high priority strategies. (Note: In these tables, italicized strategies were not included in the NCHRP Report 500 guides. Instead, these strategies were created by either the PMT or by the task teams. Therefore, the effectiveness, relative cost, and implementation timeframe for these strategies were developed by the PMT.)

The second factor considered during the selection process was relative cost to implement and operate. Given limitations regarding both personnel availability and financial constraints, considering strategies that would have a low or moderate relative cost were desirable. The final factor also included in the discussion was the typical timeframe need to implement the strategies. Since the Critical Strategies that are intended to be implemented in the first year, it was important to select strategies that can be quickly implemented. Relative cost to implement and operate along with implementation timeframe for the 52 high priority strategies have been summarized in **Tables 4-2** through **Table 4-6**.

4.2 Selection of Critical Strategies

Because road authorities and enforcement agencies have limited resources for new implementation, the number of strategies identified as Critical Strategies had to be reduced from 52 to a more manageable number. Therefore, the PMT met to discuss several factors that may influence the potential success of the strategies at meeting the 2008 goal. The Critical Strategies are the strategies expected to have the greatest potential for achieving the 2008 goal and also need to be implemented in the first year if possible. It is not intended that only the Critical Strategies be used to achieve the 2008 fatality reduction goal, instead, these are the strategies that are looked to be the primary focus. Furthermore, it is not the intent of Mn/DOT or DPS to suggest that existing safety activities, strategies, programs, policies, or roadway reconstruction should be abandoned in place of adopting the Critical Strategies. It is only because of the existing safety efforts that the number of traffic fatalities is 650 each year. The purpose of adopting the Critical Strategies is to supplement what is already being done by state and local agencies and to focus efforts on dedicated safety measures.

In addition to the voting results, several additional factors were considered when identifying the Critical strategies. These include expected effectiveness, relative cost, and implementation timeframe.

TABLE 4-2: CEA 1
Reducing Impaired Driving & Increasing Seat Belt Use - High Priority Strategies

Strategy	Effectiveness[1]	Relative Cost to Implement and Operate[1]	Typical Timeframe for Implementation[1]	Additional Comments[1]
1. Encourage the enactment of statewide primary law that will permit standard enforcement of restraint laws (62)	Tried	Low	Medium (1-2yrs.)	
2. Provide adequate resources for enforcement and administration (27)	*Tried*	*Moderate*	*Short (<1 yr.)*	
3. Work with Courts to prevent the reduction or dismissal of traffic safety charges (26)	*Tried*	*Low*	*Medium (1-2yrs.)*	
4. Conduct regular well publicized enforcement saturations to combat alcohol-related driving (20)	Proven	Moderate to High	Short (<1 yr.)	
5. Focused, hard-hitting public education to get people to buckle up and strop drinking & driving (10)	*Tried*	*Moderate*	*Short (<1 yr.)*	
6. Enact and enforce ID compliance checks with establishments selling alcohol (4)	*Experimental*	*Moderate to High*	*Medium (1-2yrs.)*	
7. Support and instill grass roots movement on traffic safety laws and enforcement (3)	*Experimental*	*Moderate*	*Long (>2 yrs.)*	
8. Enforce use of child restraints (3)	*Proven*	*Moderate*	*Short (<1 yr.)*	
9. Work with elected officials to permit law enforcement to enforce the laws (2)	*Experimental*	*Low*	*Long (>2 yrs.)*	
10. Enhance DWI detection through related traffic enforcement (1)	Tried	Low	Short (<1 yr.)	A Massachusetts study found a 42% decrease in fatal alcohol-related crashes
11. Develop media campaigns on the costs of alcohol related crashes (1)	*Experimental*	*Moderate to High*	*Medium (1-2yrs.)*	

Source: [1]NCHRP Report 500 implementation guides. However, effectiveness, cost and timeframe for italicized strategies were estimated by the PMT.

TABLE 4-3: CEA 2
Improving the Design and Operation of Highway Intersections - High Priority Strategies

Strategy	Effectiveness[1]	Relative Cost to Implement and Operate[1]	Typical Timeframe for Implementation[1]	Additional Comments[1]
1. Low cost safety improvements (31)	Tried	Low	Medium (1-2yrs.)	
2. Perform Road Safety Audits at the network level (26)	*Experimental*	*Moderate to High*	*Medium (1-2yrs.)*	
3. Implement automated enforcement of red-light running (cameras) (24)	Proven	Moderate	Medium (1-2yrs.)	(Victoria, Australia) 35% reduction in right-angle crashes, 25% reduction in right-angle turning crashes, 31%reduction in rear-end crashes, and a 28% reduction in rear-end crashes.
4. Proper maintenance of roadway facilities (24)	*Experimental*	*Moderate*	*Medium (1-2yrs.)*	
5. Improve management of access near intersections (19)	Tried	Low	Short (<1 yr.)	
6. Provide roundabouts at appropriate locations (14)	Proven	High	Long (>2 yrs.)	Estimated effectiveness of installing a roundabout at unsignalized locations: 38% reduction in total crashes, 76% reduction in injury crashes, and 90% reduction in fatal and incapacitating injury crashes
7. Improve pedestrian and bicycle facilities to reduce conflicts between motorists and nonmostorists (12)	Tried	Moderate	Medium (1-2yrs.)	Results Vary
8. Improve visibility of the intersection by providing lighting (6)	Proven	Moderate to High	Medium (1-2yrs.)	25% to 50%reductions in the nighttime crash/total crash ratio
9. Improve safety by addressing intersection safety needs along the local road systems with an incentive program for local agencies (3)	*Experimental*	*Moderate*	*Medium (1-2yrs.)*	

Source: [1]NCHRP Report 500 implementation guides. However, effectiveness, cost and timeframe for italicized strategies were estimated by the PMT.

TABLE 4-4: CEA 3
Addressing Young Drivers Over Representation & Curbing Aggressive Driving - High Priority Strategies

Strategy	Effectiveness[1]	Relative Cost to Implement and Operate[1]	Typical Timeframe for Implementation[1]	Additional Comments[2]
1. Implement stricter graduated licensing system (50)	*Proven*	*Low*	*Short (<1 yr.)*	Wisconsin experienced a 18% reduction in fatal crashes involving young drivers and 20% reduction in injury crashes.
2. Use advanced enforcement (photo) to deter aggressive driving (30)	*Tried*	*Moderate*	*Medium (1-2yrs.)*	
3. For young drivers, get stronger mandates, parent involvement, uniform curriculum, and enhanced behind the wheel and classroom instruction (23)	*Experimental*	*Low*	*Short (<1 yr.)*	
4. Organize legislature action vommittee (GDL, curriculum, liability, courts) (23)	*Experimental*	*Low*	*Short (<1 yr.)*	
5. Deter aggressive driving using targeted enforcement based on data (8)	Tried	Low	Short (<1 yr.)	
6. Deter aggressive driving by having the courts supporting law enforcement (5)	*Experimental*	*Low*	*Medium (1-2yrs.)*	
7. Consistent enforcement of young drivers (3)	*Experimental*	*Low*	*Short (<1 yr.)*	

Source: [1]NCHRP Report 500 implementation guides. However, effectiveness, cost and timeframe for italicized strategies were estimated by the PMT.

[2] http://www.dot.state.wi.us/safety/motorist/teendriving/index.htm

TABLE 4-5: CEA 4
Keeping Vehicles on the Roadway & Minimizing the Consequences of Leaving the Road - High Priority Strategies

Strategy	Effectiveness[1]	Relative Cost to Implement and Operate[1]	Typical Timeframe for Implementation[1]	Additional Comments[1]
1. Enforcement of speeding, distracted, and drunk drivers coupled with publication of the enforcement (51)	*Experimental*	*Moderate*	*Short (<1 yr.)*	
2. Install median barriers for narrow-width medians on multilane roads (23)	Proven	Moderate	Medium (1-2yrs.)	NCHRRP 500 lists as Tried
3. Provide enhanced pavement markings (15)	Tried	Low	Short (<1 yr.)	
4. Design safer sloes and ditches to prevent rollovers (16)	Proven	Moderate to High	Medium (1-2yrs.)	Study 1: 6% - 27% reduction in SV crashes (3%-15% in all crashes); Study 2: 25%-40% reduction in ROR crash rate
5. Provide turn lanes at appropriate locations (13)	*Experimental*	*Moderate*	*Medium (1-2yrs.)*	
6. Provide wider cross sections on two-lane roads to meet standards (9)	Tried	Moderate to High	Long (>2 yrs.)	NCHRP 500 lists as Experimental
7. Install edgeline rumble strips (7)	Tried	Low	Short (<1 yr.)	
8. Improve roadside hardware (6)	Tried	Moderate to High	Medium (1-2yrs.)	
9. Remove & relocate objects in hazardous locations, such as trees, utility poles, light poles, and etc. (4)	Proven	Low	Short (<1 yr.)	
10. Increase seat belt use (2)	*Proven*	*Low to Moderate*	*Medium (1-2yrs.)*	
11. Appoint CHSP Director (1)	*Experimental*	*Low to Moderate*	*Short (<1 yr.)*	

Source: [1]NCHRP Report 500 implementation guides. However, effectiveness, cost and timeframe for italicized strategies were estimated by the PMT.

TABLE 4-6: CEA 5
Increasing Driver Safety Awareness & Improving Information Systems - High Priority Strategies

Strategy	Effectiveness[1]	Relative Cost to Implement and Operate[1]	Typical Timeframe for Implementation[1]	Additional Comments[1]
1. Create a communications/marketing task force to raise visibility of the public problems (i.e., quilt, memorial wall) (44)	*Experimental*	*Moderate*	*Medium (1-2yrs.)*	
2. Establish a Governor's panel focused on traffic safety (42)	*Experimental*	*Low*	*Short (<1 yr.)*	
3. Evaluate need for adequate staffing, equipment and other resources (Evaluate timing and access to reports) (19)	*Tried*	*Low*	*Short (<1 yr.)*	
4. Participate in existing conferences to promote increased focus on traffic safety (6)	*Experimental*	*Low*	*Medium (1-2yrs.)*	
5. Create a multilevel strategic plan (reactive and proactive) (5)	*Tried*	*Moderate to High*	*Medium (1-2yrs.)*	
6. Improve driver training & licensing material with the addition of traffic safety statistics, stories, and testimonials – include instructor quality control (4)	*Experimental*	*Moderate*	*Medium (1-2yrs.)*	
7. Reporting on problem drivers (tracking, monitoring, limit privileges) (3)	*Tried*	*Moderate*	*Medium (1-2yrs.)*	
8. Establish Safe Community coalitions to address young drivers, older drivers, and traffic law offenders (2)	*Tried*	*Moderate*	*Medium (1-2yrs.)*	
9. Create partnerships with service, community, and other organizations (Lions Club, Rotary, Chamber of Commerce, etc.) to increase grass roots support and activism (2)	*Experimental*	*Low*	*Short (<1 yr.)*	
10. Safety focused press releases on a monthly basis (appeal to MN Companies) (2)	*Experimental*	*Low*	*Short (<1 yr.)*	

TABLE 4-6: CEA 5
Increasing Driver Safety Awareness & Improving Information Systems - High Priority Strategies

Strategy	Effectiveness[1]	Relative Cost to Implement and Operate[1]	Typical Timeframe for Implementation[1]	Additional Comments[1]
11. Organize an oversight committee to coordinate all agencies involved in the collection, management, and use of highway safety data (1)	*Tried*	*Low*	*Short (<1 yr.)*	
12. Create a clearinghouse of highway safety information to provide mangers with the resources needed to make the most effective use of the data (1)	*Tried*	*Moderate*	*Medium (1-2yrs.)*	
13. Initiate incentive and disincentive programs (1)	*Experimental*	*Moderate to High*	*Medium (1-2yrs.)*	
14. Funnel crash reports through Mn/DOT for improved accuracy before entered into system (1)	*Experimental*	*Moderate to High*	*Short (<1 yr.)*	

Source: [1]Effectiveness, cost and timeframe were estimated by the PMT.

Based upon the effectiveness, feasibility, and voting results for the 52 high priority strategies, 15 Critical Strategies were developed and adopted by the Mn/DOT and DPS. These 15 strategies are expected to most effectively address the safety needs for Minnesota and implementation in the first year (if possible) is intended. The selected Critical Strategies in order of relative importance are summarized in **Table 4-7**. Because of the related characteristics between various high priority strategies, some Critical Strategies were created by combining two or more of the high priority strategies. To determine which strategies were combined to form the new Critical Strategy, the third column of **Table 4-7** list the original table number (**Tables 4-2** through **4-6)** and strategy number (i.e., the fifth strategy of **Table 4-3** is summarized as 3.5).

The critical strategies have been summarized and classified into five categories, as noted below:

Enforcement
- Provide adequate law enforcement resources
- Primary seat belt law
- Implement automated enforcement
- Stronger graduated licensing system
- Support the enforcement of traffic safety laws
- Targeted enforcement

Engineering
- Cost effective lane departure improvements
- Cost effective intersection improvements
- Roadway maintenance
- Road Safety Audits

Education
- Communications and marketing task force
- Enhance driver education

EMS
- Statewide trauma system

Administrative
- High-level traffic safety panel and Legislature Action Committee
- Improve data systems

Figure 4-2 illustrates how the Critical Strategies are directly selected to address Minnesota's fatal crash problem. Only through development and implementation of additional strategies or increased efforts of existing strategies can the 2008 safety goal be achieved and the number of the number of fatal crashes reduced.

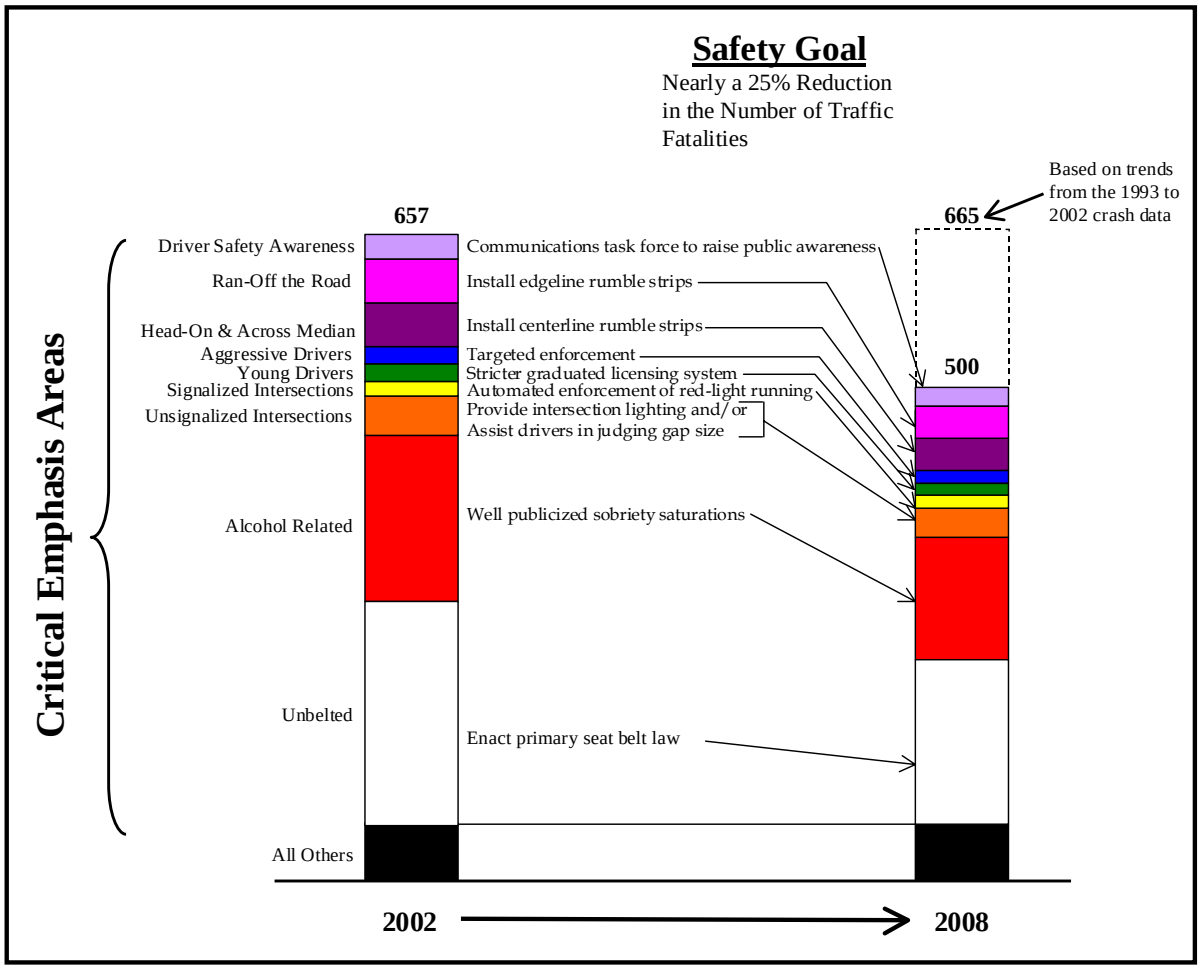

FIGURE 4-2
Implementation of Strategies to Meet Minnesota's 2008 Goal

TABLE 4-7
Minnesota CHSP Top 15 Critical Strategies

Strategy	Total Votes	Foundation Strategies*	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
1. Provide adequate resources to allow State Patrol, county sheriffs and local police to perform traffic enforcement for speeding, unbelted occupants, and impaired drivers.	78	2.2 & 5.1	Tried/ Experimental	Moderate	Short (<1 yr.)
2. Encourage the enactment of a statewide primary law that will permit standard enforcement and provide universal coverage to all vehicle occupants.	62	2.1	Proven	Low	Medium (1-2yrs.)
3. Implement automated enforcement (cameras) to deter red-light running and aggressive driving.	54	3.3 & 4.2	Proven/ Tried	Moderate	Medium (1-2yrs.)
4. Implement a stronger graduated driver licensing system.	50	4.1	Proven	Low	Short (<1 yr.)
5. Make low cost safety improvements for lane departure crashes (i.e., median barriers for narrow-width medians on multilane roads, edgeline/centerline/midlane rumble strips, enhance delineation of sharp curves and unexpected changes in horizontal alignment, enhance pavement markings, eliminate shoulder drop-offs, delineate roadside objects, and etc.). Assist local agencies in implementation of low cost improvements by providing data to identify dangerous locations, a toolbox of strategies to reduce fatal and serious injury crashes, training sessions, and an incentive program.	45	5.2, 5.3, & 5.7	Proven/ Tried	Low to Moderate	Medium (1-2yrs.)
6. Create a communications/marketing task force to raise public awareness of traffic crash issues.	44	6.1	Experimental	Moderate	Medium (1-2yrs.)

TABLE 4-7
Minnesota CHSP Top 15 Critical Strategies

Strategy	Total Votes	Foundation Strategies*	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
7. Establish a high-level panel focused on traffic safety.	66	4.4, 6.2 & 5.11	Experimental	Low	Short (<1 yr.)
8. Make low cost safety improvements at intersections including offset and longer turn lanes; acceleration lanes; indirect left-turn treatments; clearing sight triangles; eliminate parking near intersections; provide pavement markings with supplementary messages, such as STOP AHEAD; double yellow centerline at intersections and at median opening; providing lighting to increase intersection visibility; and etc. Assist local agencies in implementation of low cost improvements by providing data to identify dangerous locations, a toolbox of strategies to reduce fatal and serious injury crashes, training sessions, and an incentive program.	40	3.1, 3.8 & 3.9	Proven/ Tried	Low to Moderate	Medium (1-2yrs.)
9. Perform proper maintenance of roadway facilities, including improving roadside hardware and removing and relocating objects in hazardous locations (i.e., trees).	34	3.4, 5.8 & 5.9	Proven/ Tried/ Experimental	Low to High	Medium (1-2yrs.)
10. To combat impaired and aggressive drivers, work with courts to prevent the reduction or dismissal of traffic citations.	31	2.3 & 4.6	Tried/ Experimental	Low	Medium (1-2yrs.)
11. Use well publicized sobriety saturations and targeted enforcement to deter impaired drivers and aggressive drivers.	28	2.4 & 4.5	Proven/ Tried	Moderate to High	Short (<1 yr.)

TABLE 4-7
Minnesota CHSP Top 15 Critical Strategies

Strategy	Total Votes	Foundation Strategies*	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
12. Revise driver education with stronger mandates to include parent involvement, uniform curriculum, instructor quality control, and enhanced behind-the-wheel and classroom instruction. Also improve driver training and licensing material with the addition of traffic safety statistics, stories, and testimonials.	27	4.3 & 6.6	Experimental	Low to Moderate	Medium (1-2yrs.)
13. Perform Road Safety Audits at the network level.	26	3.2	Experimental	Moderate to High	Medium (1-2yrs.)
14. Improve data systems by ensuring adequate staffing, equipment and other resources are available. In addition ensure that users of systems are consulted when system changes are being planned and implemented. Furthermore, organize an oversight committee to coordinate all agencies involved in the collection, management, and use of highway safety data.	21	6.3, 6.11 & 6.14	Experimental	Low to Moderate	Short (<1 yr.)
15. Create and implement a statewide trauma system.	--	--	Tried	High	Long (>2 yrs.)

*If two or more high priority strategies were combined to form a Critical Strategy, then the table number and strategy are provided for reference (i.e., the **fifth** strategy of Table 4-**3** is summarized as **3.5**).

4.3 CHSP Safety Toolbox

The focus of this chapter is on the 52 high priority strategies that received at least one vote at the June 10 workshop and many of these strategies require action at the state level. However, since approximately half of all traffic fatalities occur on local road systems (i.e., counties, townships, and cities), additional efforts on these systems by the governing agencies will be essential if there is to be a realistic chance of achieving the 2008 safety goal. To provide local agencies with guidance on improving their system's safety, the *CHSP Safety Toolbox* has been prepared (see **Appendix III**). The *CHSP Safety Toolbox* contains over 120 strategies organized first by category (i.e., Enforcement, Engineering, Education, and Administrative) and then by priority (i.e., Priortiy 1 is the highest priority while Priority 3 is the lowest priority). Many of the strategies can be implemented by local agencies and are relatively low cost solutions. The *CHSP Safety Toolbox* also includes general guidance on implementation of strategies for appropriate situations and how local agencies can identify a systematic, prioritized plan for implementation.

5. Critical Strategy Action Plans

A data and information driven prioritization process described in Chapter 4 resulted in identifying the 15 Critical Strategies that form the backbone of this plan. These 15 strategies include elements that address all 4 of the safety Es and can be summarized in the following.

1. Provide adequate law enforcement resources
2. Primary seat belt law
3. Implement automated enforcement.
4. Stronger graduated driver licensing system
5. Cost effective lane departure improvements
6. Communication and marketing task force
7. High-level traffic safety panel and legislature action committee
8. Cost effective intersection improvements
9. Roadway maintenance
10. Support the enforcement of traffic safety laws
11. Targeted enforcement
12. Enhance driver education
13. Road Safety Audits
14. Improve Data System
15. Statewide Trauma System

In order to develope the implementation plan for Minnesota, additional information, particularly as it relates to targets/goals, expected effectiveness, cost of implementation and organizational issues are required. This Chapter presents the detailed descriptions of each of the 15 Critical Strategies. In addition to the goals, effectiveness, and costs, each action plan also reviews areas such as keys to success, responsible agency, and legislative needs, to name a few. To further assist in the development of the Comprehensive Plan and development of the Critical Strategy action plans, a spread sheet was created that quickly computes the potential reduction in fatal and serious injury crashes for any given combination of the Critical Strategies at an annual level of investment (see **Chapter 7** for more information).

One of the key pieces of information in the effectiveness spreadsheet and within the following action plans is the expected effectiveness for each of the strategies. Using the same convention in the NCHRP Report 500 series, the level of confidence in the reported effectiveness has been classified into one of the following three categories.

- Proven – The effectiveness of these strategies has been documented through properly designed studies. In some cases, more than one study has been done confirming the effectiveness of the strategy.
- Tried – These strategies may be commonly used and believed to be effective, but the true effectiveness of the strategy is not known. The effectiveness is unknown because the strategy has not been studied, the studies performed were not properly designed, or the studies had a wide variety of results.
- Experimental – Some of these strategies are new ideas while others have already been tried. In either case, the effectiveness of these strategies is undocumented. The effectiveness of these strategies was estimated by consulting with national and/or state professionals who are experienced in these strategies.

5.1 Critical Strategy Action Plans

Strategy 1. Provide Adequate Law Enforcement Resources	
Definition	Provide adequate resources to allow state patrol, county sheriffs and local police to perform traffic enforcement for speeding, unbelted occupants, and impaired drivers.
Technical	
Description	The intent of this strategy is to encourage state and local agencies to provide adequate funding, staff, and resources (i.e., equipment such as squad cars) needed to enable law enforcement agencies to adequately perform traffic enforcement. Often, understaffed and under funded departments are forced to cutback on the amount of traffic enforcement in order to meet other responsibilities considered a higher priority (i.e., homeland security, responding to domestic calls, etc.). By providing increased funding to allow for additional traffic enforcement, law enforcement will be able to prevent crashes by discouraging poor driver behaviors or citing offenders before a crash can occur.
Target(s)	The target for this strategy is the crashes that occur due to driver behavior (i.e., speeding, impaired driving, fatigued driving, etc.) and also to decrease the severity of the crashes by increasing seat belt use of vehicle occupants.
Goal	In 2002, there were approximately 430 traffic fatalities that involved an impaired driver, unbelted vehicle occupant, an aggressive driver, or a combination of two or more of these factors. If the interaction is not accounted for, then the average number of fatalities (1998 – 2002) for each factor is: 232 fatalities involved an impaired driver, 270 fatalities were unbelted vehicle occupants, and 135 fatalities involved an aggressive driver. To achieve the 2008 safety goal, the total number of related fatalities needs to be reduced from 430 to 318 fatalities per year. The amount of additional resources needed must be evaluated by individual law enforcement agency or patrol district. However, an enforcement goal for the State Patrol is 200 new troopers, while local law enforcement agencies may try to provide 10% percent increase in traffic enforcement.
Reactive and Proactive Plans	This strategy can be implemented reactively by targeting additional enforcement in areas (i.e., counties, cities, neighborhoods, corridors, or intersections) that have a high number of crashes or high crash rate. Proactively, community outreach and public education (i.e., Safe Communities coalitions or pubic information campaigns) can be used to inform drivers of increased enforcement to obtain voluntary driver compliance with the traffic laws.
Expected Effectiveness	(Tried/ Experimental) Historical evidence indicates that consistent and certain traffic enforcement is effective at changing driver behavior. An increase in traffic law enforcement is expected to decrease the number of crashes in areas or corridors where a higher number of traffic stops, citations, or arrests are made. Based upon the State's law enforcement experts, it is estimated that one fatality will be prevented for every additional full-time equivalent (FTE) officer added (an FTE is approximately 1,000 hours of patrol) and dedicated to traffic law enforcement. This translates into approximately 0.007 fatal crash prevented for every additional 8-hour shift.
Keys to Success	Clear understanding and acceptance of principal policy makers of the benefits of traffic law enforcement. Public support for safe roads and highways.
Potential Difficulties	Competing fiscal priorities. Competition for public resources will cause state and local officials to prioritize and select programs for funding. If public awareness and political support is not strong, traffic enforcement may be relegated to a lower priority.

Strategy 1. Provide Adequate Law Enforcement Resources	
Appropriate Measures and Data	It is difficult to measure directly the effectiveness of increased traffic enforcement. The best method to estimate the effectiveness would be to look for decreases in crashes in areas or corridors where a higher number of traffic stops, citations, or arrests were made.
Organizational and Institutional	
Champion	Minnesota Department of Public Safety and local cities and counties that provide law enforcement.
Organizational, Institutional, and Policy Issues	Even though the general public desires safe roadways, most drivers do not desire increased safety as a result of additional traffic tickets for themselves. The public as well as the government must be educated on the importance of providing high levels of traffic enforcement.
Issues Affecting Implementation Time	Implementation can only occur once funding to law enforcement has occurred. Often, budgets are set for an entire year and this limits increasing traffic enforcement until the following fiscal year.
Costs Involved	The cost associated with adding one 8-hour shift of patrol is approximately $875 to cover labor, and related overhead and vehicle costs.
Training and Other Personnel Needs	The success of a traffic enforcement program is dependent upon the individual officers involved understanding the effectiveness and benefit traffic stops and citations. Training should be provided to individual officers that will provide a framework and focus for their efforts.
Legislative Needs	Action by the Minnesota State Legislature is needed to provide the State Patrol with increased funding. Local governments will also need to take action to increase the funding provided to city police and county sheriffs.

Strategy 2. Primary Seat Belt Law	
Definition	Encourage the enactment of a statewide primary law that will permit standard enforcement and provide universal coverage to all vehicle occupants.
Technical	
Description	At present, a citation for noncompliance with Minnesota's seat belt law is a $25 fine and it is not recorded on your driving record. This strategy would not change this. The change would be that an officer would be able to enforce Minnesota's belt statute the same as every other traffic law. Additionally, the proposed law would require every vehicle occupant to wear a seat belt regardless of age or seating position. Currently, passengers in the back seat over the age of 11 are not required to wear a seat belt.
Target(s)	Studies show that the population who still consistently don't wear safety belts will only comply with the law if they believe there is a chance of being stopped and cited for it. Males ages 18 to 24 are least likely to wear safety belts.
Goal	Based on experience of other states, the National Highway Traffic Safety Administration (NHTSA) estimated that Minnesota would increase its belt use rate from 80% to 91% in the first year after a belt law upgrade took effect. The goal is to reduce the severity of crash injuries and increase the likelihood of passengers surviving when a crash occurs. In 2002, there were 299 traffic fatalities that involved an unbelted vehicle occupant. To achieve the 2008 safety goal, the total number of unbelted fatalities needs to be reduced from 299 to 221 fatalities per year.

Strategy 2. Primary Seat Belt Law	
Reactive and Proactive Plans	Enactment of a primary safety belt law is a proactive plan – getting drivers and passengers to buckle up on every trip in any vehicle so if a crash occurs they are more likely to survive it and lessen injuries. Supporters of seat belt legislation are those who witness the effects of the crashes on victims who were not properly restrained. This group includes employers, medical professionals, law enforcement, insurance providers, and community health advocates. Specifically, over 50 employers and associations have come together under the Minnesota Seat Belt Coalition. The group has been working to educate state leaders and the public about the importance of seat belts and upgrading Minnesota's restraint laws.
Expected Effectiveness	(Tried) An increase in Minnesota's seat belt use rate by 11 percentage points would save 51 lives, prevent 1,000 injuries, and save society $128 million in the first year alone (http://www.dps.state.mn.us/ots/Laws_Legislation/seat_belts_law.asp).
Keys to Success	In order for a seat belt law to be effective at increasing seat belt use, the public must perceive that all law enforcement agencies are enforcing the restraint law; otherwise vehicle occupants that currently do not wear seat belts are unlikely to change their behavior. The driving public also needs to be educated concerning the existence of a standard, universal law and why it is important to choose to obey the law.
Potential Difficulties	Opposition may be heard from individuals who perceive such legislation as intrusive government regulation.
Appropriate Measures and Data	The effectiveness of a standard seat belt law would be measured in two ways. First would be to measure if there is an increase in seat belt use after the law is passed. The second measure of effectiveness would be to see if the number of fatalities or serious injuries decreases after implementation of a new law, especially decreases in the number of fatalities and injuries for unbelted vehicle occupants.
Organizational and Institutional	
Champion	In recent years the lead agency has been the Minnesota Safety Council in cooperation with the Minnesota Seat Belt Coalition.
Organizational, Institutional, and Policy Issues	Passing of a primary seat belt law can not be done by local units of government within their jurisdiction. Although the State Legislature has been reluctant to pass such a law in the past, leadership within the Senate has shown support for the measure. However, House leadership has displayed strong opposition.
Issues Affecting Implementation Time	None identified.
Costs Involved	Little to no additional costs are anticipated since a standard seat belt law would be enforced during normal traffic enforcement. Current state employees would work with the legislature or safety organizations to inform them of the safety belt use rates and the effectiveness of safety belts and the effective of primary laws in other states. In addition, events and materials to inform the public and law enforcement of the law change could have minimal costs. No new funds are required; but up to $50,000 could be expended in current budgets both within government agencies and other organizations assisting with the adoption of a standard universal safety belt law.
Training and Other Personnel Needs	Education regarding changes to the seat belt law and its requirements will be needed for both the public and law enforcement professionals.
Legislative Needs	Minnesota's seat belt law can only be changed by the State Legislature.

Strategy 3. Implement Automated Enforcement	
Definition	Implement automated enforcement (cameras) to deter red-light running and aggressive driving.
Technical	
Description	The intent of this strategy is to deploy automated enforcement at signalized intersections for red-light running violations and at locations where speeding is a problem. Between red-light running and speeding cameras, more information is available on the use and effectiveness of red-light running cameras. Consequently, the following discussions primarily focus on the use of red-light cameras. However, using automated enforcement to deter speeding is also considered an important option in this strategy. The use of photo enforcement at intersections with semi-phore lights is gaining support nationally as it is proving effective at reducing violations and crashes. Red light running cameras are more effective than enhanced traditional traffic enforcement which is difficult for most agencies to do under present financial constraints, because the enforcement itself requires an officer to follow a violator through the red light to make the stop – endangering more lives-, and because violations are most common in congested areas where a stopped violator's and officer's vehicles increase congestion even further. The use of photo enforcement at problematic locations can be used successfully in place of a traditional officer.
Target(s)	Photo enforcement is targeted to correct drivers that are knowingly and willingly breaking the traffic laws. Distracted drivers that are speeding or run a red light will not be deterred by photo enforcement. Red light running photo enforcement is targeted at drivers who knowingly and willingly do not stop when the signal turns yellow or is red and it is best suited for implementation at locations with a crash problem related to red light running (i.e., right angle and rear end collisions).*
Goal	In 2002, there were 300 traffic fatalities that involved either excessive speed or were likely related to red light running. To achieve the 2008 safety goal, the total number of these fatalities needs to be reduced from 300 to 222 fatalities per year.
Reactive and Proactive Plans	Installing photo enforcement equipment at specific signalized intersections would be done in reaction to a prevalence of crashes occurring at that location. Publicizing the red light running program and additional installation of photo equipment at other location would be preventative measures to enhance the programs effectiveness. Similarly, use of photo enforcement for speeding can be deployed reactively at locations where there is a history of crashes where excessive speed is a common contributing factor. Publicizing the program would be a proactive plan to deter speeding.
Expected Effectiveness	(Proven/ Tried) Automated enforcement of red light violations has been used at various locations outside of Minnesota with positive results. Implementation of a camera at an intersection has been found to reduce violations by 40 percent or more. FHWA estimates that red-light running cameras will have a 15 percent reduction in related crashes. In Australia, there was approximately a 30 percent reduction in right-angle, right-angle turning, rear-end, and rear-end turning crashes.*

Strategy 3. Implement Automated Enforcement	
Keys to Success	In order for an automated enforcement program to be successful, there first must be acceptance by the local officials, general public, and law enforcement. It is important for automated enforcement to be installed at locations with documented safety problems resulting from violations. Photo enforcement that is installed as a revenue generator (i.e., through collection of fines) has a low chance of gaining acceptance among the public. Therefore, it is necessary to develop public information campaigns that explain the present problems and the potential benefits of the program.* The use of private contractors to operate portions of the program is used by some agencies. However, it is important that the contractor's fees not be linked to the number of tickets issued or fines paid as this is often perceived negatively by the public. Allowing the appropriate law enforcement agency to maintain control over the program and avoiding questionable contracts are needed for a successful program.*
Potential Difficulties	The use of photo enforcement is often controversial because of arguments centered on issues regarding personal privacy, effectiveness compared to traditional enforcement, costs exceeding the benefit, and use by government as a revenue generator (refer to ITE's *Automated Enforcement in Transportation* for counter points of view regarding these topics). It is also important that the administrative process be efficient so as to minimize the time between when the violation occurred and a citation is received.*
Appropriate Measures and Data	Decrease in the number of red-light running or speeding violations is one of the first ways to determine the strategies effectiveness. Also reviewing changes that occur in crash frequency and severity can be used to evaluate the effectiveness of automated enforcement. However, it is important to evaluate the effect automated enforcement has on all crashes and related crashes separately. Automated enforcement has also been found to have safety benefits at locations near where photo enforcement was installed. Therefore, monitoring nearby locations and comparing to control locations not influenced by new automated enforcement may reveal additional benefits.*
Organizational and Institutional	
Champion	Local units of government
Organizational, Institutional, and Policy Issues	Coordination is needed between the legislature, city councils, roadway agencies, law enforcement and traffic courts to make a program successful.
Issues Affecting Implementation Time	In Minnesota, the biggest issue facing implementation time is passing new legislation first by the State Legislature and then by local units of government. Once automated enforcement is accepted by the government, the time to gain local acceptance and approval for implementation can vary greatly depending on the local opinion and severity of the problem. (Nationwide surveys by IIHS and NHTSA both found support was already strong by "two-thirds" of respondents.)
Costs Involved	The costs for the equipment will vary depending upon the actual camera and sensor equipment selected. However, a red light camera can cost approximately $50,000 while the installation and sensor costs could range from $5,000 to $10,000 per intersection (http://www.iihs.org/safety_facts/qanda/rlc.htm#11). Additional costs include maintenance, monitoring tapes, processing citations, and moving the camera between locations. Cost to implement and operate the program can be offset by the fines collected from violators.* The cost involved with implementing cameras for speeding is assumed to be about the same as red-light running cameras.

Strategy 3. Implement Automated Enforcement	
Training and Other Personnel Needs	Training highway engineers to evaluate the technology will be needed. Additional training will also be needed for personnel responsible for maintenance of the equipment and users of the software for processing violations.*
Legislative Needs	New legislation is necessary to allow use of automated enforcement on Minnesota's State Highways. However, the City of Minneapolis is a "home rule" city, the City Council are considering deploying red-light running cameras at intersections where all approaches fall under their jurisdiction. Outside of "home rule" cities, the use of automated enforcement is not permitted. Example legislation and information regarding existing state policies can be obtained at various websites, including: • Insurance Institute for Highway Safety (http://www.iihs.org/safety_facts/state_laws/auto_enforce.htm) • National Conference of State Legislatures (http://www.nhtsa.dot.gov/ncsl/Index.cfm) The National Campaign to Stop Red Light Running (www.stopredlightrunning.com)*

*Source: NCHRP Report 500, Volume 12

Strategy 4. Stronger Graduated Licensing System	
Definition	Implement a stronger graduated driver licensing system.
Technical	
Description	Driving can be a difficult task for young drivers. Due to their lack of experience, risk-taking behavior and distractibility, the 16 to 18 year old age group is over-represented in fatal crashes. A stronger graduated licensing system (GDL) in Minnesota will result in the reduction of teen fatalities. Minnesota's current GDL requires young drivers to hold a provisional drivers license for six months before testing for full licensure. During that six months the teen driver should have 50 hours of supervised driving and all passengers in the vehicle must use a safety belt. These are minimal restrictions that have not impacted the over-representation of this age group. Stronger regulations as recommended by the Insurance Institute for Highway Safety and proven effective in other states that have adopted them should be considered in Minnesota. The restrictions include night-time and passenger restrictions for 16 and 17 year old drivers during their first year of driving.
Target(s)	All licensed drivers under the age of 18 during their first year of licensure.
Goal	In 2002, there were 139 fatal traffic crashes that involved a young driver. To achieve the 2008 safety goal, the total number of fatal crashes involving a young driver needs to be reduced from 139 to 103 fatalities per year.
Reactive and Proactive Plans	Amend the current graduated license sections of Minnesota law to add the restrictions that have been proven to be effective in reducing teen crashes and traffic fatalities.
Expected Effectiveness	(Proven) In Wisconsin, implementation of a stronger GDL decreased the number of fatal crashes involving a young driver by 18% and injury crashes by 20% (http://www.dot.state.wi.us/safety/motorist/teendriving/index.htm).
Keys to Success	In order for a stronger GDL to be effective, parents and young drivers have to be informed of the new law. Law enforcement also needs to be informed and given the resources to enforce the law. Parents will need to realize that even though restrictions on teenage driving privileges may cause inconveniences, these inconveniences are better than the alternative. Finally, it is also important that a new GDL law be enforced by law enforcement.

Strategy 4. Stronger Graduated Licensing System	
Potential Difficulties	At times policy makers and parents resist limiting the driving of new drivers. There can be a perception that teens are being unfairly targeted due only to their age. Parents who no longer have to taxi their teenager to events and localities may view the restrictions as another year of inconvenience if the safety benefits are not clearly articulated and highlighted.
Appropriate Measures and Data	The effectiveness can be measured by the change in the total number of crashes involving young drivers. In addition, evaluating the number of fatalities and serious injuries resulting from crashes involving a teen driver would be a measurement of the effectiveness of any new restrictions.
Organizational and Institutional	
Champion	Driver & Vehicle Services Division (DVS) of the Department of Public Safety
Organizational, Institutional, and Policy Issues	The current provisional licensing statute will have to be amended by the state legislature.
Issues Affecting Implementation Time	A short implementation period should be built into the system so that DVS, driver educators, law enforcement, and the general public can be informed and given time to make any system changes.
Costs Involved	Little to no additional costs would be required to achieve a law change. Current state employees would work with the legislature or safety organizations to inform them of the current teen traffic fatality rate and the effectiveness of GDL in other states. In addition, events and materials to inform the public, law enforcement and driver educators of the law change could have some costs. No new funds are required; but up to $50,000 could be expended in current budgets both within government agencies and other organizations assisting with the adoption of a stronger GDL law.
Training and Other Personnel Needs	Minimal training of law enforcement and driver educators would be needed to allow them to learn of the new restrictions.
Legislative Needs	The Minnesota State Legislature must act to amend the current provisional license provision currently in statute.

Strategy 5. Cost Effective Lane Departure Improvements	
Definition	Make low cost safety improvements for lane departure crashes (i.e., median barriers for narrow-width medians on multilane roads, shoulder/centerline/midlane rumble strips, enhance delineation of sharp curves and unexpected changes in horizontal alignment, enhance pavement markings, eliminate shoulder drop-offs, delineate roadside objects, and etc.). Assist local agencies in implementation of low cost improvements by providing data to identify dangerous locations, a toolbox of strategies to reduce fatal and serious injury crashes, training sessions, and an incentive program.
Technical	
Description	This strategy is an assortment of many strategies that are categorized as low cost and are focused at either preventing or reducing the severity of lane departure crashes. The strategies listed can either be applied reactively at locations known to have a crash problem or can be deployed proactively across a system. Combining strategies given local conditions may prove to be more effective than selecting a single strategy. NOTE: "Enhanced delineation of sharp curves…" does not have to be limited to placing larger or brighter signing along the curve. Strategies may also involve special pavement markings, such as a warning prior to the curve or improved edgeline markings along the curve. Another potential strategy is to provide lighting at the curve to assist drivers especially during the nighttime. NOTE: To "enhance pavement markings" is to provide drivers with better visibility to assist drivers staying in the proper lanes. Several methods available to enhance pavement markings include using raised pavement markings, 6-inch edgeline over a traditional 4-inch, wet reflective pavement markings and durable epoxy pavement markings. NOTE: "Eliminate shoulder drop-offs" is traditionally accomplished by performing maintenance of gravel shoulder or paving a wider shoulder. A paved shoulder eliminates a drop-off by moving it further from the edge of the travel lane to provide a driver with a larger recovery area if a vehicle does leave the travel lane. There is some experiential evidence to suggest that paved shoulders as narrow as two feet can still provide a safety benefit. Regardless of where the edge of pavement is, one approach to minimizing a shoulder drop-off is to bevel the pavement edge at a 45º angle to make it easier for vehicles to get back onto the pavement from the shoulder.
Target(s)	The crash types targeted are: (1) crashes involving a vehicle that ran-off the road and struck a fixed object or overturned; and (2) head-on or sideswipe (opposing directions) crashes on undivided roadways or roads with a traverseable median (i.e., flush or depressed).
Goal	In 2002, there were 247 fatalities resulting from a run-off the road crash and 121 fatalities from a head-on or sideswipe (opposite direction) crash. To meet the 2008 safety goal, the number of run-off the road and head-on/sideswipe fatalities needs to be reduced to approximately 185 and 90 per year respectively.
Reactive and Proactive Plans	Implementation of these strategies first along corridors and locations with a crash rate statistically significantly higher than the average (i.e., above the critical crash rate) would form the basis of a reactive plan. Afterwards, the proactive plan would be to implement the strategies at locations believed to have an increased probability of having a fatal or serious injury crash.
Expected Effectiveness	(Proven/ Tried) The effectiveness will depend upon the specific strategy chosen and whether the strategy was used in an appropriate location. Past studies have found varying results for most strategies, but some general guidance regarding expected effectiveness for select strategies follows. • Install median barriers in narrow width medians of multilane roads = performance will depend upon barrier selected (i.e., cable guardrail versus concrete guardrail) • Centerline rumble strips on two roadways = 30% crash reduction • Shoulder rumble strips = some studies have found a 20 – 30% reduction in the number of run-off the road crashes on freeways. The effectiveness on two-lane

Strategy 5. Cost Effective Lane Departure Improvements	
	roadways has been reported as unstudied. For detailed information regarding the effectiveness for all strategies, more information is available in NCHRP Report 500 Volume 4 (*A Guide for Addressing Head-On Collisions*) and Volume 6 (*A Guide for Addressing Run-Off-Road Collisions*).
Keys to Success	Implementation along a corridor or short segments of a corridor can be effective if a known, documented safety deficiency exists. However, implementation at a specific location in reaction to a fatal or high profile crash is unlikely to provide a significant safety benefit. After addressing crash locations that are statistically significantly higher than the expected (reactive deployment), a prioritized systematic deployment will be more effective at preventing fatal and injury crashes (proactive deployment). Also, many of these strategies can be combined with routine roadway maintenance or added during roadway overlays.
Potential Difficulties	A typical issue for many agencies is the maintenance associated with each strategy. Agencies need to consider that maintenance cost over time since pavement marking and signs need to be replaced, guardrail that has been struck will have to be replaced, rumble strips may cause problems for bicyclists and motorcyclists, and several of the strategies may complicate snow removal. For shoulder rumble strips, there is currently no proven design for roads with gravel shoulders or narrow paved shoulders (i.e, less than two feet).
Appropriate Measures and Data	Effectiveness of the strategies can be determined by monitoring crash data for lane departure crashes or a reduction in the crash severity.
Organizational and Institutional	
Champion	Mn/DOT, county and city highway agencies.
Organizational, Institutional, and Policy Issues	These strategies are relatively easy to implement and will typically not require coordination among multiple agencies, purchase of additional right-of-way, reconstruction or extensive modification of the roadside.
Issues Affecting Implementation Time	These strategies are relatively easy to implement and most could be performed within one or two years.
Costs Involved	The cost will vary depending upon the specific strategy and size of the project. Coordinating implementation of these strategies, especially when part of a proactive plan, with planned roadway maintenance activities (i.e., asphalt overlay) may make implementation more cost effective.
Training and Other Personnel Needs	Most agencies would not require additional personnel to implement the strategies. However, training local and state engineers on identifying the appropriate strategy for the local conditions would be needed.
Legislative Needs	None identified.

Strategy 6. Communications and Marketing Task Force	
Definition	Create a communications/marketing task force to raise public awareness of traffic crash issues.
Technical	
Description	This strategy is intended to raise public awareness regarding the impact traffic crashes have on everyday life. Public awareness can be raised through a broad base approach using press releases and advertisement campaigns. Awareness within local communities can be increased through cooperation with community groups and schools, booths at county fairs, and etc. In addition, a memorial could be prepared for all traffic fatalities in the State, or individual cities and counties could prepare a similar memorial for fatalities that occurred within their jurisdiction. Memorials could also be made mobile so that they can be transported around the state, county, or city for display at multiple locations. Whatever the approach, the purpose is to change the public erroneous acceptance of traffic fatalities as unpreventable.
Target(s)	A specific crash type (i.e., alcohol related, run-off the road, motorcycle, etc.) could be targeted or the information could broadly address traffic safety. A review of the demographics of individuals dying in traffic crashes would suggest that the message should be designed to reach males between ages 18 and 35.
Goal	In 2002, there were 657 traffic fatalities in Minnesota. Since this strategy can be directed to address all types of crashes, the overall goal of this strategy is to reach the 2008 safety goal of 500 traffic fatalities or less per year.
Reactive and Proactive Plans	The message should be both universal (proactive) and responsive to serious crashes that are occurring (reactive).
Expected Effectiveness	(Experimental) This strategy is considered experimental and therefore the potential effectiveness on the number of deaths prevented is unknown. However, there is research that shows that effective advertising, the Office of Traffic Safety Rochester/Duluth project, increases seat belt use. One can expect that strategies conducted with high quality marketing will reach more people and have a greater affect on the individuals reached.
Keys to Success	The campaigns need to be as broad based in order to maximize the number of people reached. The messages should be clear, concise, personal and let the listener know what actions they can take to make the roads safer.
Potential Difficulties	Obtaining quality, relevant data to convey to the general public in a manner that is convincing. Advertising at times that will reach targeted markets is expensive. It can be a challenge to coordinate the message.
Appropriate Measures and Data	The measure of effectiveness does not have to be limited to a reduction in the number of crashes. Since the purpose is to educate the public concerning traffic safety issues, polls that look at the change in public awareness and/or attitude to the traffic laws may provide a better idea regarding the effectiveness.
Organizational and Institutional	
Champion	Department of Public Safety – Office of Communications
Organizational, Institutional, and Policy Issues	A point person should be identified to direct proactive and reactive media messaging. Paid and earned media should be designed that will work across agency boundaries.
Issues Affecting Implementation Time	Due to the cost of both creating media messages and purchasing advertising, budget issues could prevent the timing of the media outreach. When there are multiple agencies involved, at times agreement on the direction and/or execution of the message is important. In addition, a point person needs to be identified and given authority regarding

Strategy 6. Communications and Marketing Task Force	
	decisions.
Costs Involved	Cost will vary depending upon the outreach approach selected and the quality of any brochures, press releases, memorials developed.
Training and Other Personnel Needs	The task force could be made up of existing staff from within the organization(s) or staffed with volunteers. The task force may need training regarding effective marketing and strategies for providing public education.
Legislative Needs	None, unless additional funding is sought through the appropriations process.

Strategy 7. High-Level Traffic Safety Panel and Legislature Action Committee	
Definition	Establish a high-level panel focused on traffic safety.
Technical	
Description	Within Minnesota, many agencies, organizations and companies are actively working to improve traffic safety. However, a traffic safety panel led by the Governor or the Legislature would set the traffic safety agenda for the entire State. This panel should focus on the traffic issues that have the highest importance in the state, such as the Critical Emphasis Areas, with an emphasis on implementing the *Comprehensive Highway Safety Plan*. The panel could take on many different formats, including but not limited to: • Gathering public and private safety partners to discuss and make policy recommendations and coordinate programs and activities. • Developing, funding, or contributing to safety projects carried out by other agencies or organizations following the recommendations of the group. (This would require the panel to have an operating budget.) • Preparing information and model legislation for the State legislature relative to areas where additional or stronger legislation would result in the reduction of crash fatalities and serious injuries.
Target(s)	The panel should take a statewide view of the safety issues rather than focusing on an isolated location or specific crash problem. The type of crashes targeted by the panel may vary depending upon the direction the panel feels is most important after reviewing Minnesota crash data and trends.
Goal	In 2002, there were 657 traffic fatalities in Minnesota. Since this strategy can be directed to address all types of crashes, the overall goal of this strategy is to reach the 2008 safety goal of 500 traffic fatalities or less per year.
Reactive and Proactive Plans	In general a high-level traffic safety panel should be proactive. The panel's recommendations should be based on crash data with the overall objective to make significant reductions in fatal and serious injury crashes in Minnesota.
Expected Effectiveness	(Experimental) Some states, such as Washington, have formed a Governor's Traffic Safety Commission that sets the traffic safety agenda, prioritizes programs, and distributes state and federal funding for projects. This group has a paid position that manages the operations, appointed members that help steer the traffic safety agenda, and permanent staff that carry out the activities identified by the Commission. Washington State has made some impressive improvements in the traffic safety arena, but how much of the credit goes to this structure has not been determined. A less structured panel of experts could be appointed to recommend traffic safety directions and priorities, thus giving more visibility to traffic safety issues. The panel could be convened and utilized as an advisory group to existing safety organizations and agencies.

Strategy 7. High-Level Traffic Safety Panel and Legislature Action Committee	
Keys to Success	For the commission/panel to affect an improvement in traffic safety, it is important that the members be dedicated to the purpose of the committee. The commission/panel should strive to be non-partisan regarding traffic safety issues.
Potential Difficulties	Maintaining a non-partisan, apolitical body can be delicate, if not impossible.
Appropriate Measures and Data	The method needed to determine the effectiveness of the commission/panel will depend upon the authority given to the group and in the areas in which their attention is focused.
Organizational and Institutional	
Champion	Undetermined. A high-level commission/panel could be a free standing group or could report directly to the Governor's office. In the alternative, the commission/panel could report to the commissioner of one of the current safety agencies such as the Department of Public Safety or the Department of Transportation.
Organizational, Institutional, and Policy Issues	These issues would be identified once the structure of the group is determined. Regardless, the commission/panel must have a qualified, informed director or leader to effectively facilitate the meetings and ensure responsibilities are fulfilled.
Issues Affecting Implementation Time	Traffic safety policy makers (such as the commissioners of Public Safety, Transportation, and Health; leaders from the State Patrol and a selection of Local Law Enforcement agencies and Sheriffs; local engineers, etc.) could be convened to determine the structure and authority of the group. However, if the panel was to be given control of limited funding, additional time would be needed to identify funding sources, organize participants, and identify worthy projects.
Costs Involved	The cost will depend upon the set-up of the commission/panel. If the group is simply a panel of public and private partners, the cost is limited to the time need to attend a meeting. A staff position dedicated to support the panel would be advised to ensure it has administrative support and its activities are documented and communicated. A budget of $50,000 is recommended. However, if a permanent Governor's commission is established, the cost may be substantial and require shifting for funds from current agencies and organizations.
Training and Other Personnel Needs	Although not required, training members on the responsibility of being an effective commission/panel member can result in a more effective body.
Legislative Needs	If this is to be a formal body with a budget, the legislature will have to authorize it in statute.

Strategy 8. Cost Effective Intersection Improvements	
Definition	Make low cost safety improvements at intersections including: offset and longer turn lanes; acceleration lanes; indirect left-turn treatments; clearing sight triangles; eliminate parking near intersections; provide pavement markings with supplementary messages, such as STOP AHEAD; double yellow centerline at intersections and at median opening; providing lighting to increase intersection visibility; etc. Assist local agencies in implementation of low cost improvements by providing data to identify dangerous locations, a toolbox of strategies to reduce fatal and serious injury crashes, training sessions, and an incentive program.
Technical	
Description	This strategy lists an assortment of strategies that are categorized as low cost and are focused at preventing intersection related crashes. The strategies listed can either be applied reactively at locations known to have a crash problem or can be deployed proactively across a system. Combining strategies given local conditions may prove to be more effective than selecting a single strategy, but will make it difficult to measure the effectiveness of any one strategy.
Target(s)	These strategies are generally intended to reduce the frequency (i.e., number) of intersection related crashes, but may also help reduce the average crash severity. In Minnesota, the most common intersection crash types are rear-end and right-angle, but left-turn and sideswipe are two other common intersection crash types. The specific crash type targeted will depend upon the strategy selected.
Goal	In 2002, there were 232 traffic fatalities that were intersection related. To meet the 2008 safety goal, the number of intersection related fatalities needs to be reduced to approximately 170 per year.
Reactive and Proactive Plans	Reactive - Begin with intersections over critical crash rate or with highest crash cost Proactive – Begin with high volume intersections with limited sight distance
Expected Effectiveness	(Proven/ Tried) Most of these strategies (and others) are discussed in detail in the 5th and 12th volume of NCHRP Report 500 series (A Guide for Addressing Unsignalized Intersection Collisions & A Guide for Addressing Collisions at Signalized Intersections). The NCHRP Report 500 lists these strategies as tried, but there is still no reliable estimates of their safety effectiveness. Effectiveness of these strategies will vary depending on many factors, including but not limited to: volume, existing design, and existing crash problem.
Keys to Success	In order for these strategies to be successful, proper diagnosis of the problem and likely causes is needed first. Since there are many factors that interact at an intersection, a trained and experienced professional may be needed to identify the best safety strategies. Also, one must consider if the chosen strategies will have significant impacts on the intersection's operations, especially if not justified by the crash patterns.
Potential Difficulties	In implementing any of the strategies, it is important that a good design process be followed. As an example, making a turn lane excessively long may confuse drivers if they mistake the turn lane for an additional through lane. Also, if a new design is used for the first time in an area (i.e., indirect left-turn treatments), public/driver training and information in addition to a well designed signing plan may be need to assist drivers. Another factor to consider is gaining public acceptance of strategies that may require new right-of-way or impact adjacent land use (i.e., require closing of an existing driveway). Also, strategies that increase the size of an intersection (i.e., off-set turn treatments), may cause additional problems for pedestrians that need to cross. Finally, strategies that rely on pavement markings may be less effective during the winter months if the markings are obscured, making it difficult for drivers to safely navigate.

Strategy 8. Cost Effective Intersection Improvements	
Appropriate Measures and Data	To measure the strategy's effectiveness, changes in crash frequency and/or severity are the most common methods. It is also important to look at the change in all crashes separate from the changes for relevant or targeted crash types. Also, it may be necessary to analyze crashes by approaches if only some intersection legs are improved. Other criteria that may be considered are need for additional right-of-way, number of access points affected, impact of commercial sales for adjacent land uses, and if any sight obstructions have to be removed from private property.
Organizational and Institutional	
Champion	Mn/DOT, county and city highway agencies
Organizational, Institutional, and Policy Issues	All of these strategies can be implemented by the responsible roadway agency. However, it is important for the highway agency to update/create and maintain their design policies so that future designs will be consistent with current safety standards. Having or updating maintenance manuals may also be needed so that pavement markings are routinely updated and so that field workers know when a roadside object becomes a sight obstruction and will need to be removed (i.e., a policy regarding sight obstructions on private property may also need to be developed). The roadway agency may also need to coordinate with law enforcement to make sure the new strategies are followed by drivers. For example, if parking is removed near an intersection, it will be important to make sure drivers do not continue to park in the restricted area. Another example would be to make sure drivers abide by turn restrictions when an indirect left-turn treatment is used.
Issues Affecting Implementation Time	Most strategies can be implemented in the short-term (i.e., less than a year). However, if additional right-of-way is needed or there are environmental and public resistance, then the process to implement the strategy may take much longer.
Costs Involved	The cost to design and construct these strategies will generally be low, especially in rural areas. However, the costs are highly variable depending upon need for additional right-of-way. One should also consider the additional maintenance cost that may be incurred with the addition of new pavement markings and traffic signs.
Training and Other Personnel Needs	For proper design and implementation, it is important to make sure engineering and maintenance staff are sufficiently trained in geometric design, MUTCD guidelines, and maintenance procedures.
Legislative Needs	None identified.

Strategy 9. Roadway Maintenance	
Definition	Perform proper maintenance of roadway facilities, including improving roadside hardware and removing and relocating objects in hazardous locations (i.e., trees).
Technical	
Description	Some crashes that occurred may have either been eliminated or would have been less severe if the roadway and roadside had been better maintained. "Proper maintenance" can encompass several other areas in addition to improving roadside hardware and removing/relocating fixed objects. For example, pre-treating more roadways prior to a winter storm and having more plows out during a storm may help reduce the number of crashes caused by snow packed and icy roads. As another example, properly maintaining gravel shoulders will eliminate shoulder drop-offs and can help reduce the number of run-off the road and head-on collisions. Roadways under construction must also be properly maintained by keeping loose debris off the roadway. This is especially important for motorcycles. As a final example, ensuring pavement marking lines are clearly visible can reduce the number of nighttime crashes.
Target(s)	The maintenance of roadways is primarily intended to address run-off the road and head-on crash types. Addressing weather related crashes may also provide some benefit for intersection crashes when one or more vehicles could not stop in time. Between 1998 and 2002, there was an average of 65 fatal crashes per year that were head-on and were weather related, involved a skidding vehicle, or involved a vehicle left of the centerline but not passing. There were approximately 71 fatal crashes per year where a vehicle ran-off the road and struck a roadside fixed object.
Goal	In 2002, there were 247 fatalities resulting from a run-off the road crash and 121 fatalities from a head-on or sideswipe (opposite direction) crash. It is unknown what portion of these crashes may have been prevented by maintenance activities. However, in order to meet the 2008 safety goal, the number of run-off the road and head-on/sideswipe fatalities needs to be reduced to approximately 185 and 90 per year respectively.
Reactive and Proactive Plans	Reactive – High crash locations and corridors based on critical crash rate and crash cost. Proactive – Corridors with high volume, narrow shoulders, with insufficient clear zones, or under construction.
Expected Effectiveness	(Proven/ Tried/ Experimental) Improving roadside hardware was estimated to be prevent 50% of fatalities and serious injuries when a vehicle struck guardrail. This estimate was based upon crash reductions reported in NCHRP Report 500 Volume 6 associated with moving guardrail farther from the roadway. Even though the placement is only one aspect of improving guardrail, no other reliable information was available to assess the safety benefit of replacing old guardrail or guardrail that no longer meets current crash worthiness standards. Estimates for the crash reduction for other maintenance activities was based upon discussion by the State's safety and maintenance experts. For example, maintaining gravel shoulders has been estimated to prevent 15% of run-off the road crashes. Also, placing one additional snow plow on the highways for five years was estimated to prevent 1 fatality during this period (with approximately 435 plowing hours per year, this translates into 0.004 fatal crash prevent for every 8-hour shift).

Strategy 9. Roadway Maintenance	
Keys to Success	Key to proper maintenance is having trained field personnel looking for and correcting potential hazardous situations. Having adopted official policies and actions regarding tree removal, guardrail replacement, placement of utilities, pavement marking replacement, shoulder maintenance, etc. can assist field personnel in quickly identifying and correcting maintenance issues. It is also important for staff to be familiar with the latest improvements in maintenance processes and hardware. For instance, the National Transportation Safety Board has just released a directive that all guardrail end treatments anchored in a backslope should be replaced with approved end treatments. Similarly, twist down end treatments and other guardrail end treatments still in place have been long considered obsolete and dangerous.
Potential Difficulties	One of the largest difficulties to overcome is acquiring necessary funding. Not only is funding necessary for the material and labor costs, but will also be necessary to provide training to maintenance personnel.
Appropriate Measures and Data	Improving maintenance to reduce fatal and serious injury crashes is a proactive approach towards roadway safety. Therefore, an appropriate method for estimating a safety benefit is to look at the number of crashes per year for the corridors and areas where maintenance activities were enhanced. It is also important to review the changes in relevant crash types separately from all crashes.
Organizational and Institutional	
Champion	Mn/DOT, county and city highway agencies
Organizational, Institutional, and Policy Issues	The responsible highway agency should formally devise and adopt policies regarding maintenance issues affecting highway safety (i.e., tree removal, guardrail replacement and design, etc.)
Issues Affecting Implementation Time	Implementation of updating highway hardware, providing safe roadsides, and shoulder maintenance could begin almost immediately. However, the time to cover the entire system may takes several years, depending on the number of miles of roadway in an agency's jurisdiction.
Costs Involved	Costs will typically be limited to the time for maintenance personnel. If the maintenance is for a winter storm, labor costs may significantly increase if staff are needed to work overtime. However, some materials cost will be involved with updating roadside hardware, treating snow and icy roads, eliminating shoulder drop-offs, and improving pavement markings.
Training and Other Personnel Needs	Highway engineers and maintenance staff will need to be fully trained in identifying safety issues regarding maintenance and in selecting appropriate remediation.
Legislative Needs	None identified.

Strategy 10. Support the Enforcement of Traffic Safety Laws	
Definition	To combat impaired and aggressive drivers, work with courts to prevent the reduction or dismissal of traffic citations.
Technical	
Description	Many people do not understand the potential consequences of their actions for themselves and others when they drive recklessly. This strategy is intended to make people reconsider their actions by letting them know they will be punished if caught. When drivers, especially repeat offenders, are given reduced or eliminated traffic charges, the message sent to the driver and the rest of the public is that their actions were tolerable. The purpose of this strategy is to let the offender and the public know they will be held responsible for their actions. This can only be achieve if the courts understand this strategy and are willing to uphold justified charges of traffic violations.
Target(s)	Although all traffic citations could be targeted, the primary driver population targeted by this strategy is drivers that repeatedly drive impaired. This strategy may also discourage drivers that are not habitual offenders from making similar mistakes.
Goal	In 2002, there were 657 traffic fatalities in Minnesota. It is unknown how many of these fatalities may have been prevented if traffic laws were strictly enforced in Minnesota. However, in order to reach the 2008 safety goal of 500 traffic fatalities or less per year, this strategy is important at reaching drivers who carelessly disregard Minnesota's traffic laws.
Reactive and Proactive Plans	The program is reactive to offenders that have been arrested for impaired driving. However, it will be proactive in sending a message to society that impaired driving is not tolerated by society and will result in serious penalties.
Expected Effectiveness	(Tried/ Experimental) If a driver understands that there are penalties for driving impaired, they will change their driving behavior. Changing this behavior will result in fewer crashes, save lives, and ultimately reduce the number of these cases in the court system. For each court district, it has been estimated that one fatality could be prevented each year.
Keys to Success	For this strategy to be successful, the Courts and general public first have to support the change from the status quo to a new system of appropriately sentencing first-time and repeat offenders. This strategy will also have the greatest impact on driver behavior if they are informed in advance of the changes being made by the courts.
Potential Difficulties	This strategy could potentially increase the number of people in the Court and jail systems. With a Court system often overburdened, the time for a case to be handled may initially increase.
Appropriate Measures and Data	Within the jurisdictions where judges and prosecutors are refusing to reduce traffic safety charges, one should look for a reduction in the number of impaired drivers being cited or arrested. Over time, this will likely result in a reduction in alcohol related crashes.
Organizational and Institutional	
Champion	Office of Traffic Safety and the Minnesota Supreme Court
Organizational, Institutional, and Policy Issues	The courts system finds it difficult to handle the number of court cases and often uses plea bargains to reduce their workload. Courts may initially be required to be reorganized or funded to properly handle the workload. Further, judges and prosecutors are extremely independent in their decision making. It is critical that a policy is created that provides for strict enforcement of criminal penalties while simultaneously respecting the unbiased role of the judiciary.

Strategy 10. Support the Enforcement of Traffic Safety Laws	
Issues Affecting Implementation Time	It will take time to change the culture of the criminal justice system.
Costs Involved	With the adoption of this strategy, there is likely to be increased court costs since cases may not be settled as quickly. There may be additional costs for jail and probation if more offenders are penalized to the full extent of the law. However, once the public understands that impaired driving is taken seriously within the criminal justice system, fewer people will drive impaired resulting in a decrease in costs to the system. The Office of Traffic Safety will also have to program funding to dedicate staff to work with specific judicial districts, that funding would be $150,000 per district.
Training and Other Personnel Needs	Additional staff time will be needed to meet with and educate Judges and prosecutors regarding the hazard of impaired and reckless drivers. The Court system will also need additional staff to handle the increase in work load.
Legislative Needs	None identified.

Strategy 11. Targeted Enforcement	
Definition	Use well publicized sobriety saturations and targeted enforcement to deter impaired drivers and aggressive drivers, and increased seat belt use.
Technical	
Description	This strategy is very similar to an existing safety program called NightCAP. As part of the NightCAP program, the 13 counties with the highest number of alcohol related fatalities were first identified as areas to target impaired driving enforcement. The city and county law enforcement agencies in these areas work together with the State Patrol on specific evenings; significantly increasing the amount of officers on patrol ready to identify and arrest impaired drivers. Saturation patrols can also be done by local law enforcement agencies without the aid of the State Patrol in order to extend the frequency of targeted enforcement. The saturation patrols are usually short-term enforcement in a specified area or corridor over holiday periods, weekends, or during local events. Targeted enforcement on seat belt use and speeding called a mobilization is done statewide including at least 200 agencies over a two week period. The enforcement effort will be highly publicized before the enforcement mobilization begins.
Target(s)	This strategy targets driver behavior in order to prevent crashes, in particular impaired driving. In addition to the targeted driver offense, saturation patrols often result in additional citations for other violations that were not being targeted. In particular, officers on a saturation patrol should also look for vehicles where the passengers are not buckled.
Goal	In 2002, there were 239 fatalities that were classified as alcohol related and 165 fatalities listed with excessive speed as a contributing factor. To meet the 2008 safety goal, the number of alcohol and speed related fatalities needs to be reduced to approximately 177 and 122 per year respectively..
Reactive and Proactive Plans	NightCAP or other saturation patrols and mobilizations combine reactive and proactive plans. Because the existence of the patrols are highly publicized in the area they are taking place, offenses and resulting crashes may be prevented if some drivers change their behavior due to the publicity. Saturations are also reactive as they identify the driver as he/she is committing the offense, thus not preventing the unlawful driving behavior, but perhaps having prevented a crash.

Strategy 11. Targeted Enforcement	
Expected Effectiveness	(Proven/ Tried) It is known that the presence of law enforcement has a positive influence on driver behavior, but no information is available to quantify this into a crash reduction. Through a series of discussion by the State's law enforcement experts, the safety benefit of an enforcement campaign (1 campaign = 50 impaired driving saturation patrols) is estimated to prevent one fatality and a range of two to three serious injuries.
Keys to Success	In order to deter drivers, it is important that the public is informed of the enforcement activity. Whether a two-week mobilization of a holiday weekend saturation is scheduled, the drivers in that area should know that enhanced enforcement will be taking place. In addition, it critical that the results of saturation patrols and mobilizations be widely publicized. Media releases clearly stating the number of citations given out tells the public that individual drivers were cited during the enforcement period.
Potential Difficulties	The greatest difficulty facing a saturation patrol or mobilization is finding additional funding to allow for dedicated traffic enforcement.
Appropriate Measures and Data	Initially, the program success will be seen by an increase in citations and arrests for impaired, aggressive driving, and non-belt use. As the public realizes they have an increased chance for being caught, the number of citations may begin to decrease. There should also be a corresponding decrease in the number of crashes involving an impaired or aggressive driver and a decrease in the number of unbelted injuries or fatalities.
Organizational and Institutional	
Champion	DPS Office of Traffic and State Patrol currently coordinate saturation patrols and mobilizations. However, local law enforcement agencies can also begin to organize saturation patrols for their cities or counties.
Organizational, Institutional, and Policy Issues	Saturation patrols will be most effective when multiple law enforcement agencies work together to patrol as large of an area as possible. Mobilizations should be statewide covering as large portion of Minnesota roadways and including a large percentage of law enforcement agencies.
Issues Affecting Implementation Time	Before a saturation patrol or targeted enforcement could be scheduled, crash records would first need to be analyzed so that the law enforcement can effectively target the areas with the highest incident rates.
Costs Involved	The primary cost associated with sobriety saturations and targeted enforcement is the time (and potentially overtime) needed to staff the law enforcement patrols. To conduct a statewide tow-week seat belt and speed enforcement campaign, the cost is estimated to be $750,000 per mobilization. The estimated cost is $200,000 to conduct 50 saturation patrols to reduce impaired driving over a year.
Training and Other Personnel Needs	Implementation of this strategy will require more State and local resources be devoted to traffic enforcement, particularly for removing impaired and aggressive drivers from Minnesota's highways. Law enforcement officers also have to be well-trained at identifying impaired drivers and then distinguishing if the driver is impaired by alcohol or by other substances.
Legislative Needs	None identified.

Strategy 12. Enhance Driver Education	
Definition	Revise driver education with stronger mandates to include parent involvement, uniform curriculum, instructor quality control, and enhanced behind-the-wheel and classroom instruction. Also improve driver training and licensing material with the addition of traffic safety statistics, stories, and testimonials.
Technical	
Description	Similar to Critical Strategy four, this strategy addresses safety issues related to young and inexperienced drivers. This approach is different because the focus is on the training teenage drivers receive and not on their driving privileges after receiving a license. The goal is to provide enhanced, uniform training to all young novice drivers in Minnesota, thereby preventing some crashes from happening.
Target(s)	This strategy targets the young drivers that are over-represented in traffic crashes. The young novice driver is often more likely to take risks due to his/her age and obviously lacks driving experience. Can the required driver education program focus on these characteristics and add strategies to change some harmful driving behaviors of these young, novice drivers? Increasing parental involvement, making drastic changes to the curriculum and standard training and oversight of driver educators has been suggested.
Goal	To reduce the number of crashes involving young, novice drivers and to lessen the over-representation of young drivers in fatal and serious injury crashes. In 2002, there were 139 fatal traffic crashes that involved a young driver. To achieve the 2008 safety goal, the total number of fatal crashes involving a young driver needs to be reduced from 139 to 103 fatalities per year.
Reactive and Proactive Plans	Preparing inexperienced drivers to independently operate on the roadways through a driver education program is a proactive approach. Requiring inexperienced drivers that receive citations to take a driver improvement course could be a reactive plan to change behavior before a crash occurs.
Expected Effectiveness	(Experimental) Driver education programs have not been proven effective. There are no new education strategies that have been evaluated as being more effective with this age group. Recently changes to the curriculum have been adopted in state rules.
Keys to Success	If Minnesota is to test whether a major overhaul of driver education could be effective, it is important that education material, curriculum, and teachers are of the highest quality. It is also important to gain input from instructors, parents, and law enforcement when implementing changes. This was done in the rule-making process when the new curriculum was recently adopted.
Potential Difficulties	To ensure all students are receiving quality training, the quality of driving instructors must be monitored periodically.
Appropriate Measures and Data	Enhanced behind-the-wheel training could lead to a reduction in the number of crashes involving young drivers. If teenage drivers are well trained before they are allowed to have a driver's license, the crash rate for young drivers should drop. Additionally, effectiveness could be measured by testing driver knowledge and skill at the end of the class for student drivers before and after a new program has been established.
Organizational and Institutional	
Champion	Driver & Vehicle Services division of the Department of Public Safety

Strategy 12. Enhance Driver Education	
Organizational, Institutional, and Policy Issues	There is only one driver training coordinator responsible for all driver training programs in the state and only one accredited university or training institution capable of providing instructor training. There are three driver training programs in the state: public school, private school and commercial school training. All are currently held to the same standards.
Issues Affecting Implementation Time	Implementation of major changes would be dictated by the resources available to make the changes.
Costs Involved	The costs associated with this strategy include time and cost of training instructors and also the cost to provide periodic monitoring of instructors. Enhanced behind-the-wheel training may require additional time for students to drive which may result in a slightly higher cost for the parents and students. Since Driver & Vehicle Services would be responsible for implementing these changes, significant increase in resources for the driver education program would be required. The amount would be in the $1,000,000 range.
Training and Other Personnel Needs	In addition to developing the new materials, additional staff will need to train driving instructors and ensure the quality of their instruction.
Legislative Needs	None, the Driver & Vehicle Services division has rule-making authority over the state's driver education program.
Other Key Attributes	Driver Education changes alone will not yield the effectiveness that a strong Graduated Driver Licensing law would.

Strategy 13. Road Safety Audits	
Definition	Perform Road Safety Audits at the network level.
Technical	
Description	Currently in Minnesota, Road Safety Audits (RSA) are performed for corridors and intersections that have an actual or perceived safety problem. The current RSA process relies on field review by a multi-disciplinary team after an initial review of the corridor's crash history and contributing factors. As it stands today, the purpose of a RSA is to determine the corridor's safety deficiencies, identify the probable causes during the field review and then create a set of mitigative strategies. Performing a RSA for a network would be very similar in design. However, a key element for a RSA network analysis is a database that contains the intersection, roadway and roadside characteristics. During crash analysis of the network, this database could be used to identify possible causal factors for the RSA team before they are in the field. Reconstruction and preservation projects are expected to be inherently safe if the current guidelines are followed. However, prior to the design, a RSA team could be convened to review the project and identify potential improvements that can help improve the roadway safety.
Target(s)	This strategy will target all forms of crashes within a region or zone. The size of the network can be established based upon available time and budget. The largest network that would be analyzed at one time would likely be a county and could be as small as a township.

Strategy 13. Road Safety Audits	
Goal	In 2002, there were 657 traffic fatalities in Minnesota. Since this strategy can be directed to address crashes across the entire state, the overall goal of this strategy is to help reach the 2008 safety goal of 500 traffic fatalities or less per year.
Reactive and Proactive Plans	Reactive – Locations or corridors with a high crash frequency and crash severity. Proactive – Review of an entire district, county, or city with a high number of fatal and serious injury crashes.
Expected Effectiveness	(Experimental) The effectiveness of a RSA will depend on the severity of the crash problem within the network and the commitment of the responsible highway agency to implement the mitigation strategies in a timely manner. It is likely that most of the network will not have a crash history problem, but may still have some factors that could be a probable cause for a crash. Reviewing these areas will be important to improving the entire network, but the focus of the RSA team should still be on the areas found to have a safety problem.
Keys to Success	An enhanced database of intersection and roadway characteristics will be essential for the analysis that would take place before the field review. If county and local roadways are included in the audit, then their roadways should also be incorporated into the database. Another key item to the success of a RSA is the team members. Individuals selected to perform the field review need to be experienced in roadway safety and an interdisciplinary team is needed so that the audit is comprehensive. Finally, the responsible roadway agency has to be dedicated to implementing the suggested strategies.
Potential Difficulties	Creating an enhanced intersection database will be a labor intensive project.
Appropriate Measures and Data	The effectiveness for a RSA is measured after recommended strategies have been implemented. Depending on the number and location of strategies implemented, their effectiveness may be determined individually or as a group. It is also important to review the effect on all crashes within the network and specific crash types that are targeted by the individual strategies.
Organizational and Institutional	
Champion	Mn/DOT and local highway agencies.
Organizational, Institutional, and Policy Issues	A RSA is based upon an interdisciplinary team. Therefore, forming a RSA does require many agencies to be organized for meetings and the field review. This may become an issue because of the time commitment needed to perform a network RSA.
Issues Affecting Implementation Time	Before the audit could begin for a network, the attribute database must first be compiled. Depending on the size of the network, this may significantly delay when the analysis and filed review could occur. Also, determining the network zones/regions and organizing the RSA team may lengthen the process.
Costs Involved	The cost to perform the RSA is primarily limited to labor needed to perform the crash analysis, field review, and write the report. The labor cost will vary depending on the size of network selected and the safety issues within the zone. The costs that accompany implementation of safety strategies will be separate from the cost to perform the RSA.
Training and Other Personnel Needs	Mn/DOT and State Patrol have several persons experienced in performing RSA. However, representatives from local agencies that have never participated in RSA may need some training (most likely from Mn/DOT or State Patrol personnel) or experience.
Legislative Needs	None identified.

Strategy 14. Improve Data Systems	
Definition	Improve data systems by ensuring adequate staffing, equipment and other resources are available. In addition ensure that users of systems are consulted when system changes are being planned and implemented. Furthermore, organize an oversight committee to coordinate all agencies involved in the collection, management, and use of highway safety data.
Technical	
Description	Crash data systems are the foundation of many of the programs aimed at reducing traffic fatalities. In order to select appropriate strategies to mitigate safety deficiencies, complete, accurate and timely crash data are needed for identification of problem areas. Accuracy of the crash is needed not only for the details regarding the crash (i.e., time, weather, driver demographics, etc.), but also in the crash location entered into the system. If elements of crashes are entered into Minnesota's crash record database incorrectly, this can greatly affect the recommendations and decisions made by managers. In addition to accuracy, the data must be complete. Data from reports on every crash meeting the reporting threshold would give the most complete picture of the traffic safety environment in various areas, roadways and corridors of the state. Timely reporting of the crashes will give decision makers in many safety fields such as law enforcement, engineering, policy setting etc. the data needed to plan effective countermeasures and to evaluate the countermeasures once implemented.
Target(s)	This strategy is not intended to address a particular driver demographic, crash type nor contributing factor. By ensuring crash data is reported accurately, completely and timely it will increase the confidence and effectiveness of decisions made by safety specialists.
Goal	The short term goal is to return the quality of Minnesota crash data to the level achieved with the 2002 data. The long term goal is that the Accident Records database and all other systems containing components relevant to the analysis of traffic crashes (i.e. driver license database, court records, etc.) be coordinated and managed to ensure useful data are available. Adequate systems will assist Minnesota in addressing all types of crashes and to reach the overall state goal of 500 traffic fatalities or less per year by 2008
Reactive and Proactive Plans	Reactive – Implement a Crash Data Users Group to review the current status of the Accident Records database and recommend changes, improvements and solutions, including timeframes to achieve any modifications. Proactive – Raise the visibility and effectiveness of the existing Traffic Records Coordination Committee. Involve agency management representation to strengthen the significance of the committee and enhance the opportunities for implementation of major modifications to systems.
Expected Effectiveness	(Tried/ Experimental) Although various methods to improve data systems may be proven, their exact impact on reducing fatalities is difficult to quantify.
Keys to Success	To improve the crash record information, there must be cooperation among the responsible agencies and prime users of the information (including but not limited to Driver & Vehicle Services, law enforcement agencies from all jurisdictions, and Mn/DOT, Office of Traffic Safety, etc.). In addition, Driver & Vehicle Services must have adequate resources to maintain, upgrade and improve the Accident Records database.
Potential Difficulties	Coordinating agencies, providing additional funding for quality control, implementing recommendations from oversight committee
Appropriate Measures and Data	Complete data from crashes meeting the reporting threshold are accurately and timely entered into the Accident Records database and available and useful to users.

Strategy 14. Improve Data Systems	
Organizational and Institutional	
Champion	Driver & Vehicle Services division of the Department of Public Safety is responsible for the Accident Records database.
Organizational, Institutional, and Policy Issues	Review of existing data collection and entry procedures must take place with all interested parties represented. Policies and procedures may have to be modified to achieve the goal and agencies must be open to make those changes.
Issues Affecting Implementation Time	Lack of resources may delay modifications. Exploration of various sources of funding must be explored.
Costs Involved	To upgrade the current Accident Records database to a level where timely, accurate and complete data can be achieved would take an initial output of $270,000 to Driver & Vehicle Services with an on-going cost of $130,000 annually.
Training and Other Personnel Needs	Current staff would have to be retrained if procedures are modified. Additional staff would have to be trained as well.
Legislative Needs	No legislative action is needed unless an appropriation is the only source of funding.

Strategy 15. Trauma System	
Definition	Create and implement a statewide trauma system.
Technical	
Description	After a serious traffic crash, the survival and well being of the individuals involved is highly dependent upon the time it takes to reach a trauma hospital with proper equipment, and staff trained to handle trauma. If most hospitals in the state participate in the state trauma system and are clearly identified by the level of care they can provide and first responders are provided clear instructions on assessing injury severity and directing patients to the closest appropriate trauma hospital, more trauma victims will survive. Especially in rural areas, critical time is lost when a patient is transported to the nearest emergency room if that hospital is not equipped to treat the injuries. Critical time in the trauma patient's "golden hour" is lost when a second transfer to another hospital must occur – unless the first stop is needed for patient stabilization. A statewide system will significantly reduce the time from crash to definitive care by consistently ensuring that trauma patients are transported to a hospital with the appropriate resources to care for the injuries.
Target(s)	This strategy is not intended to address a particular driving population, crash type or contributing factor, but instead is meant to improve patient care after a crash has happened. A statewide trauma system reduces both time-consuming secondary patient transfers and the time patients linger in emergency rooms and ambulances before receiving definitive care. This will be of particular benefit to patients in rural areas. Hospitals participating in the trauma system will ensure that health care practitioners have specific trauma education and treatment / transfer guidelines, which enhances the level of care and efficiency in treating the trauma patient. Further, a trauma registry supports a comprehensive process improvement program that ensures participating hospitals review actions and outcomes of each trauma case, from EMS arrival to patient discharge

Strategy 15. Trauma System	
Goal	In 2002, there were 657 traffic fatalities in Minnesota. Since this strategy would address all traffic crashes, the overall goal of this strategy is to reach the 2008 safety goal of 500 traffic fatalities or less per year.
Reactive and Proactive Plans	Not applicable.
Expected Effectiveness	(Tried) Other states that have implemented a statewide trauma system have seen approximately a nine percent decrease in the number of traffic fatalities.
Keys to Success	For a statewide trauma system to be effective, key elements include: an ongoing accurate assessment and designation of Minnesota's trauma hospitals; EMS responders properly trained in protocols for treating and transferring trauma patients; an accurate trauma registry; and a statewide authority to manage the system.
Potential Difficulties	Availability of specialty staff in many areas of the state.
Appropriate Measures and Data	In addition to a reduction in the number of crash related fatalities, the effectiveness of this strategy can be measured by other proxy measures such as a reduction in the time spent in an emergency room before transfer to surgery or another hospital and the number of secondary and tertiary transfers of patients.
Organizational and Institutional	
Champion	This strategy is dependent upon the health services industry working together to create such a system. However, it will be important for the Department of Public Safety to provide continued support.
Organizational, Institutional, and Policy Issues	This strategy will require that either a new authority be created to manage the trauma system and provide training support to hospital staff and EMS responders, or an existing health agency would have to take on this task.
Issues Affecting Implementation Time	The main issue affecting implementation is financial resources – for managing the system, paying for treatment, and dealing with uncompensated care.
Costs Involved	The state-level cost of implementing and managing a statewide trauma system is estimated at $550,000 per year.
Training and Other Personnel Needs	Additional personnel (4-5.5 FTEs) will be needed to manage the statewide system. Some EMS providers and some hospitals will need to provide additional trauma-specific training for staff, and some technical assistance will need to be provided to hospitals for implementing the trauma registry.
Legislative Needs	State statutory authority for establishing the trauma system and an ongoing appropriation to implement and manage the system.

6. Mn/DOT's Outreach to Local Highway Agencies

Presently, Minnesota counties receive 29% of the State Gas Tax and cities receive 9% for transportation funding assistance. Historically, local highway departments have selected to use this money for reconstruction projects, not specifically for safety improvements. As part of a reconstruction project, safety is nominally designed into the new roadway. But many counties are reconstructing their system on a 40 to 50 year cycle.

Additional funding sources do exist that can be used for local safety engineering projects. One such source of safety funding is FHWA's Hazard Elimination Safety (HES) program. The Federal perspective regarding the State DOT's role in allocation of HES funds may be best described as a steward in selecting safety projects, with the expectation that some local projects will be funded. The distribution of HES funds in Minnesota is performed through a competitive process where regional Area Transportation Partnerships rank the projects that have been submitted for funding assistance. In the current prioritization process, top ranked projects are primarily on the State Trunk Highways, providing rural counties and cities with little assistance on safety engineering projects.

With little available funding, it is difficult for local highway agencies to undertake dedicated safety engineering improvements. Yet, the importance of the rural and local road systems for improving Minnesota's safety was presented in the first chapter (half of Minnesota's traffic fatalities occur on local roads and over 70 percent of all fatalities in rural areas). Consequently, the *CHSP Safety Toolbox* (**Appendix III**) was prepared to provide local agencies with a set of comprehensive, prioritized strategies aimed at the problems associated with the Critical Emphasis Areas (CEAs). Without local and/or rural agencies taking an active role at improving roadway safety, it is unlikely the number of Minnesota traffic fatalities can be reduced to goal of 500 or fewer traffic fatalities per year by 2008.

An example of a Minnesota agency investing in local safety initiatives involves the Department of Public Safety, Office of Traffic Safety using the funding received from the NHTSA for grant awards to state, county and local law enforcement agencies, local government, educational institutions, and non-profit organizations. The funding is utilized to implement safety and enforcement programs at the local, county, and regional levels. Recognizing the benefits associated with this type of outreach, Mn/DOT is pursuing a new focus on providing greater levels of assistance to local highway agencies.

6.1 Potential Services for Local Highway Agencies

Since achieving the 2008 safety goal is highly dependent on the local agencies, Mn/DOT recognizes the need to provide the local highway agencies with assistance. The three areas that Mn/DOT can provide assistance is training, technical support, and funding.

- Training – One of the primary goals would be to first educate the local highway agencies (as well as local law enforcement, EMS, and public education services)

on the existence of the CHSP, how it was developed, and why it is important to them. Also informing local highway agencies about the *CHSP Safety Toolbox* and how to apply it is an important step in helping them identify appropriate safety strategies. For class development and delivery of a comprehensive safety class, the Minnesota Local Technical Assistance Program (LTAP) has prior experience of providing training to local engineering agencies. To make the training outreach comprehensive, DPS's contacts and relationships could be used to inform local law enforcement, education, and health services about classes being delivered by the Minnesota LTAP.

- Technical Support – County and city engineering departments could team with Mn/DOT to have their intersections coded into the State's database. The local highway agency would need to perform the field review in order to record the attributes. If an agency has a relatively large network and/or little ability to perform field reviews, than the agency should focus on the roadways with the greatest volumes or highest functional classification. Once the local system has been coded, Mn/DOT would be capable of performing crash analysis of the system to identify dangerous intersections or segments. Mn/DOT may also be able to assist with safety field reviews, provide support in identifying mitigation strategies for high crash locations, or assisting in creating a prioritized safety plan.
- Funding – A portion of the safety funds could be set aside for local highway agencies to use on safety projects. In order to maximize the number of projects receiving funding assistance, local agencies may be asked to provide a matching fund.

6.2 Potential Local Funding Alternatives

To assist local agencies implement safety projects, pivotal issues are assisting with funding and providing training. The process of using LTAP (along with DPS's local contacts) to develop and deliver training was discussed previously under Training. To provide funding to local agencies, three potential processes have been identified (see following). Regardless of the method used, the purpose of local funding would be to address traffic safety comprehensively and systematically within local jurisdictions.

- Competitive – The competitive process would be based on Mn/DOT setting aside a portion of the safety funding for use by local highway agencies and allowing all counties and/or cities compete for the funding. In order for a county or city to receive state funding, they would first have to submit a project to Mn/DOT. In order for a project to be selected, the agency should at least be able to document an existing safety problem, a proposed solution, and the safety benefit from the project (i.e., number of lives saved, reduction in the number of expected crashes, etc.). As this is an open process, the number of local agencies competing for the safety funds could be very high.
- Selection – This alternative would again begin with Mn/DOT setting aside dedicated funding to be used only by local agencies. In order to have access to the funding, Mn/DOT would identify the top counties and/or cities with a fatal and serious injury crash problem in the five CEAs. If an agency elected to

participate, it would be eligible to apply for the dedicated funding. However, the local highway agency would first need to assist in adding their roadway system (intersection attributes and segment characteristics) to the State's roadway attribute database. Mn/DOT's crash record would be used to identify problem areas related to the CEAs as priority projects. Locations with a safety problem unrelated to the CEAs would still be eligible for funding assistance, but would have a lower priority. A significant advantage to participating in direct selection method is that the number of cities and counties eligible to submit projects is significantly reduced. As an example of how a county could be identified to participate in this program, **Table 6-1** lists counties identified by the Minnesota County Engineer Association that had more than 10 fatal and 500 injury crashes that were rural and non-intersection.

- Lead County/City – This process is similar to the selection process in that it begins with dedicated funding for local agencies. However, instead of Mn/DOT asking local agencies to participate, a Lead County/City program would look for volunteers. The program would also rely on local agencies summarizing their intersection and roadway characteristics and then using the Minnesota crash database to search for dangerous locations and develop a prioritized plan, with an emphasis in the CEAs. A major benefit for a Lead County/City is that they would compete against a smaller number of agencies for funding assistance.

TABLE 6-1
MN Counties with Rural, Non-Intersection Crashes

	County				
1.	Anoka	6.	Hennepin	11.	Scott
2.	Blue Earth	7.	Olmsted	12.	Sherburne
3.	Carver	8.	Ramsey	13.	Stearns
4.	Crow Wing	9.	Rice	14.	Washington
5.	Dakota	10.	St. Louis	15.	Wright

6.3 Preferred Local Outreach Program

Mn/DOT's assistance to local highway agencies may take on several different forms, but several aspects are believed to be key in successfully reducing fatal crashes on local roads. The keys to success are:

- Targeted Funding – Mn/DOT must establish a separate funding source or an investment goal to assist local highway agencies with dedicated safety improvement projects. Local agencies also need to establish safety as a top priority by using a portion of their available funds to match the state assistance. The key use of this funding is to perform specific safety improvements in response to a existing need (reactive deployment) or potential need (proactive deployment).

- Commitment to Training Local Agencies – The local highway agencies need to commit to having one or more staff trained in safety analysis processes and techniques. Desired training would provide staff with the ability to review, analyze and summarize crash records; to perform field reviews at high crash locations to recognize potential causes; and to identify and design safety improvement projects.
- System Analysis – The local highway agencies need to document the roadway and intersection attributes so that they can be incorporated into Mn/DOT's system. This will allow Mn/DOT analyze the local system looking for specific corridors or intersection with a crash problem. The local highway agencies must also review the crash records for their system to identify the common crash types, locations, and causal factors and then develop plans to address these needs systematically.
- A Local Comprehensive Approach – Just as is happening at the State level, local highway agencies need to work in cooperation with local law enforcement, driver education, safety advocacy groups, and local health providers. Agencies working together to address improve roadway safety have the potential to be more effective if resources are pooled and efforts coordinated.

7. Year One Statewide Deployment

As stated previously, the overarching goal of this plan is to reduce the number of traffic fatalities to 500 or less per year by 2008. Using a comprehensive and data driven process, the target areas where Mn/DOT and DPS will focus new efforts in order to achieve the greatest reduction in traffic fatalities was identified in the five Critical Emphasis Areas. Also, the principal strategies believed to be the most effective in these emphasis areas were selected as the 15 Critical Strategies. Action plans were developed for the Critical Strategies along with identification of alternative methods to provide local highway agencies with support. Yet, the final step is still for Mn/DOT to determine how safety investments will be divided among the Critical Strategies in order to maximize the safety benefit. To assist Mn/DOT with this decision, a spreadsheet tool (Effectiveness Spreadsheet) was developed that estimates both the safety benefit (i.e., lives saved and serious injuries prevented) and the implementation costs associated with deployment of the Critical Strategies (see **Figure 7-1**). Following is a description of the Effectiveness Spreadsheet and Mn/DOT's vision for implementing the Critical Strategies.

7.1 Effectiveness Spreadsheet

The Effectiveness Spreadsheet is capable of estimating the number of traffic fatalities and serious injuries prevented (i.e., benefit) given a specified level of deployment of a Critical Strategy. The spreadsheet also documents the estimated implementation costs and then computes a B/C ratio. It must be understood that the tool was created to provide a generic/statewide look at deployment of the Critical Strategies and is based on average crash densities spread over Minnesota's state highway system. Results (i.e., safety benefit or implementation costs) for a specific project may vary greatly depending on actual crash characteristics and the local conditions. Finally, only key and/or common project types for the Critical Strategies have been listed. Some Critical Strategies are composed of many safety project types, but only a handful of options have been listed in the Effectiveness Spreadsheet.

The spreadsheet has been organized into three areas, given values, input values, and output values. Even though the user is expected to only need to alter the input values, several constant or given values may change for a local or regional level (i.e., county or city). **Table 7-1** provides a detailed description of each field in the tool.

The effectiveness values for fatal and serious injury crashes have also been color coded based on the level of confidence. Effectiveness values in green ("Proven") are strategies that have been rigorously tested and the results are considered to be very reliable. Strategies with an effectiveness value in yellow ("Tried") are often widely accepted, but quality experiments may have not been performed to document the safety benefit. The red effectiveness values ("Experimental") may have little or no research available to document their effectiveness. Effectiveness values in red were set by Mn/DOT and DPS using local professional knowledge and expertise from past experiences. For some stratagies, a range of effectiveness values may exist, but the best information available was used to determine a single effectiveness value. However, Mn/DOT and DPS realize that other agencies and

organizations may be aware of or have more information that can improve the accuracy of the effectiveness values. If so, this information can be shared with Loren Hill at Mn/DOT (651-284-3455, Loren.Hill@state.mn.us).

TABLE 7-1
Effectiveness Spreadsheet Field Descriptions

Field			Field Description
Given Values	1	Related Crashes: Fatal	The number of fatal crashes (Minnesota, 2002) that are potentially correctable by the action listed under the critical strategy. The cell's comment has the number of fatalities (i.e., lives lost) that resulted from the fatal crashes.
	2	Related Crashes: Serious Injury	The number of serious injury crashes (Minnesota, 2002) that are potentially correctable by the action listed under the critical strategy. The cell's comment has the number of serious injuries that resulted from the crashes.
	3	Effectiveness: Fatal	Reports the effectiveness of the listed strategy at reducing the number of fatal crashes. The effectiveness may be listed as a percentage (i.e., prevent 50% of related crashes for every mile treated) or as an absolute number (i.e., prevent 1 crash for every program developed). The source for the effectiveness is presented in the cell's comment.
	4	Effectiveness: Serious Injury	Reports the effectiveness of the listed strategy at reducing the number of serious injury crashes. The effectiveness may be listed as a percentage (i.e., prevent 50% of related crashes for every mile treated) or as an absolute number (i.e., prevent 1 crash for every program developed). The source for the effectiveness is presented in the cell's comment.
Input Values	5	Deployment	The level of deployment for each strategy.
	6	Unit Cost	Represents an estimate of the implementation cost (i.e., salary, construction cost, related maintenance, etc.) for the life of the project. The original values are general estimates that may be refined if more detailed information is available.
	7	Service Life	The estimated life of the project related to the unit cost.
	8	Interest Rate	The interest rate use to amortize the implementation costs into an annual value over the life of the project. The default interest rate selected was the current interest rate used by Mn/DOT in benefit-cost analysis.
Output Values	9	Crash Prevention: Fatalities	The estimated number of fatalities prevented using the amount of deployment and the effectiveness for fatal crashes. Most values are computed using only the number of fatal crashes (1), effectiveness (3), and deployment (5). However, some strategies also include a constant value when calculating the crash prevention. This constant value represents a crash density (crash per mile, crash per intersection, etc.) that was determined using the entire state trunk highway system. Even though this constant is based on the state highway system, it is a conservative value because crashes were averaged across the entire system. Therefore it is also likely relevant for use on local roadways.

TABLE 7-1
Effectiveness Spreadsheet Field Descriptions

Output Values	10	Crash Prevention: Serious Injuries	The estimated number of serious injuries prevented using the amount of deployment and the effectiveness for serious injury crashes. Most values are computed using only the number of serious injury crashes (1), effectiveness (3), and deployment (5). However, some strategies also include a constant value when calculating the crash prevention. This constant value represents a crash density (crash per mile, crash per intersection, etc.) that was determined using the entire state trunk highway system. Even though this constant is based on the state highway system, it is a conservative value because crashes were averaged across the entire system. Therefore it is also likely relevant for use on local roadways.
	11	Initial Cost	The initial cost for implementation based upon the unit cost and the amount of deployment. The cost has not been converted into a yearly cost.
	12	B/C Ratio	Annual benefit divided by the annualized cost. The annual benefit is computed as $3.4 Million for each fatal crash prevented and $270,000 for each serious injury crash prevented. (NOTE: Benefit computed on crashes prevented and not on fatalities and injuries prevented.)

7.1.1 Engineering Only Deployment Alternatives

Several alternative investment scenarios were investigated using the effectiveness spreadsheet with historic level of safety funding ($10 Million per year) distributed across the engineering strategies. The funding was spread across the strategies in a way that realistically would occur and not just simply on the strategy that had the greatest benefit-cost (B/C) ratio. Using the effectiveness spreadsheet, focusing the safety funds on the engineering Critical Strategies is estimated to result in a saving of only 7 to 10 lives per year (**Figure 7-2** is one example of how safety funds could be distributed solely on engineering strategies).

Beginning in 2005, the number of traffic fatalities needs to be reduced by an average of 50 lives per year in order to reach the 2008 safety goal. To achieve the 2008 safety goal by investing in only engineering strategies, Mn/DOT would potentially need to increase the level of safety funding to $50 Million or more each year in order to implement enough projects to save fifty lives per year. Since this is approximately five times Mn/DOT's existing investment in highway safety, it would be extremely difficult for Mn/DOT to commit this much of its resources.

7.1.2 "Four Es" Deployment Alternatives

With the limited effectiveness in addressing highway safety using only engineering strategies, several additional scenarios were investigated to determine if it would be cost effective for Mn/DOT to invest a portion of its resources in safety strategies not considered traditional for a state DOT. The scenarios reviewed directed approximately 20% to 30% of Mn/DOT's safety funds into either enforcement, health systems, and/or education. The remainder of the safety funds were again spread the across engineering strategies. A best estimate of the expected effectiveness of a more comprehensive use of Mn/DOT's safety funds is that 75 or more lives could be saved in the first year (**Figure 7-3** is one example of how safety funds could be distributed across all 15 Critical Strategies).

		Given Values					Input Values					Output Values					
										Interest Rate (8) =	3.6%					
		Related Crashes		Effectiveness								Annual Crash Prevention					
	CEA	Fatal	Serious Injury	Fatal	Serious Injury	Unit	Deployment		Unit Cost	Service Life		Fatalities	Serious Injuries	Initial Cost	BC Ratio		
Critical Strategy #1: Provide Adequate Law Enforcement Resources		(1)	(2)	(3)	(4)		(5)		(6)	(7)		(9)	(10)	(11)	(12)		
Increased Traffic Law Enforcement	1 & 3	381	1048	0.007	0.020	crash per 8-hour shift	0	8-hour shift	$ 873	1		0.0	0.0	$ -	0.0	DPS	Anne Beers
Critical Strategy #2: Primary Seat Belt Law																	
Enact Primary Seat Belt Law	1	275	642	17%	19%	of unbelted	0	law	$ 50,000	20		0.0	0.0	$ -	0.0	DPS	Kathy Swanson
Critical Strategy #3: Implement Automated Enforcement																	
Photo Speed Enforcement	3	148	406	0.1	0.3	crash per location	0	locations	$ 50,000	5		0.0	0.0	$ -	0.0	DPS	Anne Beers
Red Light Running Cameras	3	32	352	15%	15%	of RLR crashes	0	intersections	$ 50,000	5		0.0	0.0	$ -	0.0	DPS	Anne Beers
Critical Strategy #4: Stronger Graduated Licensing System																	
Enact Stronger GDL	3	139	686	18%	20%	of related crashes	0	law	$ 50,000	20		0.0	0.0	$ -	0.0	DPS	Pat McCormack
Critical Strategy #5: Cost Effective Lane Departure Improvements																	
Install Centerline Rumble Strips	4	82	199	35%	35%	of Head-On	0	miles	$ 1,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Install Edgeline Rumble Strips	4	231	523	20%	20%	of Run-Off Road	0	miles	$ 2,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Enhance Pavement Markings by Using 6" Edgelines	4	231	523	10%	10%	mile	0	miles	$ 150	1		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Enhance Delineation of Sharp Curves	4	83	190	0.005	0.011	crash per location	0	curves	$ 1,000	1		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Install Median Barriers	4	17	23	90%	90%	of Across Median	0	miles	$ 100,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Remove/relocate Roadside Objects	4	119	246	25%	25%	of Run-Off Road & struck fixed object	0	miles	$ 10,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Eliminate Shoulder Drop-Offs by Paving Shoulders	4	231	523	25%	25%	of Run-Off Road	0	miles	$ 100,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Delineate Roadside Objects	4	119	246	1%	1%	of Run-Off Road & struck fixed object	0	miles	$ 500	5		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Critical Strategy #6: Communications and Marketing Task Force																	
Create a communications & marketing task force	5	590	2226	0.03%	0.03%	of related crashes	0	program	$ 50,000	1		0.0	0.0	$ -	0.0	DPS	Kathy Swanson
Public Education and Advertisement Campaigns	5	590	2226	0.15%	0.15%	of related crashes	0	campaign	$ 500,000	1		0.0	0.0	$ -	0.0	DPS	Kathy Swanson
Critical Strategy #7: High-level Traffic Safety Panel																	
High-levelTraffic Safety Panel	5	590	2226	0.03%	0.03%	of related crashes	0	committee	$ 50,000	1		0.0	0.0	$ -	0.0	DPS	Kathy Swanson
Critical Strategy #8: Cost Effective Intersection Improvements																	
Enhance Traffic Control Devices (larger or brighter signs, supplementary messages on approach, or double yellow lines on approaches / median openings)	2	101	463	15%	15%	of right angle crashes	0	intersections	$ 5,000	15		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Clearing Sight Triangles (remove parking and roadside objects)	2	101	463	15%	15%	of right angle crashes	0	intersections	$ 5,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Install Street Lighting	2	40	75	25%	25%	of intersection at night	0	intersections	$ 5,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Acceleration Lanes	2	25	116	20%	20%	of right angle crashes	0	intersections	$ 50,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Offset and Longer Turn Lanes	2	7	112	20%	20%	of rear end crashes	0	intersections	$ 50,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Critical Strategy #9: Roadway Maintenance																	
Winter Weather Maintenance	4	61	127	0.004	0.007	crash per 8-hour shift	0	8-hour shift	$ 480	1		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Roadway and Shoulder Maintenance	4	231	523	15%	15%	of Run-Off Road	0	miles	$ 5,000	5		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Improve Roadside Hardware	4	24	26	50%	50%	of Run-Off Road & struck guardrail	0	miles	$ 25,000	10		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Critical Strategy #10: Support the Enforcement of Traffic Safety Laws																	
Work with Courts to Prevent Reduced/Dismissed Traffic Law Charges	1 & 3	147	556	0.9	3.4	crash per district	0	court district	$ 150,000	1		0.0	0.0	$ -	0.0	DPS	Kathy Swanson
Critical Strategy #11: Targeted Enforcement																	
Targeted Impaired Driving Campaign	1	211	477	0.9	2.0	crash per campaign	0	campaign (50 saturation patrols)	$ 200,000	1		0.0	0.0	$ -	0.0	DPS	Kathy Swanson
Statewide Seat Belt Campaign	1	275	642	3.7	8.6	crash per campaign	0	campaign	$ 750,000	1		0.0	0.0	$ -	0.0	DPS	Kathy Swanson
Statewide Speed Enforcement Campaign	3	148	406	0.9	2.5	crash per campaign	0	campaign	$ 750,000	1		0.0	0.0	$ -	0.0	DPS	Kathy Swanson
Critical Strategy #12: Enhance Driver Education																	
Enhance Driver Education Instructors, Training Material, and Behind the Wheel Experience	3	139	686	0.03%	0.50%	of related crashes	0	program	$ 1,500,000	20		0.0	0.0	$ -	0.0	DPS	Pat McCormack
Critical Strategy #13: Road Safety Audits																	
Perform Network Road Safety Audits	2 & 4	590	2226	0.2	0.7	crash per RSA	0	RSA	$ 25,000	1		0.0	0.0	$ -	0.0	Mn/DOT	Bernie Arseneau
Critical Strategy #14: Improve Data Systems																	
Oversight Committee	5	590	2226	0.03%	0.03%	of crashes	0	committee	$ 50,000	1		0.0	0.0	$ -	0.0	DPS	Pat McCormack & Kathy Swanson
Upgrade the Accident Records System	5	590	2226	0.03%	0.03%	of crashes	0	program	$ 920,000	5		0.0	0.0	$ -	0.0	DPS	Pat McCormack & Kathy Swanson
Critical Strategy #15: Trauma System																	
Implement a Statewide Trauma System	5	590	2226	9%	9%	of fatalities	0	trauma system	$ 550,000	1		0.0	0.0	$ -	0.0	Health	Tim Held
										Total =		**0**	**0**	**$ -**	**0.0**		
	1=Impaired/Seat Belt																
	2=Intersections																
	3=Young/Aggressive																
	4=Lane Departure																
	5=Awareness/Data																

FIGURE 7-1:
Critical Strategy
Effectiveness Spreadsheet

It is important to note that in the enforcement, education and EMS strategies, there are three strategies that can each save a significant number of lives (28 to 59 lives). These three key projects are: establish a statewide emergency trauma registry (59 lives saved), enact a primary seat belt law (50 lives saved), or enact a stronger graduated driver licensing system (28 lives saved). In order to average a reduction of 50 fatalities per year over the next three years without having to increase safety funding, it is important that at least two of these strategies are in place before 2008. However, all three require action by the State Legislature. Therefore, the effectiveness of a "Four E" approach without these three strategies was also investigated. In such a scenario, the reduction in traffic fatalities is approximately 20 per year. Which is still an additional 10 to 13 lives saved per year over the engineering only deployments (**Figure 7-4** is one example of how safety funds could be distributed across the Critical Strategies without using either the statewide trauma registry, enact a primary seat belt law, or enact a stronger graduated driver licensing system strategies). However, this is still short of the goal, and demonstrates the importance the State Legislature holds in helping agencies decrease the number of fatalities on Minnesota's roads.

	Input Values			Output Values			
				Annual Crash Prevention			
	Deployment		Unit Cost	Fatalities	Serious Injuries	Initial Cost	BC Ratio
Critical Strategy #5: Cost Effective Lane Departure Improvements							
Install Centerline Rumble Strips	700	miles	$ 1,000	1.2	2.0	$ 700,000	63.4
Install Edgeline Rumble Strips	700	miles	$ 2,000	1.5	2.2	$ 1,400,000	41.7
Enhance Pavement Markings by Using 6" Edgelines	700	miles	$ 150	0.8	1.2	$ 105,000	23.6
Enhance Delineation of Sharp Curves	130	curves	$ 1,000	0.7	1.7	$ 130,000	19.3
Install Median Barriers	20	miles	$ 100,000	0.2	0.3	$ 2,000,000	3.1
Remove/relocate Roadside Objects	0	miles	$ 10,000	0.0	0.0	$ -	0.0
Eliminate Shoulder Drop-Offs by Paving Shoulders	20	miles	$ 100,000	0.1	0.1	$ 2,000,000	1.0
Delineate Roadside Objects	0	miles	$ 500	0.0	0.0	$ -	0.0
Critical Strategy #8: Cost Effective Intersection Improvements							
Enhance Traffic Control Devices (larger or brighter signs, supplementary messages on approach, or double yellow lines on approaches / median openings)	50	intersections	$ 5,000	0.0	0.1	$ 250,000	6.3
Clearing Sight Triangles (remove parking and roadside objects)	50	intersections	$ 5,000	0.0	0.1	$ 250,000	3.8
Install Street Lighting	50	intersections	$ 5,000	0.0	0.1	$ 250,000	2.7
Acceleration Lanes	15	intersections	$ 50,000	0.0	0.0	$ 750,000	0.5
Offset and Longer Turn Lanes	15	intersections	$ 50,000	0.0	0.0	$ 750,000	0.4
Critical Strategy #9: Roadway Maintenance							
Winter Weather Maintenance	500	8-hour shift	$ 480	1.8	4.5	$ 240,000	28.0
Roadway and Shoulder Maintenance	50	miles	$ 5,000	0.1	0.1	$ 250,000	5.7
Improve Roadside Hardware	32	miles	$ 25,000	0.0	0.1	$ 800,000	2.2
Critical Strategy #13: Road Safety Audits							
Perform Network Road Safety Audits	5	RSA	$ 25,000	1.0	4.0	$ 125,000	30.7
				7	**16**	**$ 10,000,000**	**18.1**

FIGURE 7-2:
Example Engineering Only Deployment

7.2 Implementation

The greatest challenge facing traffic safety professionals in Minnesota is the need to acknowledge that the effort to reduce fatal and life changing injury crashes is tied to implementing the prioritized strategies identified in this CHSP. The guiding principles contained in AASHTO's Strategic Highway Safety Plan and NCHRP Reports 500 and 501 suggests and the analysis of the alternative safety investment scenarios proves that the most effective implementation likely involves doing things differently from what has been the practice in recent years. This includes:

	Input Values			Output Values			
				Annual Crash Prevention			
	Deployment		Unit Cost	Fatalities	Serious Injuries	Initial Cost	BC Ratio
Critical Strategy #1: Provide Adequate Law Enforcement Resources							
Increased Traffic Law Enforcement	573	8-hour shift	$ 873	4.6	13.7	$ 500,000	37.6
Critical Strategy #5: Cost Effective Lane Departure Improvements							
Install Centerline Rumble Strips	700	miles	$ 1,000	1.2	2.0	$ 700,000	63.4
Install Edgeline Rumble Strips	700	miles	$ 2,000	1.5	2.2	$ 1,400,000	41.7
Enhance Pavement Markings by Using 6" Edgelines	700	miles	$ 150	0.8	1.2	$ 105,000	23.6
Enhance Delineation of Sharp Curves	50	curves	$ 1,000	0.3	0.7	$ 50,000	19.3
Install Median Barriers	20	miles	$ 100,000	0.2	0.3	$ 2,000,000	3.1
Remove/relocate Roadside Objects	15	miles	$ 10,000	0.0	0.0	$ 150,000	2.7
Eliminate Shoulder Drop-Offs by Paving Shoulders	20	miles	$ 100,000	0.1	0.1	$ 2,000,000	1.0
Delineate Roadside Objects	150	miles	$ 500	0.0	0.0	$ 75,000	1.0
Critical Strategy #7: High-level Traffic Safety Panel							
High-levelTraffic Safety Panel	1	committee	$ 50,000	0.2	0.8	$ 50,000	15.3
Critical Strategy #8: Cost Effective Intersection Improvements							
Enhance Traffic Control Devices (larger or brighter signs, supplementary messages on approach, or double yellow lines on approaches / median openings)	20	intersections	$ 5,000	0.0	0.0	$ 100,000	6.3
Install Street Lighting	15	intersections	$ 5,000	0.0	0.0	$ 75,000	2.7
Acceleration Lanes	10	intersections	$ 50,000	0.0	0.0	$ 500,000	0.5
Offset and Longer Turn Lanes	10	intersections	$ 50,000	0.0	0.0	$ 500,000	0.4
Critical Strategy #9: Roadway Maintenance							
Winter Weather Maintenance	250	8-hour shift	$ 480	0.9	2.2	$ 120,000	28.0
Critical Strategy #11: Targeted Enforcement							
Targeted Impaired Driving Campaign	1	campaign (50 saturation patrols)	$ 200,000	1.0	2.5	$ 200,000	17.0
Statewide Seat Belt Campaign	1	campaign	$ 750,000	4.0	9.3	$ 750,000	19.2
Critical Strategy #13: Road Safety Audits							
Perform Network Road Safety Audits	5	RSA	$ 25,000	1.0	4.0	$ 125,000	30.7
Critical Strategy #14: Improve Data Systems							
Oversight Committee	1	program	$ 50,000	0.2	0.8	$ 50,000	81.1
Critical Strategy #15: Trauma System							
Implement a Statewide Trauma System	1	trauma system	$ 550,000	59.1	236.8	$ 550,000	> 100
				75	**277**	**$ 10,000,000**	**91.9**

FIGURE 7-3:
Example "Four E" Deployment

- Investing in additional enforcement,
- A statewide trauma system registry,
- Being more proactive,
- Significantly increasing the level of investment in safety improvements on local roads, and
- Actively engaging the legislature to improve our laws regarding seat belts, automated enforcement and the graduated licensing process for young drivers.

The highway related improvement strategies in this Plan are intended to be implemented both as stand alone safety projects and as design features that are incorporated into larger projects that are part of regular programs of roadway reconstruction, expansion and preservation. The reason for this two prong approach is straight forward, the need to address fatal and life changing injury crashes is great and the funding for highway reconstruction, expansion and preservation is very limited due to budget constraints. Therefore, the most effective way to maximize implementation of the prioritized strategies is to build them into every possible program and project.

It has also been observed at the national level that most highway agencies approach to addressing safety is too reliant on the practice of nominally addressing the issue by designing highways in accordance with a prescribed set of roadway design guidelines. Current research indicates that this historic approach has not adequately mitigated the problem of fatal and life changing injury crashes for the following key reasons:

- Safety is only one of several items that are considered during the development of design guides (other items include traffic operations, constructability, maintenance, cost, etc.).
- Design guides are typically applied only when roadways are reconstructed but the frequency of reconstruction has been stretched to once every 40 to 50 years.

The guiding principles suggest that a more substantive approach that directly links crash cause to mitigative strategies would be more effective.

In order to ensure that Mn/DOT's safety investments are directed to the prioritized strategies in this Plan and that projects are systematically developed that include these strategies, the following steps should be taken:

- Design guidelines should be reviewed to determine if changes are necessary to better incorporate the prioritized strategies in the Plan. For example, current research suggests that even narrow paved shoulders (2 to 4 feet in width) have proven to reduce single vehicle road departure crashes, particularly when combined with enhanced edge line pavement markings or rumble strips.
- An inventory and analysis should be completed on a system-wide level to determine where the safety strategies should be implemented on a prioritized basis. A series of prioritization criteria were developed (see **Table 7-2**) to assist with the analysis. The criteria address engineering, enforcement and education strategies and support the concept of a proactive deployment primarily as a function of roadway classification, exposure and crash causation. Road Safety Audit Reviews of segments being considered for reconstruction or preservation would also help with the project scoping process.
- A training program should be developed and implemented for Mn/DOT project development staff in order to improve their understanding of the strategies, benefits and opportunities in this Plan.
- An outreach program for local highway agencies should be developed (possibly in partnership with the Local Technical Assistance Program at the University of Minnesota), with the assistance of county and city staff, in order to establish the details of the Lead County/City Program.
- Current practices for funding the State's Safety Program should be reviewed in order to ensure that money is being spent in conformance with Federal Highway Administration guidelines. In addition, consideration should be given to establishing targets for safety investments in each of the State's Area Transportation Partnerships (ATP) and Metropolitan Planning Organizations (MPO), with the target levels reflecting the distribution of fatal crashes on all systems of roads in the State.

The strategies and partnerships identified in this Comprehensive Highway Safety Plan present the State of Minnesota the opportunity to achieve the aggressive goal of reducing fatalities to fewer than 500 by 2008 and to take the initial steps in moving Towards Zero Deaths.

	Input Values			Output Values			
				Annual Crash Prevention			
	Deployment		Unit Cost	Fatalities	Serious Injuries	Initial Cost	BC Ratio
Critical Strategy #1: Provide Adequate Law Enforcement Resources							
Increased Traffic Law Enforcement	573	8-hour shift	$ 873	4.6	13.7	$ 500,000	37.6
Critical Strategy #5: Cost Effective Lane Departure Improvements							
Install Centerline Rumble Strips	700	miles	$ 1,000	1.2	2.0	$ 700,000	63.4
Install Edgeline Rumble Strips	700	miles	$ 2,000	1.5	2.2	$ 1,400,000	41.7
Enhance Pavement Markings by Using 6" Edgelines	700	miles	$ 150	0.8	1.2	$ 105,000	23.6
Enhance Delineation of Sharp Curves	50	curves	$ 1,000	0.3	0.7	$ 50,000	19.3
Install Median Barriers	20	miles	$ 100,000	0.2	0.3	$ 2,000,000	3.1
Eliminate Shoulder Drop-Offs by Paving Shoulders	20	miles	$ 100,000	0.1	0.1	$ 2,000,000	1.0
Delineate Roadside Objects	150	miles	$ 500	0.0	0.0	$ 75,000	1.0
Critical Strategy #7: High-level Traffic Safety Panel							
High-levelTraffic Safety Panel	1	committee	$ 50,000	0.2	0.8	$ 50,000	15.3
Critical Strategy #8: Cost Effective Intersection Improvements							
Enhance Traffic Control Devices (larger or brighter signs, supplementary messages on approach, or double yellow lines on approaches / median openings)	20	intersections	$ 5,000	0.0	0.0	$ 100,000	6.3
Install Street Lighting	15	intersections	$ 5,000	0.0	0.0	$ 75,000	2.7
Acceleration Lanes	10	intersections	$ 50,000	0.0	0.0	$ 500,000	0.5
Offset and Longer Turn Lanes	10	intersections	$ 50,000	0.0	0.0	$ 500,000	0.4
Critical Strategy #9: Roadway Maintenance							
Winter Weather Maintenance	250	8-hour shift	$ 480	0.9	2.2	$ 120,000	28.0
Critical Strategy #11: Targeted Enforcement							
Targeted Impaired Driving Campaign	1	campaign (50 saturation patrols)	$ 200,000	1.0	2.5	$ 200,000	17.0
Statewide Seat Belt Campaign	2	campaign	$ 750,000	8.0	18.5	$ 1,500,000	19.2
Critical Strategy #13: Road Safety Audits							
Perform Network Road Safety Audits	5	RSA	$ 25,000	1.0	4.0	$ 125,000	30.7
				20	**48**	**$10,000,000**	**21.9**

FIGURE 7-4:
Example "Four E" Deployment without a Primary Seat Belt Law, Stronger GDL, or Statewide Trauma System

TABLE 7-2
Prioritization Criteria for Critical Strategies

Strategy	Potential Criteria	Priority 1	Priority 2	Priority 3
Engineering Strategies				
Lane Departures				
Install Edgeline Rumble Strips	System Class	Principal Arterial / NHS	Minor Arterial or Higher	Minor Arterial or Lower
	Volume	> 7,500 vpd	> 4,500 vpd	Any
	Lane Width	11	≥ 11	12
	Shoulders	Paved	Gravel or Paved	Gravel or Paved
	Crash History	Corridor CR above CCR	Corridor CR above Avg CR	Any
Install Centerline Rumble Strips (undivided)	System Class	Principal Arterial / NHS	Minor Arterial or Higher	Minor Arterial or Lower
	Volume	> 7,500 vpd	> 4,500 vpd	Any
	Lane Width	12	≥ 11	11
	Shoulders	Paved	Gravel or Paved	Gravel or Paved
	Crash History	Corridor CR above CCR	Corridor CR above Avg CR	Any
Improve Roadside Hardware Remove/Relocate Roadside Objects Delineate Roadside Objects Enhance Delineation of Sharp Curves Enhance Pavement Markings Pavement Marking Replacement Winter Weather Maintenance	System Class	Principal Arterial / NHS	Minor Arterial or Higher	Minor Arterial or Lower
	Volume	> 7,500 vpd	> 4,500 vpd	Any
	Lane Width	11	≥ 11	12
	Shoulders	Gravel or Paved	Gravel or Paved	Paved
	Crash History	Corridor CR above CCR	Corridor CR above Avg CR	Any
Eliminate Shoulder Drop-Offs Roadway and Shoulder Maintenance	System Class	Principal Arterial / NHS	Minor Arterial or Higher	Minor Arterial or Lower
	Volume	> 7,500 vpd	> 4,500 vpd	Any
	Lane Width	11	≥ 11	12
	Shoulders	Gravel	Gravel	Paved
	Crash History	Corridor CR above CCR	Corridor CR above Avg CR	Any
Across Median				
Install Median Barriers (depressed median)	System Class	Principal Arterial / NHS	Minor Arterial or Higher	Minor Arterial or Lower
	Volume	> 50,000 vpd	> 25,000 vpd	Any
	Median Width	< 30'	30' - 50'	> 50'
	Shoulders	Gravel or Paved	Gravel or Paved	Gravel or Paved
	Crash History	Corridor CR above CCR	Corridor CR above Avg CR	Any
Intersections				
Offset and Longer Turn Lanes	System Class (Major/Minor)	Principal Arterial / Principal Arterial	Principal Arterial / Minor Arterial	Minor Arterial / Minor Arterial
	Volume	> 30,000 DEV	> 15,000 DEV	Any
	Median	----	----	----
	Posted Speed Limits	> 55 mph	45 - 55 mph	< 45 mph
	Crash History	Intersection CR above CCR	Intersection CR above Avg CR	Any
Acceleration Lanes	System Class	Principal Arterial / Principal Arterial	Principal Arterial / Minor Arterial	Minor Arterial / Minor Arterial
	Volume	> 30,000 DEV	> 15,000 DEV	Any
	Median	rural divided for inside accel lane	rural divided for inside accel lane	rural divided for inside accel lane
	Posted Speed Limits	> 55 mph	45 - 55 mph	45 - 55 mph
	Crash History	Intersection CR above CCR	Intersection CR above Avg CR	Any
Clearing Sight Triangles (remove parking and roadside objects) Pavement Marking (supplementary messages on approach or double yellow lines on approaches / median openings)	System Class	Any	Any	Any
	Volume	> 30,000 DEV	> 15,000 DEV	Any
	Median	----	----	----
	Posted Speed Limits	> 55 mph	45 - 55 mph	< 45 mph
	Crash History	Intersection CR above CCR	Intersection CR above Avg CR	Any
Install Street Lighting	System Class	Principal Arterial / Principal Arterial	Principal Arterial / Minor Arterial	Minor Arterial / Minor Arterial
	Volume	> 30,000 DEV	> 15,000 DEV	Any
	Median	----	----	----
	Posted Speed Limits	> 55 mph	45 - 55 mph	< 45 mph
	Crash History	Intersection CR above CCR with nighttime crash problem	Intersection CR above Avg CR with nighttime crash problem	Any
Enforcement Strategies				
Strategy	**Criteria**	**Priority 1**	**Priority 2**	**Priority 3**
Additional Law Enforcement Officers or Targeted Enforcement	System Class	Principal Arterial / NHS	Minor Arterial or Higher	Any
	Time-of-Day	Strong evidence of a time-of-day peak in related crashes (especially fatal and serious injury crashes) at either the statewide or local level	Moderate evidence of a time-of-day peak in related crashes at either the statewide or local level	No evidence of a time-of-day peak in related crashes at either the statewide or local level
	Day-of-Week	Strong evidence of a day-of-week peak in related crashes (especially fatal and serious injury crashes) at either the statewide or local level	Moderate evidence of a day-of-week peak in related crashes at either the statewide or local level	No evidence of a day-of-week peak in related crashes at either the statewide or local level
	Crash History	Corridor or area has relatively large frequency in related crashes (especially fatal and serious injury crashes)	Corridor or area has crash rate over average CR or CCR	Corridor or area exhibits no unusual crash activity
Automated Enforcement	System Class	Principal Arterial / NHS	Minor Arterial or Higher	Any
	Volume	High volume for roadways or intersections with similar design	High or moderate volume for roadways or intersections with similar design	Moderate volume for roadways or intersections with similar design
	Crash History	Location has number of RLR or speeding crashes statistically higher than expected (especially fatal and serious injury crashes)	Location has relative high frequency of RLR or speeding crashes, but may not be statistically higher than expected	Location has number of RLR or speeding crashes higher than expected
Education Strategies				
Strategy	**Criteria**	**Priority 1**	**Priority 2**	**Priority 3**
Public Education	Audience	Target age group, gender, or working class that has been found to be overrepresented in fatal and serious injury crashes	Target age group that has been found to be overrepresented in county demographics	All
	Crash History	Region demonstrates high frequency of crashes caused by driver behavior (speeding, alchol, seat belts)	Region demonstrates high frequency of crashes	All
Agency Education	Law Enforcement	City/County/State Patrol Districts that has unusually high number of crashes related to driver behavior	Any willing to participate in training	Any willing to participate in training
	Courts	Courts that has high number of traffic citations that are reduced or dismissed	Any willing to participate in training	Any willing to participate in training

- NHS: National Highway System
- vpd: vehicles per day
- CR: crash rate
- CCR: critical crash rate
- DEV: daily entering vehicles
- RLR: red light running

8. Key Conclusions

8.1 Traffic Safety is a significant public health issue.

MnDOT has been a national leader in the area of traffic safety for over 25 years, consistently ranking among the handful of states with the lowest fatality rates. However, a critical review of the crash statistics over the past several years reveals a number of disturbing trends. First, from a peak in the 1970's, the number of traffic related fatalities experienced a significant reduction during the early 1980's but that trend has stopped. In fact both the national and Minnesota data shows a slightly upward trend in the number of fatalities. Second, the fatality rate is basically flat and recent minor reductions are only due to the fact that population growth and other demographic factors have resulted in the vehicle miles of travel (VMT) increasing faster than the number of fatalities.

The bottom line is that the annual average of 43,000 traffic deaths nationally and 650 in Minnesota makes automobile crashes the number one cause of death for people through 35 years of age. These statistics clearly demonstrate that the consequences of motor vehicle crashes are a significant public health issue.

8.2 AASHTO's Strategic Highway Safety Plan

The lack of progress in reducing the death toll on our Nation's highways led the American Association of State Highway and Transportation Officials and the Federal Highway Administration to conclude that a new focus on and approach to traffic safety was necessary to address the documented increases in fatal and life changing injury crashes. Their vision for an improved process is contained in three key documents: AASHTO's Strategic Highway Safety Plan, the National Cooperative Highway Research Program Report 501 (Integrated Safety Management Process) and the NCHRP Series 500 Reports (Guidance for Implementation of the AASHTO Strategic Highway Safety Plan).

These documents encourage agencies to develop their own Comprehensive Highway Safety Plans based on seven guiding principles:

- Comprehensive – In order to be highly effective at reducing crashes, Plans need to be comprehensive in nature and include Enforcement, Education and Emergency Service strategies, in addition to the more traditional Engineering improvements (the 4 E's).
- Systematic – The final list of safety strategies should be developed through a process that first identifies a universe of strategies and then screens the strategies through a series of filters so that the prioritized list directly links the improvements to the key factors that are contributing to high numbers of serious crashes.
- Integrated – In Minnesota, recent safety efforts by Mn/DOT have been focused on engineering type improvements along the State's system of highways. To be more effective at reducing serious crashes, the guiding principles suggest that a Safety Plan needs to be integrated across a state's entire system of roads and coordinated with all state and local agencies that have a hand in addressing public safety issues.

- Stakeholder Involved – Safety partners representing each element of the 4 E's should be involved in the process of developing and screening the safety strategies because they are likely to be a critical part of the Plan and they could be asked to participate in the future implementation of one or more of the strategies.
- Data Driven – Safety Plans need to be driven by local crash data in order to ensure that the recommended improvement strategies are directly linked to the factors contributing to high frequencies of fatal and serious injury crashes. This will help increase the overall effectiveness of the Plan and increase the probability of directing resources to those strategies that will prevent the most fatal and injury crashes.
- Proactive – Most recent safety plans have been primarily focused on reacting to locations identified as having high crash frequencies. The guiding principles suggest that the most effective safety plans would include both a reactive component to deal with know locations with safety deficiencies and a proactive component to better address the random nature of serious crashes, especially those in rural areas.
- Substantive – Most highway agencies approach to addressing safety is too reliant on the practice of nominally addressing the issue by designing highways in accordance with a prescribed set of roadway design guidelines. Current research suggests that this historic approach has not adequately mitigated the problem of fatal and life changing injury crashes for two primary reasons. First, safety is only one of several items that are considered during the development of design guides and second, the design guides are typically applied when roadways are reconstructed but the frequency of reconstruction has been stretched to once every 40 to 50 years. The guiding principles suggest that a more substantive approach that directly links crash causes to mitigative strategies would be more effective..

The Minnesota Comprehensive Highway Safety Plan did in fact start with these guiding principles and then made adjustments based on input from a variety of safety partners (through a series of workshops attended by more than 100 safety professionals) and the extensive crash records database maintained by MnDOT. The final result of this effort is a prioritized list of 15 strategies that in fact address all four of the safety E's. The priority is based on the number of serious crashes associated with each of the strategies and the estimated ability to reduce these crashes.

8.3 Implementation

The greatest challenge facing traffic safety professionals in Minnesota is the need to acknowledge that the effort to reduce fatal and life changing injury crashes is tied to implementing the prioritized strategies identified in this CHSP. The guiding principles suggest that the most effective implementation likely involves doing things differently from what has been the practice in recent years. This includes investing in additional enforcement, a statewide trauma system data base, being more proactive, significantly increasing the level of investment in safety improvements on local roads and actively engaging the legislature to improve our laws regarding seat belts, automated enforcement and the graduated licensing process for young drivers.

The highway related improvement strategies in this Plan are intended to be implemented both as stand alone safety projects and as design features that are incorporated into larger projects that are part of regular programs of roadway reconstruction, expansion and preservation. The reason for this is straight forward – the need to address fatal and life changing injury crashes is great and the funding for highway reconstruction, expansion and preservation is very limited due to budget constraints. Therefore, the most effective way to maximize implementation of the prioritized safety strategies is to build them into every possible program and project.

8.4 Next Steps

In order to ensure that MnDOT's safety investments are directed to the prioritized strategies in the CHSP and that projects are systematically developed that include these strategies, the following steps should be taken:

- Design guidelines should be reviewed to determine if any changes are necessary to better incorporate the prioritized strategies in the Plan.
- An inventory and analysis should be completed on a system-wide level to determine where these safety strategies should be implemented consistent with the prioritizing criteria identified in Chapter 4 (see **Table 7-2**).
- A training program should be developed and implemented for project development engineers at MnDOT in order to improve their understanding of the strategies, benefits and opportunities in the Plan.
- An outreach program for local highway agencies should be developed, with the assistance of county and city staff, in order to establish the details of the Lead County/City Program.
- Current practices for funding the State's Safety Program should be reviewed in order to ensure that the money is being spent in conformance with Federal guidelines and consideration should be given to establishing targets for safety investments in every region of the State.

The strategies and partnerships identified in this Comprehensive Highway Safety Plan present the State of Minnesota the opportunity to achieve the aggressive goal of reducing fatalities to fewer than 500 by 2008 and to take the initial steps in moving Towards Zero Deaths.

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TABLE A.1-1
Self-Assessment – Summary by Agency

Agency	Working Well	Needs Improving
1. FHWA	• Research/promote older driver issues • Improve rail-highway crossings • Upgrade highway hardware • Research on run-off road crashes • Research head-on crashes	• Implement pedestrian counter measures • Implement motorcycle countermeasures • Reduce truck-car conflicts
2. NHTSA	• Ensuring drivers are licensed and fully competent • Programs/procedures to reduce impaired driving • Programs/procedures to increase driver safety awareness • Legislation/programs/research to promote and improve safety restraints • Pedestrian and bicycle safety • Program to increase driver awareness of motorcycles • Motorcycle safety research on barriers to helmet laws and rider objections • Research/programs on proper use of ABS • Bystander and EMS safety training • Improve crash data collection and consistency • Created national safety agenda • Promote Safe Community programs	• Restrict commercial driver's hours-of-service to reduce fatigue related crashes* • Identify and address locations with major pedestrian safety problems • Motorcycle education programs • Educate drivers of the dangers from carbon monoxide poisoning*
3. FMCSA	• Reducing impaired driving and related crashes • Keeping drivers alert • Reducing driver errors • Crash investigation and agency coordination	• Increasing driver safety awareness • Create an effective safety management system
4. GHSR	• Programs/procedures to reduce impaired driving • Public information campaigns about driver safety • Motorcycle safety awareness campaign	• Legislation/policies to promote bicycle and pedestrian safety • Lack of a comprehensive approach to address EMS training and response* • Policy/programs/legislation regarding graduated licensing

TABLE A.1-1
Self-Assessment – Summary by Agency

Agency	Working Well	Needs Improving
5. Mn/DOT	• Implemented program to install shoulder rumble strips on appropriate roadways • Researched and targeted across median and head-on crashes • Researched and implemented safety access management guidelines • Roadside safety hardware • Researched and implemented advance technologies at intersections • Researched and implemented pavement marking and delineation program	• Develop/implement guidelines for safe urban streetscape design • Implement improvements at hazardous ditches and slopes • Implement environmentally acceptable effort to address hazardous trees
6. DMV	• Motorcycle safety awareness campaign • Safety data management and analysis • Safe community programs with local partners	• Policy/programs/legislation regarding graduated licensing • Develop performance measures for safety investments • Develop more effective ways to keep revoked drivers off the road • Bicycle and motorcycle helmet laws* • Rail-highway crossing violation countermeasures
7. State Patrol	• Addressing impaired driving including repeat offenders • Promote and monitor use of seat belts and child restraints • Targeting carriers with unusual crash history • Enforcement in work zones	• Address pedestrian safety including hazardous location identification • Identification of intersections with high number of red light running violations and use of advanced technologies for enforcement • Safety data collection and verification
8. County Engineers	• Improve pedestrian and bicycle safety • Design and maintenance strategies to keep vehicles on the roadway and minimize crash consequences • Address intersection and work zone safety	• Improve highway infrastructure to safely accommodate older drivers • Construct shoulder rumble strips on facilities prone to fatigue • Acquire training on safer access management policies

TABLE A.1-1
Self-Assessment – Summary by Agency

Agency	Working Well	Needs Improving
9. County and City Police	• Education and enforcement of proper use of seat belt and air bags • Targeted enforcement at location known to have pedestrian safety problems • Enforcement and education (of public, police, and courts) of bicycle laws and safety, including increasing helmet usage • First responder training for police and integrated EMS, public health, and public safety information systems	• Targeted DUI enforcement for the 21-34 age group • Education and enforcement of issues related to impaired pedestrians • Reducing truck crashes by targeting unsafe carriers, fatigued drivers, or high risk locations • New enforcement and informational campaigns for work zones • Improving information and decision support systems • Creating more effective processes and safety management systems
10. EMS	• Traffic safety and injury prevention included in EMS training • Implementing integrated EMS, public health and public safety information systems	• Implement voluntary bystander training programs • Create emergency preparedness model for high-incident Interstate Highway settings
11. Local Courts		• Implement program to combat aggressive driving* • Review research on countermeasures to reduce repeat DUI offenders • Developed, distributed or reviewed educational materials for police and judicial officials on bicycle laws and enforcement

*These are areas where the interviewed agency responded with “Strongly Disagree” because they are not involved in any programs because of the organizational structure and responsibilities of Minnesota’s agencies.

TABLE A.1-2
Self-Assessment – Summary by SHSP

	Working Well	Needs Improving
Part 1: Drivers	• Keeping drivers alert (1) • Research on older drivers (1) • Competency of drivers (2) • Reduce impaired driving (4) • Increase driver awareness of motorcycles (1) • Increase driver safety awareness (2)	• Strategies to address driver fatigue (2) • More effective graduated licensing (2) • Design guidelines to accommodate older drivers (1) • More effective ways to keep revoked drivers off the road (1) • Strategies to address aggressive drivers (1) • Targeted DUI enforcement for the 21-34 age group (1) • Countermeasures to reduce repeat DUI offenders (1) • Increasing driver safety awareness (1)
Part 2: Special Users	• Targeted enforcement at locations with pedestrian safety issues (1) • Bike and pedestrian safety (2) • Enforcement and education of bicycle laws and safety, including helmet usage (1)	• Implement pedestrian countermeasures (5) • More effective bicycle helmet laws (1) • Education on enforcement of bicycle laws (1)
Part 3: Vehicles	• Seat belts / airbags (3) • Research on barriers to motorcycle helmet laws and rider objections (1) • Motorcycle safety awareness campaign (2) • Proper use of ABS (1) • Targeting carriers with unusual crash history (1)	• Implement motorcycle countermeasures (2) • More effective motorcycle helmet laws (1) • Reduce truck-car conflicts (1) • Targeted truck enforcement (1) • Increasing safety enhancement in vehicles (1)
Part 4: Highways	• Implement highway/rail grade crossing measures (1) • Upgrade highway hardware (2) • Research run-off road crashes and head-on crashes (2) • Design and maintenance to prevent run-off road crashes and minimize consequences of leaving the road (1) • Implement shoulder rumble strips (1) • Pavement marking program (1) • Access management guidelines (1) • Intersection safety (2) • Work zone safety (2)	• Rail-highway crossing violation countermeasures (1) • Enforcement and education for work zones (1) • Red light running violations (1) • Address hazardous trees (1) • Guidelines for safe urban streetscape design (1) • Improvements of hazardous ditches and slopes (1) • Access management policies (1)

TABLE A.1-2
Self-Assessment – Summary by SHSP

	Working Well	Needs Improving
Part 5: Emergency Medical Services	• Bystander and EMS Safety Training (3) • Integrated EMS, public health and public safety information systems (1)	• More comprehensive approach to EMS training and response (1) • Voluntary bystander training programs (1) • Create emergency preparedness model for high-incident Interstate Highway settings (1)
Part 6: Management	• Collection of crash data (1) • Data management and analysis (1) • National safety agenda (1) • Safe Community Programs (2) • Crash investigation (1) • Agency coordination (1)	• More effective safety management system (2) • Improving information and decision support systems (1) • Develop performance measures for safety investments (1) • Safety data collection and verification (1)

Note: The numbers in parenthesis represent the number of responses (from all agencies) for each area.

TABLE A.3-1
Reducing Impaired Driving & Increasing Seat Belt Use in Minnesota - Revised List of Strategies Following June 10 Workshop

Objectives	Strategies	Priority Ranking	Voting Results	Typical Timeframe for Implementation	Relative Cost to Implement and Operate			
					Low	Moderate	Moderate to High	High
1.A—Reduce Excessive Drinking and Underage Drinking	1.A1—Increase the excise tax on beer	Low		Long (>2 yrs.)	√			
	1.A2—Require responsible beverage service policies for alcohol retailers	Low		Long (>2 yrs.)		√		
	~~1.A3—Conduct well-publicized compliance checks of alcohol retailers to reduce sales to underage persons~~			~~Short (<1 yr.)~~	~~√~~			
	1. A4— Enact and enforce ID compliance checks with establishments selling alcohol	High	4					
1.B—Enforce DWI Laws	1.B1—Conduct regular well publicized **enforcement saturations to combat alcohol-related driving**	High	20	Short (<1 yr.)			√	
	1.B2—Enhance DWI detection through related traffic enforcement	High	1	Short (<1 yr.)	√			
	1.B3—Publicize and enforce zero tolerance laws for drivers under age 21	High	0	Short (<1 yr.)		√		
	1.B4—Penalties for adult providers	High	0					
	1.B5—Work with elected officials to permit law enforcement to enforce the laws	High	2					
1.C—Prosecute, Sanction and Treat DWI Offenders	1.C1—Suspend driver's license administratively upon arrest	High	0	Medium (1-2 yrs.)	√			
	1.C2—Establish stronger penalties for BAC test refusal than for test failure	High	0	Long (>2 yrs.)	√			
	1.C3—Eliminate diversion programs and plea bargains to non-alcohol offenses	Medium		Long (>2 yrs.)		√		
	1.C4—Assess all convicted DWI offenders for alcohol problems and require treatment when appropriate	Medium		Long (>2 yrs.)			√	
	1.C5—Develop treatment strategy	Low						
	1.C6—Pilot checkpoint challenge	Low						
	1.C7— Work with Courts to prevent the reduction or dismissal of traffic safety charges							
1.D—Control High BAC and Repeat Offenders	1.D1—Seize vehicle license plates administratively upon arrest	Medium		Medium (1-2 yrs.)	√			
	1.D2—Require ignition interlocks as a condition for license reinstatement	Medium		Medium (1-2 yrs.)		√		
	1.D3—Monitor all convicted DWI offenders closely	Low		Long (>2 yrs.)			√	
	1.D3—Breathalyzer in bars	Low	3					
1.E—Maximize use of occupant restraints by all vehicle occupants	1.E1—Conduct highly publicized enforcement campaigns to maximize restraint use	High	0	Medium (1-2 yrs.)			√	
	1.E2—Provide enhanced public education to population groups with lower than average restraint use rates	Medium		Short (<1 yr.)	√			
	1.E3—Encourage the enactment of **statewide primary** law that will permit standard enforcement of restraint laws	High	62	Medium (1-2 yrs.)	√			
	1.E4—Statewide occupant protection leadership committee	Low						
1.F—Insure that restraints, especially child and infant restraints, are properly used	1.F1—Provide community locations for instruction in proper child restraint use, including both public safety agencies and health care providers, that are almost always available	Medium		Short (<1 yr.)	√			
	1.F2—Conduct high profile "child restraint inspection" events at multiple community locations	Low		Short (<1 yr.)	√			
	1.F3—Train law enforcement personnel to check for proper child restraint use in all motorist encounters	High	2	Short (<1 yr.)		√		
	1.F4—Enforce use of child restraints	High	3					
	1.F5—Upgrade child restraint laws	Medium	2					

TABLE A.3-1
Reducing Impaired Driving & Increasing Seat Belt Use in Minnesota - Revised List of Strategies Following June 10 Workshop

Objectives	Strategies	Priority Ranking	Voting Results	Typical Timeframe for Implementation	Relative Cost to Implement and Operate			
					Low	Moderate	Moderate to High	High
1.G—Provide access to appropriate information, materials, and guidelines for those implementing programs to increase occupant restraint use	1.G1—Create state-level clearing houses for materials that offer guidance in implementing programs to increase restraint use	Medium		Medium (1-2 yrs.)		√		
	1.G2—Media campaign on non-belt use	High	0					
1.H—Additional New Strategies	**1.H1— Focused, hard-hitting public education to get people to buckle up and strop drinking & driving**	High	10					
	1.H2—Provide adequate resources for enforcement and administration	High	27					
	1.H3—Community oriented policing, citizens police academy	Medium						
	1.H4—Support & instill grass roots movement on traffic safety laws & enforcement	High	3					
	1.H5—Engineering Strategies - rumble strips and/or areas to conduct enforcement	High	0					
	1.H6—Develop media campaign on costs of alcohol related crashes	High	1					

TABLE A.3-2
Improving the Design and Operation of Highway Intersections - Revised List of Strategies Following June 10 Workshop

Objectives	Strategies	Priority Ranking	Voting Results	Typical Timeframe for Implementation	Relative Cost to Implement and Operate			
					Low	Moderate	Moderate to High	High
2.A—Improve management of access near unsignalized intersections	2.A1—Implement driveway closures/relocations	High – ✻	19	Medium (1-2 yrs.)		√		
	2.A2—Implement a driveway turn restrictions			Short (<1 yr.)	√			
	2.A3—Restrict cross median access near intersections			Short (<1 yr.)	√			
	2.A4—Accommodate U-turns							
2.B—Reduce the frequency and severity of intersection conflicts through geometric design improvements	~~2.B1—Provide left-turn lanes at intersections~~			~~Medium (1-2 yrs.)~~		~~√~~		
	~~2.B2—Provide longer left-turn lanes at intersections~~			~~Medium (1-2 yrs.)~~		~~√~~		
	2.B3—Provide offset left-turn lanes at intersections	▲		Medium (1-2 yrs.)			√	
	~~2.B4—Provide bypass lanes on shoulders at T-intersections~~			~~Short (<1 yr.)~~	~~√~~			
	2.B5—Provide left-turn acceleration lanes at divided highway intersections	▲		Medium (1-2 yrs.)		√		
	~~2.B6—Provide right-turn lanes at intersections~~			~~Medium (1-2 yrs.)~~		~~√~~		
	2.B7—Provide longer right-turn lanes at intersections	▲		Medium (1-2 yrs.)		√		
	2.B8—Provide offset right-turn lanes at intersections	▲		Medium (1-2 yrs.)			√	
	2.B9—Provide right-turn acceleration lanes at intersections	▲		Medium (1-2 yrs.)		√		
	~~2.B10—Provide full-width paved shoulders in intersection areas~~			~~Medium (1-2 yrs.)~~		~~√~~		
	~~2.B11—Restrict or eliminate turning maneuvers by signing~~			~~Short (<1 yr.)~~	~~√~~			
	2.B12—Restrict or eliminate turning maneuvers by providing channelization or closing median openings	✻		Short (<1 yr.)	√			
	2.B13—Close or relocate "high-risk" intersections	✻		Long (>2 yrs.)				√
	2.B14—Convert four-legged intersection to two T-intersections	Low		Medium (1-2 yrs.)				√
	~~2.B15—Convert offset T-intersections to four-legged intersection~~			~~Medium (1-2 yrs.)~~				~~√~~
	2.B16—Realign intersection approaches to reduce or eliminate intersection skew	Medium		Medium (1-2 yrs.)				√

TABLE A.3-2
Improving the Design and Operation of Highway Intersections - Revised List of Strategies Following June 10 Workshop

Objectives	Strategies	Priority Ranking	Voting Results	Typical Timeframe for Implementation	Relative Cost to Implement and Operate			
					Low	Moderate	Moderate to High	High
	2.B17—Use indirect left-turn treatments to minimize conflicts at divided highway intersections	▲		Medium (1-2 yrs.)		√		
	2.B18—Improve pedestrian and bicycle facilities to reduce conflicts between motorists and nonmotorists	High	12	Medium (1-2 yrs.)		√		
	~~2.B19—Revise geometry of complex intersections~~			~~Long (>2 yrs.)~~				~~√~~
	~~2.B20—Construct special solutions~~			~~Long (>2 yrs.)~~				~~√~~
	2.B21—Minimum 500′ turn lanes for 65 mph roads	▲						
	2.B22—Systematic plan for interchanges							
2.C—Improve sight distance at intersections	2.C1—Clear sight triangles approaches to intersections	▲		Short (<1 yr.)	√			
	2.C2—Clear sight triangles in the medians of divided highways near intersections	▲		Short (<1 yr.)	√			
	2.C3—Change horizontal and/or vertical alignment of approaches to provide more sight distance	Low		Long (>2 yrs.)				√
	2.C4—Eliminate parking that restricts sight distance	▲		Short (<1 yr.)	√			
	2.C4—Reduce size of intersection	Medium						
2.D—Improve availability of gaps in traffic and assist drivers in judging gap sizes at unsignalized intersections	2.D1—Provide an automated real-time system to inform drivers of the suitability of available gaps for making turning and crossing maneuvers	Medium		Medium (1-2 yrs.)		√		
	2.D2—Provide roadside markers or pavement markings to assist drivers in judging the suitability of available gaps for making turning and crossing maneuvers	Medium		Medium (1-2 yrs.)	√			
	~~2.D3—Retime adjacent signals to create gaps at stop-controlled intersections~~			~~Short (<1 yr.)~~	~~√~~			
2.E—Improve driver awareness of intersections as viewed from the intersection approach	2.E1—Improve visibility of intersections by providing enhanced signing and delineation	Medium		Short (<1 yr.)	√			
	2.E2—Improve visibility of the intersection by providing lighting	High	6	Medium (1-2 yrs.)			√	
	~~2.E3—Install splitter islands on the minor-road approach to an intersection~~			~~Medium (1-2 yrs.)~~		~~√~~		
	~~2.E4—Provide a stop bar (or provide a wider stop bar) on minor-road approaches~~			~~Short (<1 yr.)~~	~~√~~			
	2.E5—Install larger regulatory and warning signs at intersections	Medium		Short (<1 yr.)	√			
	2.E6—Call attention to the intersection by installing rumble strips on intersection approaches	Low		Short (<1 yr.)	√			
	2.E7—Provide dashed marking (extended left edgelines) for major roadway continuity at divided highway intersections	Low		Short (<1 yr.)	√			
	~~2.E8—Provide supplementary stop signs mounted over the roadway~~			~~Short (<1 yr.)~~	~~√~~			
	2.E9—Provide pavement markings with supplementary messages, such as STOP AHEAD	▲		Short (<1 yr.)	√			
	~~2.E10—Provide improved maintenance of stop signs~~			~~Short (<1 yr.)~~	~~√~~			
	2.E11—Install flashing beacons at stop-controlled intersections	Low		Short (<1 yr.)	√			
	~~2.E12—Improve visibility of signals and signs at intersections~~			~~Short (<1 yr.)~~	~~√~~			
2.F—Choose appropriate intersection traffic control to minimize crash frequency and severity	2.F1—Avoid Signalizing through roads	Low		Long (>2 yrs.)				√
	~~2.F2—Provide all-way stop control at appropriate intersections~~			~~Short (<1 yr.)~~	~~√~~			
	2.F3—Provide roundabouts at appropriate locations	High	14	Long (>2 yrs.)				√
2.G—Improve driver compliance with traffic control devices and traffic laws at intersections	~~2.G1—Provide targeted enforcement of traffic laws~~			~~Short (<1 yr.)~~		~~√~~		

TABLE A.3-2
Improving the Design and Operation of Highway Intersections - Revised List of Strategies Following June 10 Workshop

Objectives	Strategies	Priority Ranking	Voting Results	Typical Timeframe for Implementation	Relative Cost to Implement and Operate			
					Low	Moderate	Moderate to High	High
	2.G2—Provide targeted public information and education on safety problems at specific intersections	High	0	Short (<1 yr.)	√			
	2.G3—Implement automated enforcement of red-light running (cameras)	High	24	Medium (1-2 yrs.)		√		
2.H—Reduce operating speeds on specific intersection approaches	~~2.H1—Provide targeted speed enforcement~~			~~Short (<1 yr.)~~		~~√~~		
	2.H2—Provide traffic calming on intersection approaches through a combination of geometric and traffic control devices	Medium		Medium (1-2 yrs.)		√		
	~~2.H3—Post appropriate speed limit on intersection approaches~~			~~Short (<1 yr.)~~	~~√~~			
	2.H4—Implement automated enforcement of approach speeds (cameras)	Low		Medium (1-2 yrs.)		√		
2.I—Guide motorist more effectively through complex intersections	~~2.I1—Provide turn path markings~~			~~Short (<1 yr.)~~	~~√~~			
	2.I2—Provide a double yellow centerline on the median opening of a divided highway at intersections	▲		Short (<1 yr.)	√			
	~~2.I3—Provide lane assignment signing or marking at complex intersections~~			~~Short (<1 yr.)~~	~~√~~			
	2.I4—Provide a double yellow centerline at intersections	▲						
2.J—Reduce frequency and severity of intersection conflicts through traffic control and operational improvements	~~2.J1—Employ multiphase signal operation~~			~~Short (<1 yr.)~~	~~√~~			
	~~2.J2—Optimize clearance intervals~~			~~Short (<1 yr.)~~	~~√~~			
	~~2.J3—Restrict or eliminate turning maneuvers (including right turns on red)~~			~~Short (<1 yr.)~~	~~√~~			
	~~2.J4—Employ signal coordination~~			~~Medium (1-2 yrs.)~~		~~√~~		
	2.J5—Employ emergency vehicle preemption	Medium		Medium (1-2 yrs.)		√		
	~~2.J6—Improve operation of pedestrian and bicycle facilities at signalized intersections~~			~~Short (<1 yr.)~~	~~√~~			
	2.J7—Remove unwarranted signal	Low		Short (<1 yr.)	√			
	2.J8—Truck prioritization at signal	Medium						
2.K—Improve safety through other infrastructure treatments	~~2.K1—Improve drainage in intersection and on approaches~~			~~Medium (1-2 yrs.)~~		~~√~~		
	2.K2—Provide skid resistance in intersection and on approaches	Medium		Medium (1-2 yrs.)		√		
	~~2.K3—Coordinate closely spaced signals near at-grade railroad crossings~~			~~Medium (1-2 yrs.)~~		~~√~~		
	~~2.K4—Relocate signal hardware out of clear zone~~			~~Short (<1 yr.)~~		~~√~~		
2.L—Improve safety by addressing intersection safety needs along local road systems	~~2.L1—Develop a pilot program to identify and prioritize safety needs at intersections along local road systems~~			~~Short (<1 yr.)~~	~~√~~			
	~~2.L2—Develop a toolbox of proven strategies to reduce fatal and injury crashes at intersections along local road systems~~			~~Short (<1 yr.)~~	~~√~~			
	~~2.L3—Develop a pilot program to implement safety strategies along local road systems~~			~~Medium (1-2 yrs.)~~		~~√~~		
	2.L4—Incentive program for locals	High	3					
2.M—Additional New Strategies	**2.M1—Perform Road Safety Audits at network level**	High	26					
	2.M2—Low cost safety improvements	High - ▲	31					
	2.M3—Proper Maintenance of roadway facilities	High	24					

TABLE A.3-3
Young Drivers & Curbing Aggressive Driving - Revised List of Strategies Following June 10 Workshop

Objectives	Strategies	Priority Ranking	Voting Results	Typical Timeframe for Implementation	Relative Cost to Implement and Operate			
					Low	Moderate	Moderate to High	High
3.A—Deter aggressive driving in specific populations, including those with a history of such behavior, and at specific locations	3.A1—Target enforcement **with data**	High	8	Short (< 1 yr.)	√			
	3.A2—Conduct educational and public information campaigns **- personnel**	Medium		Short (< 1 yr.)		√		
	3.A3—Educate and impose sanctions against repeat offenders **- Courts**	High	0	Medium (1-2 yrs.)	√			
	3.A4—Advanced enforcement – photo	High	30					
	3.A5— Media	Low						
	3.A6—Consistent enforcement	Medium						
3.B—Improve the diving environment to eliminate or minimize the external "triggers" of aggressive driving	3.B1—Change or mitigate the effects of identified elements in the environment	Low		Medium (1-2 yrs.)			√	
	3.B2—Reduce nonrecurring delays and provide better information about these delay's	Low		Medium (1-2 yrs.)			√	
	3.B3—Educate local elected officials	Medium						
	3.B4—Courts supporting law enforcement	High	5					
3.C—Develop and implement an improved competency based training and assessment procedure for entry drivers	3.C1— Implement stricter graduated licensing system	High	50					
	3.C2—Early license actions – licensing agency alerts teens to unacceptable driving behavior at first or second offense	Medium						
	3.C3—strong mandates and uniform curriculum – parent involvement – enhanced behind the wheel and classroom	High	23					
	3.C4—Violator clinic	Medium	1					
	3.C5—Educate novice drivers	Medium						
3.D—Develop and implement an evaluation system for drivers moving from the provisional to the regular license stage	3.D1—In car recording devices to alert teens to dangerous driving behaviors and to provide feedback to parents about their teen's driving	Low						
	~~3.D2—Development of parent-teen handbook~~							
	~~3.D3—Targeted enforcement~~							
	3.D4— Insurance incentives	Low	1					
	3.D5—Consistent enforcement	High	3					
3.E—Educate young drivers on the risks of driving and provide positive enforcement	3.E1— Seat belt checks with positive enforcement	Medium						
	3.E2—Warning signs at school exits	Medium						
	3.E3—Mock crashes at schools	Medium						
	3.E4—In-school messages	Medium						
	3.E5—Daily report card	Low						
	3.E6—Scholarship	Medium						
	3.E7—Media	Medium						
3.F—Additional New Strategies	**3.F1—Organize legislature action committee (GDL, curriculum, liability, court)**	High	23					

TABLE A.3-4
Reducing Head-On and Across-Median Crashes, Keeping Vehicles on the Roadway & Minimizing the Consequences of Leaving the Road - Revised List of Strategies Following June 10 Workshop

Objectives	Strategies	Priority Ranking	Voting Results	Typical Timeframe for Implementation	Relative Cost to Implement and Operate			
					Low	Moderate	Moderate to High	High
4.A—Keep vehicles from encroaching into the opposite lane	4.A1—Install centerline rumble strips for two-lane roads	Medium	1	Short (< 1 yr.)	√			
	4.A2—Install profiled thermoplastic strips for centerlines	Low		Short (< 1 yr.)	√			
	4.A3—Provide wider cross sections on two-lane roads **to meet standards**	High	9	Long (>2 yrs.)			√	
	4.A4—Provide center two-way left turn lanes for four- and two-lane roads	Low		Short (< 1 yr.)		√		
	4.A5—Reallocate total two-lane roadway width (lane and shoulder) to include a narrow "buffer median"	Low		Short (< 1 yr.)	√			
	4.A6—Prohibit/restrict trucks with very long semitrailers on roads with horizontal curves that cannot accommodate truck off-tracking	Low		Medium (1-2 yrs.)		√		
4.B—Minimize the likelihood of crashing into an oncoming vehicle	4.B1—Use alternating passing lanes or four-lane sections at key locations	Low		Medium (1-2 yrs.)			√	
	4.B2—Install median barriers for narrow-width medians on multilane roads	High	23	Medium (1-2 yrs.)		√		
4.C—Keep vehicles from encroaching on the roadside	4.C1—Install edgeline rumble strips	High	7	Short (< 1 yr.)	√			
	4.C2—Install edgeline "profile marking" edgeline rumble strips or modified shoulder rumble strops on section with narrow or no paved shoulders	Low						
	4.C3—Install midlane rumble strips	Medium		Short (< 1 yr.)	√			
	4.C4—Provide enhanced delineation of sharp curves	Medium		Short (< 1 yr.)	√			
	4.C5—Improve horizontal curve geometry	High		Long(> 2 yrs.)				√
	4.C6—Provide enhanced pavement markings	High	15	Short (< 1 yr.)	√			
	4.C7—Provide skid-resistant pavements	Medium		Medium (1-2 yrs.)		√		
	4.C8—Eliminate shoulder drop-off	High	0	Medium (1-2 yrs.)	√			
	4.C9—Provide advance warning of unexpected changes in horizontal alignment	Medium		Short (< 1 yr.)	√			
	4.C10—Provide adequate sight distance	High		Short (< 1 yr.)	√			
	4.C11—Provide skid-resistant pavement surfaces	Medium		Medium (1-2 yrs.)		√		
	4.C12—Provide grooved pavement	Low		Medium (1-2 yrs.)		√		
	4.C13—Provide lighting of the sharp horizontal curves	Medium		Medium (1-2 yrs.)		√		
	4.C14—Provide dynamic curve warning system	Medium		Medium (1-2 yrs.)		√		
	4.C15—Improve or restore superelevation	Low		Medium (1-2 yrs.)			√	
	4.C16—Install automated anti-icing systems	Medium		Medium (1-2 yrs.)			√	
4.D—Minimize the likelihood of crashing into an object or over turning if the vehicle travels beyond the edge of the shoulder	4.D1—Provide shoulder treatments or four-lane sections at key locations	Low		Medium (1-2 yrs.)		√		
	4.D2—Design safer slopes and ditches to prevent rollovers	High	16	Medium (1-2 yrs.)			√	
	4.D3—Remove/relocate objects, such as trees, utility poles, light poles, and etc., in hazardous locations	High	4	Short (< 1 yr.)	√			
	4.D4—Delineation of roadside objects	Low		Short (< 1 yr.)	√			
	4.D5—Apply traffic calming measures to reduce speeds on high-risk sections	Low		Medium (1-2 yrs.)		√		
4.E—Reduce the severity of the crash	4.E1—Improve roadside hardware	High	6	Medium (1-2 yrs.)			√	
	4.E2—Improve barriers and attenuation systems	High	0	Medium (1-2 yrs.)			√	
	4.E3—Shield motorists from striking roadside objects, such as trees, utility poles, light poles, and etc.	High	0	Short (< 1 yr.)		√		
	4.E4—Modify roadside clear zone in the vicinity of trees, utility poles, light poles, and etc.	High	0	Medium (1-2 yrs.)			√	
	4.E5—Use breakaway devices	High	0	Medium (1-2 yrs.)			√	
	4.E6—Increase seat belt use	High	2					
	4.E7—Swamp attenuation	Low						

TABLE A.3-4
Reducing Head-On and Across-Median Crashes, Keeping Vehicles on the Roadway & Minimizing the Consequences of Leaving the Road - Revised List of Strategies Following June 10 Workshop

Objectives	Strategies	Priority Ranking	Voting Results	Typical Timeframe for Implementation	Relative Cost to Implement and Operate			
					Low	Moderate	Moderate to High	High
4.F—Improve safety by addressing lane departure crashes along local road systems	4.F1—Develop a pilot program to identify and prioritize safety relative to lane departures along local road systems	Medium		Short (<1 yr.)	√			
	4.F2—Develop a toolbox of proven strategies to reduce fatal and injury lane departure crashes along local road systems	Medium		Short (<1 yr.)	√			
	4.F3—Develop a pilot program to implement safety strategies along local road systems	Medium		Medium (1-2 yrs.)		√		
4.G—Additional New Strategies	**4.G1—Appoint director for CHSP**	High	1					
	4.G2—Provide turn lanes at appropriate locations	High	13					
	4.G3—Education – awareness of lane departure, driver skills for young and inexperienced; knowledge of vehicle	High	0					
	4.G4—Enforcement of speeding, distracted, and drunk drivers coupled with publication of the enforcement	High	51					

TABLE A.3-5
Increasing Driver Safety Awareness & Improving Information Systems - Revised List of Strategies Following June 10 Workshop

Objectives	Strategies	Priority Ranking	Voting Results	Typical Timeframe for Implementation	Relative Cost to Implement and Operate			
					Low	Moderate	Moderate to High	High
5.A—Improve driver awareness of historic & current traffic safety issues	5.A1—Establish a Governor's ~~blue ribbon~~ panel (influential, high level, political) focused on traffic safety	High	42	Short (<1 yr.)	√			
	5.A2—Create new PI&E campaigns **& Establish a Safety Speaker Bureau**			Short (<1 yr.)		√		
	~~5.A3—Establish a Safety Speaker Bureau~~			~~Short (<1 yr.)~~	~~√~~			
	5.A2—Corporate traffic safety program							
	5.A4—Safe Communities outreach for young, older, and offender drivers	High	2	Medium (1-2 yrs.)		√		
	5.A5—Create partnerships with service**, community, and other** organizations (Lions Club, Rotary, Chamber of Commerce, etc.) **to increase grass roots support and activism**	High	2	Short (<1 yr.)	√			
	5.A6—Improve driver training & licensing material with the addition of traffic safety statistics, stories, and testimonials **– include instructor quality control**	High	4	Medium (1-2 yrs.)		√		
	5.A7—Safety focused press releases on a monthly basis **(appeal to MN Companies)**	High	2	Short (<1 yr.)	√			
	5.A8—Participate in existing conferences to promote increased focus on traffic safety (i.e., Mn/DOT Transportation Conference, County Engineer Conference, Sheriff Conference, CTS Research Conference, TZD Conference, *Safe & Sober* Conference, LifeSavers Conference, etc.)	High	6	Medium (1-2 yrs.)	√			
	5.A9—Create a communications/marketing task force to raise visibility of the public problem (Quilt, Memorial Wall)	High	44					
	5.A10—Initiate incentive and disincentive programs	High	1					
	5.A11—Reporting on problem drivers - **tracking and monitoring** - **limit privileges** - **backup with enforcement**	High	3					
	5.A12—Multi-level strategic plan (reactive and proative)	High	5					
5.B—Improve the accuracy, quality, quantity, and timeliness of crash data and analysis to support statewide safety initiatives.	5.B1— Organize an oversight committee to coordinate all agencies involved in the collection, management, and use of highway safety data	High	1	Short (<1 yr.)	√			
	5.B2— Create a clearinghouse of highway safety information to provide mangers with the resources needed to make the most effective use of the data	High	1	Medium (1-2 yrs.)		√		
	5.B3—Establish a group of highway safety professionals trained in the analytic methods appropriate for evaluating highway safety information			Medium (1-2 yrs.)			√	
	5.B4—Establish a information standards committee within the safety community to resolve and eliminate technical data discrepancies			Short (<1 yr.)	√			
	5.B5—Work with LTAP to provide additional training to local jurisdictions			Short (<1 yr.)		√		
	5.B6—Incentive and disincentive programs							
	5.B7—Funnel crash reports through Mn/DOT for improved accuracy before entered into system	High	1					
	5.B8—Evaluate need for adequate staffing, equipment and other resources - **Evaluate timing and access to reports** - **Underreporting of bicycle and pedestrian accidents** - **Safe-Routes-to-School**	High	19					

Background & Purpose

From a peak in the early 1970s, there has been significant reductions in the number of traffic related fatalities in Minnesota which led to noticeable decreases in the fatality rate (see **Figures 1** and **2**). However, after 1980 there has been a slight increasing trend in the number traffic fatalities while the fatality rate has flattened. The pattern in Minnesota's traffic fatalities parallels what has been happening at the national level. This led the American Association of State Highway and Transportation Official's (AASHTO) and Federal Highway Administration to adopt a new focus on and approach to traffic safety in order to address the increases in fatal and injury crashes.

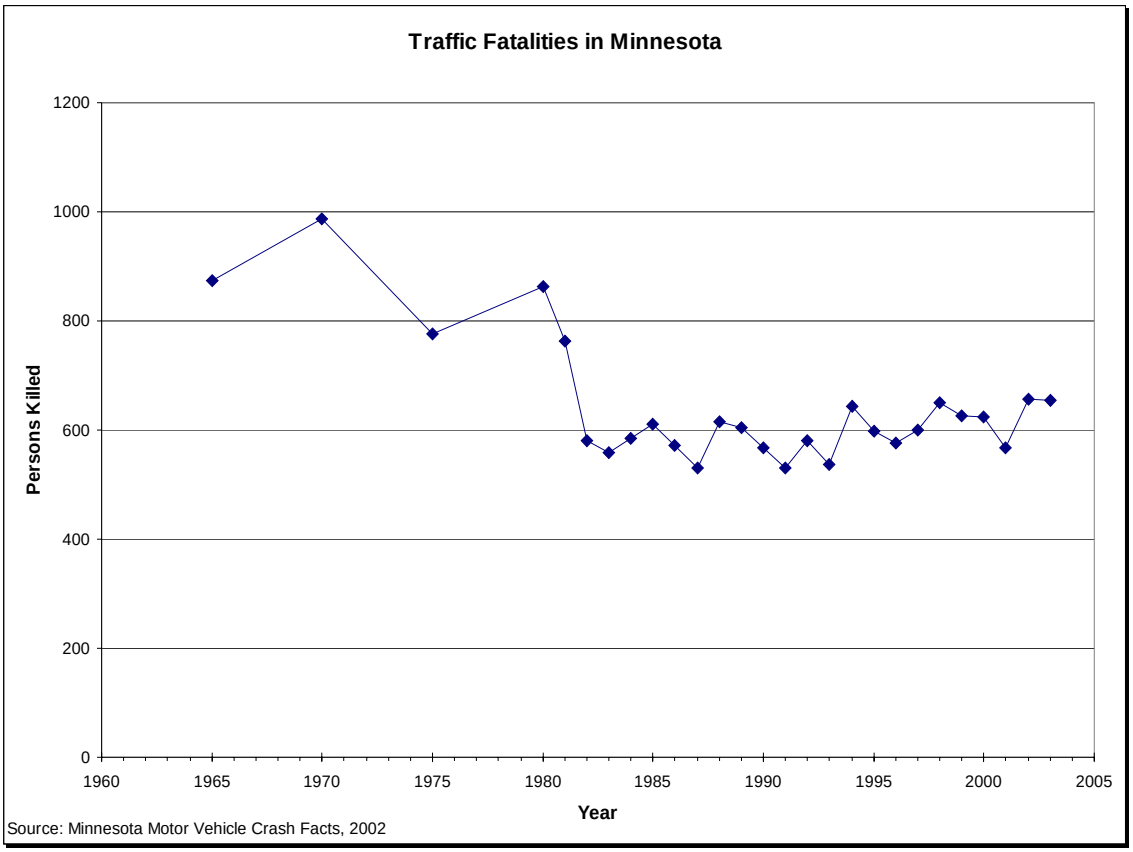


FIGURE 1
Historic Number of Minnesota Traffic Fatalities

In 2002, Minnesota had 657 traffic fatalities; based on the trend from 1993 to 2002 crash data, approximately 665 traffic fatalities would be expected by 2008. It was concluded that the previous approach to traffic safety has not continued to work, which resulted in the Minnesota Department of Transportation (Mn/DOT) and Department of Public Safety (DPS) partnering to address the State's traffic safety issues in an integrated, systematic approach by preparing the Minnesota Comprehensive Highway Safety Plan (CHSP). The goal of the CHSP is to reduce the annual number of traffic fatalities to 500 or less by 2008.

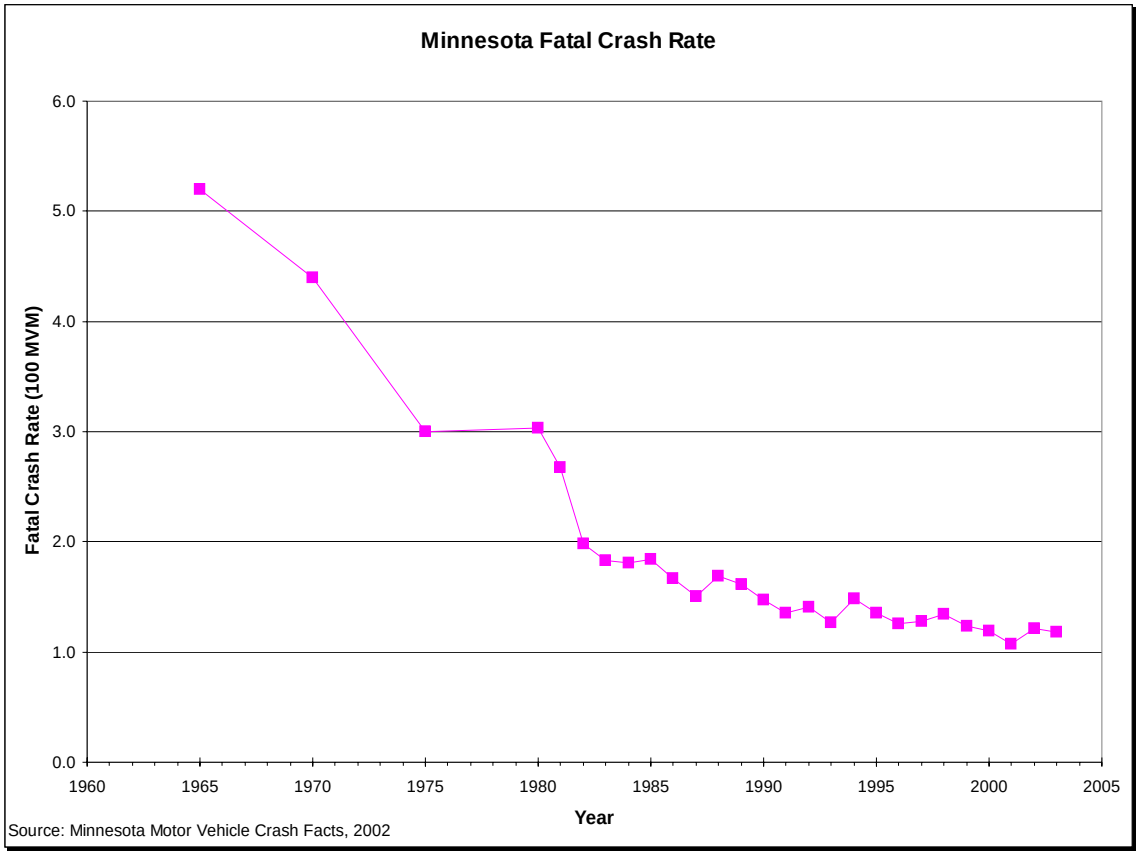


FIGURE 2
Historic Minnesota Fatal Crash Rate

Importance of the Local and Rural Road Systems

In 2002, there were 42,815 traffic fatalities in the nation, of which 60 percent occurred in rural areas. Of Minnesota's 657 traffic fatalities in 2002, over 70 percent occurred on rural roads. Also, the importance of the local road systems (i.e., county, township, and city streets) is made evident since 50 percent of all 2002 fatalities occurred on these roadways, despite that local roads account for only 41 percent of all vehicle miles traveled in the State. In fact, County Sate Aid Highways had more fatalities than any other type of roadway. The probability of a crash occurring on a local road is 64 percent higher than a crash occurring on the state highway system for equal miles traveled. When comparing just local and state fatality rates, the probability of a fatality is still 39 percent higher on a local road. This information makes evident the importance of rural and local roadway systems in order to effect a substantial decrease in the number of Minnesota's fatalities. Yet, in order to be systematic and comprehensive, the problems and issues facing safety in urban areas and on the state highways must also be addressed.

Critical Emphasis Areas

The CHSP is consistent with AASHTO's Strategic Highway Safety Plan (SHSP) which is based on 22 emphasis areas that broadly addresses the "four E's" – Engineering, Enforcement, Education and Emergency Medical Services (EMS).

The SHSP is comprised of six parts (Drivers, Special Users, Vehicles, Highways, Emergency Medical Services, and Management) and each part has one or more emphasis areas. In total, the SHSP includes 22 key emphasis areas that target distinct areas where it is believed that a significant number of deaths can be prevented each year from happening on the Nation's highways (see **Table 1**).

TABLE 1
AASHTO's 22 Emphasis Areas

	Emphasis Areas
Part 1: Drivers	23. Instituting Graduated Licensing for Young Drivers 24. Ensuring Drivers are Licensed and Fully Competent 25. Sustaining Proficiency in Older Drivers 26. Curbing Aggressive Driving 27. Reducing Impaired Driving 28. Keeping Drivers Alert 29. Increasing Driver Safety Awareness 30. Increasing Seat Belt Usage and Improving Airbag Effectiveness
Part 2: Special Users	31. Making Walking and Street Crossing Easier 32. Ensuring Safer Bicycle Travel
Part 3: Vehicles	33. Improving Motorcycle Safety and Increasing Motorcycle Awareness 34. Making Truck Travel Safer 35. Increasing Safety Enhancements in Vehicles
Part 4: Highways	36. Reducing Vehicle-Train Crashes 37. Keeping Vehicles on the Roadway 38. Minimizing the Consequences of Leaving the Road 39. Improving the Design and Operation of Highway Intersections 40. Reducing Head-On and Across-Median Crashes 41. Designing Safer Work Zones
Part 5: Emergency Medical Services	42. Enhancing Emergency Medical Capabilities to Increase Survivability
Part 6: Management	43. Improving Information and Decision Support Systems 44. Creating More Effective Processes and Safety Management Systems

Source: AASHTO Strategic Highway Safety Plan

To put the SHSP into practice, DPS and Mn/DOT used AASHTO's 22 emphasis areas as the building blocks for the CHSP. Due to limited resources (both in terms of personnel and financially), the number of emphasis areas was reduced from 22 down to the nine emphasis areas most critical for Minnesota. Selection of the nine emphasis areas was based upon a review of Minnesota's fatal crash records, discussion and prioritization at a workshop involving Minnesota's Safety Partners, and interviews of multiple agencies responsible for traffic safety in Minnesota. The nine emphasis areas identified as having the highest importance in Minnesota are:

- Reducing Impaired Driving
- Increasing Seat Belt Use
- Improving the Design and Operation of Highway Intersections
- Addressing Young Drivers' Over Involvement
- Curbing Aggressive Driving
- Reducing Head-On and Across-Median Crashes
- Keeping Vehicles on the Roadway
- Minimizing the Consequences of Leaving the Road
- Increasing Driver Safety Awareness & Improving Information Systems.

From these nine emphasis areas, Mn/DOT and DPS chose to group several emphasis areas together because of similarities and/or interaction between the emphasis areas in order to form the final Critical Emphasis Areas (CEAs). The five CEAs are:

CEA 1 – Reducing Impaired Driving & Increasing Seat Belt Use

CEA 2 – Improving the Design and Operation of Highway Intersections

CEA 3 – Addressing Young Drivers' Over Involvement & Curbing Aggressive Driving

CEA 4 – Reducing Head-On and Across-Median Crashes, Keeping Vehicles on the Roadway & Minimizing the Consequences of Leaving the Road

CEA 5 – Increasing Driver Safety Awareness & Improving Information Systems.

These emphasis areas were deemed critical for Minnesota. It is important to note that any of the 22 AASHTO emphasis areas will likely improve safety and are considered part of this plan.

Safety Strategies

To address the fatal and serious injury crash problem in the five CEAs and achieve the 2008 safety goal (see **Figure 3**), decreases in the number of fatal crashes is needed on not only the State's system, but also on the local road systems. Since approximately half of all traffic fatalities occur on the local systems, additional efforts on these systems by governing agencies will be essential if there is to be a realistic chance of achieving the desired goal.

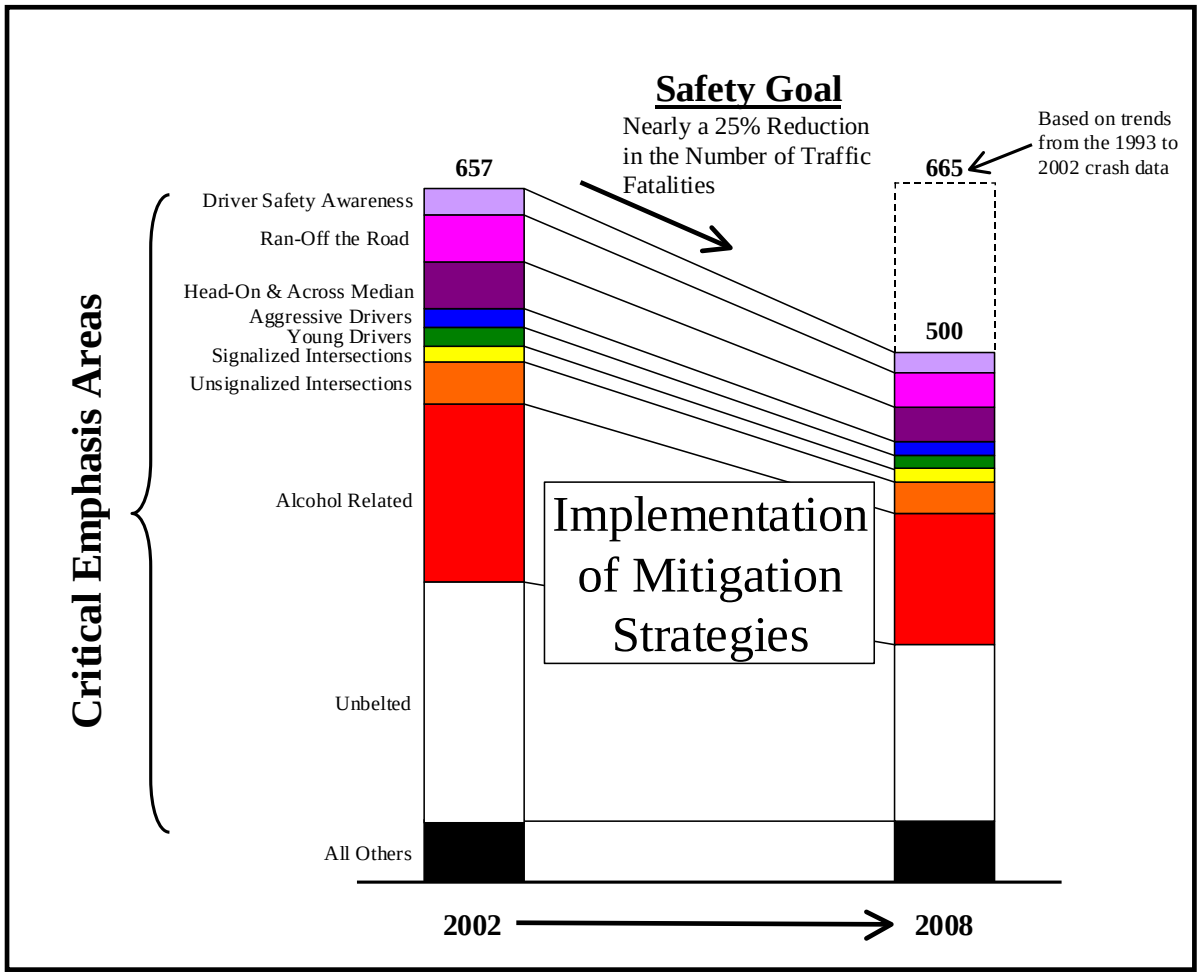


FIGURE 3
Needed Reduction in Fatal Crashes In Order to Meet Minnesota's 2008 Goal

To assist agencies in decreasing the number of traffic fatalities in their local region, a set of interdisciplinary strategies has been identified for implementation at both the state and local level (see **Tables 5-8**). The primary source for the strategies was the National Cooperative Highway Research Program (NCHRP). As companion guides to AASHTO's SHSP, the NCHRP Report 500 series was written as a set of guides to assist state and local agencies implement the strategies associated with AASHTO's 22 emphasis areas. Some additional

strategies were developed for Minnesota at a June 10, 2004 workshop. Task Teams were assembled to screen and prioritize the strategies for each of the CEAs.

The strategies have been separated into four tables, one table for each of Enforcement, Engineering, Education, and Administrative. For each category, the strategies were then divided into three priorities, with each priority have the following definition:

Priority 1 – In order to achieve the 2008 safety goal, implementation of each strategy as quickly as possible is desired and across as much of the agency's jurisdiction as possible.

Priority 2 – Implementation of these strategies is also expected to be crucial to achieve the safety goal. However, a system wide implementation may not be necessary for local agencies given local conditions. Specific application at problematic locations may prove more cost effective.

Priority 3 – Typically implementation will not occur at a system wide level unless unique circumstances exist across the agency's jurisdiction. Implementation of these strategies is best considered on a individual basis given local conditions.

Local Development of a Comprehensive, Prioritized & Systematic Implementation Plan

Before effective implementation can be conducted by an individual agency, a thorough understanding of the problems occurring on an agency's entire system is needed. To develop an understanding, a crucial step is a review of the fatal and serious injury crash records (see *Minnesota Motor Vehicle Crash Facts* [http://www.dps.state.mn.us/OTS/crashdata/crash_facts.asp] or contact persons in **Table 2** for crash record information). Quantifying the number, location, and contributing factors associated with fatal and serious injury crashes and then comparing to expected values[1] can be useful in not only understanding the problem, but also in developing a prioritized plan for implementation of appropriate strategies. A second approach to understanding the problem is to meet with individuals and agencies involved in traffic safety within the area. A list of potential agencies to include in a meeting have been provided below. If possible, a combination of crash statistics review and meeting with local agencies is likely to provide the best picture of problem.

- Mn/DOT and DPS
- State & local law enforcement
- Local engineering services (county, township, city)
- Emergency medical services
- Driver education
- Traffic Courts

[1] Information regarding expected crash rates, crash type distributions, and contributing factors (i.e., weather) can be obtained from the Traffic Safety Fundamentals Handbook. An electronic copy of this document can be downloaded from Mn/DOT's website at http://www.dot.state.mn.us/trafficeng/otepubl/fundamentals/safetyfundamentals.pdf.

- Specialty organizations (i.e., MADD, Safe Community Coalitions, etc.)
- Elected officials (local and state)

TABLE 2
Contacts for Minnesota Crash Data

Agency	Contact Person	Area
DPS	Alan Rodgers Office of Traffic Safety 445 Cedar Street, Suite 150 St. Paul, Minnesota 55101 Alan.Rodgers@state.mn.us (651) 296-9489	Data requests regarding crash types (i.e., demographics, alcohol related, intersection, etc.) or crash frequencies for an entire city or county.
Mn/DOT	Loren Hill Office of Traffic, Safety and Operations 395 John Ireland Blvd Mail Stop 725 St. Paul, Minnesota 55155 Loren.Hill@state.mn.us (651) 284-3455	Data request regarding specific locations (i.e., intersection or segment of roadway.) and crash mapping.

The problems facing traffic safety in Minnesota can not be solved by a single agency continuing to do business the old way. Therefore, it is important that agencies across the "four E's" work together, building off one another to increase their effectiveness and reach. A new effort to provide a comprehensive method from the national level to local agencies is essential.

In addition to being comprehensive, a systematic and prioritized plan is also a key to success. For example, because the location of a fatal or serious injury crash is difficult to forecast and often random, the process of implementing safety strategies at specific locations in response to a fatal crash is unlikely to be effective. Instead, reviewing multiple years of crash records may help identify factors that indicate where a fatal crash has an increase probability of occurring (i.e., narrow shoulders and limited clear zones leading to a increased chance in a run-off the road crash occurring and resulting in a fatality) and will hopefully be more successful at eliminating fatal and serious injury crashes. For example, a systematic plan would be to install edgeline rumble strips on all appropriate roadways to help prevent run-off the road crashes. However, a prioritized plan would suggest that paving shoulders and adding edgeline rumble strips first at the previous example roadway may prove more effective at reducing fatal run-off the road crashes than on a corridor with wide, paved shoulders and sufficient clear zones.

Implementation Guidance

Actual implementation of the safety strategies must be made on a individual basis given local conditions and characteristics of the system. Yet, some guidance has been prepared to assist in the selection of appropriate strategies. **Figure 4** outlines an analytical process that begins with identifying deficiencies and then leads to appropriate categories of strategies within the context of the "4E's." It is also important to note that EMS (one of the "4E's") refers to more than just the emergency responders. This strategy really encompasses the entire emergency medical health system, including persons being directed to the appropriate hospitals and the level of care the injured persons receive. The process can be applied reactively to safety problems at individual intersections or along roadway segments, or used proactively to form a prioritized, systematic plan for an entire roadway system.

If, after following the analytical process, one is still unable to either pinpoint the safety deficiencies and/or a list of appropriate mitigation strategies, then outside assistance can be sought. One method of obtaining outside assistance is through the Road Safety Audit (RSA) program[2]. The RSA program allows local agencies to receive outside assistance from Mn/DOT, state and local police, safety activist groups, university researchers, and consultants for a safety review and development of mitigation strategies. The Interactive Highway Safety Design Model (IHSDM) is another tool that can be used to perform a safety review for the engineering design of a roadway[2]. Currently the IHSDM is limited to two-lane roadways, but additional research is being done to develop modules for other roadway designs.

Process for a Reactive Safety Study

The purpose of a reactive safety study is to search out and identify "dangerous" locations. One approach is to simply rely on local knowledge of law enforcement, engineers, maintenance workers, and citizens to identify areas that need safety improvements. This strategy could prove effective for some locations, yet many "dangerous" locations may not be identified. The preferred strategy for identifying high crash locations is to look for anomalies in the crash records that are statistically significantly different than what is expected. One of the simplest screens is to look for intersections and corridors with a high number of crashes - **crash frequency**. From past research, it is known that crash frequency is a function of exposure (i.e., traffic volumes). Since all segments do not have similar volumes, another method to measure crash history is needed. Calculating a **crash rate** provides similar information, but the number of crashes are normalized for traffic volume. Different roadway and intersection designs are known to affect the crash rate and must be considered when comparing crash rates. Factors discovered to be important in influencing crash rate include facility type (i.e., freeway, expressway or conventional), number of lanes, type of intersection traffic control, and environment (i.e., urban or rural). For example, a rural freeway has an expected crash rate of 0.6 crashes per million vehicle miles (MVM) while the

[2] Contact Loren Hill at Mn/DOT's Office of Traffic, Security, and Operations (see **Table 2**) for assistance is setting up a RSA or to learn more about the IHSDM software.

expected crash rate for an urban four-lane roadway with no median is 5.9 crashes per MVM (see page A-18 of the *Traffic Safety Fundamentals Handbook* [*TSFH*]). If the crash rate is equal to or greater than the **critical crash rate**, then the crash rate is statistically significantly higher than the average crash rate.

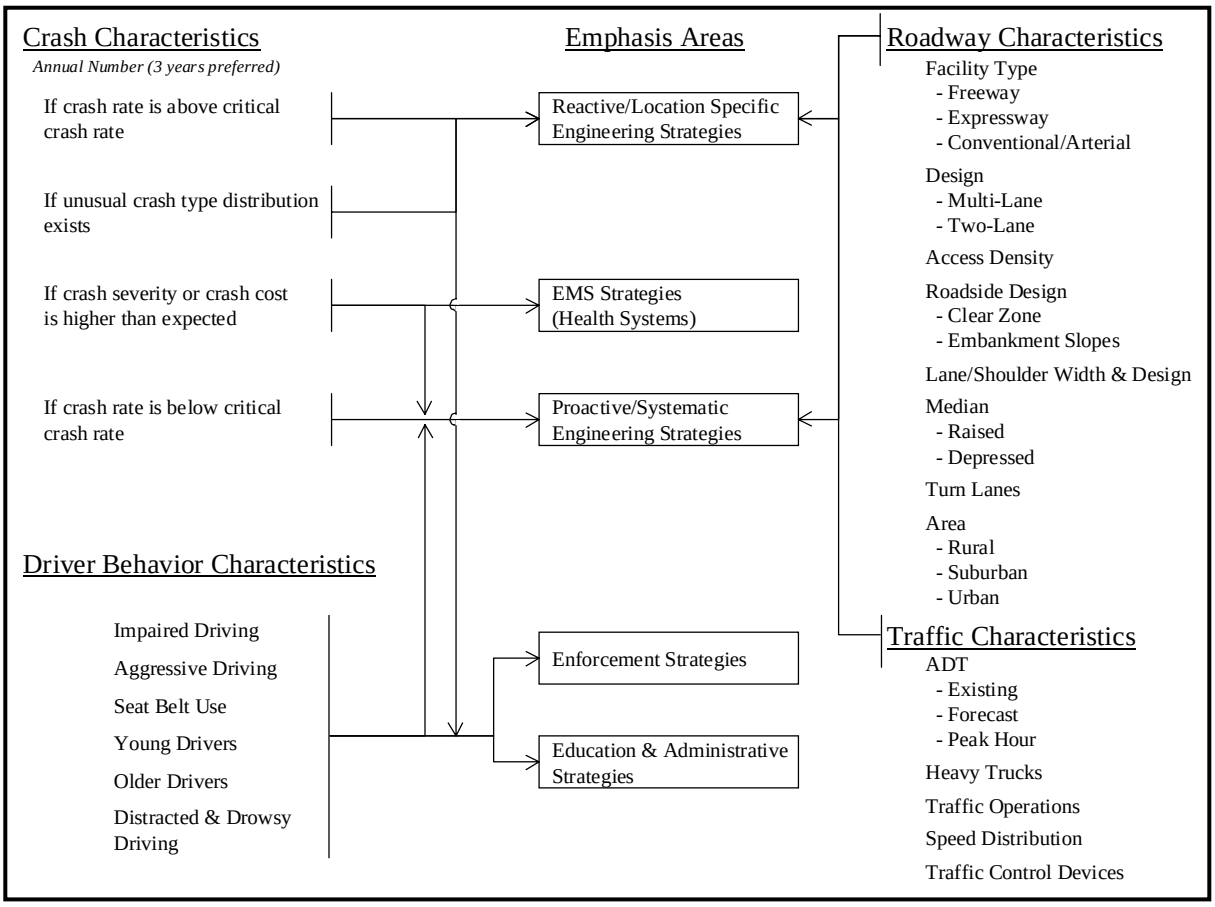


FIGURE 4
Safety Strategy Identification Process

The previous methods simply analyze the number of crashes that occurred in the study area. If the goal is to address the most severe crashes, then further analysis is needed. Calculating a crash rate using only the number of fatal crashes produces a **fatality rate**. This lacks any information regarding injury and property damage only crashes. Calculating the **severity rate** or **crash cost** will allow the average crash severity to be compared between locations.

Once a location has been identified as having a safety deficiency (unusual number or severity of crashes), the next step is to identify the causal factors. If possible, a field review should always be included as part of any safety study. The field review will allow for some safety deficiencies to be identified that would never be visible by simply reviewing crash records. But prior to a field review, it is still best to perform some analysis of the crash records to provide a better picture of the problem.

For a corridor safety study, identifying the number of crashes that were intersection related versus non-intersection is needed to know if the problems are typically isolated to the intersections or occur throughout the corridor. Whether the safety study is for a corridor or an intersection, the first review is typically the **crash type distribution** (i.e., percentage of right angle, run-off road, head-on, etc.). Similar to crash rate, location and design can affect the crash type distribution. For example, rear-end collisions account for 43 percent at urban signalized intersections, but only 18 percent at rural thru-STOP intersections (see page A-16 of the *TSFH*). By comparing the actual distribution to the expected distribution, one can identify which types of crashes are the predominate problem. Other causal factors typically reviewed include **lighting** (i.e., dark versus daylight distribution), **weather** (i.e., percent that occurred during a rain storm, snow storm, etc.) and **road conditions** (i.e., dry, snow packed, wet, etc.). It is also best to review the driver's physical condition and actions reported by the law enforcement to see if the problem could be behavioral. Distribution of **drivers' age, alcohol involvement, speeding, seat belt use** are driver behaviors that could be important causal factors.

Equations and Expected Values

The key to successfully using crash data is being able to identify locations with anomalies or unexpected values. Many of the commonly used equations, average crash rates and expected distributions for Minnesota are already published in the *TSFH*, but the key equations and factors used by Mn/DOT are as follows. If the information in the *TSFH* is not sufficiently current or detailed, then Loren Hill at Mn/DOT can provide up to date information. Key pages from the *TSFH* are included at the end of the *CHSP Safety Toolbox*, but more information is still available within the original manual (http://www.dot.state.mn.us/trafficeng/otepubl/fundamentals/safetyfundamentals.pdf).

Crash Rate (CR):

Intersections: $$CR \text{ (crashes per MEV)} = \frac{\text{(number of crashes) (1 million)}}{\text{(number of years) (DEV*) (365)}}$$

Segments: $$CR \text{ (crashes per MVM)} = \frac{\text{(number of crashes) (1 million)}}{\text{(segment length) (number of years) (ADT) (365)}}$$

Severity Rate (SR):

Severity Factor = (number fatal crashes * 5) + (number "A" injury crashes * 4) + (number "B" injury crashes * 3) + (number "C" injury crashes * 2) + (number property damage only crashes * 1)

Intersections: $$SR \text{ (per MEV)} = \frac{\text{(Severity Factor) (1 million)}}{\text{(number of years) (DEV) (365)}}$$

Segments: $$SR \text{ (per MVM)} = \frac{\text{(Severity Factor) (1 million)}}{\text{(segment length) (number of years) (ADT) (365)}}$$

* Daily Entering Vehicles (DEV) = The number vehicles that enters the intersections during a day.

Critical Crash Rate:

$R_c = R_a + K (R_a/m)^{1/2} + 0.5/m$

R_c = critical crash rate

R_a = expected crash rate by intersection or highway type

m = vehicle exposure

$m_{intersection}$ = (number of years) (DEV) (365) / (1 million)

$m_{segment}$ = (segment length) (number of years) (ADT) (365) / (1 million)

K = Constant for Level of confidence

Level of Confidence	0.995	0.95	0.900
K	2.576	1.645	1.282

Mn/DOT Crash Cost (CC):

Crash Cost = (number fatal crashes * $540,000) + (number "A" injury crashes * $270,000) + (number "B" injury crashes * $58,000) + (number "C" injury crashes * $29,000) + (number property damage only crashes * $4,200)

Intersections: $CC (\$) = \frac{(\text{Crash Cost})}{\text{number of years}}$

Segments: $CC (\$) = \frac{(\text{Crash Cost})}{(\text{number of years})\ (\text{segment length})}$

Reactive Case Examples

To illustrate some of the safety analysis procedures, two case examples have been provided. The first case example provides an overview of a corridor analysis while the second case example is a safety analysis for an intersection.

Corridor Case Example

Corridor Description: Trunk Highway (TH) 525 is a rural expressway with a 65 mph speed limit and divided median that connects two urban centers located approximately 35 miles apart. The long range plan (> 20 years) for TH 525 is conversion from a expressway into a freeway facility, however, concerns about the existing safety of the roadway have been raised. The corridor has traffic volumes that range from 15,000 vehicles per day (vpd) in the center of the corridor to volumes over 25,000 vpd near the urban areas.

Safety Deficiencies: Review of the crash rate for the corridor reveals that all segments are at or below the expected crash rate (0.9 crashes/MVM). Even though the segment crash rates are at or below expected, the corridor's crashes are heavily weighted to fatal and severe run-off road crashes that either resulted in an overturn or struck a fixed object (21 percent expected, 50 percent actual). Further review of the crash records reveals that heavy trucks are involved in about 25 percent of all crashes but account for only 10 percent of the traffic. Weather and road condition distributions were consistent with the expected values, but

nighttime crashes were found to be over represented at unlighted intersections (25 percent expected, 35 percent actual). When the driver behavior characteristics were reviewed, it was discovered that excessive speed was found to be a reported contributing factor in a majority of the crashes and a field review discovered that law enforcement had a low presence.

Mitigation Strategies: **Table 3** identifies a list of 19 strategies that would address the crash problem along TH 525. These strategies were taken either directly from **Tables 5**, **6**, **7**, and **8** or were slightly modified from the strategies included in the tables**.** Given the specific safety deficiencies noted, the general goals of the strategies can be summarized as:

- Keep vehicles from leaving the lane or minimizing the consequences when a lane departure crash occurs
- Increase daytime and nighttime awareness of intersection locations for both mainline and minor street traffic
- Slow down speeders through increased presence of law enforcement and publicize enforcement efforts
- Provide more effective truck enforcement by designing safe areas for patrol to conduct inspections
- Educate drivers regarding the crash risks and safety issues along the corridor

The corridor attributes and safety deficiencies have been mapped in the flowchart to show how the strategies were arrived at (see **Figure 5**).

TABLE 3
Potential Safety Strategies for the TH 525 Corridor

Enforcement Strategies
Provide adequate resources to allow State Patrol, county sheriffs and local police to perform traffic enforcement for speeding.
Use well publicized targeted enforcement to deter aggressive drivers.
Implement automated enforcement (cameras) to deter aggressive driving.
Educate and impose sanctions against repeat offenders.
Work with elected officials and Courts to support enforcement of laws regarding aggressive driving and prevent reduced or elimination of related traffic safety charges.
Deter aggressive driving by providing consistent enforcement and by initiating community oriented policing (i.e., citizens police academy)
Engineering Strategies
Install median barriers for narrow-width medians, edgeline rumble strips, provided enhance pavement markings, eliminate shoulder drop-offs, and delineate roadside objects. For sharp curves or unexpected changes in horizontal lighting, provide enhanced delineation, advance warnings, and/or lighting. Assist local agencies in implementation of low cost improvements by providing data to identify dangerous location, a toolbox of strategies to reduce fatal and serious injury crashes, training sessions, and an incentive program..
Improve the roadside by designing safer slopes and ditches to prevent rollovers, improving barriers and attenuation systems, using breakaway devices, and shielding motorists from striking roadside objects.
Change roadway geometry to improve horizontal curves and provide adequate sight distance.
Provide lighting to increase intersection visibility; and minimum 500' turn lanes for roads with 65 mph speed limits.
Improve visibility of intersections by providing enhanced signing and delineation.
Provide dashed marking (extended left edgelines) for major roadway continuity at divided highway intersections.
Increase visibility and call attention to the intersections by installing larger regulatory and warning signs at intersections, rumble strips on approaches, and flashing beacons at stop-controlled intersections.
Design/construct areas to conduct enforcement for heavy commercial vehicles.

TABLE 3
Potential Safety Strategies for the TH 525 Corridor

Education Strategies
Safe Community Coalitions activity to prevent/reduce aggressive driving.
Create a communications/marketing task force to raise public awareness of traffic crash issues.
Provide media with safety focused press releases on a monthly basis. Use media to convey information regarding the costs and dangers of aggressive driving.
Create partnerships with service, community, and other organizations (Lions Club, Rotary, Chamber of Commerce, etc.) to increase grass roots support and activism.
Educate drivers on the dangers of driving by creating new PI&E campaigns, establishing a Safety Speaker Bureau, and by working with corporations to create traffic safety programs for their employees.

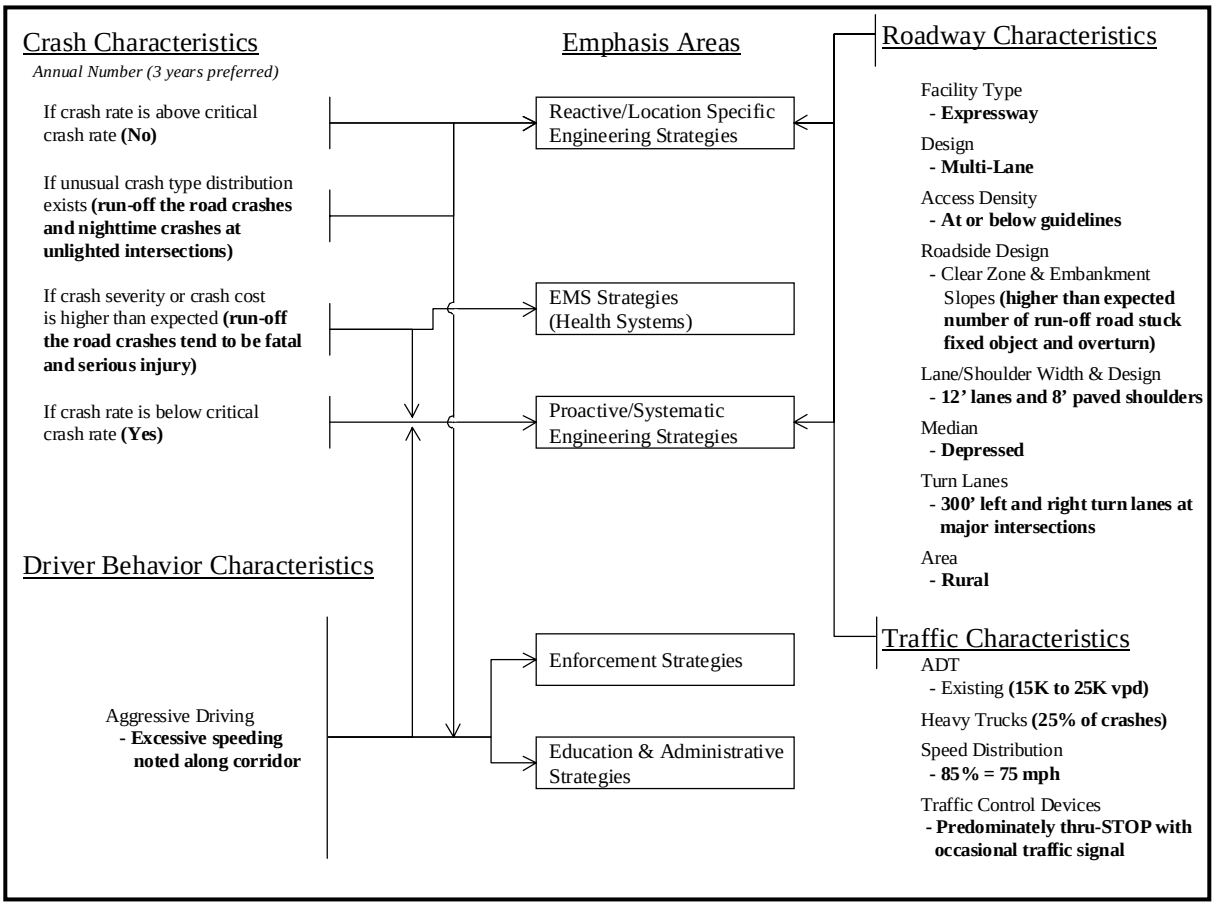


FIGURE 5
Flow Chart for Corridor Case Example

Intersection Case Example

Intersection Description: TH 311 is a rural expressway with a 65 mph speed limit where the intersections are at-grade and two-way stop controlled (STOP sign for the minor street). TH 311 has a depressed median that allows for a small storage area at each intersection. Because the area is rural, intersection lighting has been provided at only a few major intersections. At

the intersection with County Road (CR) 12, concern has been raised about the intersections safety. On TH 311, left and right turn bays have already been constructed, but were built to the minimum standard (300'). The minor street is a two-lane highway with a 55 mph posted speed limit. The minor street approaches do not have turn lanes. The advance guide signing for all intersection approaches was designed for a 55 mph travel speed.

Safety Deficiencies: CR 12 was identified as having a crash rate over the critical crash rate. The safety problem at the intersection was overwhelmingly right angle crashes (28 percent expected, 65 percent actual). Detailed review of the intersection crash reports found that a majority of the right angle crashes occurred when a driver stopped and then pulled out into traffic (i.e., gap selection related). Due to the high mainline volumes and speeding, adequate gaps are likely in short supply and drivers are selecting insufficient gaps. Consistent with statewide averages, weather and road surface conditions appeared to have been the cause for a small number of intersections. Yet, the number of nighttime crashes was higher than expected.

Mitigation Strategies: **Table 4** identifies a list of 16 strategies that would address the crash problem at the TH 552 intersection. These strategies were taken either directly from **Tables 5**, **6**, **7**, and **8** or were slightly modified from the strategies included in the tables**.** Given the specific safety deficiencies noted, the general goals of the strategies can be summarized as:

- Provide stopped vehicles on minor street with assistance in judging gap size
- Increase daytime and nighttime awareness of intersection locations for both mainline and minor street traffic
- Provide acceleration areas for vehicles turning onto TH 552
- Manage access at and near "dangerous" intersections
- Slow down speeders through increased presence of law enforcement and media
- Educate drivers regarding the risks and safety issues along the corridor

The intersection attributes and safety deficiencies have mapped in the flowchart to show how the strategies were arrived at (see **Figure 6**).

TABLE 4
Potential Safety Strategies for the TH 311 Intersection

Enforcement Strategies
Provide adequate resources to allow State Patrol, county sheriffs and local police perform traffic enforcement for speeding.
Use well publicized targeted enforcement to deter aggressive drivers.
Provide targeted or automated (camera) speed enforcement on intersection approaches
Engineering Strategies
Provide an automated real-time system to inform drivers of the suitability of available gaps for making turning and crossing maneuvers.
Provide roadside markers or pavement markings to assist drivers in judging the suitability of available gaps for making turning and crossing maneuvers.
Implement driveway closures/relocations, driveway turn restrictions, restrict cross median access near intersections, and close/relocate "high-risk" intersections.
Change horizontal and/or vertical alignment of approaches to provide more sight distance.

TABLE 4
Potential Safety Strategies for the TH 311 Intersection

Provide left- and right-turn acceleration lanes lighting to increase intersection visibility; and minimum 500' turn lanes for roads with 65 mph speed limits.
Improve visibility of intersections by providing enhanced signing and delineation.
Provide dashed marking (extended left edgelines) for major roadway continuity at divided highway intersections.
Increase visibility and call attention to the intersections by installing larger regulatory and warning signs at intersections, rumble strips on approaches, and flashing beacons at stop-controlled intersections.
Education Strategies
Create a communications/marketing task force to raise public awareness of traffic crash issues.
Provide media with safety focused press releases on a monthly basis. Use media to convey information regarding the costs and dangers of aggressive driving.
Create partnerships with service, community, and other organizations (Lions Club, Rotary, Chamber of Commerce, etc.) to increase grass roots support and activism.
Educate drivers on the dangers of driving by creating new PI&E campaigns, establishing a Safety Speaker Bureau, and by working with corporations to create traffic safety programs for their employees.
Provide targeted public information and education on safety problems at specific intersections.

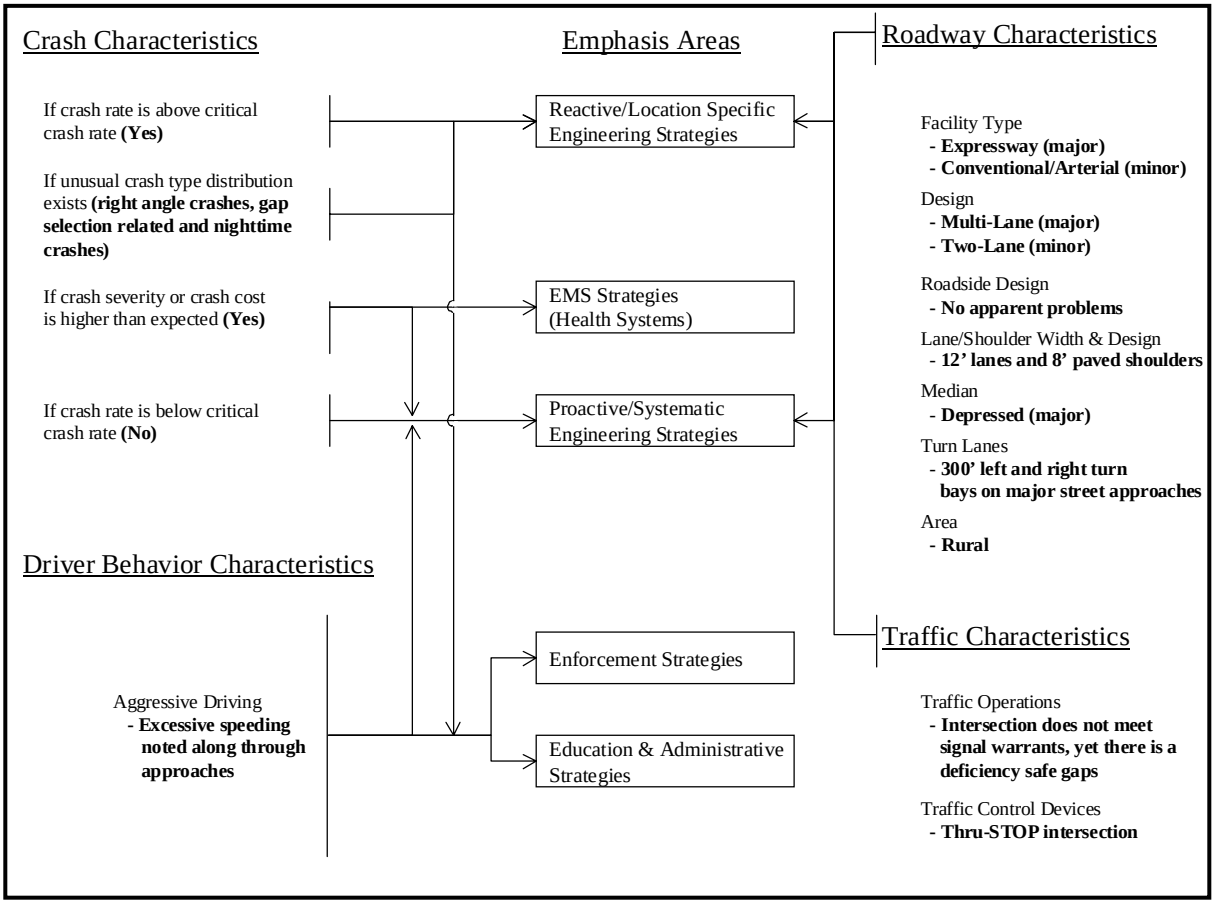


FIGURE 6
Flow Chart for Intersection Case Example

Process for a Proactive Safety Plan

The location of a crash is often random. Therefore, implementing strategies at "dangerous" location may address many crashes, but will not be sufficient for all crashes. This then leads to the need for a system-wide plan to prevent or reduce the severity of crashes. A proactive safety plan is not intended to identify locations with existing safety problems, but rather to identify factors that may lead to a increased chance of a crash. Once these factors have been identified, the key is to develop and implement a mitigation strategy prior to a crash occurring.

The first step in a proactive plan is to create a database of roadway and intersection characteristics for the roadway system. Even though the purpose of a proactive plan is to address the entire system, beginning with the locations that include common causal factors is preferred. Therefore, the database can help identify corridors and intersections with high volumes and potential casual factors. These locations can then be given priority in implementation of proactive strategies.

Casual factors may be identified by several methods. First, a multitude of safety research exists that addresses roadway safety and causes. Also, addressing "dangerous" locations will provide first hand knowledge of local factors that play an important role in crashes. The following list of common causal factors is not intended to be exhaustive or definitive, but instead provides a sense of what to look for in creating a prioritized plan.

- At a thru-STOP intersection, the number of right crashes is often correlated to the minor street volume.
- At a thru-STOP intersection, high mainline volumes and high speeds may not provide stopped vehicles with many safe gaps to choose from.
- Intersection recognition may be more difficult for unlighted intersections or for intersections without appropriate advanced signing and pavement markings.
- Higher access density along a corridor can increase the probability of a crash occurring.
- Curvilinear alignments combined with narrow shoulders can result in an increased number of run-off the road crashes.
- Fixed objects in the clear zone or steep slopes may result in more severe run-off the road crashes.
- High speed, high volume roadways with narrow medians may have problems with across-median crashes.

Proactive Case Examples

To illustrate creating and prioritizing a proactive safety plan, several examples have been provided. The first case examples provides an overview of a corridor analysis while the second set of case examples is for an intersection.

Corridor Case Examples

Highway Hardware: Many guardrail installations still have end treatments considered unsafe by today's standards. These may include plate beam guardrail anchored in

backslopes, plate beam guardrail turned down, and other outdated end treatments. Even though deficient guardrail end treatments may exist, it is impossible to predict when one may be hit and replacement of all locations is cost prohibitive. Therefore, a proactive approach is needed to systematically replace all outdated end treatments before they can be hit. In establishing a priority for end treatment replacement, selecting corridors with relatively high volumes or high functional classification first would be preferred. Also, as guardrails are hit, any deficient end treatments should be replaced.

Paved Shoulders: There are approximately 195 fatal run-off the road crashes in Minnesota each year. In response to these crashes, an agency may consider paving shoulders to create a small recovery area and move the shoulder drop-off away from the travel lane. Highways with paved shoulders have been found to have 15 percent fewer crashes than similar roadways with gravel shoulders. Even though paved shoulders may address many crashes, the linear nature of the strategy suggests that systematic deployment is best to address the safety issue. Since 8 or 10 feet paved shoulder would be preferred, this could require significant regrading of the roadside. In such cases, even providing three to four feet of paved shoulder is believed to still have a safety benefit. For establishing a priority for implementation, an agency may first start with corridors that have a relatively high volume or high functional classification. Other criteria that can be considered is crash history, roadways with curvilinear alignments, or a roadway that will be having an overlay done as part of regular maintenance.

Edgeline and Centerline Rumble Strips: In addition to the fatal run-off the road crashes, there are another 100 fatal head-on and opposing sideswipe fatalities each year in Minnesota. Similar to the paved shoulders, edgeline and centerline rumble strips are successful mitigation strategies. Again, because a run-off the road or head-on crash could happen almost anywhere, systematic deployment is the best option for reducing the number of these crashes. In establishing a priority for development, an agency could use the same criteria outlined for paved shoulders.

Intersection Case Example

Overhead Flashers: The presence of overhead flashers have been found to not have a significant reduction in the number of crashes at thru-STOP intersections and some drivers were found to be confused by the flasher, believing instead that they were at an all-way STOP. Therefore, Mn/DOT adopted a program of replacing overhead amber/red flashers at thru-STOP controlled intersections. Similarly, overhead flashers at thru-STOP intersections should also be systematically removed on local roadways. At intersections where overhead flashers are removed, the overhead flashers could be replaced with STOP sign mounted flashers, but this decision should be made on a case-by-case basis. If a large number of overhead flashers need to be removed over the course of several years, establishing a priority would be best. Selecting intersections with high mainline volumes (i.e., small number of gaps for stopped vehicles to choose) and/or with high volumes on the minor street is a good first screen. Also, functional classification and crash history can be used to prioritize the process.

Street Lights: Another strategy that can be used to proactively prevent intersection crashes at rural intersections, especially at night, is to install intersection lighting. The presence of intersection lighting was found to reduce the number of nighttime crashes involving a single or multiple vehicles. Identifying candidate intersections would need to be completed first (Mn/DOT already has already established warrants in their Traffic Engineering Manual). After identifying candidate intersections, criteria for a prioritizing can include functional classification, major and minor street approach volumes, and nighttime crash history.

Minnesota Critical Strategies

Because Mn/DOT and DPS have limited resources for new implementation, a smaller number of core strategies (i.e., Critical Strategies) were identified. To identify the strategies best capable of achieving the 2008 safety goal, a multi-step screening process was used that began with seeking input from over 70 individuals representing 31 agencies, private companies and organizations at a CHSP workshop on June 10, 2004 (see **Figure 7**). Based upon participants input and a final screen by the Project Management Team (PMT) (which considered effectiveness, timeframe, cost, and number of fatal crashes that may be corrected by each strategy), 15 Critical Strategies were identified. The Critical Strategies are the strategies believed to have the greatest potential for achieving the 2008 goal and also need to be implemented in the first year if possible. It is not intended that only the Critical Strategies be used to achieve the 2008 fatality reduction goal, instead, these are the strategies that are looked to be the primary focus for new efforts. Furthermore, it is not the intent of Mn/DOT or DPS to suggest that existing safety activities, strategies, programs, policies, or roadway reconstruction should be abandoned in place of adopting the Critical Strategies. It is only because of the existing safety efforts that the number of traffic fatalities is not higher than 650 each year. The purpose of adopting the Critical Strategies is to supplement what is already being done by state and local agencies.

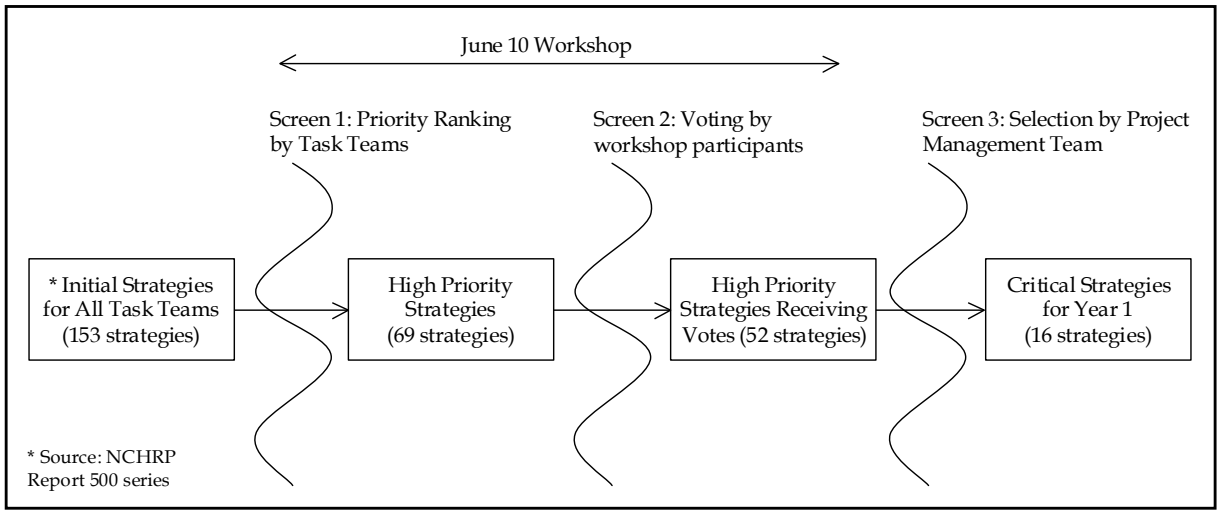


FIGURE 7
Critical Strategy Prioritization Process

For a detailed description and an action plan for the 15 Critical Strategies, refer to Chapter 5 of the *Minnesota Comprehensive Highway Safety Plan*. The statewide deployment goals for year one are presented in Chapter 7. These deployment goals were developed use a new planning tool that was created to assist Mn/DOT and DPS form a top level plan for additional safety efforts. The planning tool is a spreadsheet that computes a general cost and effectiveness for a given level of deployment. On the following page, the critical strategies have been summarized and then classified into five categories.

Enforcement
- Provide adequate law enforcement resources
- Primary seat belt law
- Implement automated enforcement
- Stronger graduated licensing system
- Support the enforcement of traffic safety laws
- Targeted enforcement

Engineering
- Cost effective lane departure improvements
- Cost effective intersection improvements
- Roadway maintenance
- Road Safety Audits

Education
- Communications and marketing task force
- Enhance driver education

EMS
- Statewide trauma system

Administrative
- High-level traffic safety panel and Legislature Action Committee
- Improve data systems

Figure 8 demonstrates how several of the Critical Strategies are directly related to the Critical Emphasis Areas.

Importance of the State Legislature and Local Units of Government

Of the Critical Strategies identified in the CHSP, nearly half (including the first four) first require action be taken by either the State Legislature or local government agencies. This demonstrates how crucial it is for elected officials to be involved in and support traffic safety. In order for any agency responsible for roadway safety to be effective, it is important that the agency work closely with the local and State government, providing them with information and facts they need to make the best decisions regarding public safety.

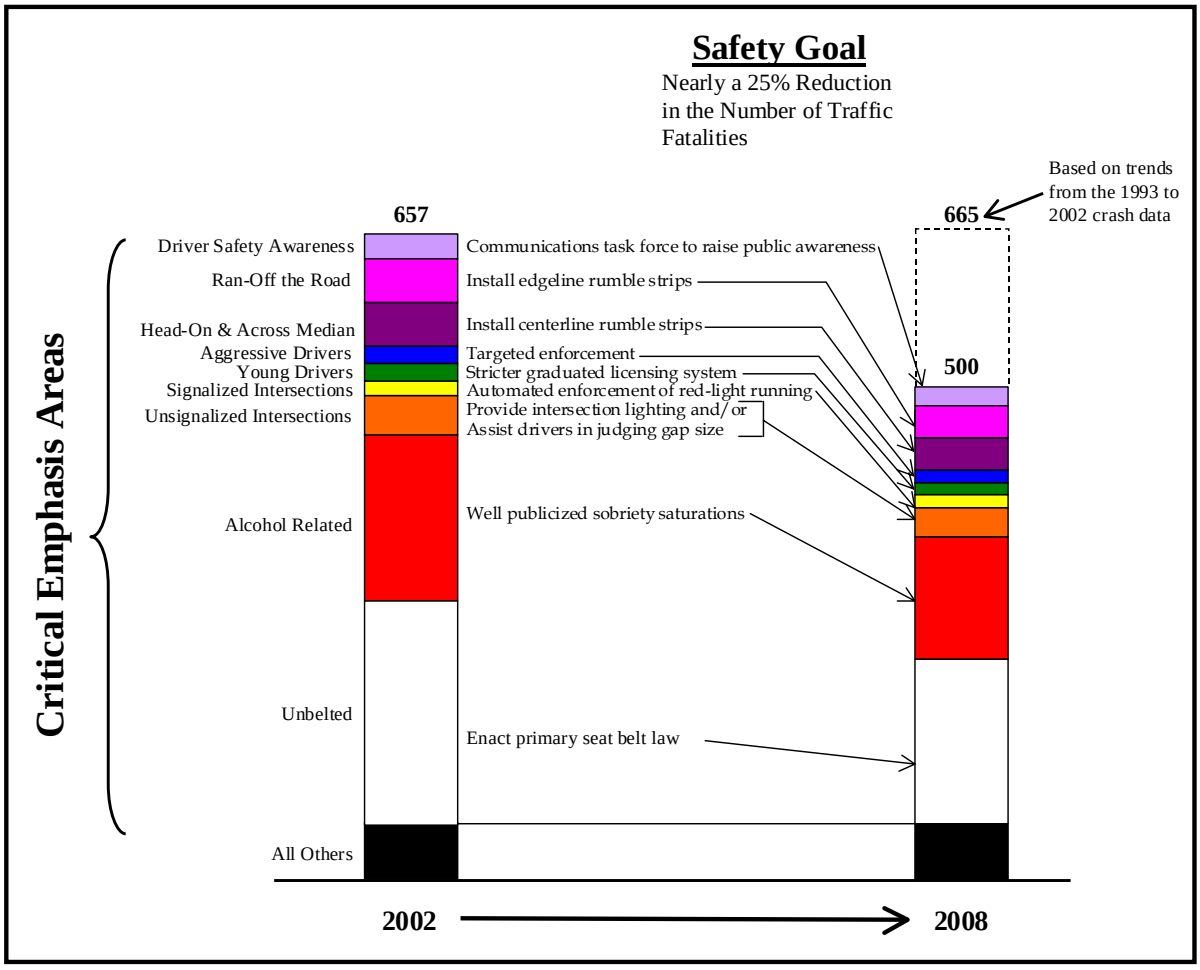


FIGURE 8
Implementation of Strategies to Meet Minnesota's 2008 Goal

TABLE 5
Prioritized ENFORCEMENT Strategies

Objectives	Strategies	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
Priority 1 Strategies				
Increase presence and effectiveness of law enforcement.	Provide adequate resources to allow state patrol, county sheriffs and local police to perform traffic enforcement for speeding, unbelted occupants, and impaired drivers	[2] Tried/ Experimental	Moderate	Short (<1 yr.)
Prosecute, Sanction and Treat Offenders	To combat impaired and aggressive drivers, work with courts to prevent the reduction or dismissal of traffic citations	[2] Tried/ Experimental	Low	Medium (1-2 yrs.)
	Work with elected officials to permit law enforcement to enforce the laws regarding aggressive driving, impaired drivers, seat belt use, and etc.	[2] Tried	Moderate	Long (>2yrs.)
Reduce Excessive Drinking and Underage Drinking	Enact and enforce compliance checks with establishments selling alcohol	[2] Experimental	Moderate to High	Medium (1-2 yrs.)
Enforce DWI Laws	Enhance DWI detection through related traffic enforcement	[1] Tried	Low	Short (<1 yr.)
	Publicize and enforce zero tolerance laws for drivers under age 21	[1] Proven	Moderate	Short (<1 yr.)
	Penalties for adult providers	[2] Tried	Low	Short (<1 yr.)
Prosecute, Sanction and Treat DWI Offenders	Suspend driver's license administratively upon arrest	[1] Proven	Low	Medium (1-2 yrs.)
	Establish stronger penalties for BAC test refusal than for test failure	[1] Tried	Low	Long (>2 yrs.)
Deter impaired drivers and aggressive driving in specific population and/or at specific locations	Use well publicized sobriety saturations and targeted enforcement to deter impaired drivers and aggressive drivers, and increase seat belt use	[1] Proven/Tried	Moderate to High	Short (< 1 yr.)
Deter aggressive driving and improve driver compliance at intersections	Implement automated enforcement (cameras) to deter red-light running and aggressive driving	[1] Proven/Tried	Moderate	Medium (1-2 yrs.)
	Provide targeted enforcement to increase compliance with traffic control devices and traffic laws at intersections	[1] Tried	Moderate	Short (<1 yr.)
	Provide targeted speed enforcement on intersection approaches	[1] Proven	Moderate	Short (<1 yr.)
Develop and implement an improved competency based training and assessment procedure for entry drivers	Implement a stronger graduated driver licensing system	[1] Proven	Low	Short (<1 yr.)
Maximize use of occupant restraints by all vehicle occupants	Conduct highly publicized enforcement campaigns to maximize restraint use	[1] Proven	Moderate to High	Medium (1-2 yrs.)
	Encourage the enactment of a statewide primary law that will permit standard enforcement and provide universal coverage to all vehicle occupants	[1] Tried	Low	Medium (1-2 yrs.)
	Train law enforcement personnel to check for proper child restraint use in all motorist encounters	[1] Tried	Moderate	Short (<1 yr.)
	Enforce use of child restraints	[2] Proven	Moderate	Short (<1 yr.)
Priority 2 Strategies				
Prosecute, Sanction and Treat DWI Offenders	Eliminate diversion programs and plea bargains to non-alcohol offenses	[1] Proven	Moderate	Long (>2 yrs.)
	Assess all convicted DWI offenders for alcohol problems and require treatment when appropriate	[1] Proven	Moderate to High	Long (>2 yrs.)
	Pilot checkpoint challenge	[2] Experimental	Moderate to High	Short (<1 yr.)
Control High BAC and Repeat Offenders	Seize vehicle license plates administratively upon arrest	[1] Proven	Low	Medium (1-2 yrs.)
	Require ignition interlocks as a condition for license reinstatement	[1] Proven	Moderate	Medium (1-2 yrs.)
Deter aggressive driving in specific populations, including those with a history of such behavior, and at specific locations	Educate and impose sanctions against repeat offenders - Courts	[1]Tried	Low	Medium (1-2 yrs.)

TABLE 5
Prioritized ENFORCEMENT Strategies

Objectives	Strategies	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
Reduce aggressive driving and increase compliance among young drivers	Deter aggressive driving and attain compliance among young drivers by providing consistent enforcement and by initiating community oriented policing (i.e., citizens police academy)	[2] Experimental	Moderate to High	Medium (1-2 yrs.)
Develop and implement an improved competency based training and assessment procedure for entry drivers	Early license actions – licensing agency alerts teens to unacceptable driving behavior at first or second offense	[2] Tried	Moderate	Medium (1-2 yrs.)
	Violator clinic	[2] Tried	Moderate	Medium (1-2 yrs.)
Reduce operating speeds on specific intersection approaches	Implement automated enforcement of approach speeds (cameras)	[1] Tried	Moderate	Medium (1-2 yrs.)
Improve driver awareness of historic & current traffic safety issues	Reporting on problem drivers – tracking and monitoring – limit privileges – backup with enforcement	[2] Tried	Moderate	Medium (1-2 yrs.)
Priority 3 Strategies				
Prosecute, Sanction and Treat DWI Offenders	Develop treatment strategy	[2] Experimental	High	Long (>2 yrs.)
Control High BAC and Repeat Offenders	Monitor all convicted DWI offenders closely	[1] Proven	Moderate to High	Long (>2 yrs.)
	Breathalyzer in bars	[2] Experimental	High	Long (>2 yrs.)
Insure that restraints, especially child and infant restraints, are properly used	Upgrade child restraint laws	[2] Experimental	Low	Short (<1 yr.)
Keep vehicles from encroaching into the opposite lane	Prohibit/restrict trucks with very long semitrailers on roads with horizontal curves that cannot accommodate truck off-tracking	[1] Tried	Moderate	Medium (1-2 yrs.)

[1]NCHRP Report 500 series
[2]Project Management Team

TABLE 6
Prioritized ENGINEERING Strategies

Objectives	Strategies	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
Priority 1 Strategies				
Address safety through proper maintenance and updating of roadsides.	Perform proper maintenance of roadway facilities, including improving roadside hardware and removing and relocating objects in hazardous locations (i.e., trees)	[1,2] Proven/Tried/ Experimental	Low to High	Medium (1-2 yrs.)
Address safety through expanded review of roadways.	Perform Road Safety Audits at network level	[2] Experimental	Moderate to High	Medium (1-2 yrs.)
Low cost safety improvements to address intersection crashes by geometric improvements and increasing driver awareness	Provide offset and longer left- and right-turn lanes at intersections; left-turn acceleration lanes at divided highway intersections, right-turn acceleration lanes; indirect left-turn treatments at divided highway intersections; clear sight triangles on approaches and in medians of divided highway intersections; eliminate parking that restricts sight distance; provide pavement markings with supplementary messages, such as STOP AHEAD; double yellow centerline at intersections and at median opening; providing lighting to increase intersection visibility; and minimum 500' turn lanes for roads with 65 mph speed limits. Assist local agencies in implementation of low cost improvements by providing data to identify dangerous location, a toolbox of strategies to reduce fatal and serious injury crashes, training sessions, and an incentive program.	[1] Proven/Tried	Low to Moderate	Medium (1-2 yrs.)
Improve management of access near intersections	Implement driveway closures/relocations, driveway turn restrictions, restrict cross median access near intersections, accommodate U-turns, restrict or eliminate turning maneuver by providing channelization or signing, and closing/relocating "high-risk intersections.	[1] Tried	Moderate	Medium (1-2 yrs.)
Reduce the frequency and severity of intersection conflicts through geometric design improvements	Realign intersection approaches to reduce or eliminate intersection skew	[1] Proven	High	Medium (1-2 yrs.)
Improve availability of gaps in traffic and assist drivers in judging gap sizes at unsignalized intersections	Provide an automated real-time system to inform drivers of the suitability of available gaps for making turning and crossing maneuvers	[1] Experimental	Moderate	Medium (1-2 yrs.)
	Provide roadside markers or pavement markings to assist drivers in judging the suitability of available gaps for making turning and crossing maneuvers	[1] Experimental	Low	Medium (1-2 yrs.)
Choose appropriate intersection traffic control to minimize crash frequency and severity	Provide roundabouts at appropriate locations	[1] Proven	High	Long (>2 yrs.)
Low cost safety improvements to address lane departure crashes by either keeping vehicles in their lane or by minimizing likelihood of crashing into an oncoming car or roadside object	Install median barriers for narrow-width medians on multilane roads, centerline rumble strips for two-lane road or install profiled thermoplastic strips for centerlines. Install edgeline or midlane rumble strips, provided enhance pavement markings, eliminate shoulder drop-offs, and/or delineate roadside objects. For sharp curves or unexpected changes in horizontal lighting, provide enhanced delineation, advance warnings, and/or lighting. Assist local agencies in implementation of low cost improvements by providing data to identify dangerous location, a toolbox of strategies to reduce fatal and serious injury crashes, training sessions, and an incentive program..	[1,2] Proven/Tried	Low to Moderate	Medium (1-2 yrs.)
Keep vehicles from encroaching into the opposite lane	Provide wider cross sections on two-lane roads to meet standards	[1] Experimental	Moderate to High	Long (>2 yrs.)
Minimize the likelihood of crashing into an object or over turning if the vehicle travels beyond the edge of the shoulder	Design safer slopes and ditches to prevent rollovers	[1] Proven	Moderate to High	Medium (1-2 yrs.)

TABLE 6
Prioritized ENGINEERING Strategies

Objectives	Strategies	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
Reduce the severity of the crash	Improve barriers and attenuation systems	[1] Tried	Moderate to High	Medium (1-2 yrs.)
	Use breakaway devices	[1] Tried	Moderate to High	Medium (1-2 yrs.)
Priority 2 Strategies				
Address alcohol related crashes through engineering solutions	Use Engineering Strategies to address alcohol related crashes, such as rumble strips and designing/constructing areas to conduct enforcement.	[2] Experimental	Low	Medium (1-2 yrs.)
Low cost safety improvements to address intersection crashes by geometric improvements, operational improvements, selection of appropriate traffic control, and increasing driver awareness	Provide bypass lanes on shoulders at T-intersections, wider stop bar on minor-road approaches, supplementary stop signs mounted over the roadway, improved maintenance of stop signs, turn path markings, and lane assignment signing or marking at complex intersections.	[1] Tried	Low	Short (<1 yr.)
	Retime adjacent signals to create gaps at stop-controlled intersections, improve visibility of signals and signs at intersections, employ multiphase signal operation, optimize clearance intervals, and improve operation of pedestrian and bicycle facilities at signalized intersections.	[1] Proven/ Tried	Low	Short (<1 yr.)
	Provide all-way stop control at appropriate intersections	[1] Proven	Low	Short (<1 yr.)
Reduce the frequency and severity of intersection conflicts through geometric design improvements	Improve pedestrian and bicycle facilities to reduce conflicts between motorists and nonmotorists	[1] Tried	Moderate	Medium (1-2 yrs.)
	Revise geometry of complex intersections	[1] Proven/Tried	High	Long (>2 yrs.)
	Systematic plan for interchanges	[2] Proven	High	Long (>2 yrs.)
Improve sight distance at intersections	Change horizontal and/or vertical alignment of approaches to provide more sight distance	[1] Tried	High	Long (>2 yrs.)
	Reduce size of intersection	[2] Tried	Moderate	Medium (1-2 yrs.)
Improve driver awareness of intersections as viewed from the intersection approach	Improve visibility of intersections by providing enhanced signing and delineation	[1] Tried	Low	Short (<1 yr.)
	Provide dashed marking (extended left edgelines) for major roadway continuity at divided highway intersections	[1] Tried	Low	Short (<1 yr.)
Choose appropriate intersection traffic control to minimize crash frequency and severity	Avoid Signalizing through roads	[1] Tried	High	Long (>2 yrs.)
Keep vehicles from encroaching on the roadside	Install edgeline "profile marking", edgeline rumble strips or modified shoulder rumble strops on section with narrow or no paved shoulders	[1,2] Experimental	Low	Short (<1 yr.)
	Improve horizontal curve geometry	[1] Proven	High	Long(> 2 yrs.)
	Provide adequate sight distance	[1] Tried	Low	Short (< 1 yr.)
Minimize the likelihood of crashing into an object or over turning if the vehicle travels beyond the edge of the shoulder	Provide shoulder treatments or four-lane sections at key locations	[1] Tried	Moderate	Medium (1-2 yrs.)
Reduce the severity of the crash	Shield motorists from striking roadside objects, such as trees, utility poles, light poles, and etc.	[1] Tried	Moderate	Short (< 1 yr.)
	Modify roadside clear zone in the vicinity of trees, utility poles, light poles, and etc.	[1] Tried	Moderate to High	Medium (1-2 yrs.)
Remove stopped vehicles from travel lanes to prevent head-on and run-off road crashes.	Address lane departure crashes by providing turn lanes at appropriate locations	[2] Experimental	Moderate	Medium (1-2 yrs.)

TABLE 6
Prioritized ENGINEERING Strategies

Objectives	Strategies	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
Priority 3 Strategies				
Reduce the frequency and severity of intersection conflicts through geometric design improvements	Provide full width paved shoulders in intersection areas	[1] Tried	Moderate	Medium (1-2 yrs.)
	Convert four-legged intersection to two T-intersections	[1] Tried	High	Medium (1-2 yrs.)
	Convert offset T-intersections to four-legged intersection	[1] Tried	High	Medium (1-2 yrs.)
	Construct special solutions	[1] Tried	High	Long (>2 yrs.)
Improve driver awareness of intersections as viewed from the intersection approach	Install splitter islands on the minor-road approach to an intersection	[1] Tried	Moderate	Medium (1-2 yrs.)
	Increase visibility and call attention to the intersections by installing larger regulatory and warning signs at intersections, rumble strips on approaches, and flashing beacons at stop-controlled intersections	[1] Tried	Low	Short (<1 yr.)
Reduce operating speeds on specific intersection approaches	Provide traffic calming on intersection approaches through a combination of geometric and traffic control devices	[1] Proven	Moderate	Medium (1-2 yrs.)
Reduce frequency and severity of intersection conflicts through traffic control and operational improvements	Employ signal coordination	[1] Proven	Moderate	Medium (1-2 yrs.)
	Employ emergency vehicle preemption and truck prioritization at signal	[1] Proven	Moderate	Medium (1-2 yrs.)
	Remove unwarranted signal	[1] Proven	Low	Short (<1 yr.)
Improve safety through other infrastructure treatments	Improve drainage in intersection and on approaches	[1] Tried	Moderate	Medium (1-2 yrs.)
	Provide skid resistance in intersection and on approaches	[1] Tried	Moderate	Medium (1-2 yrs.)
	Coordinate closely spaced signals near at-grade railroad crossings	[1] Tried	Moderate	Medium (1-2 yrs.)
	Relocate signal hardware out of clear zone	[1] Tried	Moderate	Short (<1 yr.)
Keep vehicles from encroaching into the opposite lane	Provide center two-way left turn lanes for four- and two-lane roads	[1] Tried	Moderate	Short (< 1 yr.)
Minimize the likelihood of crashing into an oncoming vehicle	Use alternating passing lanes or four-lane sections at key locations	[1] Tried	Moderate to High	Medium (1-2 yrs.)
Keep vehicles from encroaching on the roadside	Provide skid-resistant or grooved pavements, dynamic curve warning system, and improve or restore superelevation	[1] Proven/Tried	Moderate to High	Medium (1-2 yrs.)
Minimize the likelihood of crashing into an object or over turning if the vehicle travels beyond the edge of the shoulder	Apply traffic calming measures to reduce speeds on high-risk sections	[1] Tried	Moderate	Medium (1-2 yrs.)
Reduce the severity of the crash	Swamp attenuation	[2] Experimental	Moderate	Short (<1 yr.)

[1]NCHRP Report 500
[2]Project Management Team

TABLE 7
Prioritized EDUCATION Strategies

Objectives	Strategies	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
Priority 1 Strategies				
Improve driver training for entry level drivers.	Revise driver education with stronger mandates to include parent involvement, uniform curriculum, instructor quality control, and enhanced behind-the-wheel and classroom instruction. Also improve driver training and licensing material with the addition of traffic safety statistics, stories, and testimonials	[2] Experimental	Low to Moderate	Medium (1-2 yrs.)
Public education	Provide enhanced, hard-hitting, focused public education to target groups of people in order to increase seat belt use and prevent drinking & driving.	[2] Tried	Moderate	Short (<1 yr.)
	Support & instill grass roots movement on traffic safety laws & enforcement	[2] Experimental	Moderate	Long (>2 yrs.)
Insure that restraints, especially child and infant restraints, are properly used	Provide community locations for instruction in proper child restraint use, including both public safety agencies and health care providers, that are almost always available	[1] Tried	Low	Short (<1 yr.)
Develop and implement an improved competency based training and assessment procedure for entry drivers	Educate novice drivers	[2] Tried	Moderate	Medium (1-2 yrs.)
Improve driver awareness of historic & current traffic safety issues	Safe Communities outreach for young, older, and offender drivers	[2] Proven	Moderate	Medium (1-2 yrs.)
	Create a communications/marketing task force to raise public awareness of traffic crash issues	[2] Experimental	Moderate to High	Medium (1-2 yrs.)
Improve the accuracy, quality, quantity, and timeliness of crash data and analysis to support statewide safety initiatives	Work with LTAP to provide additional training to local jurisdictions	[2] Tried	Moderate	Short (<1 yr.)
Priority 2 Strategies				
Provide community education using the mass media.	Provide media with safety focused press releases on a monthly basis. Also use media to encourage seat belt use, convey information regarding the costs of alcohol related crashes, dangers of aggressive driving, and problems associated with young drivers.	[2] Experimental	Low	Short (< 1 yr.)
Insure that restraints, especially child and infant restraints, are properly used	Conduct high profile "child restraint inspection" events at multiple community locations	[1] Proven	Low	Short (<1 yr.)
Provide access to appropriate information, materials, and guidelines for those implementing programs to increase occupant restraint use	Create state-level clearing houses for materials that offer guidance in implementing programs to increase restraint use	[1] Experimental	Moderate	Medium (1-2 yrs.)
Improve driver compliance with traffic control devices and traffic laws at intersections	Provide targeted public information and education on safety problems at specific intersections	[1] Tried	Low	Short (<1 yr.)
Deter aggressive driving in specific populations, including those with a history of such behavior, and at specific locations	Conduct educational and public information campaigns - personnel	[1,2] Tried	Moderate	Short (< 1 yr.)
Improve the diving environment to eliminate or minimize the external "triggers" of aggressive driving	Reduce nonrecurring delays and provide better information about these delay's	[1,2] Tried	Moderate to High	Medium (1-2 yrs.)

TABLE 7
Prioritized EDUCATION Strategies

Objectives	Strategies	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
Educate young drivers on the risks of driving and provide positive enforcement	In local communities, implement seat belt checks with positive enforcement, place warning signs at school exits, conduct mock crashes at schools, and prepare in-school safety messages	[2] Tried	Low	Short (<1 yr.)
Educate drivers in the prevention of lane departure crashes	Education – awareness of lane departure, driver skills for young and inexperienced; knowledge of vehicle	[2] Tried	Moderate	Medium (1-2 yrs.)
Improve driver awareness of historic & current traffic safety issues	Create partnerships with service, community, and other organizations (Lions Club, Rotary, Chamber of Commerce, etc.) to increase grass roots support and activism	[2] Experimental	Low	Short (<1 yr.)
	Participate in existing conferences to promote increased focus on traffic safety (i.e., Mn/DOT Transportation Conference, County Engineer Conference, Sheriff Conference, CTS Research Conference, TZD Conference, *Safe & Sober* Conference, LifeSavers Conference, etc.)	[2] Tried	Low	Medium (1-2 yrs.)
Priority 3 Strategies				
Improve the diving environment to eliminate or minimize the external "triggers" of aggressive driving	Change or mitigate the effects of identified elements in the environment	[1,2] Tried	Moderate to High	Medium (1-2 yrs.)
Develop and implement an evaluation system for drivers moving from the provisional to the regular license stage	In car recording devices to alert teens to dangerous driving behaviors and to provide feedback to parents about their teen's driving	[2] Experimental	Moderate to High	Medium (1-2 yrs.)
	Insurance incentives	[2] Experimental	Moderate to High	Medium (1-2 yrs.)
Educate young drivers on the risks of driving and provide positive enforcement	Provide young drivers with daily report cards that assess their observed driving behavior and create partnerships to provide rewards/scholarship for students that demonstrate safe driving behavior.	[2] Experimental	Moderate	Medium (1-2 yrs.)
Improve driver awareness of historic & current traffic safety issues	Educate drivers on the dangers of driving by creating new PI&E campaigns, establishing a Safety Speaker Bureau, and by working with corporations to create traffic safety programs for their employees.	[2] Experimental	Moderate	Short (<1 yr.)

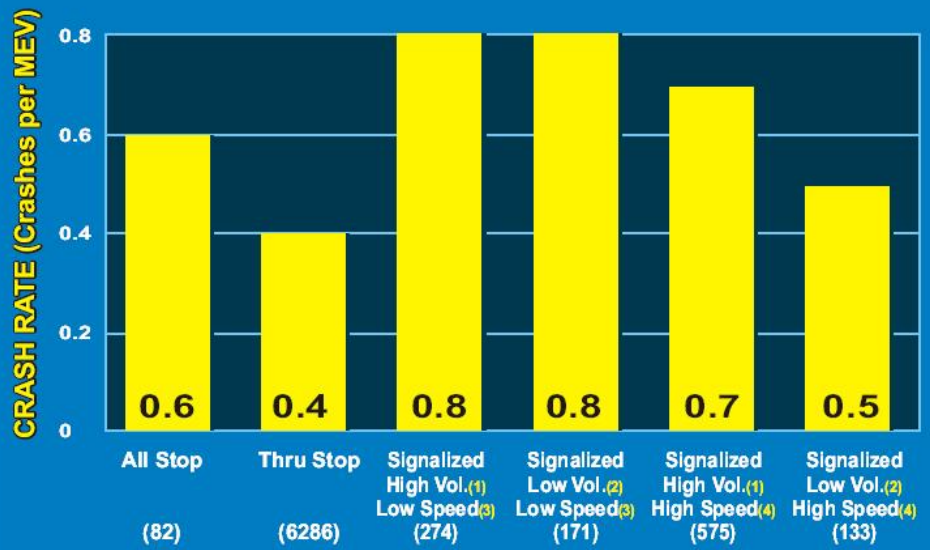
[1]NCHRP Report 500
[2]Project Management Team

TABLE 6
Prioritized EMS and ADMINISTRATIVE Strategies

Objectives	Strategies	Effectiveness	Relative Cost to Implement and Operate	Typical Timeframe for Implementation
Priority 1 Strategies				
Improve recognition of level of care need and decrease time from accident until appropriate trauma system is reached.	Create and implement a statewide trauma system	Tried	High	Long (>2 yrs.)
Improve driver awareness of historic & current traffic safety issues	Establish a high-level panel focused on traffic safety	[2] Experimental	Low	Short (<1 yr.)
	Initiate incentive and disincentive programs	[2] Experimental	Moderate to High	Medium (1-2yrs.)
	Multi-level strategic plan (reactive and proactive)	[2] Tried	Moderate to High	Medium (1-2yrs.)
Improve the accuracy, quality, quantity, and timeliness of crash data and analysis to support statewide safety initiatives.	Improve data systems by ensuring adequate staffing, equipment and other resources are available. In addition ensure that users of systems are consulted when system changes are being planned and implemented. Furthermore, organize an oversight committee to coordinate all agencies involved in the collection, management, and use of highway safety data	[2] Tried/ Experimental	Low to Moderate	Short (<1 yr.)
	Create a clearinghouse of highway safety information to provide mangers with the resources needed to make the most effective use of the data	[2] Tried	Moderate	Medium (1-2 yrs.)
Priority 2 Strategies				
Improve the accuracy, quality, quantity, and timeliness of crash data and analysis to support statewide safety initiatives.	Establish a group of highway safety professionals trained in the analytic methods appropriate for evaluating highway safety information	[2] Tried	Moderate to High	Medium (1-2 yrs.)
	Establish a information standards committee within the safety community to resolve and eliminate technical data discrepancies	[2] Tried	Low	Short (<1 yr.)
Priority 3 Strategies				
Reduce Excessive Drinking and Underage Drinking	Increase the excise tax on beer	[1] Tried	Low	Long (>2 yrs.)
	Require responsible beverage service policies for alcohol retailers	[1] Proven	Moderate	Long (>2 yrs.)
Maximize use of occupant restraints by all vehicle occupants	Statewide occupant protection leadership committee	[2] Experimental	Low	Short (<1 yr.)

[1]NCHRP Report 500
[2]Project Management Team

Intersection Crash Rates (Minnesota) By Control Type and Family



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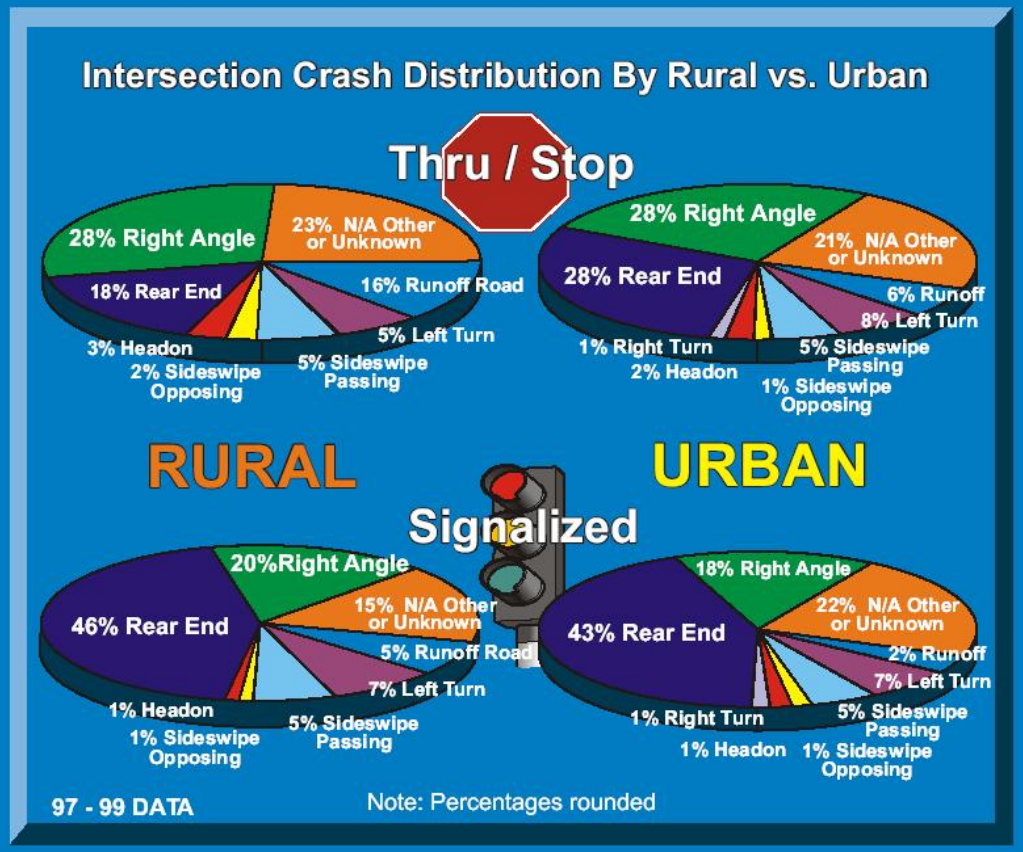
Intersection Crash Rates (Minnesota) By Control Type and Family

Source: Mn/DOT 1997 - 1999 Crash Data (note: Only State Highway Intersections)

HIGHLIGHTS:

- Crash frequency at intersections tends to be a function of exposure - the volume of traffic traveling through the intersection. As a result, the most commonly used intersection crash statistic is the crash rate - the number of crashes per million entering vehicles (MEV).
- Crash frequency also tends to be a function of the type of traffic control at the intersection. Contrary to the popularly held opinion that increasing amounts of intersection control results in increased safety, the average crash rate at signalized intersections (0.7 per MEV) is almost 80% higher than the average crash rate at STOP controlled intersections (0.4 per MEV).
- A wealth of research also supports the conclusion that traffic signals are only rarely safety devices. Most Before vs. After studies of traffic signal installations document increases in the number and rate of crashes, a change in the distribution of the type of crashes and a modest decrease in the severity of the crashes.
- The data at a limited number (82) of All-Way STOP controlled intersections indicates that the average crash rate (0.6) is approximately 25% less than the average at signalized intersections (0.8).
- There is also a limited amount of crash data to support a conclusion that some type of left turn phasing (either exclusive or exclusive/permitted) helps to minimize crashes at signalized intersections.



Intersection Crash Distribution By Rural vs. Urban

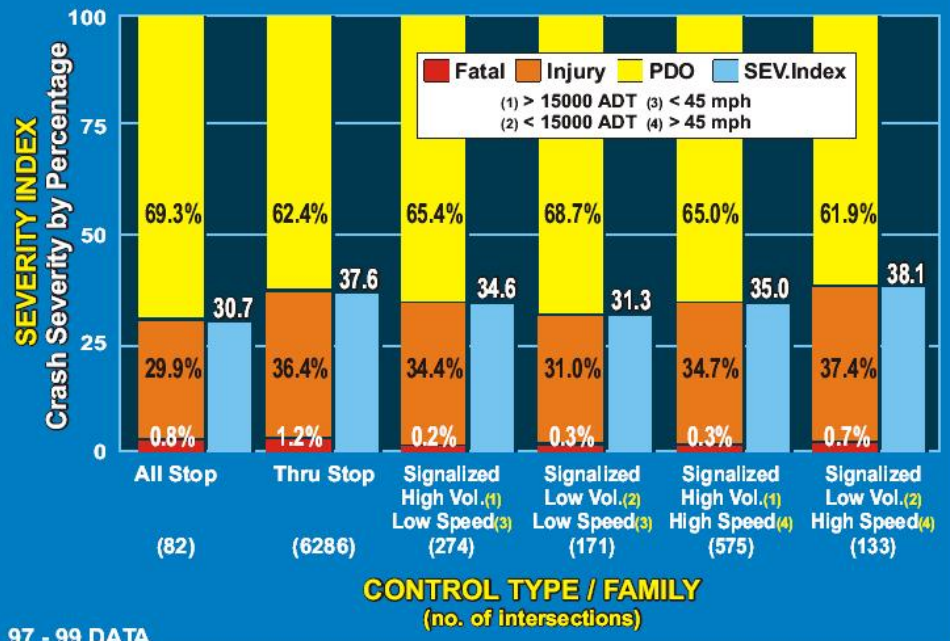
A-16

Source: Mn/DOT 1997 - 1999 Crash Data (note: Only State Highway Intersections)

HIGHLIGHTS:

- The distribution of crash type that can be expected at any intersection is primarily a function of the type of intersection control.
- At Stop controlled intersections, in both rural and urban areas, the most common types of crashes are right angle and rear end collisions.
- At signalized intersections the most common types of crashes are rear end, right angle, and left turn collisions.
- There are about three times as many single vehicle crashes at rural intersections, compared to urban intersections.
- Several key points:
  - Traffic signals appear to reduce but not eliminate right angle crashes.
  - Right turns present a very low probability of a crash (1% of intersection crashes).
  - Left turns present a higher probability of a crash (5% to 8% of intersection crashes).
  - Crossing conflicts present a very high probability of a crash (18% to 28% of intersection crashes).
  - Rear end conflicts present the highest probability of a crash (18% to 46% of intersection crashes).

Intersection Crash Severity (Minnesota) By Control Type and Family



97 - 99 DATA

Intersection Crash Severity (Minnesota)
By Control Type and Family

A-15

Source: Mn/DOT 1997 - 1999 Crash Data (note: Only State Highway Intersections)

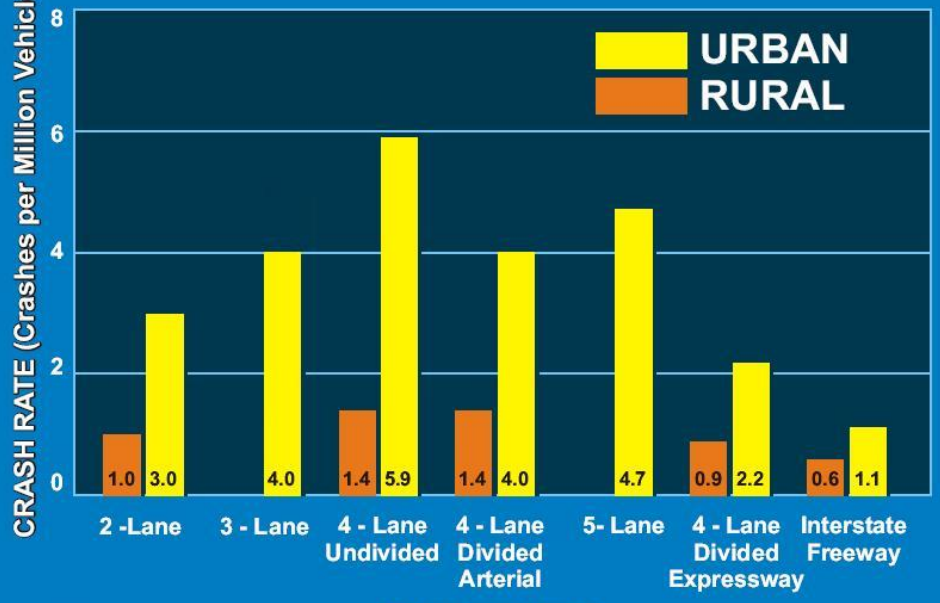
HIGHLIGHTS:

- The distribution of intersection crash severity appears to be a function of the type / degree of intersection control. Based on a review of over 35,000 crashes at more than 7500 intersections, All-Way STOP controlled intersections were found to have the highest percentage of Property Damage Only crashes (69%) and the lowest percentage of Injury crashes (30%). Intersections with traffic signal control had the lowest percentage of fatal crashes (0.2%).
- The data also suggests that (on average) the installation of a traffic signal results in a small reduction in crash severity. The **severity index** (sum of the PI%+F%) at signalized intersections (34.7% combined) is about 3% lower than at intersections with Thru/STOP control (37.6%).
- Looking at severity from the perspective of exposure (total million entering vehicles) provides somewhat different results. Intersections with Thru/STOP control had the lowest severity rate (0.9) and signalized intersections had the highest severity rate (1.5). Intersections with All-Way STOP control were in-between (1.2).
- This data tends to support the theory that increasing amounts of intersection control does not necessarily result in a higher level of intersection safety.

TRAFFIC SAFETY FUNDAMENTALS HANDBOOK

page 18 of 53

Roadway Segment Crash Rates of Facility Type By Rural vs. Urban



Roadway Segment Crash Rates of Facility Types By Rural vs. Urban

A-18

Source: Mn/DOT Metro Division Office of Traffic Engineering

HIGHLIGHTS:

- Average crash rates vary by location (Rural vs. Urban) and type of facility
- Freeways have the lowest crash rates and are the safest roadway system in the state.
- Rural Roadways have lower crash rates than similar urban roads.
- Urban minor arterials (which serve both a mobility and land access function) have the highest crash rate.
- 4 - Lane Undivided roadways have the highest crash rates. Over the years, this average has been lowered (from a rate of 8.0 in 1990) due to Mn/DOT's efforts to convert the worst segments to either, 3 - Lane, 4 - Lane Divided or 5 - Lane roads.
- Systems of left turn lanes reduce crash frequency on urban arterials 25 to 40%.

TRAFFIC SAFETY FUNDAMENTALS HANDBOOK

Roadway Segment Crash and Fatality Rates By Jurisdictional Class

Roadway / Jurisdictional Classification	MILES	CRASHES	FATALITIES	CRASH RATE*	FATALITY RATE**
Interstate	914	11,149	61	1.0	0.5
Trunk Highway	11,012	28,211	270	1.4	1.4
County Roads/CSAH	45,356	26,631	217	2.2	1.8
City, MSAS & Munic	18,259	27,701	45	3.8	0.6
Other (Township, etc.)	56,109	3,121	33	2.9	3.1
State Total	131,650	96,813	626	1.9	1.2

* per million vehicle miles (MVM)
** per 100 million vehicle miles (100 MVM)

99 DATA

A-17

Roadway Segment Crash and Fatality Rates By Jurisdictional Class

Source: Minnesota Motor Vehicle Crash Facts (1999)

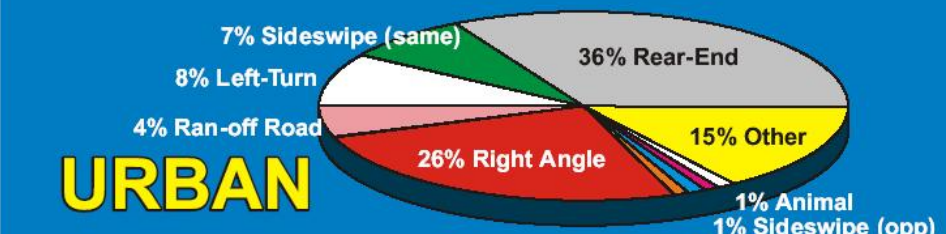
HIGHLIGHTS:

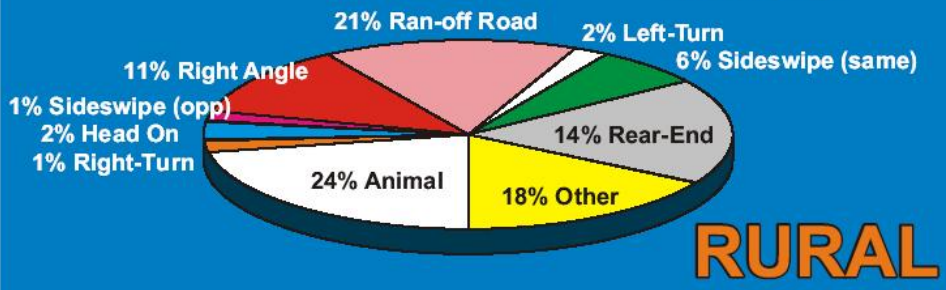
- As a class, freeways have lower crash and fatality rates than conventional roadways. This is likely due to three factors:
  - Freeways only serve a mobility function
  - Freeways tend to have a consistently high standard of design
  - Freeways have a very strict control of access
- Of the conventional roadways, Trunk Highways had the lowest crash rate (1.4) and the second lowest fatality rate (1.4).
- City streets had the highest crash rate (3.8) and the lowest fatality rate (0.6).
- County and Township roads had moderately high crash rates and the highest fatality rates. This distribution of crashes generally supports the idea that greater numbers of crashes occur in urban areas and greater numbers of fatal crashes occur in rural areas.
- Crash rates and fatality rates by roadway jurisdiction (and for the state as a whole) are interesting, however, there is a great deal of evidence to suggest that crash rates are more a function of roadway design than who owns the road.

TRAFFIC SAFETY FUNDAMENTALS HANDBOOK

page 20 of 53

Roadway Segment Crash Distribution By Rural vs. Urban





99 DATA

Note: Percentages rounded

HIGHLIGHTS:

- There is a significant difference in the types of crashes that occur on urban versus rural roads.
- Urban crashes are predominately 2 vehicle (about 85%) and rural crashes are predominately single vehicle (about 55%).
- The most common types of urban crashes include:
  - Rear-End (36%)
  - Right Angle (26%)
  - Left Turn (8%)
- The most common types of rural crashes include:
  - Deer Hits (24%)
  - Run off the Road (21%)
  - Rear-End (14%)
  - Right Angle (11%)
- Some types of crashes are more severe than others. Only 2% of all rural crashes involve head-on collisions, but they account for 20% of the fatal crashes.

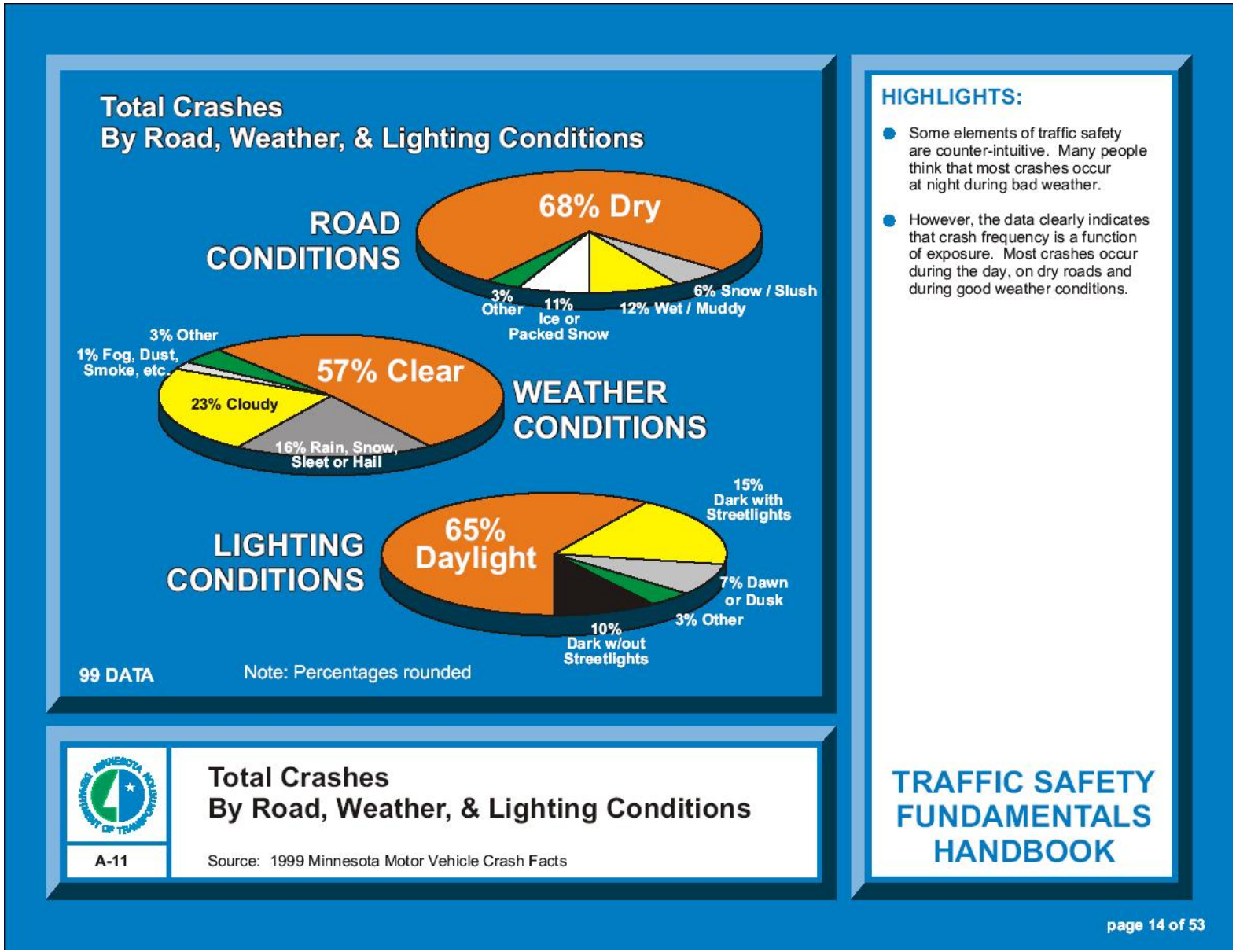
Roadway Segment Crash Distribution By Rural vs. Urban

A-19

Source: 1999 Minnesota Motor Vehicle Crash Facts

TRAFFIC SAFETY FUNDAMENTALS HANDBOOK

page 22 of 53


Total Crashes
By Road, Weather, & Lighting Conditions
ROAD CONDITIONS
68% Dry
3% Other
11% Ice or Packed Snow
12% Wet / Muddy
6% Snow / Slush
WEATHER CONDITIONS
57% Clear
3% Other
1% Fog, Dust, Smoke, etc.
23% Cloudy
16% Rain, Snow, Sleet or Hail
LIGHTING CONDITIONS
65% Daylight
15% Dark with Streetlights
7% Dawn or Dusk
3% Other
10% Dark w/out Streetlights
99 DATA
Note: Percentages rounded
A-11
Total Crashes
By Road, Weather, & Lighting Conditions
Source: 1999 Minnesota Motor Vehicle Crash Facts
HIGHLIGHTS:
Some elements of traffic safety are counter-intuitive. Many people think that most crashes occur at night during bad weather.
However, the data clearly indicates that crash frequency is a function of exposure. Most crashes occur during the day, on dry roads and during good weather conditions.
TRAFFIC SAFETY FUNDAMENTALS HANDBOOK
page 14 of 53

Alternative Methods for Identifying Potentially Hazardous Locations

1. Number of Crashes annually is greater than X crashes per year
2. Crash Rate is greater than Y crashes per million vehicles annually
3. Critical Rate equals statistically adjusted Crash Rate to account for random nature of crashes.

B-04

Alternative Methods for Identifying Potentially Hazardous Locations

HIGHLIGHTS:

- There are three primary methods for identifying potentially hazardous locations.
- The first method would involve setting an arbitrary threshold value of X crashes per year at any particular location. This is the simplest approach with the least data requirements. However, the selection of the threshold value is subjective and this methodology does not account for variations in traffic volume or roadway design/traffic control characteristics.

  This method is better than nothing and would be most applicable in systems consisting of similar types of roads with only small variations in traffic volumes.
- The second method consists of computing crash rates and then comparing to an arbitrarily selected threshold value of Y crashes per unit of exposure (a crash rate).
  Advantage:
  - Allows comparison of facilities with different traffic volumes

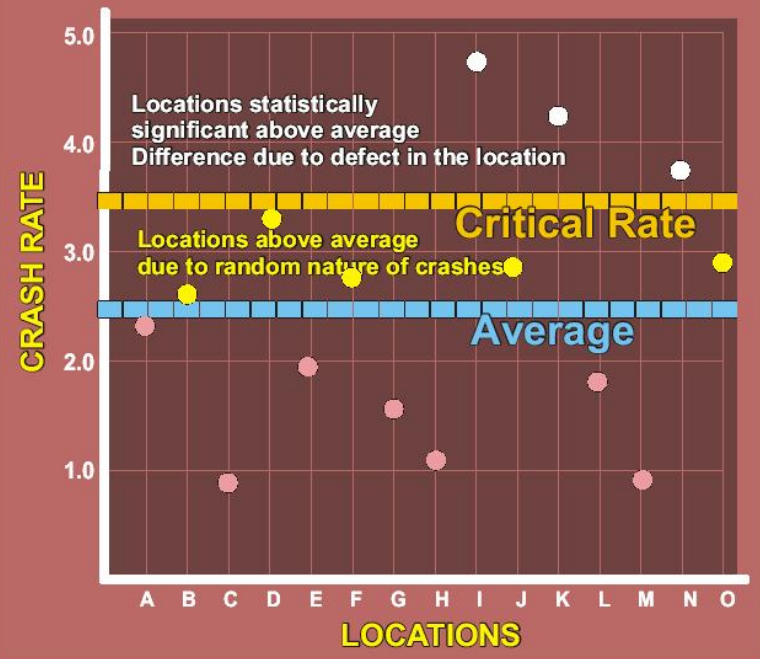
  Disadvantages:
  - Subjective selection of the threshold value
  - Requires more data (traffic volumes)
  - Does not account for known variation in crash rates among different types of road designs.
  - Does not account for the random nature of crashes

  Conclusion:
  - Limited applicability, better than just using crash frequency
- The third method involves using a statistical quality control technique called "Critical Crash Rate"
  Advantage:
  - Only identifies those locations as hazardous if they have a crash rate statistically significantly higher than at similar facilities

  Disadvantage:
  - Most data intensive methodology (volumes and categorical averages)

  Conclusion:
  - The best, most accurate, and statistically reliable method for identifying hazardous locations.

Effect of Random Distribution of Crashes



B-05

Effect of Random Distribution of Crashes

HIGHLIGHTS:

The Concept of "Critical Crash Rate"

- The technique that uses the critical crash rate is considered to be the best for identifying hazardous locations.
- The critical crash rate accounts for the key variables that effect safety, including:
  - The design of the facility
  - The type of intersection control
  - The amount of exposure
  - The random nature of crashes
- The concept suggests that any sample or category of intersections or roadway segments can be divided into three basic parts:
  - Locations with a crash rate below the categorical average: these locations are considered to be SAFE because of the low frequency of crashes and can be eliminated from further review.
  - Locations with a crash rate above the categorical average, but below the critical rate: these locations are considered to be SAFE because there is a very high probability (90-95%) that the higher than average crash rate is due to the random nature of crashes.
  - Locations with a crash rate above the critical rate: these locations are considered to be UNSAFE and in need of further review because there is a high probability (90-95%) that conditions at the site are contributing to the higher crash rate.
- The other primary advantage of using the critical crash rate is that it helps screen out the 90% of the locations that do not have a problem and focuses an agency's attention and resources on the limited number of locations that do have a documented problem (as opposed to a perceived problem).

page 30 of 53

Calculating Crash Rates

Intersection Rates:

Rate per Million Entering Vehicles = $\frac{\text{(number of crashes) (1 million)}}{\text{(number of years) (ADT) (365)}}$

Segment Rates:

Rate per Million Vehicle Miles = $\frac{\text{(number of crashes) (1 million)}}{\text{(segment length) (number of years) (ADT) (365)}}$

Critical Rate: $R_c = R_a + K (R_a / m)^{1/2} + 0.5/m$

R_c = Critical Crash Rate
for intersections: crashes per MEV
for segments: crashes per MVM

R_a = System Wide Average Crash Rate by Intersection or Highway Type

m = Vehicle Exposure During Study Period
for intersections: ADT ($365/10^6$)
for segments: ADT ($365/10^6$) length

k = Constant based on Level of Confidence

Level of Confidence	0.995	0.950	0.900
k	2.576	1.645	1.282

B-06

Calculating Crash Rates

HIGHLIGHTS:

- The number of crashes at any location is almost always a function of exposure. As the number of vehicles entering an intersection or the vehicle miles of travel along roadway segments the number of crashes increases..
- The use of crash rates (crash frequency per some measure of exposure) accounts for this variability and allows for comparing locations with similar designs but different volumes.
- Intersection crash rates are typically expressed as the number of crashes per million entering vehicles.
- Segment crash rates are typically expressed as the number of crashes per million vehicle miles (of travel).
- The Critical Crash Rate is calculated by adjusting the systemwide categorical average based on the amount of exposure and a statistical constant indicating level of confidence.
- The critical rate increases as the volume decreases.
- The same formulas can be used to calculate fatality or injury rates or the rate at which any particular type of crash is occurring.
- A good rule of thumb is to use three years of crash data when available. More data is almost always useful, but increases the concern about changed conditions. Using only one or two years of data presents concerns about sample size and statistical reliability.