R E P O R T

District Safety Plans Update

Prepared for

Minnesota Department of Transportation

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Contents

Table(s)

Figure(s)

Acronyms and Abbreviations

ADT	average daily traffic
CMF	crash modification factor
CRF	crash reduction factor
CSAH	County State Aid Highway
ERA	edge risk assessment
FA	Fatal + Incapacitating
FHWA	Federal Highway Administration
FYA	flashing yellow arrow
HO/SSO	head-on and sideswipe opposing
HO + RE + SSP + SSO	Head-on + Rear-end + Sideswipe Passing + Sideswipe Opposing
HAWK	High-Intensity Activated Crosswalk Beacon
HSIP	Highway Safety Improvement Program
MnDOT	Minnesota Department of Transportation
MNTH	Minnesota Trunk Highway
mph	mile(s) per hour
MVMT	million vehicle-miles traveled
NCHRP	National Cooperative Highway Research Program
RCI	reduced conflict intersection
RICWS	rural intersection conflict warning system
ROR/SSSD	run-off-road and sideswipe same direction
SHCL	sustained high-crash locations
SHSP	Strategic Highway Safety Plan
SSO	sideswipe opposing
TIS	Transportation Information System
TZD	Toward Zero Deaths
USTH	U.S. Trunk Highway

Introduction

The Minnesota Department of Transportation (MnDOT) is updating the 2009 through 2012 safety plans for the seven districts in the Greater Minnesota region. The seven districts that participated are: District 1 (Duluth), District 2(Bemidji), District 3 (Baxter), District 4 (Detroit Lakes), District 6 (Rochester), District 7 (Mankato), and District 8 (Willmar). District 5 (Metro) chose not to participate in developing further analysis and the district safety plan. The Office of Traffic, Safety, and Technology provides strategic oversight for the updated, comprehensive safety review and analysis across the state trunk highway system (state system). The updated analysis was conducted because:

- The number of fatal crashes on the state system has been flat for several years.
- A systemic risk assessment of Minnesota's county roadways was completed in 2013, which generated a number of technical refinements in safety project development. The refinements resulted in widespread implementation of low-cost safety improvements. The widespread implementation may be related to a 25 percent reduction in fatality rates on the county system (Figure 1-1).
- The previous safety plans were becoming outdated.

The updated analysis of the state system incorporated lessons learned from the County Roadway Safety Plans, an effort that reviewed more than 36,000 miles of paved county roadways, 15,000 intersections, and 20,000 horizontal curves. The county effort resulted in the identification of more than 17,000 projects with estimated implementation costs in excess of $245 million.

This effort of updating the district safety plans also included a site analysis that examined the state system to determine high-crash locations. In addition, a systemic risk assessment of the system was conducted, which identified four levels of prioritization:

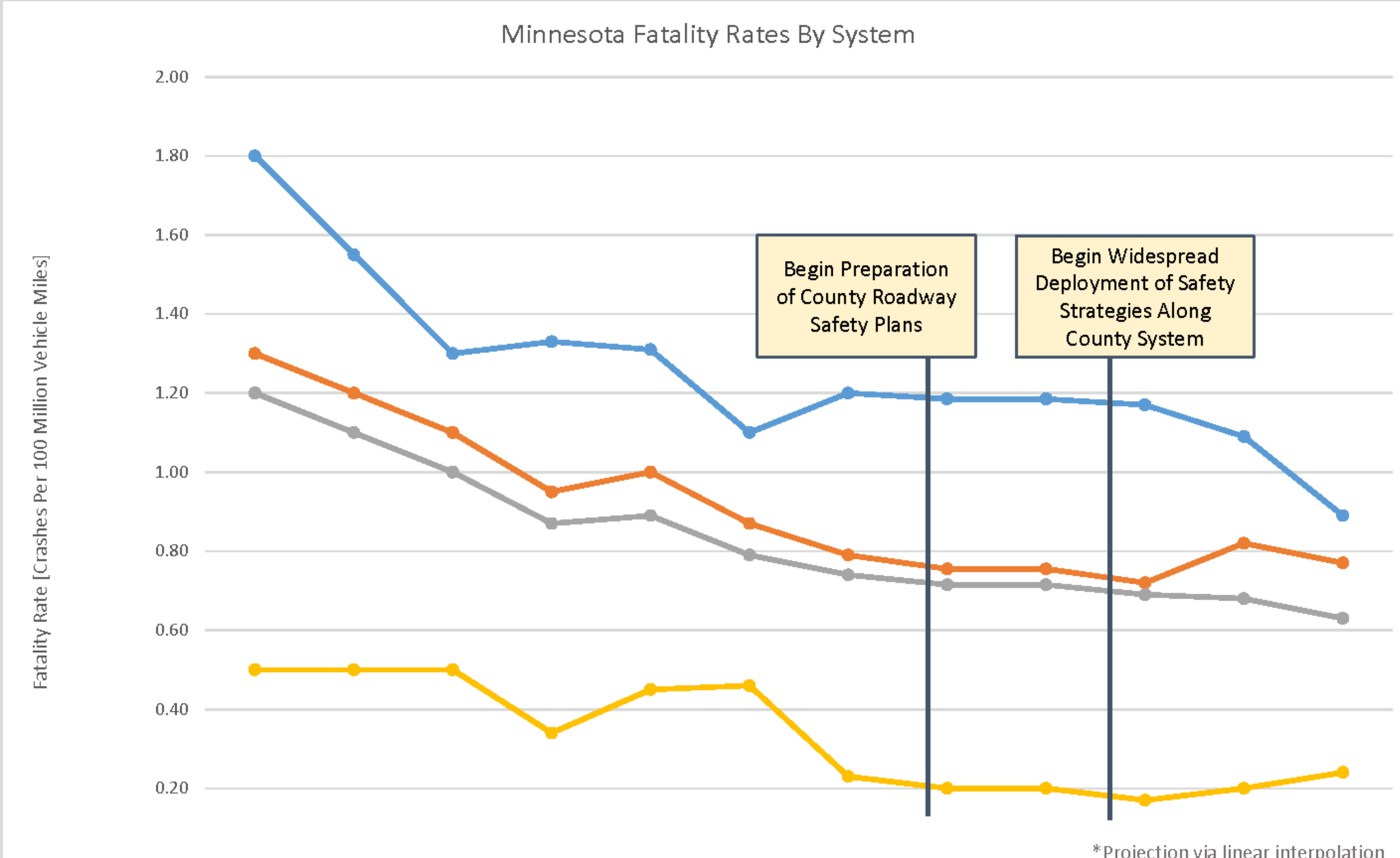
1. The types of crashes with the highest number of occurrences that represent the greatest opportunity for reduction (known as focus crash types). This first level also identified the roadway and traffic characteristics that are common to the locations with the focus crash types.
2. The prioritization of highway segments, curves, and intersections based on the presence of risk factors found at locations with the focus crash types. The locations with multiple risk factors were considered high-priority candidates for safety investment.
3. A prioritized short list of safety strategies that have been proven effective at mitigating the focus crash types.
4. Suggested safety projects for a specific safety strategy at locations identified as high-priority candidates for safety investment.

The analysis provided a comprehensive list of suggested safety projects based on the site analysis, identification of the high-crash locations, and the systemic risk assessment of the state system and adopted risk factors. The comprehensive list with the results was provided to each of the seven participating districts.

After the results were disseminated to district staff, the suggested safety projects needed to be discussed and finalized. Coordination with district staff was an integral part of the overall process to finalize the safety projects. District traffic engineers provided feedback on the definition of high-crash locations and the roadway and traffic characteristics used in the systemic risk assessment. In addition, staff from the seven districts participated in two, safety-focused workshops in their respective district. The first workshop focused on potential innovative solutions for problem locations identified by the districts. The second workshop focused on providing comments on the systemic risk process and the initial identification of “at-risk” locations considered high-priority candidates for safety investment. Ultimately, district staff reviewed the initial lists of suggested safety projects and decided the projects that would make their final comprehensive lists.

Sections of this plan include:

- Section 1 - Introduction
- Section 2 - Methodology and Analytical Process
- Section 3 - Statewide Results and Key Findings
- Section 4 - District 3 Safety Plan
- Section 5 - References
- Appendices include risk rating results (Appendix A), project decision trees (Appendix B), Greater Minnesota and District Crash Trees (Appendix C), literature reviews (Appendix D), district evaluation plans (Appendix E), and district project development (Appendix F).



	2003	2004*	2005	2006	2007	2008	2009	2010*	2011*	2012	2013	2014
County	1.80	1.55	1.30	1.33	1.31	1.10	1.20	1.19	1.19	1.17	1.09	0.89
Trunk Highway	1.30	1.20	1.10	0.95	1.00	0.87	0.79	0.76	0.76	0.72	0.82	0.77
State Total	1.20	1.10	1.00	0.87	0.89	0.79	0.74	0.72	0.72	0.69	0.68	0.63
Interstate	0.50	0.50	0.50	0.34	0.45	0.46	0.23	0.20	0.20	0.17	0.20	0.24

Figure 1-1. Minnesota Fatality Rate Trend Line

SECTION 2

Methodology and Analytical Process

2.1 Background

The methodology used for each of the seven districts in the Greater Minnesota region focused on identifying and prioritizing specific locations along the state system that could be considered candidates for safety investment through MnDOT-distributed Highway Safety Improvement Program (HSIP). Consistent with current guidelines and nationwide best practices, the analysis was comprehensive and identified candidate locations through a site analysis at sustained high-crash locations (SHCL) and a systemic risk assessment of the entire state system in each district. In addition, for a designated subset of locations determined to be a high priority, safety projects were developed for the implementation of a specific strategy or combination of strategies at a specific location.

A key underlying factor in the analytical process was to recognize that the final list of suggested safety projects identified through the site analysis and systemic risk assessment needed to be balanced. District staff must provide each district with the flexibility to effectively manage their construction program and improve safety at as many high-priority locations as possible while responding to the concerns of local officials and working with a limited HSIP budget. The total funding for HSIP is approximately $31 million annually with slightly more than 60 percent reserved for supporting safety projects on local systems, which results in approximately $12.4 million available to support safety improvements on the state system. The overall safety funding accounts for slightly more than 1 percent of the state annual construction program. Safety funding combined with statewide distribution of funding proportionate to the fraction of fatal and serious injury crashes results in a district target HSIP allocation for state highways ranging from approximately $660,000 to $3.9 million (Table 2-1).
The Figure 2-1 map shows the districts that receive safety funding.

Table 2-1. Allocation of Federal Highway Safety Improvement Program Funds

District	2017 HSIP Allocation
1 – Duluth	$1.2 million
2 – Bemidji	$660,000
3 – Baxter	$1.9 million
4 – Detroit Lakes	$930,000
6 – Rochester	$1.4 million
7 – Mankato	$1.4 million
8 – Willmar	$1.0 million
5 – Metro	$3.9 million
Total	**$12.4 million**

Figure 2-1. District Map

Almost 90 percent of severe crashes occur at locations not considered high-crash locations. Also, the randomness of severe crashes and limited HSIP funding supports directing safety funds to standalone projects that involve implementation of highly effective, low-cost strategies that can be widely deployed across the state system. Typically, the phrase highly effective, as it relates to the safety program, is defined as having a proven history (which is documented safety research showing success across a large number of deployments) of reducing particular types of crashes. A proven history of success provides HSIP managers and district staff with a high level of confidence that deployment of a particular strategy will result in crash reductions. Low-cost (or relatively low-cost) strategies allow for the widest possible investment across many miles, curves, and intersections. Wide deployment of low-cost strategies have been demonstrated to be the most effective approach for mitigating crashes with very low densities. For example, rural highway segments and intersections average around 0.01 severe crashes per mile (or per intersection per year).

The MnDOT Office of Traffic Safety and Technology approach to funding safety projects is consistent with national priorities established by the Federal Highway Administration (FHWA), which encourage the development of stand-alone safety projects. Candidate locations for safety investment need to be based on either a crash history or a risk assessment justifying the safety improvement. The risk assessment often supports the selection of stand-alone projects based on an estimated crash reduction. However, in some cases, candidate safety locations may overlap with other planned projects (maintenance overlays and bridge replacement) and economies may be realized by combining efforts into a single project. To be considered for HSIP funding, safety needs must be justified based on crash history or the results of a risk assessment, regardless of how the project is delivered or programmed.

2.2 Network Overview

Highway segments, intersections, and curves were identified as part of the assessment. MnDOT's 2013 Tool kit (trunk highway crash database) provided base information and addressed the major gaps in the information. More than 1,000 intersections were added to the assessment and a comprehensive database containing almost 5,500 curves was developed and delivered to MnDOT. In total, 10,702 miles of trunk highway, 6,260 intersections, and 5,466 horizontal curves were included in the analysis (Table 2-2). The Metro District opted out of participating in developing further analysis and district safety plans.

Table 2-2. Statewide Network Overview

	Rural			Urban	
District	***Miles***	***Curves***	***Intersections***	***Miles***	***Intersections***
1 – Duluth	1,434	1,454	419	104	181
2 – Bemidji	1,689	489	772	81	553
3 – Baxter	1,522	969	716	126	265
4 – Detroit Lakes	1,510	631	599	87	241
6 – Rochester	1,278	1,018	641	136	258
7 – Mankato	1,243	449	634	91	283
8 – Willmar	1,317	456	499	84	199
Total	**9,994**	**5,466**	**4,280**	**708**	**1,980**

Data in Table 2-2 include all rural highways and intersections in the Greater Minnesota region. A sample of urban segments and intersections in seven cities was selected by each participating district. In addition, more than 90 percent of the total highway miles and 65 percent of intersections are considered rural and more than 80 percent of rural highway miles are considered conventional (primarily two-lane highways).

2.3 Crash Overview

The crash data used in the analysis were obtained from the Minnesota Transportation Information System (TIS) database and the most recent 5 years of data available at the beginning of the study were used (2009 to 2013). Consistent with Minnesota's adopted safety performance measures, the analysis focused on severe crashes; those involving fatalities and serious injuries. An overview of the crash data (Figures 2-2 and 2-3) indicate:

- Rural
  - In the Greater Minnesota region, 86 percent of severe crashes occur on rural roads.
  - Of the severe crashes on rural roads, 68 percent occur on conventional roads followed by 18 percent on expressways (limited access/controlled entryways and exits) and 14 percent on freeways (fully controlled access).
  - On rural two-lane roads, 63 percent of severe crashes are segment related versus 31 percent of severe crashes at intersections.
  - On rural expressways, there are slightly more intersection-related crashes (49 percent) compared to segment-related crashes (47 percent); the remaining 4 percent of crashes are categorized as occurring at other or unknown facilities
  - On all rural segments, the most common type of crash is lane departure (77 percent), of which 35 percent are head-on and sideswipe opposing (SSO) and approximately 30 percent are curve related.
  - At rural intersections, 68 percent of severe crashes occur at thru-stop control. The most common type of severe crash involves a right-angle collision (71 percent).
- Urban
  - In urban areas, 78 percent of severe crashes occur on conventional roadways (as opposed to 22 percent on roadways with some level of access management).
  - In urban areas, 61 percent of severe crashes occur at intersections, of which 48 percent occur at intersections with traffic signal control and 48 percent at thru-stop control.
  - The most common types of severe crashes at traffic signal control and thru-stop control intersections are right-angle collisions (45 percent) and pedestrian or bicyclist involved collisions (13 percent).

Crash data indicate a need for increased focus on lane departure along segments and curves and right-angle collisions at intersections with thru-stop control in rural areas. Right-angle collisions and pedestrian involved crashes in urban areas are priorities for safety investment and represent the greatest opportunity for reducing severe crashes in urban areas across the state system. Crashes involving deer (2 percent) and winter weather (13 percent) are not considered priorities for safety investment because of the relatively few number of severe crashes. Therefore, crashes involving deer and winter weather are not crash emphasis areas in the current Strategic Highway Safety Plan (SHSP).

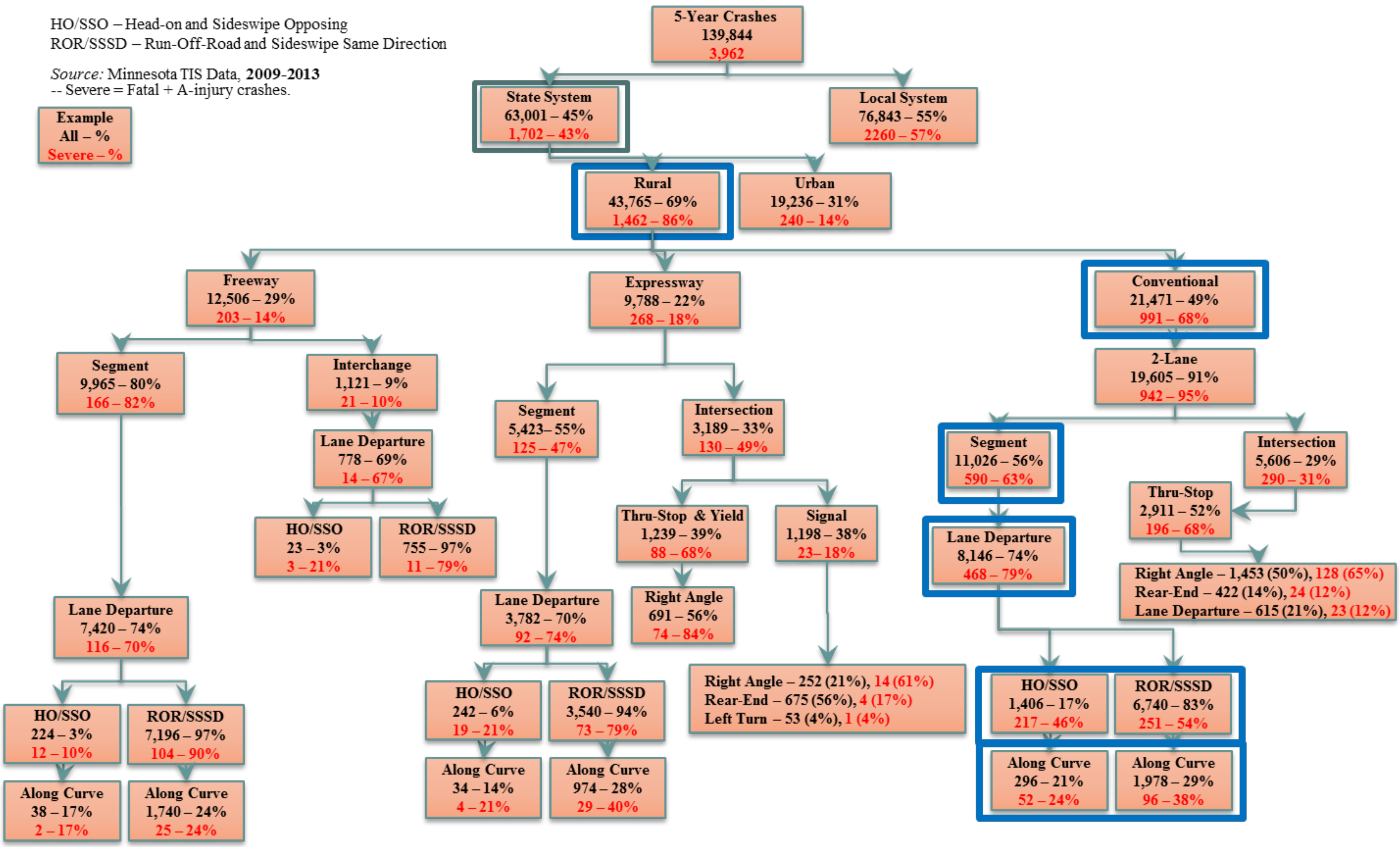


Figure 2-2. Greater Minnesota Rural Crash Tree

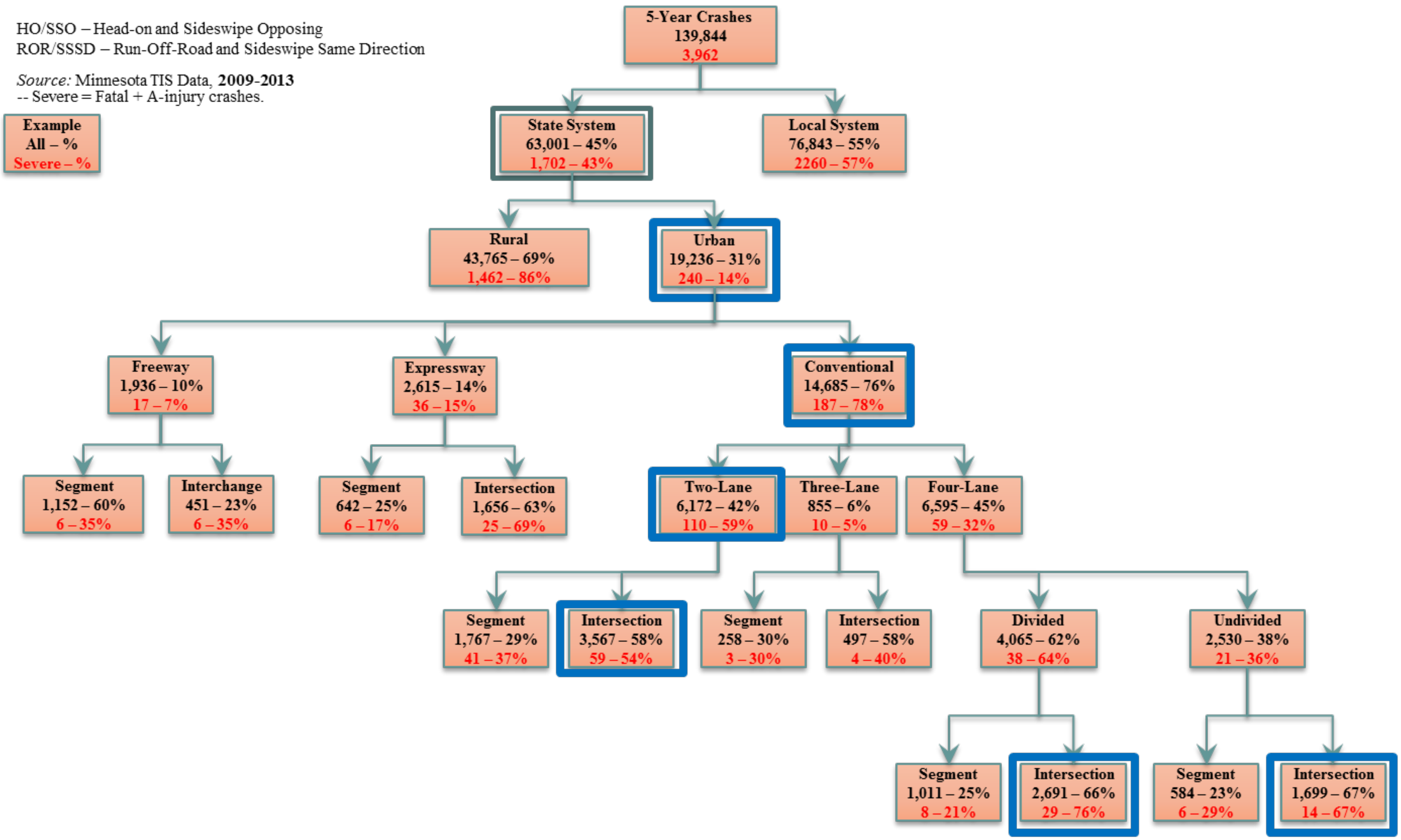


Figure 2-3. Greater Minnesota Urban Crash Tree

2.4 Safety Strategies

There are three key points regarding the identification of safety strategies. First, there is no universal safety strategy; national safety research categorizes various strategies with specific types of crashes. Second, safety program managers have exhibited a bias toward selecting projects that use strategies proven effective at reducing specific types of crashes. The bias is based on the expectation that, if the limited supply of safety funds in Minnesota are used to implement strategies proven to reduce crashes at hundreds of other locations around the country, then the investment in Minnesota will result in a reduction of crashes. Third, safety program managers have a bias toward directing the limited amount of safety funds toward projects that involve low-cost strategies. Since less than 25 percent of severe crashes occur at locations considered high-crash areas, it is necessary to use low-cost strategies to systemically implement safety improvements across the state system.

The basic approach to identifying a short list of high-priority safety strategies began by documenting the focus crash types, reviewing national research to assemble a comprehensive list of possible strategies, and conducting a series of screening exercises. A review of national research (National Cooperative Highway Research Program [NCHRP] Report 500 Series, Minnesota's SHSP [MnDOT, 2014], the FHWA's Crash Modification Factor [CMF] Clearinghouse [focusing on roadway related strategies] [FHWA, 2015]), reveals there are more than 600 safety-related strategies, including more than 30 strategies intended to mitigate lane departure crashes, more than 70 strategies intended for thru-stop controlled intersections, and more than 40 strategies for signal controlled intersections.

Initial screening eliminated strategies determined not feasible based on factors such as climate (raised pavement markers) or agency practices (installing reflective material on fixed objects such as trees or utility poles). Subsequent rounds of screening were based on proven documentation of crash reduction factors (CRFs). High-crash reduction with high-quality of supporting research creates strong screening data, estimates implementation costs (lower costs are preferred), and maintains consistency with priorities established in Minnesota's SHSP.

The initial lists of safety strategies and the screening factors (CRFs and estimated implementation costs) were shared with the districts for review and comment. The adopted lists of high-priority safety strategies for rural and urban facilities are documented in Tables 2-3 through 2-7. The subsequent development of safety projects across all seven districts utilized these lists of high-priority strategies.

Table 2-3. Strategies – Rural Segments

Strategy	Crash Reduction Factor[a]	Typical Installation Costs
Centerline Rumble Strip	40% for head-on/SSO crashes	$3,600 per mile
Buffers Between Opposing Lanes	50% for all crashes and 100% for head-on crashes [based on Trunk Highway 5 in Lake Elmo, Minnesota]	$150,000 to $500,000 per mile
Shoulder/Edgeline Rumble Strip	20% for run-off-the-road road crashes	$5,850 per mile
Safety Edge	5% to 10%[b]	
Enhanced Edgeline (6 inch and 8 inch)	10% to 45% for all rural serious crashes (6 inches)	$1,980 per mile
Shoulder Paving (2 feet, 4 feet, 6 feet)	20% to 30% for run-off-road crashes (with shoulder rumble) (2 feet only)	$54,000 per mile +$5,850 per mile (for edge rumble)

Table 2-3. Strategies – Rural Segments

Strategy	Crash Reduction Factor[a]	Typical Installation Costs
Clear Zone Maintenance/ Enhancements		
Ditch/Embankment Improvements		$500,000 to $1 million per mile

Notes:

[a] CRFs based on review of CMF Clearinghouse and other published research

[b] For all crashes

Table 2-4. Strategies – Rural Intersections

Strategy	Crash Reduction Factor[a]	Typical Installation Costs
Upgrade Signs and Pavement Markings	40% for upgrading all signs and pavement markings/ 15% for STOP AHEAD pavement marking	$3,000 per approach
Street lights (and approaches)	25% to 40% of night time crashes	$6,000 per light
All-way Stop/Yield		$1,000 per intersection
Reduced Conflict Intersection (RCI)	17% all crashes/ 100% angle crashes	$750,000 per intersection
Rural Intersection Conflict Warning System (RICWS)	50% all crashes/ 75% severe right-angle crashes	$150,000 per intersection
Offset T-Intersection		
Roundabout	20% to 50% all crashes/ 60% to 90% right-angle crashes	$2,000,000 per intersection
Turn Lanes (offset, channelized)		

Note:

[a] CRFs based on review of CMF Clearinghouse (FHWA, 2015) and other published research.

Table 2-5. Strategies – Rural Curves

Strategy	Crash Reduction Factor[a]	Typical Installation Costs
Chevrons	20% to 30%	$3,000 per curve
Delineators	18% to 34%[b]	
High Friction Surface Treatment		
Dynamic Curve Signing		$50,000 per curve
Lighting		
Clear Zone Maintenance/Enhancements		
Reconstruct → TT to Single T Intersection		

Notes:

[a] CRFs based on review of CMF Clearinghouse (FHWA, 2015) and other published research.
[b] Non-intersection, head-on, run-off-road, sideswipe, night time crash types

Table 2-6. Strategies – Urban Intersections

Strategy	Crash Reduction Factor[a]	Typical Installation Costs
Echelon		
Continuous Flow Intersection		
Signalized RCI		
Confirmation Lights	25% to 84% reduction in violations	$1,200 per two approaches
Traffic Enforcement Cameras (D3 example)		$50,000
Pedestrian Countdown Times	25% vehicle/pedestrian crashes	$12,000 per intersection
Leading Pedestrian Intervals	Up to 60% pedestrian/vehide crashes	$600 per intersection
Curb Extensions	Increase in vehicles yielding to pedestrians	$36,000 per corner
Center Island Medians	46% in vehicle/pedestrian crashes	$24,000 per approach
Roundabout (including mini roundabout)	20% to 50% all crashes/ 60% to 90% right-angle crashes	$3,000,000 per intersection
Urbanization (make it feel urban)		
Rectangular Rapid Flash Beacon	75% of drivers yield to pedestrians	$15,000
High-Intensity Activated Crosswalk Beacon (HAWK)	69% vehicle/pedestrian	$50,000 to $120,000
Flashing Yellow Arrow (FYA) --> Note: Permitted to FYA	19.4% left-turn crashes	
Turn Lanes (offset, channelized)	27%	$150,000 to $500,000

Note:

[a] CRFs based on review of CMF Clearinghouse (FHWA, 2015) and other published research.

Table 2-7. Strategies – Urban Segments

Strategy	Crash Reduction Factor[a]	Typical Installation Costs
Road Diet (three- and five-lane conversions)	30% to 50%	$48,000 per mile (three-lane) $54,000 per mile (five-lane)+$36,000 per signalized intersection for updates (e.g., loop and signal head placement)
¾-Intersection	25%	$150,000 per location
Divided Roadway	22% (Highway Safety Manual [MnDOT, 2014] b13.4.2.6)	$5 million to $10 million per mile
Access Management (Access Management Plan)	5% to 31%	$360,000 per mile[b]
Bike Lane/Boulevard	Approximately 60% (Some studies have noted increases)	
Urbanization (make it feel urban)		
Dynamic Speed Feedback Sign		$30,000 per location

Notes:

[a] CRFs based on review of CMF Clearinghouse (FHWA, 2015) and other published research.

[b] For management of unsignalized intersection movements within a corridor that has a divided median. A typical project may include minor street diverters, signed turn restrictions, and median closings.

2.5 Sustained High-crash Assessment

The initial crash analysis of the state system focused on identifying intersections that met the definition for SHCLs. To be considered a SHCL, an intersection had to have a Fatal + Incapacitating (FA) Injury Crash Rate above the Critical FA Crash Rate. The Critical FA Crash Rate is a statistical technique that compares the actual FA crash rate at intersections to the expected crash value. The results of the comparison identified approximately 5 percent of intersections where the actual rate was statistically significantly higher than expected. Intersections identified as SHCLs were considered eligible for improvement through the state HSIP and were included in the safety project development exercise.

An overview of the 212 intersections across the state system, identified as SHCLs, is provided in Section 3 and a listing of the SHCLs in each district is in Section 4.

In addition to identifying the 212 high-crash intersections, the analysis produced another key conclusion. Severe crashes at these high-crash intersections accounted for approximately 10 percent of all severe crashes across the state system. This conclusion is what led to the companion effort of conducting a systemic risk assessment of the system.

2.6 Systemic Risk Assessment

Crash data support the identification of candidates for safety investment through site analysis of high-crash locations. However, while a necessary part of a comprehensive safety program, the site analysis alone is not sufficient. A systemic risk analysis must also be conducted.

The state intersection site analysis showed that a combination of high crash rates and at least 1 severe crash only identified approximately 5 percent of the intersections as being high-crash locations. These intersections accounted for around 10 percent of all severe crashes, which means that approximately 90 percent of severe crashes occur at locations whose crash histories do not exceed the critical FA crash rate. A detailed analysis indicates that these remaining severe crashes are widely distributed across more than 6,000 intersections and 10,000 miles of state highways. The resulting average density of crashes is 2 severe crashes per intersection (or per mile), *every 100 years*.

When initial efforts were made to engage Minnesota's counties in the state HSIP, Minnesota's system had a large number of severe crashes but only a few high-crash locations, which results in low densities of crashes in Minnesota. It was concluded that the traditional site analysis approach would not be effective at identifying candidate locations for safety investment. From a safety perspective, the entire system is considered "at-risk" because of a lack of high-crash locations and a large county system. To address system characteristics, MnDOT developed the systemic risk assessment, which was used across county highway systems to identify and prioritize the fraction of locations determined to be "at-risk" for severe crashes. The "at-risk" determination was based on a combination of roadway and traffic characteristics.

Severe crashes may be widely (but not randomly) scattered around the highway system. Therefore, the basic premise behind the systemic risk assessment approach is to examine the system to prioritize candidates according to the similar characterizes attributed to severe crashes. Locations with more characteristics associated with locations with severe crashes are more "at-risk" and, therefore, a higher priority for safety investment. This systemic risk analysis proved successful in the application to the county system. A set of risk factors were identified and locations with multiple risk factors were considered high-priority candidates for safety investment. Ultimately, more than 36,000 miles, 20,000 curves, and 15,000 intersections were analyzed. This effort resulted in the development of more than 17,000 safety projects (a specific mitigation measure at a specific location) valued at more than $245 million (an average of slightly more than $14,000 per project).

The approach used to identify risk factors in the update of each district's safety plans was similar to that used in the systemic risk assessment of the county system. Crash data for the state system was reviewed along with information for locations with severe crashes obtained from video logs, aerial photography, and a variety of MnDOT databases. The results of this effort combined with information from national research (NCHRP Report 500 Series, Minnesota's SHSP [MnDOT, 2014], the FHWA's CMF Clearinghouse (focusing on roadway related strategies) [FHWA, 2015]) resulted in an initial set of risk factors submitted to the district traffic engineers for review and comment. The final list of roadway and traffic characteristics used in the risk assessment of rural highways, curves, and intersections are documented in Table 2-8 and the risk factors for urban facilities in Table 2-9. The final set of roadway and traffic characteristics used in the assessment of the state system is similar to those used to evaluate the county roadway system, with three notable exceptions:

- The range of traffic volumes associated with locations with severe crashes is higher on the state system.
- The upper end of the range of curve radii is higher on the state system.
- The risk factors for rural divided highways is entirely new since there are no divided roadways on the rural county system.

The selection of the risk factors documented in Tables 2-8 and 2-9 required data analysis to identify characteristics associated with high densities of severe crashes. Particular emphasis was focused on severe lane departure crashes along rural segments and curves and severe angle crashes at intersections. This process supports the prioritization of the state system by identifying characteristics that represent a majority of the crashes on a minority of the system. Four examples of the type of data reviewed and the results that supported the selection of the particular risk factor include:

- Two-lane Rural Segments – Average Daily Traffic (ADT) (Figure 2-4): 78 percent of severe head-on/ SSO crashes occur along the 43 percent of miles with daily traffic volumes over 2,250 vehicles per day.
- Two-lane Rural Segments - Curve Density (Figure 2-5): 43 percent of severe lane departure crashes occur along the 32 percent of miles with curve density greater than 0.6 curves per mile.
- Rural Intersections – Distance to Previous STOP Sign (Figure 2-6): 57 percent of severe right-angle crashes occur at 44 percent of intersections where the previous STOP sign was more than 5 miles away (along the minor leg).
- Rural Curves – Curve Radius (Figure 2-7): 46 percent of severe lane departure crashes occur on the 36 percent of curves with radii between 500 feet and 1,800 feet.

Table 2-8. Risk Factors for Rural Facilities

	Two-lane Undivided		Four-lane Expressway		Four-lane Freeway	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Segments						
Shoulder Width (feet)	-	2				
Critical Radius Curve Density (curves per mile)	0.1	Unlimited	0.25	Unlimited	0.125	Unlimited
Median Width (feet)			-	65 feet		
Edge Risk Assessment (1 to 3)[a]	2	3				
Access Density (accesses per mile)	8	Unlimited	5	Unlimited		
ADT Range (vehicles per day)	3,500	Unlimited	16,000	Unlimited	20,000	Unlimited
Severe Lane Departure Density (crashes per mile per year)	0.014	Unlimited	0.037	Unlimited	0.028	Unlimited
Interchange Density (interchanges per mile)					0.4	Unlimited
Curves						
Radius (feet)	500	1,800	500	3,750		
ADT Range (vehicles per day)	2,000	Unlimited	16,000	Unlimited		
Severe Lane Departure Density (crashes per curve per year)	0.007	Unlimited	0.019	Unlimited		
Visual Trap	Present		Present			
Intersection on Curve	Present		Present			
Shoulder Width (feet)	-	4				
Intersections						
Skew (degrees)	10	Unlimited	10	Unlimited		
On/Near Curve	Present		Present			
Adjacent Development	Present		Present			
Previous Stop >5 Miles	Present		Present			
Volume Cross Product[b] (vehicles per day squared)	400,000	Unlimited	6,000,000	Unlimited		
Severe Right Angle Density (crashes per intersection per year)	0.007	Unlimited	0.022	Unlimited		

Notes:

Version 10/7/2015

[a] The 1 to 3 scale is based on a rating where 1 is low risk and 3 is high risk.

[b] Volume cross product is defined as the multiplication product of the major and minor approach average entering ADT.

Table 2-9. Risk Factors for Urban Facilities

	Minimum	Maximum
Segments		
ADT Range (vehicles per day)	9,000	Unlimited
Road Geometry	Multi-Lane (4+)	
Access Density (accesses per mile)	36	Unlimited
Speed Limit (miles per hour)	35	45
Primary Land Use	Urban or Suburban Retail	
Severe HO + RE + SSP + SSO Crash History	0.019	
Intersections - Right Angle		
Volume Cross Product (vehicles per day)	3,000,000	Unlimited
Traffic Control	Signal	
Major Corridor Speed (mph)	40	Unlimited
Skew (degrees)	5	Unlimited
Adjacent Curve	Present	
Primary Land Use	Urban or Suburban Retail	
Severe Right Angle Crash History (crashes per intersection per year)	0.006	
Intersections - Pedestrian/Bicycle		
Volume Cross Product (vehicles per day squared)	3,000,000	Unlimited
Traffic Control	Signal	
Major Corridor Speed (mph)	35	Unlimited
Skew (degrees)	5	Unlimited
Adjacent Curve	Present	
Primary Land Use	Urban or Suburban Retail	
Severe Pedestrian/Bicycle Crash History (crashes per intersection per year)	0.001	

Notes:

Version 10/19/2015

HO + RE + SSP + SSO = Head-on + Rear-end + Sideswipe Passing + Sideswipe Opposing

Seventy-eight percent of severe head-on/sideswipe opposing crashes occur on **43 percent** of the miles.

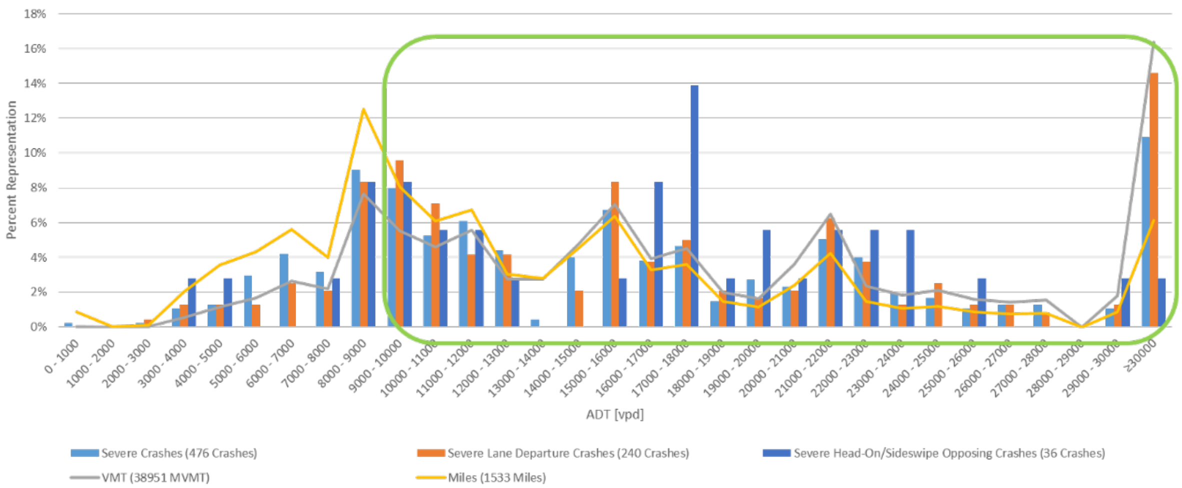


Figure 2-4. Two-lane Rural Segments – Average Daily Traffic

Forty-three percent of severe lane departure crashes occur on **32 percent** of the miles

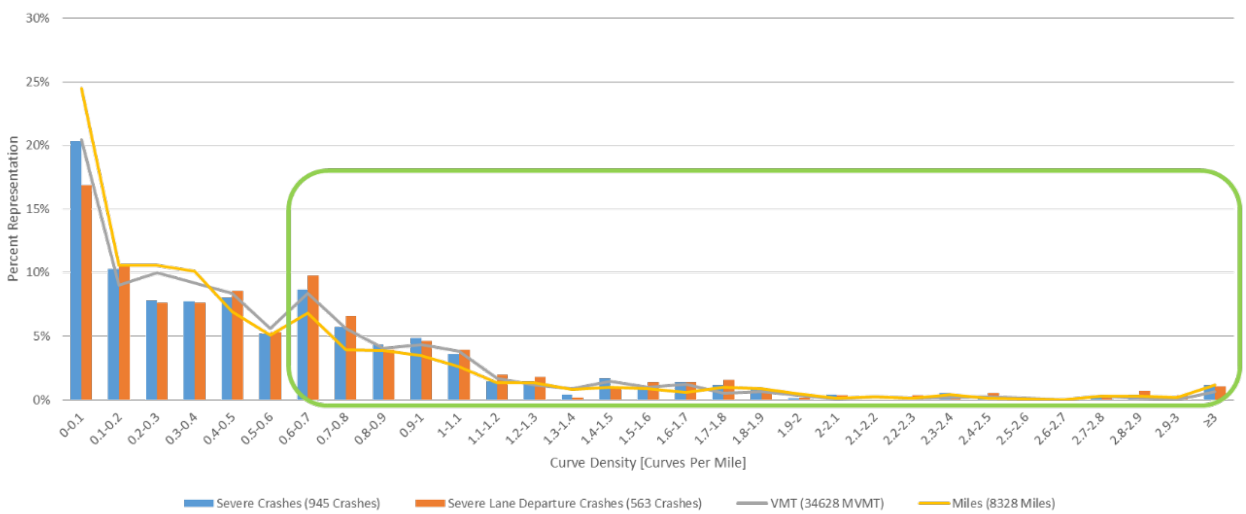


Figure 2-5. Two-lane Rural Segments - Curve Density

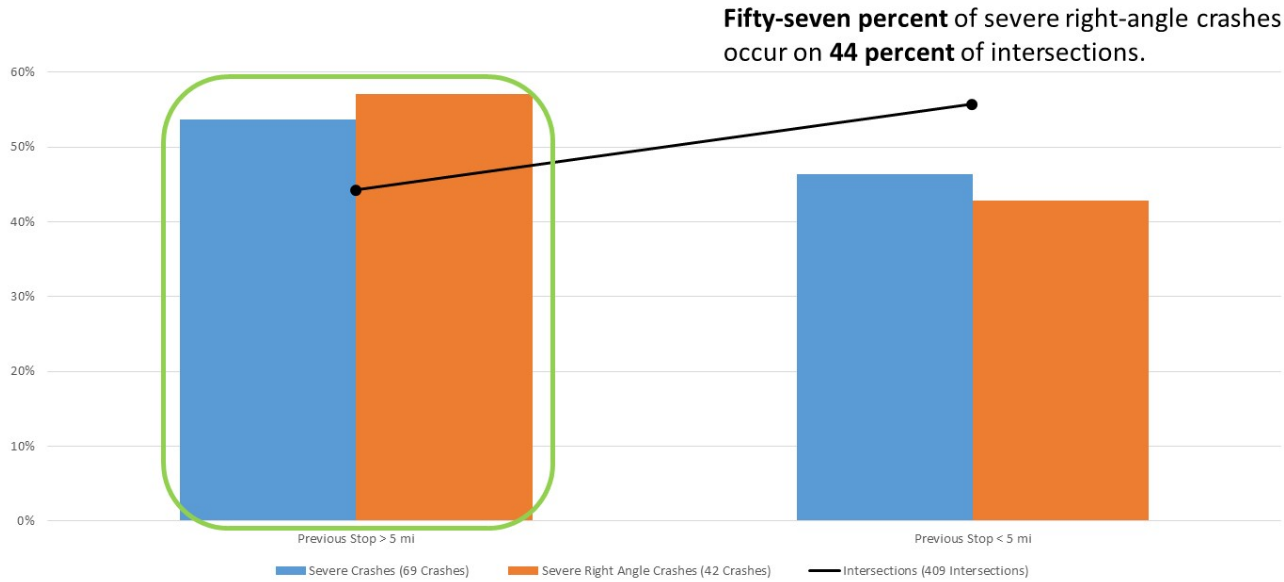


Figure 2-6. Rural Intersections – Distance to Previous STOP Sign

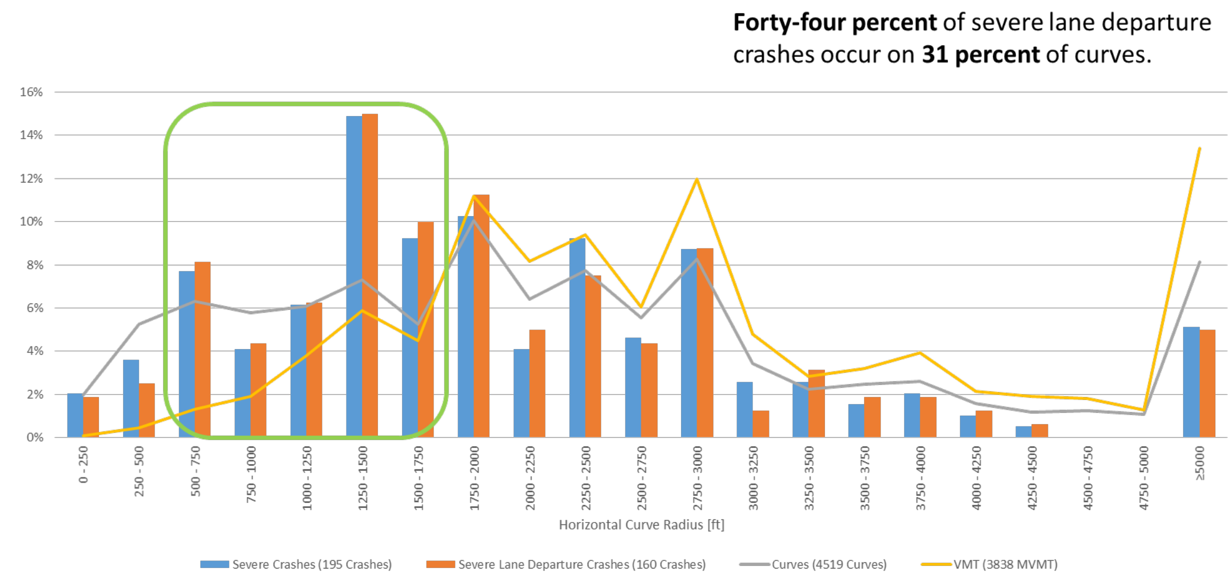


Figure 2-7. Rural Curves – Curve Radius

Figures 2-4 through 2-7 indicate that severe crashes are not uniformly distributed across the system and the presence of these roadway and traffic characteristics are associated with greater risk. In addition, as the number of risk factors increased, the number of locations decreased and the density of severe crashes increased. For example, the risk assessment of two-lane rural intersections determined that a minority (approximately 25 percent) of the system was considered high priority (three or more of the risk factors present) and the trends for severe crash density (Figure 2-8) indicate that as the number of risk factors increases, the crash densities also increase. This trend supports the notion of prioritization; suggesting the greater the number of factors, the higher the density of crashes.

Figure 2-8. Severe Crashes Versus Systemic Risk Rating: Rural Two-lane Intersections

Conducting the systemic risk assessment of the state system involved preparing prioritized lists of highway segments, intersections, and curves where roadway and traffic characteristics associated with severe crashes were present. The locations with multiple risk factors were considered high priorities for safety investment.

The analysis of statewide data for rural two-lane highways provided a roadway characteristic that was not chosen as a risk factor but consistently points to segments that have high densities of severe crashes. The segments along which the speed limits were increased to 60 mph have severe crash densities approximately 50 percent higher than on similar roadways with 55 mph limits (Figure 2-9). This high-crash density on 60 mph segments is greatest on highways with one, two, and three risk factors. There are no segments with five or six risk factors and a speed limit of 60 mph. The effect on crash densities of raising the speed limit approximates the effect of adding a risk factor, which further suggests that raising the speed limit on highways with risk factors would result in an increase in severe crashes.

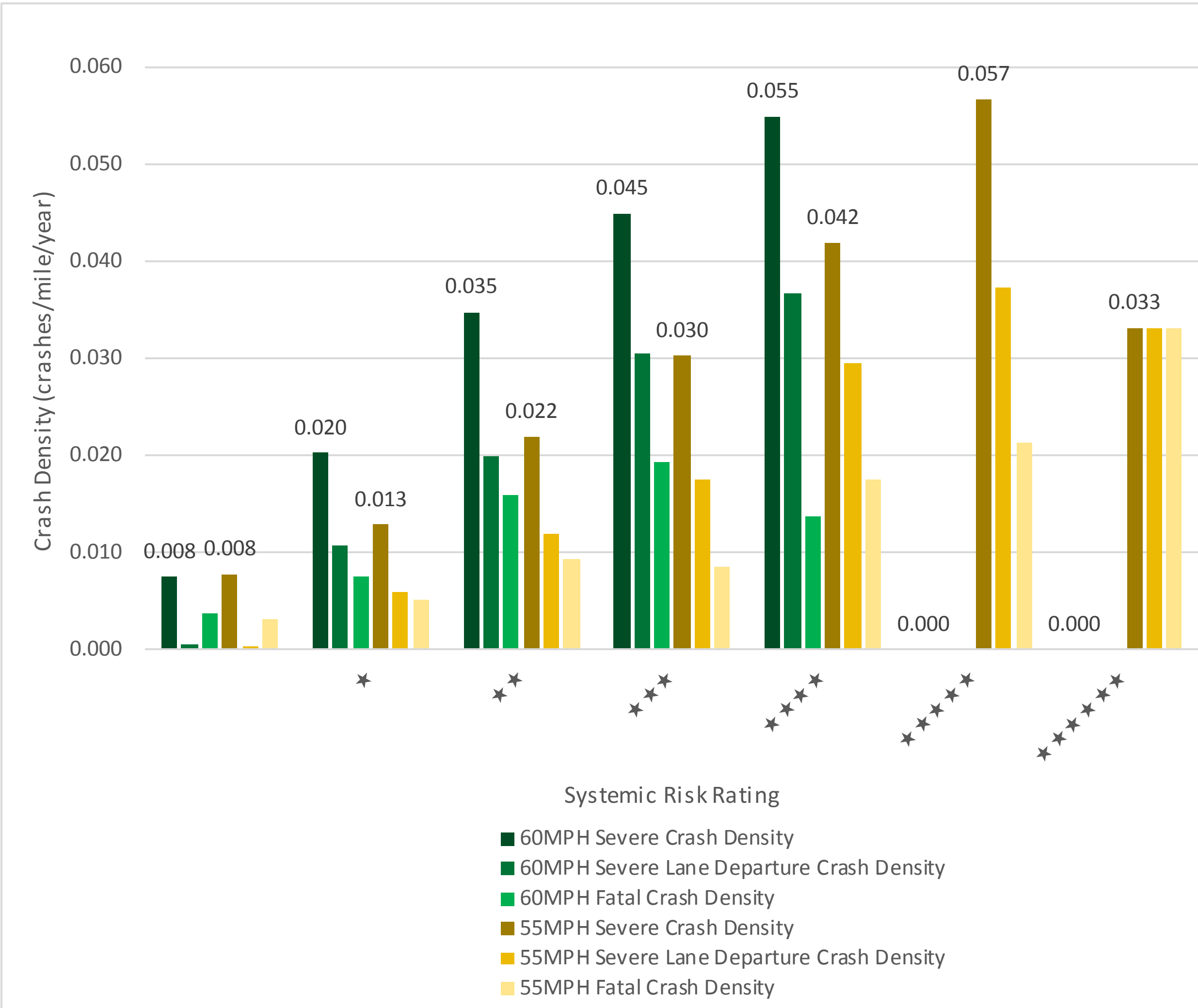


Figure 2-9. Severe Crash Density Versus Systemic Risk Rating Versus Speed Limit: Rural Two-lane Segments

The systemic risk assessment involved conducting separate analyses of rural and urban facilities. In rural areas, individual assessments using a different set of risk factors were conducted along two-lane, expressway and freeway segments. It was decided not to designate four-lane undivided highways as a separate and distinct type of highway for analysis because there are so few miles (24 miles out of a total of 9,994 miles of rural highways equals 0.2 percent) and so few severe crashes (3 out of a total of 1,457 severe crashes equals 0.2 percent). It was concluded the four-lane undivided segments by themselves represented too small of an opportunity for reduction to make the analytical effort worthwhile. As a result, these rural four-lane undivided segments were not evaluated. This is not to suggest that the 14 segments spread over all but one of the Districts (Metro District) should not be considered candidates for improvement. The risks associated with the four-lane undivided cross-section (primarily high-speed, rear-end collisions involving vehicles stopped in the inside through lane waiting for a gap to make a left turn) are well known. Statewide, there are only 14 segments totaling 24 miles, which indicates that the Districts are aware of the safety concerns. However, the very low number of severe crashes does suggest that the chances of further reducing crashes are very small. Therefore, projects that convert the segments to a safer cross-section or to add a median would likely be considered a low priority for safety funding.

In urban areas, a review of the data for four-lane undivided segments supported a similar conclusion. The 40 urban segments had too few miles (39 miles out of a total of 697 miles of urban highways equals 6 percent) and severe crashes (20 out of 280 equals 7 percent) to warrant a separate analytical effort. These urban four-lane undivided segments were included as part of the assessment of all urban highways. The risks associated with four-lane undivided highways are well known (crash rates 30 to 80 percent higher than other urban cross-sections). Also, the Districts have a long history of improving these types of highways by adding two-way left-turn lanes or medians. As was the case with rural four-lane undivided highways, the urban segments are likely candidates for improvements but because of the small number of statewide crashes, the urban segments may not be a high priority for safety funding.

Table 2-10. Rural Four-lane Undivided Segments

Corridor ID	Route System	Route Number	Start	End	Length (miles)
1.002.003	USTH	2	1.6 miles west CSAH 87 (speed limit 60)	0.3 mile west CSAH 87 (speed limit 40)	1.26
1.002.005	USTH	2	0.2 miles east Cohasset (speed limit 55)	0.5 mile west CSAH 63 (speed limit 60)	0.75
1.002.006	USTH	2	0.5 miles west CSAH 63 (speed limit 60)	0.1 mile west CSAH 63 (speed limit 50)	1.91
1.002.007	USTH	2	0.1 mile west CSAH 63 (speed limit 50)	0.1 mile west 17 Avenue NW Grand Rapids (speed limit 30)	0.67
1.002.022	USTH	2	0.1 mile east 1 Avenue (speed limit 40)	West Junction Interstate 35 (speed limit 55)	0.96
1.023.017	MNTH	23	0.1 mile east 130 Avenue west (speed limit 50)	0.1 mile west Prescott Street Duluth (speed limit 30)	2.09
2.002.021	USTH	2	0.5 mile west Bagley (speed limit 55)	West Bagley (speed limit 40)	0.58
3.012.005	USTH	12	Begin four-lane pass east Cokato	End four-lane Pass east Cokato	1.55
3.012.016	USTH	12	East Junction Trunk Highway 25	Junction CSAH 14	1.90
6.019.004	MNTH	19	0.73 mile west Lonsdale Limits (speed limit 55)	0.35 mile east Lonsdale Limits	1.05
6.044.008	MNTH	44	0.05 mile south MNTH 76 (two-lane/four-lane)	Caledonia Limits (speed limit 55)	0.26
7.169.006	USTH	169	0.3 mile south Trunk Highway 109 (four-lane/two-lane)	0.2 mile North Winnebago Limits (speed limit 40)	6.79
8.012.010	USTH	12	0.5 mile east US 71 (speed limit 55)	0.2 east west Junction CSAH 8	3.01
8.012.024	USTH	12	Four-lane pass section (speed limit 55)	End four-lane pass section	1.35
				Total Miles	24.13

Notes:

CSAH = County State Aid Highway
MNTH = Minnesota Trunk Highway
USTH = U.S. Trunk Highway

Table 2-11. Rural Intersections along Four-lane Undivided Segments

Int ID	Corridor ID	Route System	Route Number	Intersection Description
1.002.004	1.002.005	USTH	2	CSAH 62 LT/Cohasset
1.002.005	1.002.007	USTH	2	CSAH 63/WOF Grapids
3.012.009	3.012.005	USTH	12	CSAH 5 RT
6.044.016	6.044.008	MNTH	44	E Junction Trunk Highway 76/Kingston Street
7.169.014	7.169.006	USTH	169	CSAH 6 LT/N Ofblueearth
7.169.015	7.169.006	USTH	169	CSAH 5 LT
7.169.016	7.169.006	USTH	169	CSAH 10 Huntlyrd LT/S Winnbgo
8.012.014	8.012.010	USTH	12	CSAH 8 RT/West Ofkandiyohi

2.7 Safety Project Development

There are two objectives for the safety planning effort. The first objective is to prepare a safety plan for each district that includes a prioritized list of rural and urban facilities and a comprehensive list of safety projects. The locations, referred to as high-priority locations, of safety projects are identified through the SHCL and systemic risk analyses. The second objective is to suggest safety strategies at the specific high-priority locations.

To maintain continuity across the state system, it was important to consistently develop similar projects for locations with similar characteristics (as identified through the systemic risk assessment). It is equally important to shape driver expectations by providing a common set of roadway characteristics, regardless of the location of the driver in Minnesota. To achieve this level of consistency in safety project development, the initial efforts to assign projects were guided by decision trees. The decision trees provide guidance for safety analysts when considering roadway and traffic characteristics that point to a preferred strategy from many possibilities. Decision trees for rural two-lane segments (Figure 2-10), rural two-lane intersections (Figure 2-11), and rural curves (Figure 2-12) show how characteristics such as traffic volume thresholds, crash history, the presence of specific risk factors, and vehicle speeds lead to the identification of specific strategies.

Decision trees were used to produce a list of safety projects that were reviewed by district staff. These reviews resulted in modifications (selection of another strategy) to some suggested safety projects. Projects not consistent with current district priorities were categorized as a low-priority. In addition, a number of projects were deleted from the list of safety projects as there were concerns about effectiveness and increased maintenance costs.

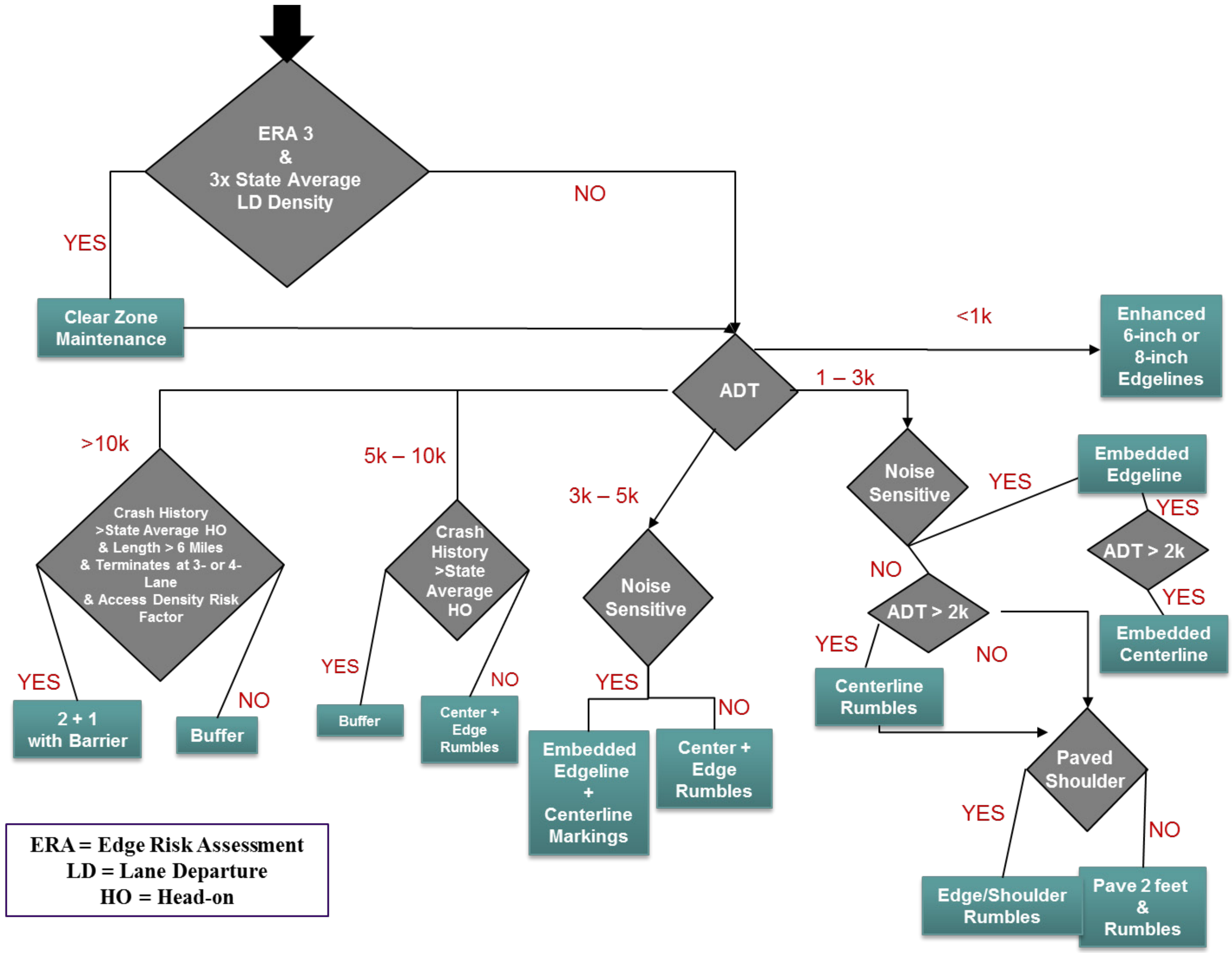


Figure 2-10. Rural Two-lane Segments Decision Tree

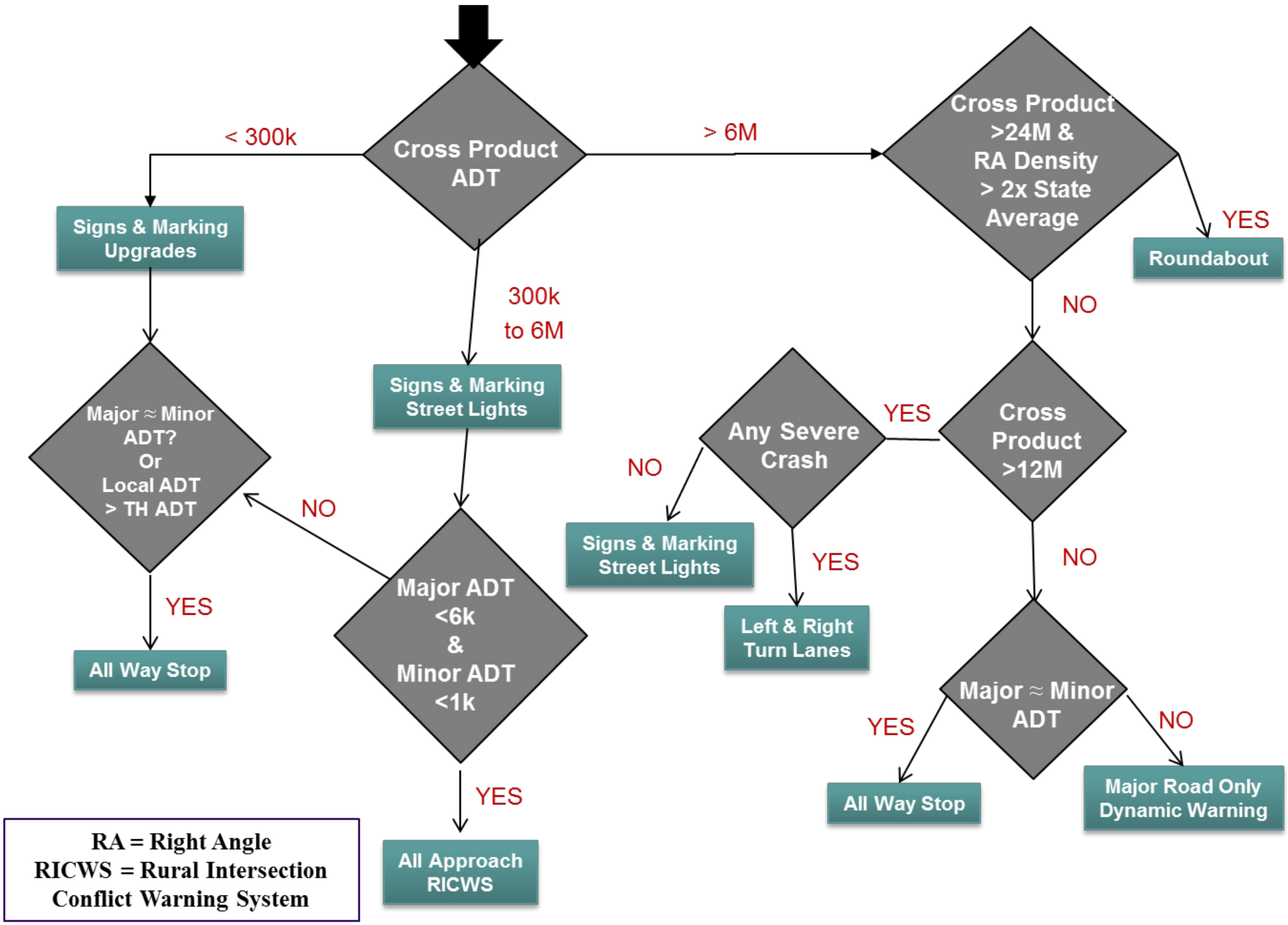


Figure 2-11. Rural Two-lane Intersections Decision Tree

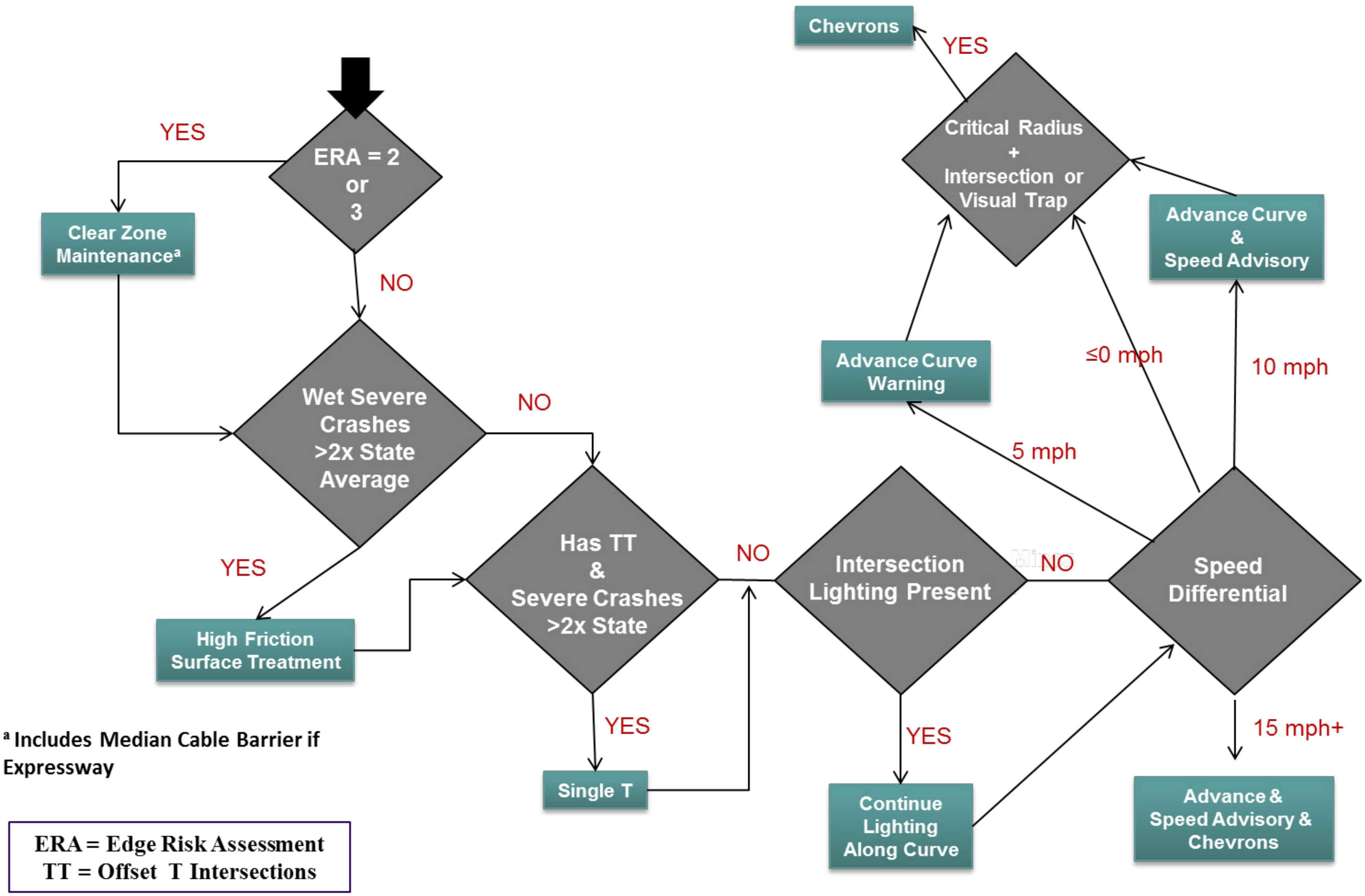


Figure 2-12. Rural Curves Decision Tree

Statewide Results and Key Findings

3.1 Sustained High-crash Intersections

More than 6,260 rural and urban intersections in the state system were evaluated to identify the subset of locations that met the SHCL criteria. To meet SHCL criteria, there must be a FA crash rate statistically significantly higher than the expected value for similar intersections. This effort identified 212 intersections (about 3 percent) that met the criteria. A district-by-district breakdown (Table 3-1) finds that District 8 had the greatest number of high-crash intersections (47) and District 7 had the fewest (9). The complete list of high-crash intersections in each district is documented in Section 4.

Table 3-1. District-by-District Breakdown[a]

District	Severe Intersection Crashes	Severe SHCL Crashes	SHCL Intersections	Severe SHCL Crashes (%)	All Severe Crashes	All Severe Crashes (%)
1 – Duluth	65	36	27	55	368	10
2 – Bemidji	63	47	38	75	243	19
3 – Baxter	116	51	41	44	602	8
4 – Detroit Lakes	66	15	13	23	296	5
6 – Rochester	88	46	37	52	454	10
7 – Mankato	57	9	9	16	300	3
8 – Willmar	75	55	47	73	302	18
Total	**530**	**259**	**212**	**49**	**2,565**	**10**

Note:

[a] This table shows the crash statistics for each district that is separated by intersection, severe intersection crashes, severe SHCL crashes (the number of crashes and percent of crashes), and all severe crashes (the number of crashes and percent of crashes).

Noteworthy characteristics associated with the high-crash intersections include:

- A total of 530 severe crashes occurred at intersections along MnDOT's Trunk Highway system. Of the 530 severe intersection crashes, 259 severe crashes occurred at the 212 high-crash intersections during the 5-year study period. This results in an average crash density of 0.2 severe crashes per intersection per year, which is more than 10 times the average for all 6,260 intersections.
- Of the 212 high-crash intersections, only 39 (18 percent of high-crash locations and 0.6 percent of all intersections) had more than 1 severe crash during the 5-year study period. Only one intersection along the state system (Trunk Highway 52 at Goodhue County Highway 9) averaged more than 1 severe crash per year. This intersection (which represents 0.5 percent of high-crash locations and 0.02 percent of all intersections) had 6 severe crashes during the 5-year study period and was recently upgraded to a grade-separated interchange.
- Traffic signal-controlled intersections are over-represented among high-crash locations. Seventeen percent of high-crash locations had traffic signal control compared to 9 percent of all intersections with traffic signal control.

- The average density of severe crashes at high-crash locations with traffic signal control was 0.04 severe crashes per intersection per year versus 0.01 at high-crash locations with thru-stop control.
- The most common type of severe crash at the high-crash locations was a right-angle collision. The average density of these severe right-angle collisions was 0.02 at locations with traffic signal control and 0.007 at locations with thru-stop control.
- Approximately 49 percent of all severe intersection crashes occur at high-crash intersections.
- The number of severe crashes at the high-crash intersections represents 10 percent of all severe crashes. Ninety percent of severe crashes occur at locations that do not have a statistically significant, above-average history of severe crashes.

Following a review of the high-crash locations for each district, a total of 331 safety projects were identified at 179 of the 212 intersections. The projects were identified using the safety strategies and decision trees identified in Section 2. More than one project was suggested at many of the high-crash intersections. At 33 high-crash locations where no project was suggested, district staff concluded that they had either already implemented a project, had already identified an improvement project, or had concluded that no improvement was necessary. The 331 suggested projects had 2 main efforts. The first effort was upgrading signs, markings, and street lights at rural two-lane intersections, RCIs, and expressway intersections. The second effort was adding confirmation lights and countdown timers at urban signals. The 331 projects had an estimated implementation cost totaling $49 million (the average of each project would cost approximately $148,000).

A statewide overview of safety projects identified at the high-crash locations is provided in Table 3-2 and details about the projects in each district are included in Section 4.

Table 3-2. Statewide Overview

High-crash Location	Safety Project(s)
Rural Two-lane Intersections	Signs and Markings Street Lights RICWS
Expressway Intersections	RCI’s
Urban Signals – Right Angle	Confirmation Lights
Urban Signals – Pedestrian/Bicycle	Countdown Timers Curb Extensions

3.2 Systemic Risk Locations

In addition to analysis that evaluated high-crash locations, a systemic risk assessment was conducted to provide a comprehensive approach for identifying candidate locations for safety investment along the state system. The results of the analysis found that approximately 10 percent of severe crashes occur at high-crash locations. The results reinforce the value of a comprehensive approach that includes conducting a thorough evaluation of the entire system where more than 90 percent of severe crashes occur. The systemic risk assessment process was applied to 10,299 miles of state highways, 5,107 intersections, and 5,462 horizontal curves. The assessment process consisted of searching the state system for roadway and traffic characteristics at common at locations with severe crashes. The presence of multiple characteristics at the same locations were considered “at-risk” and, therefore, high-priority candidates for safety improvement.

The systemic risk assessment identified 3,274 miles, 1,334 intersections, and 1,584 horizontal curves as "at-risk" (approximately 25 percent of the state system, Table 3-3).

Table 3-3. Systemic High-risk Locations by Intersections, Segments, and Curves

District	Number Qualified for Projects (number of intersections)	Number of Severe Crashes at Qualified Locations	Number All Ranked (number of intersections)	Number of Severe Crashes at Ranked Locations	System Qualified (%)	Severe Crashes at Qualified Locations (%)
1 – Duluth	240	41	526	61	46	67
2 – Bemidji	115	26	979	62	12	42
3 – Baxter	328	66	897	104	37	63
4 – Detroit Lakes	126	30	656	66	19	45
6 – Rochester	237	60	742	83	32	72
7 – Mankato	128	22	638	50	20	44
8 – Willmar	160	39	669	70	24	56
Total	**1,334**	**284**	**5,107**	**496**	**26**	**57**
District	**Number Qualified for Projects (number of segments)**	**Number of Severe Crashes at Qualified Locations**	**Number All Ranked (number of segments)**	**Number of Severe Crashes at Ranked Locations**	**System Qualified (%)**	**Severe Crashes at Qualified Locations (%)**
1 – Duluth	120	148	297	238	40	62
2 – Bemidji	64	62	254	141	25	44
3 – Baxter	157	266	412	408	38	65
4 – Detroit Lakes	65	71	230	185	28	38
6 – Rochester	122	197	349	285	35	69
7 – Mankato	45	50	185	198	24	25
8 – Willmar	56	53	322	204	17	26
Total	**629**	**847**	**2,049**	**1,659**	**31**	**51**
District	**Number Qualified for Projects (number of curves)**	**Number of Severe Crashes at Qualified Locations**	**Number All Ranked (number of curves)**	**Number of Severe Crashes at Ranked Locations**	**System Qualified (%)**	**Severe Crashes at Qualified Locations (%)**
1 – Duluth	317	26	1,454	53	22	49
2 – Bemidji	158	18	489	23	32	78
3 – Baxter	346	52	965	71	36	73
4 – Detroit Lakes	227	18	631	28	36	64
6 – Rochester	243	44	1,018	73	24	60
7 – Mankato	150	15	449	28	33	54
8 – Willmar	143	15	456	22	31	68
Total	**1,584**	**188**	**5,462**	**298**	**29**	**63**

Characteristics associated with the "at-risk" locations include:

- Roadway and traffic characteristics that are associated with severe crash locations with crash densities higher than the systemwide average. There was only a small number of severe crashes occurring at "at-risk" locations.
- There were at least 847 unique severe crashes at the "at-risk" locations. Approximately 284 unique severe crashes occurred along segments and 188 unique severe crashes occurred along horizontal curves. Approximately 259 unique severe crashes occurred at the high-crash locations.
- The small number of severe crashes at the "at-risk" locations points to the advantage of adding the systemic risk assessment, which is to supplement the historic use of the high-crash analysis. With the systemic risk assessment, it is possible to implement safety improvements at locations that collectively have more than three times as many severe crashes as the high-crash locations, but where many of the individual "at-risk" locations have yet to experience a severe crash.

Safety projects were identified at the "at-risk" locations using decision trees (Section 2) and the results were reviewed by district staff. The conclusion was the identification of 3,922 systemic-based safety projects with approved implementation costs of approximately $350 million of systemic-based safety projects across the state system (Table 3-4). The average cost of these projects was $123,547 per project. Approximately, three-quarters of the projects were on rural systems. The most common projects for rural areas were enhanced pavement markings and edge and center rumble strips on two-lane highways; cable median barriers along expressways; enhanced curve warning signs; upgraded signs, markings, and street lights; and adding RCI's at expressway intersections. In urban areas, the most common types of projects were improved access management, confirmation lights at signalized intersections, and pedestrian amenities.

Table 3-4. Systemic Based Project Summary

"At-risk" Location	Recommended	Approved
Rural		
Two-lane Segments	$92,863,587	$71,543,504
Expressway Segments	$27,751,437	$22,495,788
Freeway Segments	$43,541,624	$13,167,194
Curves	$22,667,776	$11,852,490
Two-lane Intersections	$89,649,000	$50,838,000
Expressway Intersections	$80,375,000	$52,963,000
Urban		
Urban Segments	$37,078,859	$37,031,624
Urban Intersections (Right Angle)	$79,167,400	$79,167,400
Urban Intersections (Pedestrian/Bicycle)	$11,457,800	$11,457,800
Total	**$484,552,482**	**$350,516,799**

In total, the analyses identified approximately $485 million of safety projects across the state system, of which approximately $350 million was approved.

3.3 Driver Behavior Results

3.3.1 Strengthen Infrastructure Safety Impact – District Collaborations to Improve Driver Behavior

Motor vehicle crashes are complex occurrences that most often have multiple crash contributors. Traffic crashes may result from any combination of overlapping crash factors including the roadway, the vehicle, and driver behavior. Figure 3-1 illustrates the complex interrelationship among these three crash contributors. Table 3-5 details the driver behavior emphasis area.

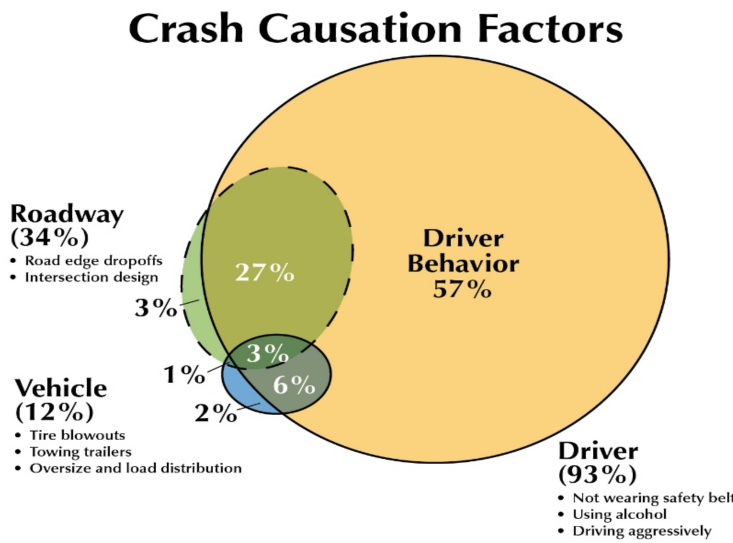


Figure 3-1. Traffic Crash Causation Factors

Source: Human Factors & Highway Safety, FHWA Office of Safety Programs

Table 3-5. Driver Behavior Emphasis Area

Emphasis Area	Severe Crashes	All Severe Crashes (%)
Unbelted	2,272	34
Speeding	1,234	18
Inattentive	1,281	19
Impaired	1,776	26
All Severe Crashes	6,764	100

Source: MnDOT TIS, 2009-2013

In 93 percent of vehicle crashes, the crash was a result, in part, of driver behavior (Figure 3-1). Poor driver behavior (risky decisions, driver error, inattention, poor judgment, and driver limitations) is the main factor contributing to traffic crashes. In addition, severe crashes often involve multiple high-risk behavioral factors contributing to the crash (e.g., unbelted, impaired driver who was driving too fast). Serious traffic crashes on Minnesota's roadway can largely be prevented and reduced if motorists were to: buckle up, drive at safe speeds, pay attention, and plan ahead for a safe ride after drinking.

Traffic safety research and nationwide best practices support the notion that transportation engineering safety professionals must reach beyond infrastructure strategies and adopt a comprehensive, multi-disciplinary approach to improve road safety. In addition, MnDOT District safety initiatives may have the best-engineered and maintained plans for road safety, but the problem isn't solved until motorists make safer choices. Leveraging infrastructure strategies with driver behavior initiatives will strengthen the impact of reducing future severe crashes.

3.3.2 District Infrastructure Coordination with Minnesota Toward Zero Deaths Program

The statewide Minnesota Toward Zero Deaths (TZD) Program was created to foster interdisciplinary cooperation and engagement at the state, regional, district, and local level. The program employs an integrated approach of engineering, enforcement, education, emergency medical and trauma services, and more (e.g., supportive judicial system and strong traffic safety legislation) to collaboratively move Minnesota closer to its vision of zero fatalities. In addition to the statewide TZD Program, partnerships have been created in eight geographic areas of Minnesota to coordinate regional TZD efforts. Each Regional TZD partnership has a local steering committee, co-led by MnDOT and State Highway Patrol, to foster traffic safety cooperation, establish safety priorities and initiatives, and leverage resources. MnDOT districts will continue to collaborate with local TZD partners and with its Regional TZD Program Coordinator to strengthen the impact of infrastructure safety improvements. Collaborative efforts will include supporting public education and media campaigns, enforcement, and emergency medical and public health campaigns for traffic safety.

3.3.3 Example Collaborations to Strengthen Safety Impact

Examples of infrastructure-based safety strategies that are enhanced through interdisciplinary TZD collaboration include:

- Deploy lane departure infrastructure safety strategies coupled with enhanced enforcement to maximize the expected safety benefit of the lane departure safety strategies. Strategies that will reduce risky driver behaviors include: centerline and edge line rumble strips, high visibility pavement markings, adding or widening edge lines, integrating increased enforcement presence at targeted "at-risk" locations and timeframes, and media outreach about law enforcement (surveillance and traffic monitoring).
- Support expanded use of red-light running confirmation lights coupled with enhanced surveillance and traffic monitoring to reduce right-angle crashes. Right- angle crashes are the most common type of serious crashes at signalized intersections. Innovative downstream confirmation lights will reduce red-light running, which will reduce right-angle crashes. Adding confirmation lights requires strong collaboration between engineers and law enforcement. In addition, public education and media outreach about the red-light running confirmation lights and law enforcement helps deter high-risk aggressive driving.
- Use changeable message signs that will support law enforcement campaigns. Promote MnDOT District support of statewide law enforcement saturations through overhead changeable message signs that display safety-related messages. A message sign such as, "*Extra DWI Enforcement, This Weekend, Plan a Sober Ride*" will deter high-risk impaired driving behavior. In addition, portable roadside electronic message boards will support public outreach for corridor-specific driving while intoxicated enforcement efforts.

- Expand the Road Safety Audits to include an independent multi-disciplinary team examining the safety performance, design, and operation of road segments and intersections. The team also can suggest improvements and offer a systemic, low-cost approach to improving road safety and maximizing the impact of infrastructure safety strategies.

Although the focus of the MnDOT District Safety Plans is to identify priority infrastructure safety investments at high-risk locations, district staff recognizes the importance of reaching beyond infrastructure and implementing a collaborative, multi-disciplinary approach to improving road safety consistent with Minnesota TZD Program and the Minnesota SHSP.

District 4 Safety Plan

The District Safety Plan has prioritized lists of individual highway segments, intersections, and curves along with descriptions of safety projects developed for each location. Prioritization of the state system in District 4 consisted of identifying the small number of intersections considered to be sustained high-crash intersections and identifying additional "at-risk" locations based on roadway and traffic characteristics common to locations with severe crashes. The end result of this process was the identification of 275 separate safety projects (a specific strategy at a specific location) with an estimated implementation cost of around $15 million.

4.1 Sustained High-crash Intersections

A total of 13 intersections in District 4 (Table 4-1) met the criteria for designation as a sustained high-crash intersection; a crash rate statistically significantly higher than other similar intersections plus at least one severe (involving a fatality or serious injury) crash during the 5-year study period. Characteristics of these high-crash intersections include:

- Sustained high-crash intersections account for approximately 2 percent of the intersections along the state system in District 4 (543).
- Ten high-crash intersections were along rural highways (77 percent). Seven high-crash intersections were along two-lane highways and 3 were along expressways.
- The 13 high-crash intersections had a total of 15 severe crashes that resulted in an average of 0.2 severe crashes per intersection per year. None of the intersections had more than two severe crashes during the study period.
- Eleven high-crash intersections had thru-stop control and 2 had signal control.
- The most common crash types at the high-crash intersections were right-angle crashes (73 percent) followed by rear end crashes (20 percent).
- Trunk Highway 9, and Trunk Highway 10 had the greatest number of high-crash intersections (three and four respectively).
- Seven high-crash intersections (54 percent) were identified as "at-risk" through the systemic risk analysis.

Safety projects were developed at high-crash intersections using the decision trees in Appendix B. Through the systemic risk assessment, 8 projects were identified at 4 high-crash intersections that were not considered "at-risk." The projects at high-crash and "at-risk" locations are documented in Section 4 with the other "at-risk" based projects. The projects at the intersections designated only as high crash (Table 4-2) had an estimated implementation cost of approximately $30,000. The most common types of intersection projects included: upgraded signs, markings, and street lights along two-lane highways, RCI's along expressways, and pedestrian enhancements at urban intersections.

Table 4-1. District 4 High-crash Intersection List

Count	Intersection ID	Route System	Route No.	Description	Reference Point	Facility Type	General Environment	Traffic Control	Major Entering ADT	Minor Entering ADT	Total Entering ADT	Cross Product	Skew	On/Near Curve	Severe RA Crashes	Severe RA Density	Development	RR Xing	Previous STOP (>5mi)	Total Severe Crashes	Crash Cost
1	4.009.004	MN	9	120TH AV NE CSAH 33/SWIFT CO	024+00.500	2-Lane	Rural	Thru-Stop	1,200	358	1,558	429,000	5	Yes	0	0	No	No	Yes	1	$557,400
2	4.009.011	MN	9	GRACE AV CSAH2 LTM 5 RT	041+00.560	2-Lane	Rural	Thru-Stop	2,000	320	2,320	640,000	10	Yes	1	0.2	No	No	No	1	$710,000
3	4.009.076	MN	9	CSAH 26	170+00.719	2-Lane	Rural	Thru-Stop	1,650	1,650	3,300	2,722,500	5	No	1	0.2	No	No	Yes	1	$10,636,800
4	4.010.023	US	10	TH 9/3 MIE GLYNDON	012+00.786	Expressway	Rural	Signal	14300	1350	15650	19305000	0	No	2	0.4	No	No	Yes	2	$11,610,400
5	4.010.032	US	10	CSAH 7 LTPRIVRD RT/LAKE PARK	032+00.197	Expressway	Rural	Thru-Stop	12,000	1,440	13,440	17,274,000	0	No	0	0	Yes	No	No	1	$10,506,400
6	4.010.050	US	10	W JCT CSAH10(OLD87)/BCKRCO	052+00.622	Expressway	Rural	Thru-Stop	10,000	1,290	11,290	12,895,000	20	Yes	2	0.4	No	No	No	2	$1,100,000
7	4.010.071	US	10	CSAH 75/OTTERTAIL CO	087+00.822	2-Lane	Rural	Thru-Stop	7,000	830	7,830	5,810,000	25	No	0	0	No	Yes	No	1	$1,019,600
8	4.012.008	US	12	CR 77/3 MINEOF ODESSA	009+00.579	2-Lane	Rural	Thru-Stop	1,100	28	1,128	30,250	0	No	1	0.2	No	No	No	1	$712,000
9	4.075.095	US	75	70TH AVE CR67LT T218 RT/KURTZ	244+00.346	2-Lane	Rural	Thru-Stop	1,550	20	1,570	31,000	0	No	1	0.2	No	No	No	1	$10,624,400
10	4.075.112	US	75	CR93 LT T110 RT/N OF MOORHEAD	256+00.458	2-Lane	Rural	Thru-Stop	2,650	140	2,790	371,000	0	No	1	0.2	No	Yes	No	1	$10,745,400
11	4.029.024	MN	29	DAKOTA STMSAS128 LT M200/ALEX	077+00.393		Urban	Signal	20250	2714.5	22964.5	54968625	0	No	0	0	NV	NV	NV	1	$2,551,000
12	4.059.058	US	59	CR 142 LTCSAH34 RT/OGEMA	284+00.234		Urban	Thru-Stop	4275	660	4935	2821500	0	No	1	0.2	NV	NV	NV	1	$564,800
13	4.078.009	MN	78	TH 210/BATTLELAKE	021+00.543		Urban	Thru-Stop	2350	2775	5125	6521250	0	Yes	1	0.2	NV	NV	NV	1	$1,366,800

Table 4-2. District 4 High-crash Intersection – Project List

Page	Intersection ID	Route System	Route No.	Description	RP	Risk Ranking	Upgrade Signs & Markings	All-Way STOP Conversion	Street Lights	Left & Right Turn Lanes	Mainline Dynamic Warning Sign	All Approach RICWS	Roundabout	Project Cost
89	4.010.071	US	10	CSAH 75/OTTERTAIL CO	087+00.822	★★	-	-	-	-	-	-	-	$0
90	4.012.008	US	12	CR 77/3 MINEOF ODESSA	009+00.579	★	2	-	-	-	-	-	-	$6,000
101	4.075.095	US	75	70TH AVE CR67LT T218 RT/KURTZ	244+00.346	★	2	-	-	-	-	-	-	$6,000
103	4.075.112	US	75	CR93 LT T110 RT/N OF MOORHEAD	256+00.458	★	2	-	2	-	-	-	-	$18,000
					Totals		*6*	*0*	*2*	*0*	*0*	*0*	*0*	*$30,000*

4.2 Systemic Risk Locations

A systemic risk assessment was conducted along 1,524 highway miles, 654 intersections, and 631 curves using roadway and traffic characteristics common at locations with severe crashes. The traffic characteristics were subsequently adopted as risk factors. The outcome of this effort was a prioritized list of segments, intersections, and curves based on the number of risk factors present. Documentation has been provided (at a statewide level) that indicates facilities with multiple risk factors consistently have a high density of severe crashes and therefore represent a great risk. In District 4, the results of this systemic risk evaluation found that approximately 29 percent of the state system of segments, intersections, and curves were "at-risk." The 29 percent identified, were considered high-priority candidates for safety investment. A total of 275 safety projects were developed for District 4 using decision trees (Section 2). The projects have an estimated implementation cost of slightly more than $15 million (Table 4-3).

Table 4-3. District 4 Systemic Project Summary

Rural	
Two-lane Segments	$566,877
Four-lane Segments	$125,144
Freeway Segments	$1,338,417
Two-lane Intersections	$1,179,000
Four-lane Intersections	$4,183,000
Horizontal Curves	$1,202,524
Rural Subtotal	$7,256,545
Urban	
Segments	$429,647
Intersections	$6,274,200
Urban Subtotal	$6,703,847
District 4 Total	**$15,173,666**

A discussion of findings for each facility type, a sample of the output, and a summary of the suggested safety projects are provided in the following paragraphs. See Appendix F for the complete list.

4.2.1 Rural Two-lane Segment Prioritization/Project Summary

- A total of 183 rural two-lane segments (1,313 miles) were analyzed using the adopted risk factors and 43 of the segments (23 percent) were found to have 3 or more factors. Approximately $560,000 is the estimated implementation cost dedicated to the 43 segments with the most common types of projects, such as adding edge and center rumble stripes, enhanced pavement markings, and paving narrow shoulders combined with the installation of edge rumbles (Tables 4-4 and 4-5).

Table 4-4. District 4 Rural Two-lane Segment Prioritization

															Tiebreakers	
#	Corridor	Route System	Route No.	Start	End	Length	ADT	ADT Range	Severe Lane Departure Density	Access Density	Critical Curve Radius Density	Edge Risk	Shoulder Width	Total	Edge Risk	ADT
1	4.007.003	MNTH	7	4 MI N ORTONVILLE (SL 40)	N ORTONVILLE (SL 30)	4.0	670		★	★	★	★	★	★★★★★	2	670
2	4.113.004	MNTH	113	.4 MI W CR 144 (SL 50)	.1 MI W CR 37 (SEGMENT LENGTH)	15.6	407		★	★	★	★	★	★★★★★	2	407
3	4.078.010	MNTH	78	.8 MI N JCT TH 108 (SL 55)	S PERHAM (SL 45)	9.8	4,145	★	★	★	★		★	★★★★★	1	4,145
4	4.034.006	MNTH	34	N DETROIT LAKES (SL 55)	.1 MI S CR 56 (SEGMENT LENGTH)	9.8	4,942	★	★	★		★		★★★★	2	4,942
5	4.029.019	MNTH	29	.42 MI S PARKERS PRAIRIE (SL 45)	S PARKERS PRAIRIE (SL 30)	0.4	4,050	★	★	★		★		★★★★	2	4,050
6	4.200.005	MNTH	200	W ROY LAKE (SL 40)	.3 W CR 16 (SL 30)	0.3	940			★	★	★	★	★★★★	2	940
7	4.007.002	MNTH	7	.5 MI N CSAH 3 (SL 50)	4 MI N ORTONVILLE (SL 40)	8.4	355		★		★	★	★	★★★★	2	355
8	4.029.005	MNTH	29	.1 MI S CR 2 (SEGMENT LENGTH)	1.1 MI S JCT MN 28 STARBUCK (SL 40)	9.5	2,200		★	★	★		★	★★★★	1	2,200
9	4.108.005	MNTH	108	E PELICAN RAPIDS (SL 50)	LAKE LIDA (SL 40)	3.6	1,693		★	★	★		★	★★★★	1	1,693
10	4.032.003	MNTH	32	N ROLLAG (SL 55)	S US 10 (SL 30)	9.7	1,150		★	★	★		★	★★★★	1	1,150
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
179	4.054.001	MNTH	54	JCT TH 27 (SL 55)	JCT MN 55	10.8	688								1	688
180	4.028.006	MNTH	28	E BEARDSLEY (SL 55)	W BARRY (S45)L	7.0	639								1	639
181	4.075.015	USTH	75	.1 MI S MN 9 (SL 60)	S BRECK (SL 45)	6.5	570								1	570
182	4.009.017	MNTH	9	N TINTAH (SL 55)	S CAMPBELL (SL 45)	6.9	450								1	450
183	4.007.001	MNTH	7	MN 28 (SL 55)	.5 MI N CSAH 3 (SL 50)	11.7	195								1	195
							Total Stars --	30	49	75	43	13	68			
							% That Gets Star --	16%	27%	41%	23%	7%	37%			

	#	%	Mileage	%
★★★★★★	0	0%	0.0	0%
★★★★★	3	2%	29.4	2%
★★★★	10	5%	70.7	5%
★★★	30	16%	210.5	16%
★★	35	19%	223.2	17%
★	63	34%	421.8	32%
	42	23%	357.8	27%
	183	100%	1313.4	100%

	Stars
ADT Range -	If segment has an ADT in the range of most at risk ADT based on statewide totals. (3500 < ADT < 1000000)
Lane Departure Density -	If segment has higher lane departure density than the statewide average (0.014).
Access Density	If segment has higher access density than the statewide overrepresented threshold (8).
Curve Critical Radius Density -	If segment has higher critical radius curve density than 0.1 per mile.
Edge Risk Assessment -	Edge risk of 2 or 3, based on assessment of roadway edge and clear zone.
Shoulder Width -	If a segment has shoulder width less than or equal to 4 feet

Table 4-5. District 4 Rural Two-lane Segment Project Summary

										Mileage								
Page	Segment ID	Route System	Route No.	Start	End	Start RP	End RP	Length	Risk Ranking	Enhanced Edgelines (6" or 8")	Shoulder Rumble Strips	Pave 2' shoulder	Recessed Wet Reflective Markings	Median Buffer	2 + 1 w/ Cable Median Barrier	Clear Zone Maintenanc e	Centerline Rumble Strips	Project Cost
1	4.007.003	MNTH	7	4 MI N ORTONVILLE (SL 40)	N ORTONVILLE (SL 30)	020+00.103	024+00.083	4.0	★★★★★	4.0	-	-	-	-	-	-	-	$7,936
2	4.113.004	MNTH	113	.4 MI W CR 144 (SL 50)	.1 MI W CR 37 (SEGMENT LENGTH)	025+00.287	049+00.586	15.6	★★★★★	15.6	-	-	-	-	-	-	-	$31,193
3	4.078.010	MNTH	78	.8 MI N JCT TH 108 (SL 55)	S PERHAM (SL 45)	037+00.171	046+00.974	9.8	★★★★★	-	9.8	-	-	-	-	-	9.8	$35,334
4	4.034.006	MNTH	34	N DETROIT LAKES (SL 55)	.1 MI S CR 56 (SEGMENT LENGTH)	036+00.645	065+00.421	9.8	★★★★	-	-	-	-	-	-	-	9.8	$35,104
5	4.029.019	MNTH	29	.42 MI S PARKERS PRAIRIE (SL 45)	S PARKERS PRAIRIE (SL 30)	099+00.481	099+00.901	0.4	★★★★	-	-	-	-	-	-	-	-	$0
6	4.200.005	MNTH	200	W ROY LAKE (SL 40)	.3 W CR 16 (SL 30)	065+00.579	065+00.929	0.3	★★★★	0.3	-	-	-	-	-	-	-	$694
7	4.007.002	MNTH	7	.5 MI N CSAH 3 (SL 50)	4 MI N ORTONVILLE (SL 40)	011+00.674	020+00.103	8.4	★★★★	8.4	-	-	-	-	-	-	-	$16,753
8	4.029.005	MNTH	29	.1 MI S CR 2 (SEGMENT LENGTH)	1.1 MI S JCT MN 28 STARBUCK (SL 40)	033+00.442	053+00.890	9.5	★★★★	-	-	-	-	-	-	-	9.5	$34,237
9	4.108.005	MNTH	108	E PELICAN RAPIDS (SL 50)	LAKE LIDA (SL 40)	012+00.855	016+00.431	3.6	★★★★	-	-	-	-	-	-	-	-	$0
10	4.032.003	MNTH	32	N ROLLAG (SL 55)	S US 10 (SL 30)	005+00.822	022+00.173	9.7	★★★★	-	-	-	-	-	-	-	-	$0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
39	4.087.005	MNTH	87	W CR 43 (SL 55)	BECKER COUNTY LINE (END D4)	003+00.030	029+00.372	11.8	★★★	11.8	-	-	-	-	-	-	-	$23,655
40	4.027.002	MNTH	27	.1 MI N CR 3 (SL 55)	S WHEATON (SL 30)	000+00.000	022+00.928	10.8	★★★	10.8	-	-	-	-	-	-	-	$21,542
41	4.108.008	MNTH	108	LAKE LIDA (SL 50)	STAR LAKE (SL 40)	018+00.271	024+00.900	6.6	★★★	6.6	-	-	-	-	-	-	-	$13,283
42	4.104.002	MNTH	104	.1 MI E TH 161 (SEGMENT LENGTH)	S GLENWOOD (SL 40)	014+00.446	040+00.031	13.0	★★★	13.0	-	-	-	-	-	-	-	$26,029
43	4.108.015	MNTH	108	E OTTERTAIL (SL 55)	LEAF LAKE (SL 45)	048+00.874	053+00.827	5.0	★★★	5.0	-	-	-	-	-	-	-	$9,930
							Totals	***298.5***		***135.2***	***35.9***	***0.0***	***2.4***	***0.0***	***0.0***	***0.0***	***54.9***	***$566,877***

4.2.2 Rural Four-lane Segment Prioritization/Project Summary

- A total of 14 rural, four-lane segments (70 miles) were analyzed and 2 of the segments (14 percent) had 3 or more factors. Approximately $125,000 is the estimated implementation cost dedicated to the most common types of segment projects, such as adding edge and centerline rumble strips and enhanced pavement markings (Tables 4-6 and 4-7).

Table 4-6. District 4 Rural Four-Lane Segment Prioritization

#	Corridor	Route System	Route No.	Start	End	Length	ADT	ADT Range	Severe Lane Departure Density	Access Density	Critical Curve Radius Density	Median Width	Total	Tiebreakers: Severe Lane Departure Density	Tiebreakers: ADT
1	4.010.020	USTH	10	.1 MI E CSAH 53 (SL 65)	FRWY W JCT CSAH 10	5.3	11,626		★	★	★	★	★★★★	0.08	11,626
2	4.010.015	USTH	10	W DETROIT LAKES (SL 55)	.25 MI W US 59 (SL 40)	0.4	20,300	★		★		★	★★★	0.00	20,300
3	4.010.008	USTH	10	MN 9 (SL 65)	W HAWLEY (SL 50)	7.1	10,800			★		★	★★	0.03	10,800
4	4.010.010	USTH	10	E HAWLEY (SL 65)	W LAKE PARK (SL 55)	9.4	11,000			★		★	★★	0.02	11,000
5	4.010.005	USTH	10	E DILWORTH (SL 65)	W GLYNDON (SL 30)	5.2	13,338			★		★	★★	0.00	13,338
6	4.010.007	USTH	10	E GLYNDON (SL 65)	W HAWLEY (SL 50)	4.1	12,300			★		★	★★	0.00	12,300
7	4.010.011	USTH	10	W LAKE PARK (SL 55)	E LAKE PARK (SL 65)	0.7	11,600			★		★	★★	0.00	11,600
8	4.010.012	USTH	10	E LAKE PARK (SL 65)	W AUDUBON (SL 55)	5.1	11,600			★		★	★★	0.00	11,600
9	4.010.013	USTH	10	W AUDUBON (SL 55)	E AUDUBON (SL 65)	0.6	11,600			★		★	★★	0.00	11,600
10	4.075.020	USTH	75	.1 MI N JCT MN 210 (SL 60)	.4 MI N N JCT MN 210	1.0	6,500			★		★	★★	0.00	6,500
11	4.010.014	USTH	10	E AUDUBON (SL 65)	W DETROIT LAKES (SL 55)	5.5	14,471					★	★	0.00	14,471
12	4.010.024	USTH	10	E JCT CSAH 80 (SL 65)	.2 MI S 550TH AVE NEW YORK MILLS (SEGMENT LENGTH)	11.4	7,240				★		★	0.00	7,240
13	4.010.022	USTH	10	E JCT CSAH 10 (SL 65)	W JCT CSAH 80	6.5	8,200							0.03	8,200
14	4.010.025	USTH	10	.2 MI S 550TH AVE NEW YORK MILLS (SEGMENT LENGTH)	2.5 MI W WADENA (SL 55)	7.1	7,091							0.00	7,091
							Total Stars --	1	1	10	2	11			
							% That Gets Star --	7%	7%	71%	14%	79%			

	#	%	Mileage	%
★★★★★	0	0%	0.0	0%
★★★★	1	7%	5.3	8%
★★★	1	7%	0.4	1%
★★	8	57%	33.2	48%
★	2	14%	16.9	24%
	2	14%	13.6	20%
	14	100%	69.5	100%

Stars	
ADT Range -	If segment has an ADT in the range of most at risk ADT based on statewide totals. (16000 < ADT < 1000000)
Severe Lane Departure Density -	If segment has higher lane departure density than the statewide average (0.037).
Access Density	If segment has higher access density than the statewide overrepresented threshold (5).
Curve Critical Radius Density -	If segment has higher critical radius curve density than 0.25 per mile.
Median Width -	If segment has a median width less than or equal to 65'

Table 4-7. District 4 Rural Four-lane Segment Project Summary

Page	Segment ID	Route System	Route No.	Start	End	Start RP	End RP	Length	Risk Ranking	Mileage: Recessed Left Marking	Mileage: Rumbles (CL + EL)	Mileage: Cable Median Barrier	Mileage: Intersection Projects*	Mileage: Clear Zone Maintenance	Project Cost
1	4.010.020	USTH	10	.1 MI E CSAH 53 (SL 65)	FRWY W JCT CSAH 10	047+00.341	052+00.722	5.3	★★★★	10.6	5.3	-	-	-	$125,144
2	4.010.015	USTH	10	W DETROIT LAKES (SL 55)	.25 MI W US 59 (SL 40)	043+00.677	044+00.107	0.4	★★★	-	-	-	-	-	$0
							Totals	***5.8***		***10.6***	***5.3***	***0.0***	***0.0***	***0.0***	***$125,144***

4.2.3 Rural Freeway Prioritization

- A total of 12 rural freeway segments (121 miles) were analyzed and 1 segment (8 percent) was found to have 3 or more factors. Approximately $1.3 million is the estimated implementation cost dedicated to adding 6-inch wet reflective recessed edge lines (Tables 4-8 and 4-9).

Table 4-8. District 4 Rural Freeway Segment Prioritization

#	Corridor	Route System	Route No.	Start	End	Length	ADT	ADT Range	Severe Lane Departure Density	Interchange Density	Critical Curve Radius Density	Total	Tiebreakers: Severe Lane Departure Density	Tiebreakers: ADT
1	4.094.007	ISTH	94	.9 MI NW N JCT TH 59 FERGUS FALLS	.3 MI SE S JCT TH 59 FERGUS FALLS	12.1	17,064		★	★		★★	0.03	17,064
2	4.094.002	ISTH	94	.4 MI E MAIN AVE MOORHEAD (SL 70)	.4 MI E TH 336	3.4	26,136		★			★	0.12	26,136
3	4.094.003	ISTH	94	.4 MI E TH 336	.8 MI N CR 10 (SEGMENT LENGTH)	8.3	19,800		★			★	0.05	19,800
4	4.094.010	ISTH	94	.5 MI NW CSAH 7	.4 MI W TH 29 ALEXANDRIA	13.2	16,752		★			★	0.05	16,752
5	4.010.023	USTH	10	W JCT CSAH 80 (SL 65)	E JCT CSAH 80	5.8	5,596		★			★	0.03	5,596
6	4.094.005	ISTH	94	.5 MI NW TH 34	.5 MI S CR 178 (SEGMENT LENGTH)	12.1	15,552		★			★	0.03	15,552
7	4.094.006	ISTH	94	.5 MI S CR 178 (SEGMENT LENGTH)	.9 MI NW N JCT TH 59 FERGUS FALLS (SEGMENT LENGTH)	13.9	12,600		★			★	0.03	12,600
8	4.094.008	ISTH	94	.3 MI SE S JCT TH 59 FERGUS FALLS	.6 MI NW MN 78 (SEGMENT LENGTH)	14.5	15,162						0.03	15,162
9	4.094.011	ISTH	94	.4 MI W TH 29 ALEXANDRIA	TODD COUNTY LINE (END D4)	12.5	20,860						0.02	20,860
10	4.094.009	ISTH	94	.6 MI NW MN 78 (SEGMENT LENGTH)	.5 MI NW CSAH 7 (SEGMENT LENGTH)	12.9	16,902						0.02	16,902
11	4.094.004	ISTH	94	.8 MI N CR 10	.5 MI NW TH 34 (SEGMENT LENGTH)	9.2	17,000						0.00	17,000
12	4.010.021	USTH	10	W JCT CSAH 10 (SL 65)	E JCT CSAH 10	3.2	8,000						0.00	8,000
							Total Stars --	0	7	1	0			
							% That Gets Star --	0%	58%	8%	0%			

	#	%	Mileage	%
★★★★★	0	0%	0.0	0%
★★★★	0	0%	0.0	0%
★★★	0	0%	0.0	0%
★★	1	8%	12.1	10%
★	6	50%	56.7	47%
	5	42%	52.3	43%
	12	100%	121.1	100%

	Stars
ADT Range -	If segment has an ADT in the range of most at risk ADT based on statewide totals. (20000 < ADT < 1000000)
Lane Departure Density -	If segment has higher lane departure density than the statewide average (0.028).
Interchange Density -	If segment has higher interchange density than the statewide overrepresented threshold (0.4).
Curve Critical Radius Density -	If segment has higher critical radius curve density than 0.125 per mile.

Table 4-9. District 4 Rural Freeway Segment Project Summary

Page	Segment ID	Route System	Route No.	Start	End	Start RP	End RP	Length	Risk Ranking	Mileage: 6-inch Wet Reflective Edgelines	Mileage: Edge Rumbles	Mileage: Snow Fence	Mileage: Cable Median Barrier	Mileage: Clear Zone Maintenance	Mileage: Dynamic Road Condition Speed Advisory System	Project Cost
1	4.094.007	ISTH	94	.9 MI NW N JCT TH 59 FERGUS FALLS	.3 MI SE S JCT TH 59 FERGUS FALLS	050+00.000	062+00.000	12.1	★★	12.1	-	-	-	12.1	-	$1,338,417

4.2.5 Rural Two-lane Intersection Prioritization/Project Summary

- A total of 543 intersections along rural two-lane highways were analyzed and 88 intersections (16 percent) were found to have 3 or more factors. Approximately $1.2 million is the estimated implementation cost dedicated to the most common types of intersection projects, such as upgrading traffic signs and markings, adding street lights, and adding RICWS (Tables 4-10 and 4-11).

Table 4-10. District 4 Rural Two-lane Intersection Prioritization

#	Intersection ID	Route System	Route No.	Intersection Description	Cross Product	Skew	On/Near Curve	Development	Severe RA Density	Previous STOP (>5mi)	Total Stars	Tiebreakers Crash Cost
1	4.029.017	MN	29	TH 55	★	★	★		★	★	★★★★★	$20,782,200
2	4.059.038	US	59	CSAH 9 LT/PELICAN RAPIDS	★	★	★	★		★	★★★★★	$0
3	4.029.013	MN	29	CR 29/POPE CO		★	★		★	★	★★★★	$10,388,400
4	4.210.017	MN	210	CSAH 29 RT/E SIDE FERGUSFLS	★	★			★	★	★★★★	$10,307,400
5	4.028.050	MN	28	CR 29/POPE CO		★	★	★	★		★★★★	$10,300,000
6	4.027.035	MN	27	CO RD 91 SW/DOUGLAS CO	★	★	★		★		★★★★	$1,681,800
7	4.059.043	US	59	CSAH 17/6MI SDETLKS	★	★	★			★	★★★★	$853,800
8	4.009.011	MN	9	GRACE AV CSAH2 LTM 5 RT	★	★	★		★		★★★★	$710,000
9	4.059.023	US	59	MN 55/BARRETT	★	★	★			★	★★★★	$550,000
10	4.113.007	MN	113	CR 35/BECKER CO		★	★		★	★	★★★★	$550,000
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
539	4.113.001	MN	113	CR 26 T136/MAHNOMEN CO								$0
540	4.200.005	MN	200	CSAH 2/MAHNOMEN CO								$0
541	4.210.003	MN	210	CR 161 RT/E OFBRECKENRIDGE								$0
542	4.210.004	MN	210	W JCT CR 169/NEAR EVERDELL								$0
543	4.210.009	MN	210	MAIN ST CSAH 23 RT/FOXHOME								$0
				Total Stars --	178	235	185	35	22	142		
				% That Gets Star --	33%	43%	34%	6%	4%	26%		

Totals

	#	%
★★★★★★	0	0%
★★★★★	2	0%
★★★★	23	4%
★★★	63	12%
★★	166	31%
★	174	32%
	115	21%
	543	100%

	Stars
Volume Cross Product -	If intersection has an ADT cross product > 400000
Skew -	If intersection is skewed at an angle of 10 degrees or greater.
On/Near Curve -	If intersection is on or within 1,000 feet of curve.
Development -	If intersection has a commercial development with access near intersection.
Severe Right Angle Crash Density -	If intersection has higher severe right angle crash density than 0.007.
Previous STOP (>5 mi) -	If stop-controlled vehicles have not had a previous stop along the roadway within 5 miles.

Table 4-11. District 4 Rural Two-lane Intersection Project Summary

Page	Intersection ID	Route System	Route No.	Description	RP	Risk Ranking	Upgrade Signs & Markings	All-Way STOP Conversion	Street Lights	Left & Right Turn Lanes	Mainline Dynamic Warning Sign	All Approach RICWS	Roundabout	Project Cost
1	4.029.017	MN	29	TH 55	065+00.188	★★★★★	-	-	-	2	-	-	-	$300,000
2	4.059.038	US	59	CSAH 9 LT/PELICAN RAPIDS	241+00.173	★★★★★	-	-	-	-	-	-	-	$0
3	4.029.013	MN	29	CR 29/POPE CO	051+00.735	★★★★	1	-	-	-	-	-	-	$3,000
4	4.210.017	MN	210	CSAH 29 RT/E SIDE FERGUSFLS	029+00.066	★★★★	-	-	1	-	-	-	-	$6,000
5	4.028.050	MN	28	CR 29/POPE CO	083+00.180	★★★★	1	-	-	-	-	-	-	$3,000
6	4.027.035	MN	27	CO RD 91 SW/DOUGLAS CO	074+00.266	★★★★	1	-	2	-	-	-	-	$15,000
7	4.059.043	US	59	CSAH 17/6MI SDETLKS	256+00.828	★★★★	2	-	2	-	-	-	-	$18,000
8	4.009.011	MN	9	GRACE AV CSAH2 LTM 5 RT	041+00.560	★★★★	1	-	1	-	-	-	-	$9,000
9	4.059.023	US	59	MN 55/BARRETT	188+00.167	★★★★	-	-	1	-	-	-	-	$6,000
10	4.113.007	MN	113	CR 35/BECKER CO	033+00.950	★★★★	1	-	-	-	-	-	-	$3,000
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
84	4.075.119	US	75	CSAH 34 RTCR100 LT/GEORGETOW	265+00.903	★★★	2	-	1	-	-	-	-	$12,000
85	4.078.003	MN	78	CSAH 82/ASHBY	004+00.572	★★★	2	-	1	-	-	-	-	$12,000
86	4.210.022	MN	210	OAK ST CSAH 5LT/CLITHERALL	049+00.627	★★★	-	-	1	-	-	-	-	$6,000
87	4.210.023	MN	210	CSAH 5 RTT 1461 LT/CLITHERALL	049+00.886	★★★	2	-	2	-	-	-	-	$18,000
88	4.210.027	MN	210	MN 108 DOUGLAS AVE/HENNING	060+00.618	★★★	2	-	1	-	-	-	-	$12,000
					Totals		***79***	***0***	***82***	***2***	***2***	***0***	***0***	***$1,179,000***

4.2.6 Rural Four-lane Intersection Prioritization/Project Summary

- A total of 42 intersections along rural four-lane highways were analyzed and 10 intersections (24 percent) were found to have 3 or more factors. Approximately $4.2 million is the estimated implementation cost dedicated to the most common type of intersection projects, such as converting full access intersections to RCI's (Tables 4-12 and 4-13).

Table 4-12. District 4 Rural Four-lane Intersection Prioritization

#	Intersection ID	Route System	Route No.	Intersection Description	Cross Product	Skew	On/Near Curve	Development	Severe RA Density	Previous STOP (>5mi)	Total Stars	Tiebreakers Crash Cost
1	4.010.050	US	10	W JCT CSAH10(OLD87)/BCKRCO	★	★	★		★		★★★★	$1,100,000
2	4.010.054	US	10	TH 228/LUCE	★	★	★			★	★★★★	$601,800
3	4.010.023	US	10	TH 9/3 MIE GLYNDON	★				★	★	★★★	$11,610,400
4	4.010.037	US	10	CSAH 11 RTM 18 LT/AUDUBON	★	★		★			★★★	$10,723,200
5	4.010.059	US	10	E JCT CSAH80(OLD10)/PERHAM	★	★	★				★★★	$10,504,400
6	4.010.061	US	10	DIAMOND LKRDCSAH137/NYMILLS		★	★			★	★★★	$10,314,800
7	4.010.065	US	10	E JCT CSAH84(OLD10)/NY MLLS		★	★	★			★★★	$344,200
8	4.010.038	US	10	CSAH 15 RT	★	★				★	★★★	$174,800
9	4.010.036	US	10	CSAH 13 LT/AUDUBON	★	★		★			★★★	$125,400
10	4.075.068	US	75	N JCT TH 210 LT PRIV RDRT	★		★	★			★★★	$0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
38	4.010.029	US	10	280TH ST CSAH37/EOF HAWLEY								$125,400
39	4.010.030	US	10	297TH ST CR 118 RT/E OFHAWLEY								$95,800
40	4.010.035	US	10	CSAH 51 LT/AUDUBON								$95,800
41	4.010.031	US	10	CSAH 1 RTT 414 LT/CLAYCO								$37,000
42	4.336.002	MN	336	CR 72 12TH AVE S/CLAY CO								$0
				Total Stars --	14	20	17	9	2	4		
				% That Gets Star --	33%	48%	40%	21%	5%	10%		

Totals

	#	%
★★★★★★	0	0%
★★★★★	0	0%
★★★★	2	5%
★★★	8	19%
★★	11	26%
★	12	29%
	9	21%
	42	100%

	Stars
Volume Cross Product -	If intersection has an ADT cross product > 6000000
Skew -	If intersection is skewed at an angle of 10 degrees or greater.
On/Near Curve -	If intersection is on or within 1,000 feet of curve.
Development -	If intersection has a commercial development with access near intersection.
Severe Right Angle Crash Density -	If intersection has higher severe right angle crash density than 0.22.
Previous STOP (>5 mi) -	If stop-controlled vehicles have not had a previous stop along the roadway within 5 miles.

Table 4-13. District 4 Rural Four-lane Intersection Project Summary

Page	Intersection ID	Route System	Route No.	Description	RP	Risk Ranking	Upgrade Signs & Markings	Street Lights	Close Median(s)	Reduced Conflict Intersection	Single Quadrant	Grade Separated T	Project Cost
1	4.010.050	US	10	W JCT CSAH10(OLD87)/BCKRCO	052+00.622	★★★★	-	-	1	1	-	-	$800,000
2	4.010.054	US	10	TH 228/LUCE	059+00.826	★★★★	-	2	1	-	-	-	$62,000
3	4.010.023	US	10	TH 9/3 MIE GLYNDON	012+00.786	★★★	-	-	-	1	-	-	$750,000
4	4.010.037	US	10	CSAH 11 RTM 18 LT/AUDUBON	037+00.989	★★★	-	-	1	1	-	-	$800,000
5	4.010.059	US	10	E JCT CSAH80(OLD10)/PERHAM	068+00.332	★★★	-	-	1	1	-	-	$800,000
6	4.010.061	US	10	DIAMOND LKRDCSAH137/NYMILLS	075+00.409	★★★	-	1	1	-	-	-	$56,000
7	4.010.065	US	10	E JCT CSAH84(OLD10)/NY MLLS	078+00.346	★★★	1	1	1	-	-	-	$59,000
8	4.010.038	US	10	CSAH 15 RT	038+00.690	★★★	-	1	1	-	-	-	$56,000
9	4.010.036	US	10	CSAH 13 LT/AUDUBON	037+00.833	★★★	-	-	1	1	-	-	$800,000
10	4.075.068	US	75	N JCT TH 210 LT PRIV RDRT	207+00.460	★★★	-	-	-	-	-	-	$0
						Totals	***1***	***5***	***8***	***5***	***0***	***0***	***$4,183,000***

4.2.7 Rural Horizontal Curves Project Summary

- Six hundred thirty-one curves along rural highways were analyzed and 68 curves (11 percent) were found to have 3 or more factors. Approximately $1.2 million is the estimated implementation cost dedicated to the most common type of curve project, such as upgrading curve warning signs (Table 4-14).

Table 4-14. District 4 Rural Horizontal Curves Project Summary

Count	Curve ID	Segment ID	Route System	Route No.	Start	End	Segment Start RP	Segment End RP	Risk Rating	Chevron or Arrow Board	Lighting	TT to Single T	Advance Horizontal Alignment Warning Sign	Advisory Speed Plaque	Clear Zone Maintenance	Cable Median Barrier	High Friction Surface Treatment	Project Cost
1	4.007.003	4.007.002	MNTH	7	.5 MI N CSAH 3 (SL 50)	4 MI N ORTONVILLE (SL 40)	011+00.674	020+00.103	★★★	x	-	-	-	-	x	-	-	$23,000
2	4.007.012	4.007.002	MNTH	7	.5 MI N CSAH 3 (SL 50)	4 MI N ORTONVILLE (SL 40)	011+00.674	020+00.103	★★★	x	-	-	-	-	x	-	-	$23,000
3	4.007.014	4.007.002	MNTH	7	.5 MI N CSAH 3 (SL 50)	4 MI N ORTONVILLE (SL 40)	011+00.674	020+00.103	★★★	x	-	-	-	-	x	-	-	$23,000
4	4.009.007	4.009.005	MNTH	9	N BENSON (SL 55)	5 MI N CLONTARF	036+00.691	059+00.413	★★	x	-	-	-	-	-	-	-	$3,000
5	4.009.016	4.009.019	MNTH	9	N CAMPBELL (SL 55)	JCT US 75 DORAN	103+00.444	110+00.855	★★★	x	-	-	-	-	-	-	-	$3,000
6	4.009.017	4.009.019	MNTH	9	N CAMPBELL (SL 55)	JCT US 75 DORAN	103+00.444	110+00.855	★★★	x	-	-	-	-	-	-	-	$3,000
7	4.012.005	4.012.006	USTH	12	.1 MI E CTY 53 (SL 55)	2 MI E JCT MN 119	001+00.660	041+00.977	★★★	x	-	-	-	-	-	-	-	$3,000
8	4.027.017	4.027.002	MNTH	27	.1 MI N CR 3 (SL 55)	S WHEATON (SL 30)	000+00.000	022+00.928	★★	x	-	-	-	-	-	-	-	$3,000
9	4.027.043	4.027.017	MNTH	27	E OSAKIS (SL 40)	JCT US 71 (END D4)	092+00.487	105+00.191	★★★	x	-	-	-	-	-	-	-	$3,000
10	4.028.012	4.028.012	MNTH	28	E CHOKIO (SL 55)	W OF MORRIS (SL 40)	035+00.397	047+00.113	★★★	-	x	-	-	-	-	-	-	$30,000
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
64	4.114.012	4.114.005	MNTH	114	W JCT 55	JCT I 94	007+00.272	019+00.949	★★	x	-	-	-	-	-	-	-	$3,000
65	4.114.016	4.114.005	MNTH	114	W JCT 55	JCT I 94	007+00.272	019+00.949	★★	x	-	-	-	-	-	-	-	$3,000
66	4.117.002	4.117.001	MNTH	117	SOUTH DAKOTA STATE LINE	JCT MN 27	000+00.000	001+00.797	★★	x	-	-	-	-	x	-	-	$23,000
67	4.200.002	4.200.003	MNTH	200	N OF MAHNOMEN (SL 55)	JCT T 86 (SL 40)	046+00.994	065+00.579	★★★	x	-	-	-	-	-	-	-	$3,000
68	4.329.001	4.329.001	MNTH	329	JCT US 59 (SL 55)	MN 329 U OF M EXPERIMENTAL STATION	000+00.000	001+00.112	★★	x	-	-	x	-	-	-	-	$4,000
									Totals	***55***	***6***	***1***	***4***	***2***	***24***	***0***	***1***	***$1,202,524***

4.2.8 Urban Segment Prioritization/Project Summary

- A total of 25 urban segments (20 miles) were analyzed and 19 of the segments (76 percent) were found to have 3 or more factors. Approximately $430,000 is the estimated implementation cost dedicated to the most common type of segment project, such as addressing access management (Tables 4-15 and 4-16).

Table 4-15. District 4 Urban Segment Prioritization

#	Corridor ID	Route System	Route No.	Start	End	Length	Speed Limit	ADT Range	Road Geometry	Access Density	Speed Limit Range	Primary Land Use	Severe HO + RE + SSP + SSO Crash Density	Total Stars	Crash Cost	Access Density
1	4.029.012	MNTH	29	.1 MI S JCT I 94 (SL 45)	1.85 MI N JCT I 94 (SL 40)	1.92	45	★	★		★	★	★	★★★★★	$8,708,200	8.9
2	4.029.016	MNTH	29	E JCT CR 82 (SL 30)	N ALEXANDRIA (SL 55)	0.91	30	★	★	★		★	★	★★★★★	$2,883,800	49.2
3	4.029.014	MNTH	29	UNDIV 4 LN ALEXANDRIA (SL 30)	W JCT CR 82 (SL 30)	1.04	30	★	★	★		★		★★★★	$6,953,600	65.5
4	4.010.003	USTH	10	.1 MI W 14TH ST (SL 45)	W DILWORTH (SL 30)	2.37	45	★	★		★	★		★★★★	$5,579,000	11.4
5	4.010.001	USTH	10	NORTH DAKOTA STATE LINE (SL 30)	S JCT US 75	0.40	30	★	★	★		★		★★★★	$4,395,200	55.0
6	4.010.002	USTH	10	W JCT US 75 (SL 30)	.1 MI W 14TH ST (SL 45)	0.41	30	★	★	★		★		★★★★	$1,945,600	72.5
7	4.029.015	MNTH	29	W JCT CR 82 (SL 30)	E JCT CR 82 (SL 30)	0.53	30	★	★	★		★		★★★★	$1,659,200	50.9
8	4.029.013	MNTH	29	1.85 MI N JCT I 94 (SL 40)	UNDIVIDED 4 LN ALEXANDRIA (SL 30)	0.40	40	★	★		★	★		★★★★	$1,009,400	17.5
9	4.010.016	USTH	10	.25 MI W US 59 (SL 40)	.2 MI E US 59 (SL 30)	0.47	40	★	★		★	★		★★★★	$786,600	10.5
10	4.210.004	MNTH	210	4 LN DIV W FERGUS FALLS (SL 45)	W JCT I 94	0.40	45	★	★		★	★		★★★★	$280,400	10.0
11	4.010.018	USTH	10	.3 MI E ROOSEVELT (SL 45)	.7 MI E ROOSEVELT (SL 50)	0.42	45	★	★		★	★		★★★★	$248,400	2.4
12	4.075.028	USTH	75	1 MI S W JCT US10 (SL 30)	W JCT US 10	1.01	30	★	★	★				★★★	$6,038,000	55.2
13	4.075.027	USTH	75	.47 MI S JCT I 94 (SL 40)	1 MI S W JCT US 10 (SL 30)	1.39	40	★	★		★			★★★	$5,705,800	12.2
14	4.059.022	USTH	59	.3 MI S US 10 (SL 40)	.6 MI N MN 34 (SL 60)	0.90	40	★			★		★	★★★	$2,486,600	12.2
15	4.010.017	USTH	10	.2 MI E US 59 (SL 30)	.3 MI E ROOSEVELT (SL 45)	1.08	30	★	★			★		★★★	$2,127,800	12.1
16	4.010.019	USTH	10	.7 MI E ROOSEVELT (SL 50)	.1 MI E CSAH 53 (SL 65)	1.27	50	★	★			★		★★★	$1,401,000	3.1
17	4.075.029	USTH	75	E JCT US 10 (SL 45)	.6 MI N E JCT US 10 (SL 60)	0.60	45		★		★	★		★★★	$968,800	20.0
18	4.075.026	USTH	75	S MOORHEAD (SL 45)	.47 MI S JCT I 94 (SL 40)	0.60	45	★	★		★			★★★	$418,200	10.0
19	4.029.011	MNTH	29	.4 MI S JCT I 94 (SL 50)	.1 MI S JCT I 94 (SL 45)	0.19	50	★	★			★		★★★	$255,800	10.5
20	4.009.008	MNTH	9	S MORRIS (SL 30)	N MORRIS (SL 55)	1.20	30			★		★		★★	$1,542,000	57.4
21	4.034.005	MNTH	34	.5 MI W N JCT US 59 (SL 35)	N DETROIT LAKES (SL 55)	0.54	35				★	★		★★	$806,400	24.0
22	4.009.007	MNTH	9	.4 MI W JCT US 59 (SL 45)	S MORRIS (SL 30)	0.51	45				★	★		★★	$29,600	21.6
23	4.028.013	MNTH	28	W OF MORRIS (SL 40)	.5 MI W MN 9 (SL 30)	0.45	40				★			★	$10,555,800	31.1
24	4.034.004	MNTH	34	N JCT US 59 (SL 30)	.5 MI W N JCT US 59 (SL 35)	0.59	30			★				★	$1,030,600	57.6
25	4.028.014	MNTH	28	.5 MI W MN 9 (SL 30)	S JCT MN 9	0.48	30			★				★	$381,200	50.3
							Total Stars --	18	18	9	13	18	3			
							% That Gets Star --	72%	72%	36%	52%	72%	12%			

	#	%	Mileage	% Mileage
★★★★★★	0	0%	0.0	0%
★★★★★	2	8%	2.8	14%
★★★★	9	36%	6.4	32%
★★★	8	32%	7.0	35%
★★	3	12%	2.3	11%
★	3	12%	1.5	8%
	0	0%	0.0	0%
	25	100%	20.1	100%

Table 4-16. District 4 Urban Segment Project Summary

Count	Corridor ID	Route System	Route No.	Start	End	Begin RP	End RP	Length	Risk Rating	Access Management	Signalized RCI	Cable Median Barrier	3-Lane Conversion	5-Lane Conversion	Signal Updates	Dynamic Speed Feedback Sign	Project Cost
1	4.029.012	MNTH	29	.1 MI S JCT I 94 (SL 45)	1.85 MI N JCT I 94 (SL 40)	076+00.893	078+00.783	1.9	★★★★★	-	-	-	-	-	-	-	-
2	4.029.016	MNTH	29	E JCT CR 82 (SL 30)	N ALEXANDRIA (SL 55)	080+00.748	081+00.550	0.9	★★★★★	0.3	-	-	-	-	-	-	$98,811
3	4.029.014	MNTH	29	UNDIV 4 LN ALEXANDRIA (SL 30)	W JCT CR 82 (SL 30)	079+00.183	080+00.219	1.0	★★★★	0.5	-	-	-	-	-	-	$186,807
4	4.010.003	USTH	10	.1 MI W 14TH ST (SL 45)	W DILWORTH (SL 30)	000+00.930	003+00.118	2.4	★★★★	-	-	-	-	-	-	-	-
5	4.010.001	USTH	10	NORTH DAKOTA STATE LINE (SL 30)	S JCT US 75	000+00.000	000+00.428	0.4	★★★★	0.4	-	-	-	-	-	-	$144,030
6	4.010.002	USTH	10	W JCT US 75 (SL 30)	.1 MI W 14TH ST (SL 45)	000+00.516	000+00.930	0.4	★★★★	-	-	-	-	-	-	-	-
7	4.029.015	MNTH	29	W JCT CR 82 (SL 30)	E JCT CR 82 (SL 30)	080+00.219	080+00.748	0.5	★★★★	-	-	-	-	-	-	-	-
8	4.029.013	MNTH	29	1.85 MI N JCT I 94 (SL 40)	UNDIVIDED 4 LN ALEXANDRIA (SL 30)	078+00.783	079+00.183	0.4	★★★★	-	-	-	-	-	-	-	-
9	4.010.016	USTH	10	.25 MI W US 59 (SL 40)	.2 MI E US 59 (SL 30)	044+00.107	044+00.567	0.5	★★★★	-	-	-	-	-	-	-	-
10	4.210.004	MNTH	210	4 LN DIV W FERGUS FALLS (SL 45)	W JCT I 94	023+00.889	024+00.248	0.4	★★★★	-	-	-	-	-	-	-	-
11	4.010.018	USTH	10	.3 MI E ROOSEVELT (SL 45)	.7 MI E ROOSEVELT (SL 50)	045+00.643	046+00.056	0.4	★★★★	-	-	-	-	-	-	-	-
12	4.075.028	USTH	75	1 MI S W JCT US10 (SL 30)	W JCT US 10	249+00.267	250+00.274	1.0	★★★	-	-	-	-	-	-	-	-
13	4.075.027	USTH	75	.47 MI S JCT I 94 (SL 40)	1 MI S W JCT US 10 (SL 30)	247+00.890	249+00.267	1.4	★★★	-	-	-	-	-	-	-	-
14	4.059.022	USTH	59	.3 MI S US 10 (SL 40)	.6 MI N MN 34 (SL 60)	263+00.682	264+00.573	0.9	★★★	-	-	-	-	-	-	-	-
15	4.010.017	USTH	10	.2 MI E US 59 (SL 30)	.3 MI E ROOSEVELT (SL 45)	044+00.567	045+00.643	1.1	★★★	-	-	-	-	-	-	-	-
16	4.010.019	USTH	10	.7 MI E ROOSEVELT (SL 50)	.1 MI E CSAH 53 (SL 65)	046+00.056	047+00.341	1.3	★★★	-	-	-	-	-	-	-	-
17	4.075.029	USTH	75	E JCT US 10 (SL 45)	.6 MI N E JCT US 10 (SL 60)	251+00.382	252+00.006	0.6	★★★	-	-	-	-	-	-	-	-
18	4.075.026	USTH	75	S MOORHEAD (SL 45)	.47 MI S JCT I 94 (SL 40)	247+00.340	247+00.890	0.6	★★★	-	-	-	-	-	-	-	-
19	4.029.011	MNTH	29	.4 MI S JCT I 94 (SL 50)	.1 MI S JCT I 94 (SL 45)	076+00.660	076+00.893	0.2	★★★	-	-	-	-	-	-	-	-
							Totals	***16.3***		***1.2***	***-***	***-***	***-***	***-***	***-***	***-***	***$429,647***

4.2.9 Urban Intersection (Right-angle Crash Focus) Prioritization/Project Summary

- A total of 69 urban intersections were analyzed with a focus on mitigating/preventing right-angle crashes and 53 (77 percent) were found to have four or more factors. Approximately $5.3 million is the estimated implementation cost dedicated to the most common types of intersection projects, such as the addition of confirmation lights at traffic signals (to aid in red-light running enforcement) and converting standard turn lanes to offset, left-turn lanes with traffic signal upgrades (Table 4-17 and 4-18).

Table 4-17. District 4 Urban Intersection (Right-angle Crash Focus) Prioritization

#	Intersection ID	Route System	Route No.	Description	Speed Limit	Cross Product	Traffic Control	Major Corridor Speed	Skew	On/Near Curve	Primary Land Use	Severe RA Crash Density	Total Stars	Crash Cost
1	4.029.025	MN	29	CR46/ALEXANDRIA	45	★	★	★	★	★	★		★★★★★★	$2,034,600
2	4.029.023	MN	29	50TH AV M111/ALEXANDRIA	45	★	★	★	★	★	★		★★★★★★	$1,692,200
3	4.029.027	MN	29	22ND AV CSAH 23 MSAS 121/ALEX	45	★	★	★	★	★	★		★★★★★★	$1,427,200
4	4.010.009	US	10	21ST ST SRT 1ST AVN/MOORHEAD	45	★	★	★	★	★	★		★★★★★★	$1,114,800
5	4.010.012	US	10	30TH ST/MOORHEAD	45	★		★	★	★	★	★	★★★★★★	$1,098,600
6	4.010.010	US	10	E JCT TH 75/MOORHEAD	45	★	★	★	★	★	★		★★★★★★	$885,400
7	4.059.047	US	59	MAIN ST/DETROIT LAKES	40	★		★	★	★	★	★	★★★★★★	$631,000
8	4.029.026	MN	29	30TH AV MSAS 119/ALEXANDRIA	45	★	★	★	★	★	★		★★★★★★	$560,800
9	4.010.008	US	10	14TH ST MSAS 122/MOORHEAD	45	★	★	★	★	★	★		★★★★★★	$88,400
10	4.075.101	US	75	24TH AVE S/MOORHEAD	40	★	★	★			★	★	★★★★★	$11,749,800
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
65	4.009.022	MN	9	6TH ST/MORRIS	30						★		★	$125,400
66	4.009.024	MN	9	E 10TH ST/MORRIS	30						★		★	$7,400
67	4.034.006	MN	34	NORTH ST/DETROIT LAKES	30					★			★	$0
68	4.028.022	MN	28	E 6TH ST/MORRIS	30									$81,000
69	4.009.026	MN	9	PARK AVE/MORRIS	30									$7,400
						64	37	26	20	23	62	5		
						93%	54%	38%	29%	33%	90%	7%		

Totals

	#	%
★★★★★★★	0	0%
★★★★★★	9	13%
★★★★★	7	10%
★★★★	12	17%
★★★	25	36%
★★	11	16%
★	3	4%
	2	3%
	69	100%

Table 4-18. District 4 Urban Intersection (Right-angle Crash Focus) Project Summary

#	Intersection ID	Route System	Route No.	Description	Reference Point	Risk Rating	Roundabout	RCI	Signalized RCI	Grade Separated T	Signal Upgrade + Offset Turn Lanes	Offest Turn Lanes	Confirmation Lights	Lighting	All-Way Stop	Project Cost
1	4.029.025	MN	29	CR46/ALEXANDRIA	NV	★★★★★★					1		2			$752,400
2	4.029.023	MN	29	50TH AV M111/ALEXANDRIA	077+00.071	★★★★★★					1		1			$751,200
3	4.029.027	MN	29	22ND AV CSAH 23 MSAS 121/ALEX	078+00.693	★★★★★★					1		2			$752,400
4	4.010.009	US	10	21ST ST SRT 1ST AVN/MOORHEAD	001+00.340	★★★★★★					1		2			$752,400
5	4.010.012	US	10	30TH ST/MOORHEAD	NV	★★★★★★										$0
6	4.010.010	US	10	E JCT TH 75/MOORHEAD	001+00.450	★★★★★★							2			$2,400
7	4.059.047	US	59	MAIN ST/DETROIT LAKES	NV	★★★★★★										$0
8	4.029.026	MN	29	30TH AV MSAS 119/ALEXANDRIA	078+00.307	★★★★★★					1		1			$751,200
9	4.010.008	US	10	14TH ST MSAS 122/MOORHEAD	000+01.010	★★★★★★							2			$2,400
10	4.075.101	US	75	24TH AVE S/MOORHEAD	248+00.645	★★★★★							2			$2,400
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
49	4.075.099	US	75	40TH AV SMSAS138/MOORHEAD	247+00.388	★★★							1			$1,200
50	4.009.018	MN	9	ELM/MORRIS	NV	★★★										$0
51	4.029.028	MN	29	18TH AVE E/ALEXANDRIA	NV	★★★										$0
52	4.009.019	MN	9	SOUTH ST/MORRIS	NV	★★★										$0
53	4.009.023	MN	9	7TH ST/MORRIS	060+00.572	★★★							1			$1,200
							0	**2**	**0**	**0**	**5**	**0**	**52**	**0**	**0**	
															Total Estimated Project Cost	**$5,312,400**

4.2.10 Urban Intersection (Pedestrian/Bicyclist Focus) Prioritization/Project Summary

- The same 69 urban intersections were analyzed with a focus on mitigating/preventing pedestrian/bicycle involved crashes and 55 (80 percent) were found to have 4 or more factors. Approximately $962,000 is the estimated implementation cost dedicated to the most common types of intersection projects, such as adding median refuge islands, curb extensions, and countdown timers at traffic signals (Tables 4-19 and 4-20).

Table 4-19. District 4 Urban Intersection (Pedestrian/Bicycle Crash Focus) Prioritization

#	Intersection ID	Route System	Route No.	Description	Speed Limit	Cross Product	Traffic Control	Major Corridor Speed	Skew	On/Near Curve	Primary Land Use	Severe Ped/Bike Crash Density	Total Stars	Crash Cost
1	4.029.025	MN	29	CR46/ALEXANDRIA	45	★	★	★	★	★	★		★★★★★★	$2,034,600
2	4.029.023	MN	29	50TH AV M111/ALEXANDRIA	45	★	★	★	★	★	★		★★★★★★	$1,692,200
3	4.029.027	MN	29	22ND AV CSAH 23 MSAS 121/ALEX	45	★	★	★	★	★	★		★★★★★★	$1,427,200
4	4.010.009	US	10	21ST ST SRT 1ST AVN/MOORHEAD	45	★	★	★	★	★	★		★★★★★★	$1,114,800
5	4.010.010	US	10	E JCT TH 75/MOORHEAD	45	★	★	★	★	★	★		★★★★★★	$885,400
6	4.059.047	US	59	MAIN ST/DETROIT LAKES	40	★		★	★	★	★	★	★★★★★★	$631,000
7	4.034.008	MN	34	RICHWD RDRSVLT AV/DET LKS	35	★	★	★	★	★	★		★★★★★★	$614,800
8	4.029.026	MN	29	30TH AV MSAS 119/ALEXANDRIA	45	★	★	★	★	★	★		★★★★★★	$560,800
9	4.010.008	US	10	14TH ST MSAS 122/MOORHEAD	45	★	★	★	★	★	★		★★★★★★	$88,400
10	4.075.101	US	75	24TH AVE S/MOORHEAD	40	★	★	★			★	★	★★★★★	$11,749,800
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
65	4.009.022	MN	9	6TH ST/MORRIS	30						★		★	$125,400
66	4.009.024	MN	9	E 10TH ST/MORRIS	30						★		★	$7,400
67	4.034.006	MN	34	NORTH ST/DETROIT LAKES	30					★			★	$0
68	4.028.022	MN	28	E 6TH ST/MORRIS	30									$81,000
69	4.009.026	MN	9	PARK AVE/MORRIS	30									$7,400
						64	37	27	20	23	62	3		
						93%	54%	39%	29%	33%	90%	4%		

Totals

	#	%
★★★★★★★	0	0%
★★★★★★	9	13%
★★★★★	7	10%
★★★★	11	16%
★★★	26	38%
★★	11	16%
★	3	4%
	2	3%
	69	100%

Table 4-20. District 4 Urban Intersection (Pedestrian/Bicycle Crash Focus) Project Summary

#	Intersection ID	Route System	Route No.	Description	Reference Point	Risk Rating	Countdown Timers	Leading Ped Interval	HAWK	RRFB	Curb Extension	Median Refuge	Lighting	Project Cost
1	4.029.025	MN	29	CR46/ALEXANDRIA	NV	★★★★★★	1							$12,000
2	4.029.023	MN	29	50TH AV M111/ALEXANDRIA	077+00.071	★★★★★★	1							$12,000
3	4.029.027	MN	29	22ND AV CSAH 23 MSAS 121/ALEX	078+00.693	★★★★★★	1							$12,000
4	4.010.009	US	10	21ST ST SRT 1ST AVN/MOORHEAD	001+00.340	★★★★★★		1						$600
5	4.010.010	US	10	E JCT TH 75/MOORHEAD	001+00.450	★★★★★★	1							$12,000
6	4.059.047	US	59	MAIN ST/DETROIT LAKES	NV	★★★★★★								$0
7	4.034.008	MN	34	RICHWD RDRSVLT AV/DET LKS	036+00.325	★★★★★★		1						$600
8	4.029.026	MN	29	30TH AV MSAS 119/ALEXANDRIA	078+00.307	★★★★★★								$0
9	4.010.008	US	10	14TH ST MSAS 122/MOORHEAD	000+01.010	★★★★★★								$0
10	4.075.101	US	75	24TH AVE S/MOORHEAD	248+00.645	★★★★★		1						$600
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
51	4.029.028	MN	29	18TH AVE E/ALEXANDRIA	NV	★★★								$0
52	4.009.019	MN	9	SOUTH ST/MORRIS	NV	★★★								$0
53	4.075.104	US	75	7TH AVE S/MOORHEAD	249+00.737	★★		1						$600
54	4.075.106	US	75	2ND AV S MSAS111 M32/MOORHEAD	250+00.114	★★								$0
55	4.009.023	MN	9	7TH ST/MORRIS	060+00.572	★★★	1	1			4			$156,600
							15	**23**	**0**	**0**	**20**	**2**	**0**	
										Total Estimated Project Cost				**$961,800**

SECTION 5

References

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