Systemic Safety Project Selection Tool
Supplemental Case Studies

December 2016

U.S. Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
Investment in roadway safety saves lives

Notice

Quality Assurance Statement

Cover Photos

Left: North Dakota Department of Transportation—https://www.flickr.com/photos/nddot/29154311966
License terms: http://creativecommons.org/licenses/by-sa/2.0/legalcode
Top Right: CH2M.
Bottom Right: Washington County, Minnesota.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-SA-17-002		

4. Title and Subtitle	5. Report Date
Systemic Safety Project Selection Tool Supplemental Case Studies	December 2016
	6. Performing Organization Code
7. Author(s)	**8. Performing Organization Report No.**
9. Performing Organization Name and Address Cambridge Systematics, Inc. 555 12th Street, Suite 1600 Oakland, CA 94607 and CH2M Hill, Inc. 1295 Northland Drive, Suite 200 Mendota Heights, MN 55120	**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.** DTFH61-10-D-00020
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration (FHWA) Office of Safety 1200 New Jersey Avenue, SE Washington, D.C. 20590	**13. Type of Report and Period Covered** **14. Sponsoring Agency Code** SA

15. Supplementary Notes

FHWA COTM: Karen Scurry, Office of Safety

16. Abstract

FHWA published the *Systemic Safety Project Selection Tool (Systemic Tool)* in 2013 and, given the condition of the practice at that time, most discussion and examples were based on rural applications and were located along a system with strong supporting data for crashes and road system characteristics. Since publication of the original Systemic Safety Project Selection Tool (FHWA, 2013), additional systemic analyses have indicated the systemic process can be successfully applied in urban areas and along systems with little supporting data. This supplement to the Systemic Safety Project Selection Tool provides two additional case studies demonstrating the systemic analysis process. One case study demonstrates how State, county, and local government agencies in Minnesota evaluated pedestrian and bicycle safety issues in urban areas and developed a program to address these issues based on risk. The second case study illustrates how North Dakota conducted a systemic analysis with little supporting data initially available for analysis.

17. Key Words	18. Distribution Statement
Federal Highway Administration (FHWA); systemic analysis; Strategic Highway Safety Plan (SHSP); systemic approach; risk-based approach	No restrictions

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	43	N/A

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Table of Contents

List of Tables

List of Figures

Introduction

Transportation agencies across the country are focusing efforts on reducing the most severe crashes (i.e., those involving fatalities and serious injuries) on their system of roadways. With the shift from analysis that looks at all severities of crashes to the focus on only the most severe, many safety professionals found a new challenge—how to identify candidate locations for safety investment.

Safety professionals have found that the density of most types of severe crashes is very low and most occur at locations that did not meet definitions for designation as high-crash locations. As such traditional hot spot analysis methods may overlook many safety investment opportunities.

To address this challenge, safety professionals developed and began using a systemic approach to safety analysis. The systemic approach to safety is intended to supplement and complement the traditional site analysis. The systemic approach is data driven and considers risk as well as crash history. The approach involves analyzing and prioritizing roadway facilities based on the presence of roadway and traffic characteristics (i.e., risk factors) that are found to be common at the locations across a system where severe crashes occur. This risk-based approach provides safety program managers the information necessary to proactively deploy safety countermeasures at high-risk locations, instead of only reacting to the occurrence of severe crashes.

FHWA published the *Systemic Safety Project Selection Tool (Systemic Tool)* in 2013 and, given the state of the practice at that time, most discussion and examples focused on rural applications located along a system with strong supporting data for crashes and road system characteristics. Since publication of the *Systemic Tool*, safety professionals have asked:

- Can the systemic process be applied in applications for pedestrian and bicycle crashes?
- Can the systemic process be successfully applied in situations where little supporting data are available?

The answer to both questions is yes. The systemic safety planning process can be successfully applied in urban areas for pedestrian and bicycle crashes and along systems where little supporting data are available.

Systemic Safety Analysis

Systemic safety analysis is data driven and considers risk as well as crash history.

This risk-based approach provides safety program managers the data necessary to proactively deploy safety countermeasures at high-risk locations, instead of only reacting to the occurrence of severe crashes.

The purpose of this supplement is to demonstrate the application of the systemic safety planning process for these situations through two case studies. One case study demonstrates how State, county, and local government agencies in Minnesota evaluated pedestrian and bicycle safety issues in urban areas and developed a program to address these issues based on the identification and assessment of risk factors. The second case study illustrates how North Dakota conducted systemic analysis with little supporting data available before the project was initiated.

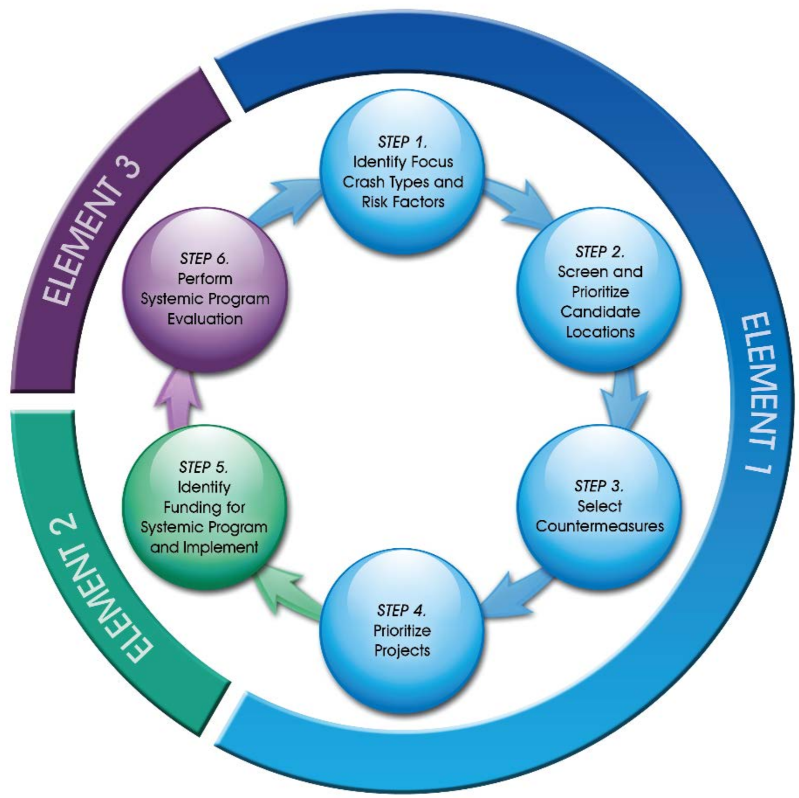
This supplement serves as a complement to the *Systemic Tool*, providing case study applications of the systemic safety planning process. This supplement does not take the place of the technical information and guidance provided in the *Systemic Tool*. Safety professionals should refer to the *Systemic Tool* for additional information and detail on the systemic safety analysis process.

Overview of Systemic Approach

The *Systemic Tool* provides a step-by-step process for conducting systemic safety planning, considerations for determining a reasonable distribution between the implementation of spot safety improvements and systemic safety improvements, and a mechanism for quantifying the benefits of safety improvements implemented through a systemic approach. The framework for the *Systemic Tool* process (Figure 1) includes three key elements:

- **Element 1:** The Systemic Safety Planning Process helps safety professionals identify priority crash types and associated risk factors; evaluate proven low-cost safety countermeasures; prioritize alternative candidate locations for safety investment; and develop and prioritize safety projects with specific strategies to be deployed at specific locations.
- **Element 2:** A Framework for Balancing Systemic and Traditional Safety Investment provides basic data that can aid in setting funding goals to support projects identified through the systemic and site analysis approaches.
- **Element 3:** The Evaluation of a Systemic Safety Program provides high-level direction for evaluating the effectiveness of systemic safety programs.

Figure 1. Framework for the Systemic Safety Project Selection Tool



Source: FHWA, adapted from the *Systemic Safety Project Selection Tool*, 2013.

The case studies included in this supplement focus on Element 1: The Systemic Safety Planning Process. As shown in Figure 2, the process begins by looking at systemwide data to analyze and identify focus crash types (those representing the greatest number of severe crashes) and potential risk factors. As the downward arrows indicate, the approach then moves to a microlevel risk assessment of locations across the network, which then leads to selecting relevant mitigating countermeasures most appropriate for broad implementation across those locations, and prioritizing projects for implementation. The upward arrows indicate that the results of one step might suggest the need to return to a previous step and make adjustments before continuing the process.

Figure 2. Systemic Safety Planning Process

Source: FHWA, adapted from the *Systemic Safety Project Selection Tool*, 2013.

Each step can be scaled based on the availability of technical resources and the quality or quantity of data available to support different analytical approaches. The case studies included in this supplement demonstrate each of these steps, the data used, and overall process outcomes.

Case Study 1: Pedestrian and Bicycle-Focused Systemic Analysis

Minnesota's 2007 *Strategic Highway Safety Plan* (SHSP) committed to increasing the level of engagement of local highway agencies in the statewide safety planning process because approximately 50 percent of severe crashes (those involving a fatality or incapacitating injury) occurred on local roads. Minnesota Department of Transportation (MnDOT) and its Federal and local partners developed the County Roadway Safety Plans Program to provide technical assistance to counties for data-driven systemic risk assessment of the county road system.

Follow up analyses associated with the MnDOT 2014 SHSP identified crashes involving pedestrians and bicycles as a statewide priority (MnDOT, 2014). After successfully completing the county safety plans, MnDOT decided to update the safety plans for each of their districts using the systemic approach to evaluate and prioritize the State's highway system. The initial analysis of the State's system also identified crashes involving pedestrians and bicycles to be a priority. MnDOT determined that approximately 67 percent of all severe crashes involving pedestrians and bicyclists occurred in the Minneapolis-St. Paul metropolitan area and more than 80 percent of these occurred on local systems. As a result, MnDOT partnered with the city of St. Paul to conduct a systemic evaluation of their street system with a focus on pedestrian and bicycle crashes. Through these three projects, systemic pedestrian and bicycle safety has been investigated on the State, county, and municipal roadway systems in Minnesota. The following case study illustrates how MnDOT applied the systemic safety planning process to pedestrian and bicycle crashes in the urban areas across the State's system in Greater Minnesota (i.e., the 80 Counties outside of the seven county Minneapolis St. Paul area), the county system across all 87 Counties in the State and Minneapolis/St. Paul.

The primary sources of data used to support the systemic analysis included:

- MnDOT's crash records system: Geolocated severe crashes along the State and local road systems; it also provided information about roadway geometry and intersection control characteristics at the crash site and insight about contributing factors.
- Video-logs: Provided current images of the State and county road system (number of lanes, cross-section, and alignment) and road edges (in-place traffic signs, on-street parking, boulevards, sidewalks, bus stops, and adjacent land use).
- Google Earth: Supplemented information obtained from the video logs and provided a history of roadway and traffic control changes over time.
- MnDOT's database of traffic volumes: Provided daily traffic volumes along the State highway system and on the State-aided portion of county and municipal systems.

Step 1: Identify Focus Crash Types and Risk Factors—Task 1: Select Focus Crash Types

Case Study 1

Table 1. Minnesota Focus Crash Types

Focus Area	Crashes	Percent
Lane departure	3,199	45.5%
Intersection	2,945	41.9%
Unbelted occupants	2,463	35.0%
Impaired roadway users	1,850	26.3%
Younger drivers	1,367	19.4%
Inattentive drivers	1,319	18.7%
Speed	1,309	18.6%
Motorcyclists	1,244	17.7%
Older drivers	1,028	14.6%
Commercial vehicles	714	10.1%
Unlicensed drivers	702	10.0%
Pedestrians	**649**	**9.2%**
Bicyclists	**286**	**4.1%**
Work zones	103	1.5%
Trains	21	0.3%

Source: Minnesota SHSP http://www.dot.state.mn.us/trafficeng/safety/shsp/.

Purpose

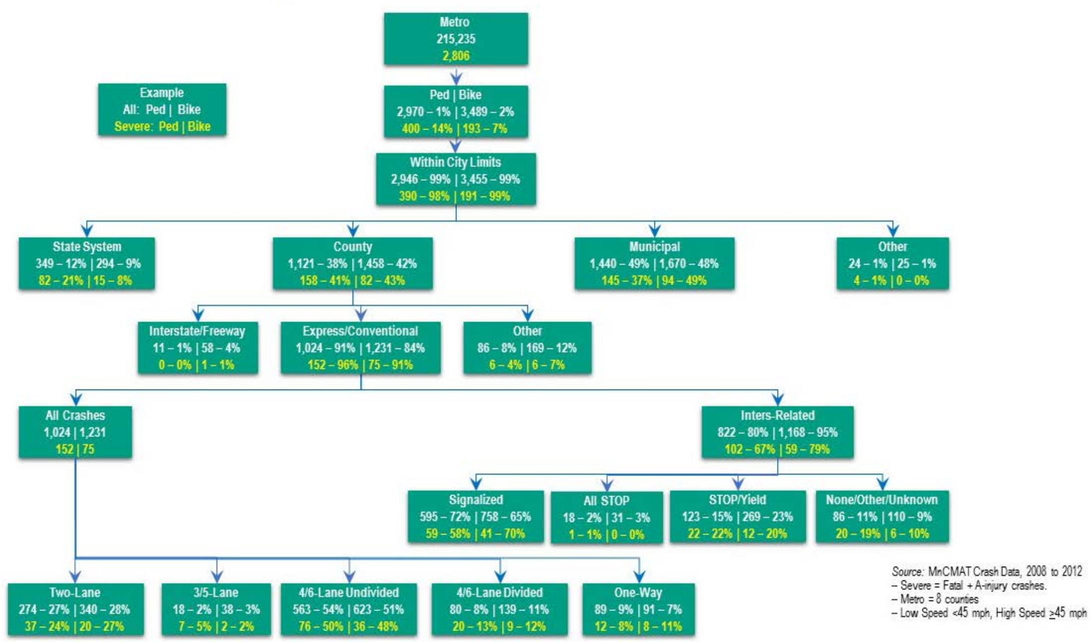
Identify the high-priority emphasis area—categories of severe crashes that represent the greatest opportunity for reduction.

Description

- Demonstrates disaggregation of Minnesota's statewide crash data.
- The Minnesota State SHSP identifies pedestrian and bicycle crashes on the list of focus crash types (Table 1).
- Studying the statewide pedestrian and bicycle crash data in further detail showed:
  - In almost 420 cities across Greater Minnesota, on average there were 8 severe pedestrian and bicycle crashes per year. Although a low number, it is the second highest of any crash type (second to right angle collisions).
  - In Minnesota's largest urban area (Minneapolis/St. Paul), there are approximately 61 severe pedestrian and bicycle crashes per year and that is the highest total of any crash type.
  - Two-thirds of all severe pedestrian and bicycle crashes in the State occur in the Minnesota/St. Paul metropolitan area.

Step 1: Identify Focus Crash Types and Risk Factors—Task 2: Select Focus Facilities

Figure 3. Minneapolis/St. Paul Crash Tree



Source: Adapted from CH2M, 2014.

Purpose

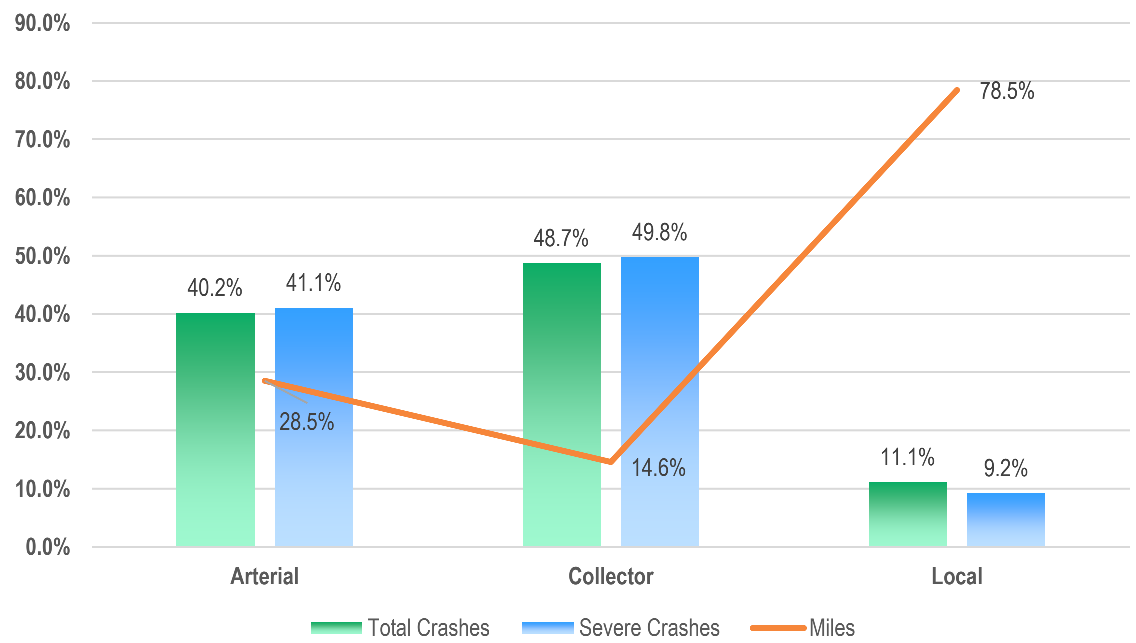
Identify where crash types most frequently occur.

Description

- This is a crash tree analysis focusing on the pedestrian and bicycle crashes in the Minneapolis/St. Paul metropolitan area. The disaggregation of the county road system crashes allowed for focus facilities to be identified for the County Road Safety Plans.
    - Analysis shows approximately 67 percent of all severe crashes involving pedestrians and bicyclists occurred in the Minneapolis/St. Paul metropolitan area and approximately 80 percent of these crashes occurred on the local system.
    - Among all roadway types, approximately 65 percent of severe pedestrian and bicycle crashes occur at intersections.

STEP 1: IDENTIFY FOCUS CRASH TYPES AND RISK FACTORS—TASK 2: SELECT FOCUS FACILITIES (CONTINUED)

Figure 4. St. Paul Crashes Compared to Functional Classification



Source: Adapted from CH2M, 2016.

Purpose

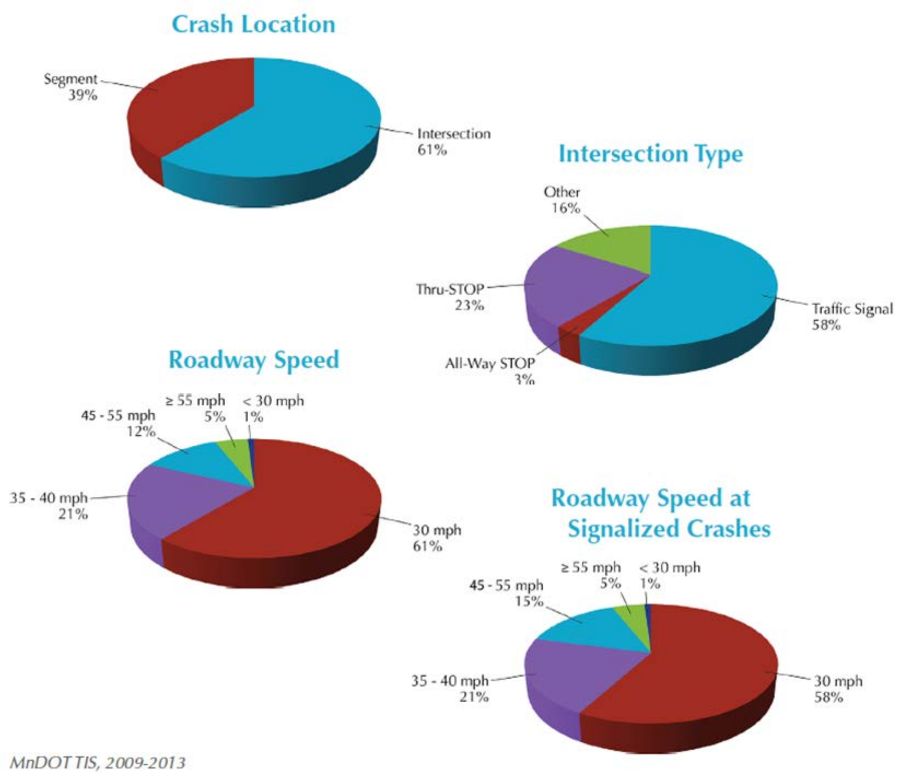
Identify where crash types most frequently occur.

Description

- This graph compares the proportion of roadway mileage to the proportion of crashes along St. Paul's municipal roadway system.
- The initial analysis of pedestrian and bicycle crashes in St. Paul found that 91 percent of these crashes occurred on 43 percent of the system roads classified as arterials and collectors (Figure 4).
- These data support the decision to designate arterials and collectors as the focus facility types and to concentrate on the detailed analysis of these roads because the large number of severe crashes provided the greatest opportunity for reduction.

Step 1: Identify Focus Crash Types and Risk Factors—Task 3: Identify and Evaluate Risk Factors

Figure 5. Crashes versus Intersection and Intersection Control and Crashes versus Speed Limit Pie Chart



Source: Adapted from MnDOT, 2015.

Purpose

Identify roadway characteristics to use as initial set of potential risk factors to be further evaluated for use in systemic network screening. In these systemic analyses, the largest group of attainable urban data was used to increase the data sample size; in some instances this is Minneapolis/St. Paul metropolitan data, and in other cases statewide.

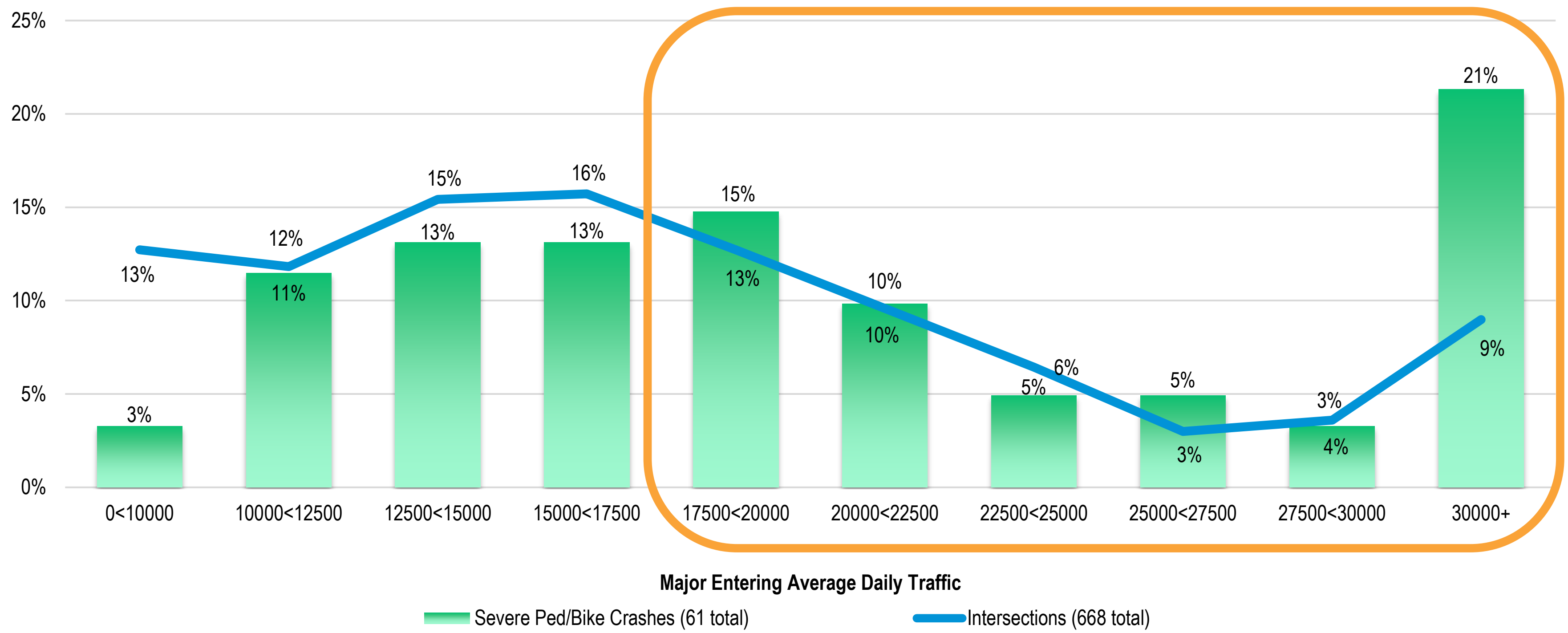
Description

Examples of the results of these analyses supporting the adoption of a set of risk factors in the Minneapolis/St. Paul metropolitan area include:

- More than 60 percent of the severe pedestrian and bicycle crashes occurred at intersections and almost 60 percent of these intersections had traffic signal control.
- Almost 60 percent of the locations with severe pedestrian and bicycle crashes had a 30-mile-per-hour speed limit, which is the statutory speed limit in urban areas in Minnesota.
- While not shown here, the analysis showed approximately 75 percent of severe pedestrian and bicycle crashes occurred at intersections where a pedestrian generator (retail or institutional land use) was present.
- Almost 60 percent of severe pedestrian and bicycle crashes occurred at intersections where the major road entering volume was greater than 17,500 vehicles per day (Figure 6).

Step 1: Identify Focus Crash Types and Risk Factors—Task 3: Identify and Evaluate Risk Factors (continued)

Figure 6. Crashes Compared to Average Daily Traffic Volume—Minneapolis/St. Paul



Source: CH2M, 2016.

STEP 1: IDENTIFY FOCUS CRASH TYPES AND RISK FACTORS—TASK 3: IDENTIFY AND EVALUATE RISK FACTORS (CONTINUED)

Table 2. Minnesota Adopted Risk Factors for Pedestrian and Bicycle Crashes

Characteristic	Minnesota County Roadway Safety Plans	Minnesota District Safety Plans
Traffic Signal	●	●
Speed Limit	●	●
Four Legs	●	
Undivided	●	
Bus Stop	●	
Ped Generator	●	●
Volume	●	●
Skew		●
Curve		●

Source: CH2M, 2016.

Purpose

Identify roadway characteristics and network elements to use as an initial set of potential risk factors to be further evaluated for use in systemic network screening.

Description

- The results supported the adoption of a set of risk factors that were used in the systemic evaluation of the local system in the Minneapolis/St. Paul metropolitan area and for the State system in Greater Minnesota (Table 2).
- The systemic analyses of Minnesota's county and State systems found four common characteristics among the intersections with severe pedestrian and bicycle crashes:
  - » Traffic signal control.
  - » Speed limit (major approach).
  - » Presence of pedestrian generator.
  - » Traffic volume.

These same four characteristics applied to the St. Paul municipal system along its arterial and collector facilities.

Step 2: Screen and Prioritize Candidate locations—Tasks 1-3: Prioritize Focus Facility Elements

Figure 7. Sample Documentation of State System Urban Signalized Intersection Screening for Pedestrian and Bicycle Risk[a]

#	Intersection ID	Route System	Route No.	Description	Speed Limit	Cross Product[b]	Traffic Control	Major Corridor Speed	Skew	On/Near Curve	Primary Land Use	Severe Ped/Bike Crash Density	Total Stars	Crash Cost
34	3.210.025	MN	210	4TH ST NWCSAH20 MSAS103/BRNRD	35	★	★	★		★	★		★★★★★	$1,050,200
35	3.024.009	MN	24	CSAH 75/CLEARWATER	40	★	★	★	★		★		★★★★★	$747,600
36	3.023.028	MN	23	19 1/2 AV/ST CLD	35	★		★	★	★	★		★★★★★	$574,800
37	3.023.050	MN	23	TH 25/FOLEY	45	★	★	★	★		★		★★★★★	$558,000
38	3.027.015	MN	27	4TH ST MSAS 106/LITTLE FALLS	30	★	★		★	★	★		★★★★★	$366,400
39	3.023.011	MN	23	RED RVR AVCSAH 2/COLD SPRING	35	★	★	★		★	★		★★★★★	$292,800
40	3.023.020	MN	23	6TH AV S MSAS107 M95/WAITPK	40	★	★	★		★	★		★★★★★	$0
41	3.210.021	MN	210	ELDER DR SM140/BAXTER	55	★		★	★		★		★★★★	$10,558,200
42	3.012.003	US	12	JOHNSON AVE M-54 LT/COKATO	35	★		★			★	★	★★★★	$10,418,000
43	3.015.011	MN	15	N JCT TH 23 DIV ST/ST CLOUD	45	★	★	★			★		★★★★	$5,838,400
44	3.015.012	MN	15	3RD ST N CSAH81 MSAS 114/STC	45	★	★	★			★		★★★★	$4,310,200
45	3.169.004	US	169	197TH AV MSAS116 M118/ELKRV	55	★	★	★			★		★★★★	$1,696,200
46	3.015.019	MN	15	CSAH 29/SAUK RAPIDS	60	★	★	★			★		★★★★	$1,671,800
47	3.010.011	US	10	E JCT TH 210 LT/MOTLEY	30	★	★			★	★		★★★★	$1,612,200
48	3.210.026	MN	210	4TH ST N MSAS114/BRAINERD	35	★	★	★			★		★★★★	$1,241,800
49	3.210.027	MN	210	TH 371B RTM 60 LT/BRAINERD	35	★	★	★			★		★★★★	$1,186,600
50	3.023.022	MN	23	WAITE AVEMSAS101/WAITEPARK	40	★	★	★			★		★★★★	$1,146,000
53	3.025.030	MN	25	RIVER ST MSAS112/MONTICELLO	30	★	★			★	★		★★★★	$891,400
54	3.012.020	US	12	BUFFALO AVCSAH 12TH 25/MONTR	35	★	★	★			★		★★★★	$641,000
55	3.023.088	MN	23	N JCT TH 65 CSAH 6/MORA	30	★	★		★		★		★★★★	$622,200
56	3.025.029	MN	25	BROADWAY CSAH75/MONTICELLO	30	★	★			★	★		★★★★	$619,600

Source: CH2M, 2016.

[a] This step was not conducted for the Minneapolis-St. Paul metropolitan area. This figure shows how the process was conducted for urban areas in MNDOT District 3 in the north central part of the State.

[b] Cross Product—Multiplication of the average minor approach volumes and average major approach volumes.

Purpose

Evaluate the risk factors of the systems and locations selected for analysis using roadway and traffic characteristics in order to rank/prioritize at-risk locations. While this step was not conducted for the Minneapolis/St. Paul area, Figure 7 shows the process for urban areas in MNDOT District 3 in the north central part of the State.

Description

- Aerial photography and video-logs were used to screen the focus facilities (State highways in urban areas in Greater Minnesota and arterials and collectors along local systems in the Minneapolis/St. Paul Metropolitan area) to document risk factors present at each of the 1,979 signalized intersections.
- The systemic evaluation produced a prioritization of intersections as candidates for safety investment based on the number of risk factors present.
- Where the number of risk factors present was equal across a number of intersections, the ranking was then based on the designated crash cost.
- The tabular format documents both the overall prioritization of intersections and documentation of the risk factors present.

STEP 3: SELECT COUNTERMEASURES—TASK 3: SELECT COUNTERMEASURES FOR DEPLOYMENT

Table 3. Adopted Short-List of Pedestrian and Bicycle Countermeasures

Countermeasure	Crash Reduction Factor	Implementation Cost
Countdown Timers	25%	$12,000 per intersection
Leading Pedestrian Interval	Up to 60%	$600 per intersection
Lighting	33%-44%	$10,000-$25,000 per intersection
Curb Extensions	30%-46%	$36,000 per corner
Median Refuge Island	39%-46%	$24,000 per approach
High-intensity Activated crossWalK (HAWK) Signals	69%	$50,000-$120,000
Rapid Flash Beacons	Increase Yield to Pedestrians	$15,000

Source: CH2M, 2016.

Purpose

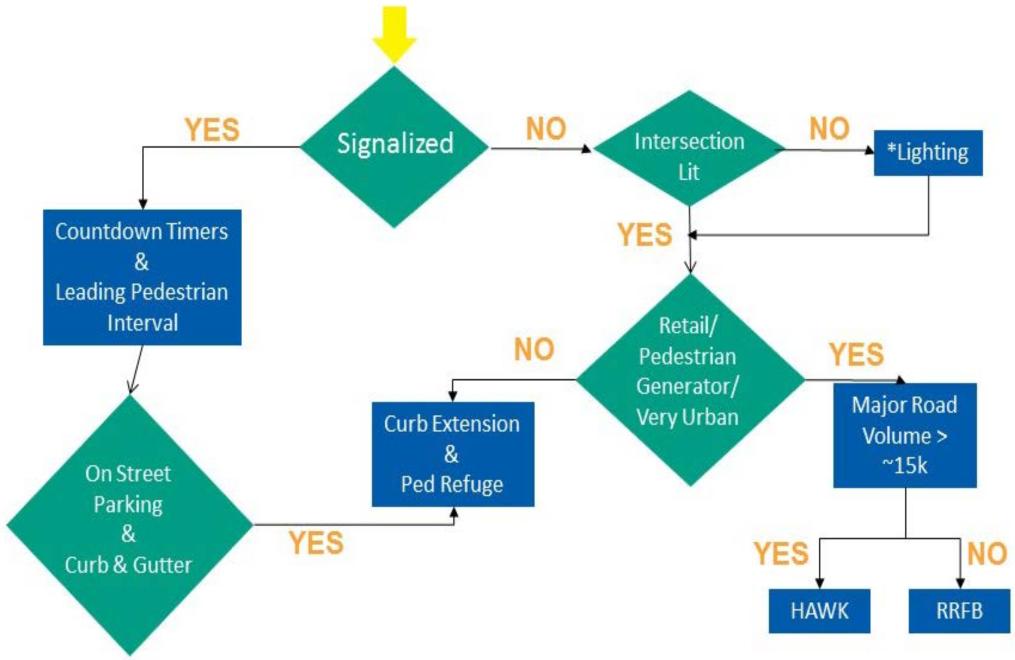
Assemble an initial comprehensive list of countermeasures. Evaluate and screen the initial list to identify feasible countermeasures for implementation. Identify and select countermeasures for each focus crash type based on the evaluation of the countermeasures and consideration of agency priorities, practices, and policies.

Description

- Analysts evaluated a short-list of pedestrian and bicycle on two key issues: 1) effectiveness and 2) implementation cost.
- The adopted short list of countermeasures was primarily focused on signalized intersections, but also included a variety of strategies that could be used at Thru/ STOP controlled intersections and one strategy primarily intended for urban segments. The adopted countermeasures, documented crash reduction factors, and estimated implementation costs are documented in Table 3.
- Analysis of Minnesota's crash data indicated that the majority of bicycle involved crashes occurred at intersections, the same as for pedestrian involved crashes. As a result analysts concluded that countermeasures focused on intersections were equally applicable to mitigating both pedestrian and bicycle involved crashes.

STEP 4: PRIORITIZE PROJECTS—TASK 1: CREATE A DECISION PROCESS FOR COUNTERMEASURE SELECTION

Figure 8. Pedestrian and Bicycle Project Development Decision Tree



Source: CH2M, 2016.

Purpose

Develop a decision process to facilitate consistency in the selection of countermeasures.

Description

- After identifying at-risk, high priority candidates for safety investment, safety professionals developed safety projects at each location. The project development process considered key features of intersections, including traffic control, street cross-section, presence of on-street parking, presence of a pedestrian generator, and major road volume to develop a project decision tree (Figure 8).
- Examples of the documentation of the project development along the State's urban highways in Greater Minnesota (Figure 9) include intersection identification, type of intersection control, presence of street lighting and on-street parking, and the suggested safety project based on the application of the decision tree.

Step 4: Prioritize Projects—Task 2-3: Develop and Prioritize Safety Projects

Figure 9. Example Pedestrian and Bicycle Safety Project Overview for Greater Minnesota

#	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
34	3.210.025	MN	210	4TH ST NWCSAH20 MSAS103/BRNRD	121+00.917	★★★★★	1					4		$ 108,000
35	3.024.009	MN	24	CSAH 75/CLEARWATER	044+00.401	★★★★★	1							$ 12,000
36	3.023.028	MN	23	19 1/2 AV/ST CLD	205+00.618	★★★★★								$ -
37	3.023.050	MN	23	TH 25/FOLEY	220+00.925	★★★★★	1							$ 12,000
38	3.027.015	MN	27	4TH ST MSAS 106/LITTLE FALLS	135+00.817	★★★★★	1							$ 12,000
39	3.023.011	MN	23	RED RVR AVCSAH 2/COLD SPRING	190+00.653	★★★★★	1							$ 12,000
40	3.023.020	MN	23	6TH AV S MSAS107 M95/WAITPK	203+00.307	★★★★★	1					2		$ 60,000
41	3.210.021	MN	210	ELDER DR SM140/BAXTER	120+00.275	★★★★								$ -
42	3.015.011	MN	15	N JCT TH 23 DIV ST/ST CLOUD	150+00.644	★★★★	1					4		$ 108,000
43	3.015.012	MN	15	3RD ST N CSAH81 MSAS 114/STC	151+00.066	★★★★	1					4		$ 108,000
44	3.169.004	US	169	197TH AV MSAS116 M118/ELKRV	160+00.900	★★★★	1							$ 12,000
45	3.015.019	MN	15	CSAH 29/SAUK RAPIDS	155+00.290	★★★★	1							$ 12,000
46	3.010.011	US	10	E JCT TH 210 LT/MOTLEY	114+00.798	★★★★								$ -
47	3.210.026	MN	210	4TH ST N MSAS114/BRAINERD	122+00.519	★★★★	1							$ 12,000
48	3.210.027	MN	210	TH 371B RTM 60 LT/BRAINERD	122+00.663	★★★★	1			2				$ 42,000
49	3.023.022	MN	23	WAITE AVEMSAS101/WAITEPARK	203+00.810	★★★★	1					2		$ 60,000
50	3.023.026	MN	23	25TH AV MSAS 132/STCLOUD	205+00.236	★★★★	1					2		$ 60,000
51	3.023.029	MN	23	Cooper Ave. S	NV	★★★★	1					4		$ 108,000
52	3.025.030	MN	25	RIVER ST MSAS112/MONTICELLO	068+00.683	★★★★								$ -
53	3.012.020	US	12	BUFFALO AVCSAH 12TH 25/MONTR	132+00.095	★★★★	1							$ 12,000

Source: CH2M, 2016.

The information in Figure 9 (abridged from complete project list) indicates that 14 of the 16 high risk intersections were suggested for projects—including countdown timers at signalized intersections, one HAWK, one Rectangular Rapid Flash Beacon, three intersections with curb extensions, and three more with median refuge islands. In total, the systemic safety process identified approximately $1.7 million worth of pedestrian and bicycle projects along the local system in the Minneapolis/St. Paul Metropolitan area and $11.5 million worth of projects along urban State highways in Greater Minnesota.

SUMMARY

Data generated as part of the systemic risk evaluations conducted along the State's urban highways in Greater Minnesota and along the local system in the Minneapolis/St. Paul Metropolitan area demonstrate:

- Systemic process assisted in the identification of focus crash and facility types.
- Adoption of a set of risk factors.
- Screening and prioritizing of the systems.
- Development of a short-list of safety countermeasures.
- Identification of more than $13 million worth of pedestrian and bicycle focused safety projects at designated high-risk candidate locations.

Case Study 2: Systemic Safety Analysis with Limited Data

The following case study illustrates how the North Dakota Department of Transportation (NDDOT) applied the systemic safety planning process as a part of a statewide effort to provide technical support and funding to prepare safety plans for 53 counties and 12 major cities. The initial analysis focused on highway-related crashes and disaggregated the crashes by system (i.e., State, county and city; urban and rural; roadway segments and intersections) and by type of crash (i.e., road departure, right angle, pedestrian, and bicycle). In addition, the analysis focused on paved county roads plus a category called County Major Collectors because these roads accounted for 52 percent of severe crashes, even though they accounted for approximately 10 percent of the county system by mileage.

NDDOT was able to provide comprehensive geolocated crash data for the analyses, but limited roadway data. This case study demonstrates how a systemic safety analysis can be conducted with limited available roadway data. In this case, it is possible to supplement available data with commercial aerial photography, a photo inventory taken by project staff, and analytical judgment. The data was collected and analyses conducted for urban and rural environments in North Dakota. However, this case study focuses on the rural environment only. The following data sources were used to conduct the analysis:

- **Crash Data—**North Dakota's database provided 5 years of geolocated crashes along the local system, an overview of key roadway characteristics, the relationship to intersections, and a set of contributing factors.
- **Aerial/Street-Level Imagery**—Roadway street-level imagery—NDDOT could not provide street-level imagery of the local system, so safety professionals used aerial photography (Google Earth) supplemented with a photo inventory of rural county roads taken by project staff to document roadway characteristics. A photo inventory of the city streets was not necessary because Google Earth, although limited, provided street view images used for this purpose.
- **Traffic volume**—NDDOT provided current or forecast daily traffic volumes for approximately 40 percent of the system under investigation, primarily the more important and higher-volume roads and city streets. For the remainder of the system, traffic volume data were estimated using one of three approaches:

Data for Systemic Safety Analysis

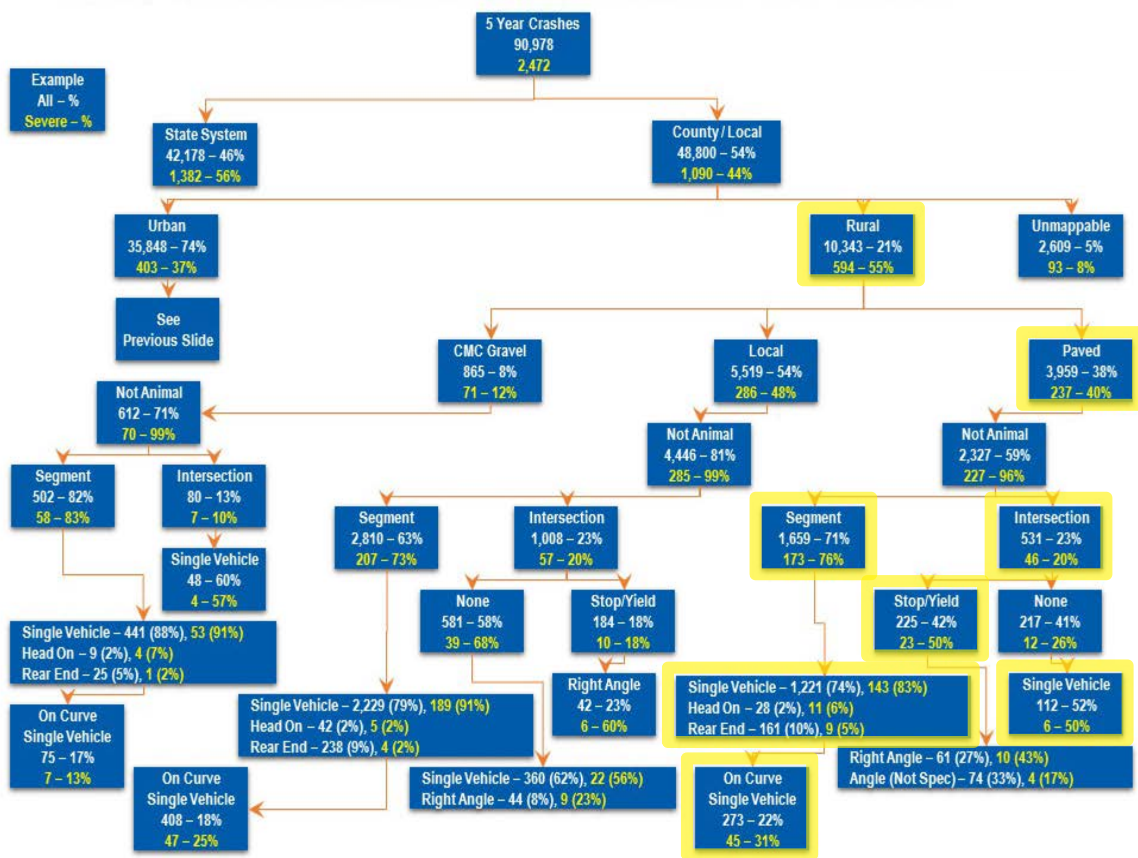
It is necessary to have some data to conduct systemic safety analysis. Data can be gathered through traditional engineering field work; and estimated using engineering judgement. For example, an analyst could estimate traffic volumes for specific facilities based on average or typical volumes on comparable facilities; roadway speeds could be categorized based on local knowledge of traffic flow; or roadway characteristics can be estimated from aerial photography and street view photos from Google Earth.

If the resources are not available to acquire data for a systemic safety analysis, agencies may want to consider implementing low cost safety countermeasures systemwide as part of roadway maintenance or other improvement projects.

- Local agencies were asked to provide any volume data they might have that were not included in the State database.
- If volume data were not available for a particular segment but were available on segments upstream or down, project staff interpolated the data.
- If no volume data were available, a default of 29 vehicles per day in rural areas was derived from a sample of automatic traffic recording stations around the State. Note the number was not rounded to 30 to serve as a “flag” for safety professionals to know this was an assumed value.

Step 1: Identify Focus Crash Types and Risk Factors—Tasks 1-2: Select Focus Crash Types and Facilities

Figure 10. Rural Crash Tree



Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Purpose

Identify where crash types most frequently occur.

Description

- This is a crash tree analysis focusing on rural crashes in North Dakota (Figure 10).
- The focus crash types are:
  - » Lane departure crashes.
  - » Right-angle crashes.
  - » Segments, horizontal curves.
  - » Thru/STOP controlled intersections.

Figure 11. Example of a Visual Trap

Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Purpose

Identify selected risk factors.

Description

The adopted rural risk factors and data sources include:

- Rural Horizontal Curves:
  - » Occurrence of a severe crash—from NDDOT crash records.
  - » Range of curve radii—estimated from Google Earth.
  - » Range of daily traffic volume—from database, interpolation or default.
  - » Presence of an intersection—from Google Earth.
  - » Presence of a visual trap—from Google Earth and photo inventory (Figure 11).
- Rural Segments:
  - » Range of average daily traffic volume – from database, estimate or default.
  - » Density of lane departure crashes—from NDDOT crash records.
  - » Access density—from Google Earth.
  - » Curve density—from Google Earth.
  - » Edge risk assessment: from photo inventory (Figure 12).
- Rural Intersections:
  - » Occurrence of an intersection related crash—from NDDOT crash records.
  - » Skewed minor approaches—from Google Earth.
  - » In/near curve—from Google Earth.
  - » Cross-product of major and minor street traffic volume—from database, estimate or default.
  - » Presence of commercial development—from Google Earth and photo inventory.
  - » Distance (along the minor approaches) to the previous STOP sign—from Google Earth.
  - » Proximity to a rail grade crossing—from Google Earth.

Step 1: Identify Focus Crash Types and Risk Factors—Task 3: Identify and Evaluate Risk Factors (continued)

Figure 12. Sample Edge Risk Assessment Ratings

Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Purpose

Identify roadway characteristics to use as an initial set of potential risk factors to be further evaluated for use in systemic network screening.

Description

- North Dakota project safety professionals reviewed the following State and national research reports to identify relationships between crashes and roadway characteristics:
  - National Cooperative Highway Research Program (NCHRP) Report 500 Series, (NCHRP, 2003-2009).
  - American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (AASHTO, 2010).
  - FHWA Crash Modification Factors Clearinghouse.
- For example, the AASHTO *Highway Safety Manual* (HSM) has identified the following variables to be dependent factors in the computation of each category:
  - Edge risk in the computation of the estimated number of crashes along rural segments (Figure 12).
  - Skew in the computation of crashes at rural intersections.
  - Speed limit in the computation of crashes along urban segments.
- Edge risk was one of the risk factors adopted for the evaluation of rural road segments. Safety professionals were trained using this set of photos to assign a rating of Good (Photo 1) where they observed a usable shoulder and a reasonable clear zone, a rating of Poor (Photo 3) where they observed no usable shoulder, and a roadside with obstacles and a rating of Fair (Photo 2) if they found a variety of features.

Figure 13. Sample Rural Intersection Prioritization/Bottineau County

Rank	Int #	Intersection Description	Skew	On/Near Curve	Development	RR Xing	Previous STOP (>5mi)	Total Crashes	ADT Cross Product > 80000	Priority	Crash Cost
1	6.07	103rd St NW/NE (Bottineau 6) & 1st Ave NE	★	★	★		★	★	★	★★★★★★	$ 412,000
2	28.02	82nd St NE (Bottineau 28) & ND 60	★		★		★	★		★★★★	$ 91,000
3	17.04	93rd St NW & ND 5/93rd St NW	★	★				★	★	★★★★	$ 12,000
4	503.01	13th Ave NE & ND 5/97th St NE			★		★	★	★	★★★★	$ 12,000
5	17.03	20th Ave NW (Bottineau 17B) & 90th St NW (Bottineau 20)	★	★			★		★	★★★★	$ -
6	502.02	98th St NE & 13th Ave NE					★	★	★	★★★	$ 91,000
7	26.02	83rd St NW (Bottineau 26A) & 30th Ave NW/Laurel St					★	★	★	★★★	$ 12,000
8	26.03	83rd St NW (Bottineau 26A) & US 83/27th Ave NW					★	★	★	★★★	$ 12,000
9	49.02	Town Line Rd (Bottineau 49) & 98th St NE			★			★	★	★★★	$ 12,000
10	57.01	21st Ave NE (Bottineau 57) & ND 5/96th St NE					★	★	★	★★★	$ 12,000
11	6.03	103rd St NW/Railway Ave W (Bottineau 6) & US 83/3rd St E			★		★		★	★★★	$ -
12	17.05	20th Ave NW & ND 5/20th Ave NW (Southern)	★	★					★	★★★	$ -
13	17.06	20th Ave NW & ND 5/20th Ave NW (Northern)	★	★			★			★★★	$ -
14	47.01	11th Ave NE (Bottineau 47) & ND 5/97th St NE/11th St E			★		★		★	★★★	$ -
15	49.03	Town Line Rd/12th Ave NE (Bottineau 49) & ND 43/106th St NE		★			★		★	★★★	$ -
16	503.02	Lake Rd/Lake Loop Rd W & ND 43/106th St NE			★		★		★	★★★	$ -
17	504.03	Larson Beach Rd & ND 43/106th St NE		★			★		★	★★★	$ -
18	508.01	Svingen Rd & ND 43/106th St NE	★	★			★			★★★	$ -
19	2.02	107th St NW (Bottineau 2) & ND 256/27th Ave NW					★	★		★★	$ 1,248,000
20	17.01	20th Ave NW (Bottineau 17C) & 80th St NW (Bottineau 30)					★	★		★★	$ 12,000
21	20.06	88th St NE/Kramer Rd (Bottineau 20) & 10th Ave NE (Bottineau 47)					★	★		★★	$ 12,000
22	22.01	87th St NE & ND 60/19th Ave NE					★	★		★★	$ 12,000
23	502.01	98th St NE & 11th Ave NE					★	★		★★	$ 12,000
24	6.08	103rd St NE (Bottineau 6) & ND 14/7th Ave NE					★		★	★★	$ -
25	20.03	86.5 St NW & 9th Ave NW				★	★			★★	$ -
26	20.04	88th St NW (Bottineau 20) & ND 14/Central Ave				★	★			★★	$ -

Abridged version of complete table. Partial data shown.

Rank	Int #	Intersection Description	Skew	On/Near Curve	Development	RR Xing	Previous STOP (>5mi)	Total Crashes	ADT Cross Product > 80000	Priority	Crash Cost
43	6.06	103rd St NW (Bottineau 6) & 3rd Ave NW					★			★	$ -
44	17.02	20th Ave NW (Bottineau 17C) & 84th St NW (Bottineau 26B)					★			★	$ -
45	20.01	90th St NW (Bottineau 20) & 15th Ave NW (Bottineau 21)					★			★	$ -
46	20.02	90th St NW (Bottineau 20) & 10th Ave NW					★			★	$ -
47	27.02	8th Ave NW (Bottineau 27A) & ND 5/97th St NW					★			★	$ -
48	28.01	82nd St NE (Bottineau 28A) & 15th Ave NE (Bottineau 51)					★			★	$ -
49	33.01	3rd Ave NW (Bottineau 33) & ND 5/97th St NW					★			★	$ -
50	57.03	104th St NE (Bottineau 57) & ND 43/106th St NE		★						★	$ -
51	504.01	Lake Loop Rd W & 107th St NE							★	★	$ -
52	504.02	Lake Loop Rd W & 108th St NE		★						★	$ -
53	6.02	103rd St NW (Bottineau 6) & 20th Ave NW (Bottineau 17A)									$ -
54	26.01	83rd St NW (Bottineau 26A) & Main Ave									$ -
55	505.01	19th Ave NE & ND 43/106th St NE									$ -
		Total Stars --	7	13	7	4	45	15	22		
		% That Gets Star --	13%	24%	13%	7%	82%	27%	40%		

Totals

	#	%
★★★★★★★	0	0%
★★★★★★	1	2%
★★★★★	0	0%
★★★★	4	7%
★★★	13	24%
★★	18	33%
★	16	29%
-	3	5%
	55	100%

Stars	
Skew -	If intersection is skewed at an angle of 20 degrees or greater.
On/Near Curve -	If intersection is on or within 1,000 feet of curve.
Development -	If intersection aerial shows a commercial development with access near intersection.
RR Xing -	If intersection has a railroad crossing on any approach within 500 feet.
Previous STOP (>5 mi) -	If vehicles approaching the stop control have not had a previous stop along the roadway within 5 miles
Total Crashes -	If intersection has at least 1 crash.
ADT Cross Product -	If intersection has an ADT cross product > 80000

Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Purpose

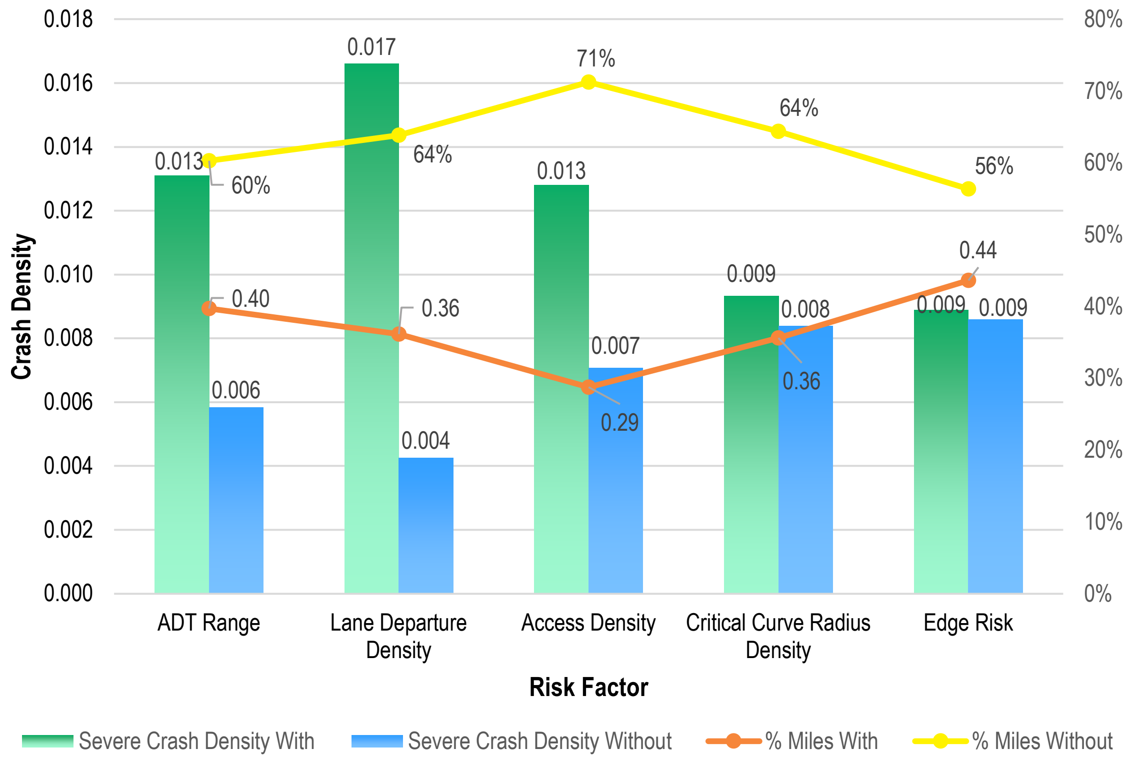
Identify network elements from the focus facility types which represent the locations where the focus crash types tend to occur. The elements are for use in network screening.

Description

- Using Google Earth and the photo inventory, analysts conducted a census of the system and screened segments (12,000 miles), horizontal curves (1,800), and intersections (3,400), noting the presence of risk factors observed at each location in a spread sheet.
- The prioritization of the segments, curves, and intersections was based on the number of risk factors—the higher the number of risk factors, the higher the priority. In most cases, the presence of three or more risk factors resulted in designation of high-priority and each of those locations were subject to the project development process (Figure 13).

Step 2: Screen and Prioritize Candidate Locations—Tasks 1-3: Prioritize Focus Facility Elements

Figure 14. Rural Segment Risk Factor Evaluation



Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Purpose

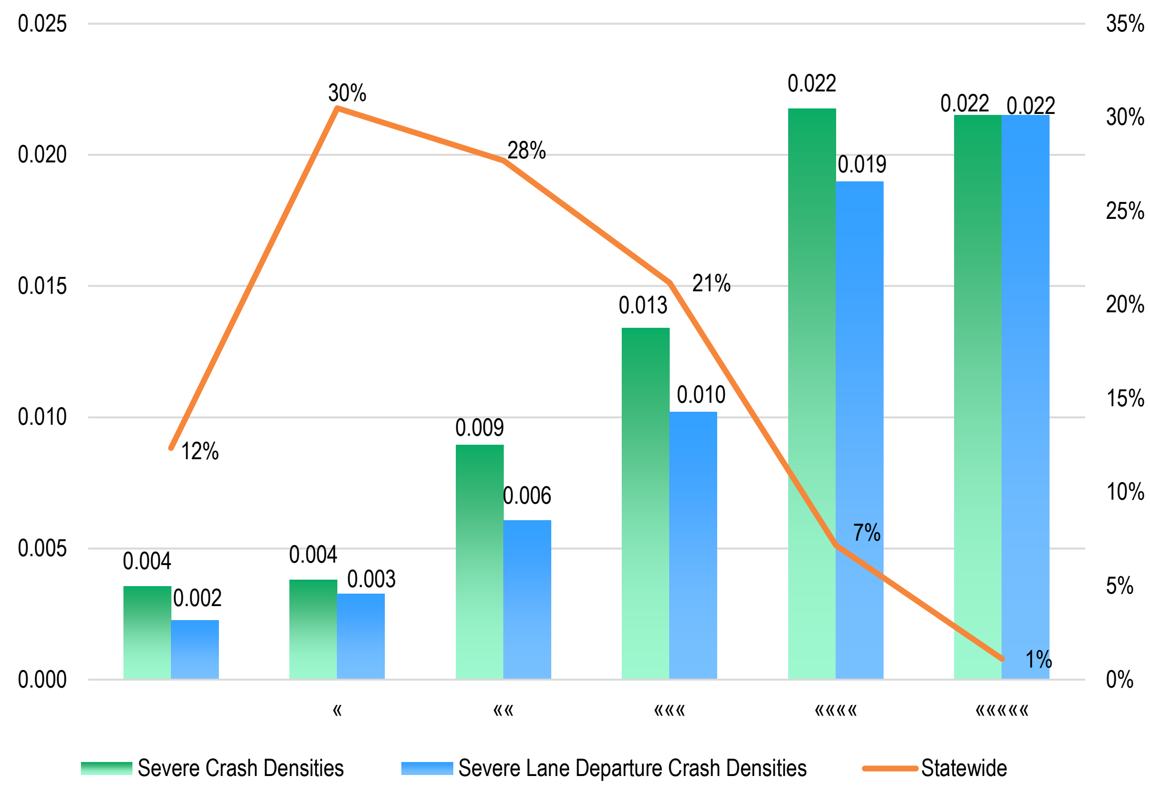
Assess selected risk factors to determine their feasibility for differentiating between elements (curves, segments, and intersections) on the focus facility type.

Description

- Rural County Road Segment—11,200 miles of rural paved and gravel major county collectors were evaluated
  - Average crash density equaled 0.004 severe lane departure crashes per mile per year. For example, high levels of access density was adopted as one of the risk factors for Lane Departure crashes along rural segments. High levels of access density were found along a minority of the system (30%) and the crash density at these locations was almost double (0.013 versus 0.007) that at locations with low levels of access density.
- The results confirm the use of average daily traffic (ADT), access density, curve density, and edge risk assessment as risk factors; the density of severe crashes was consistently higher in segments with each factor present, compared to segments without the factor (Figure 14).

Step 2: Screen and Prioritize Candidate Locations—Task 3: Prioritize Focus Facility Elements—Threshold for Selecting Candidate Locations

Figure 15. Rural Segment Risk Factor Ranking



Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Purpose

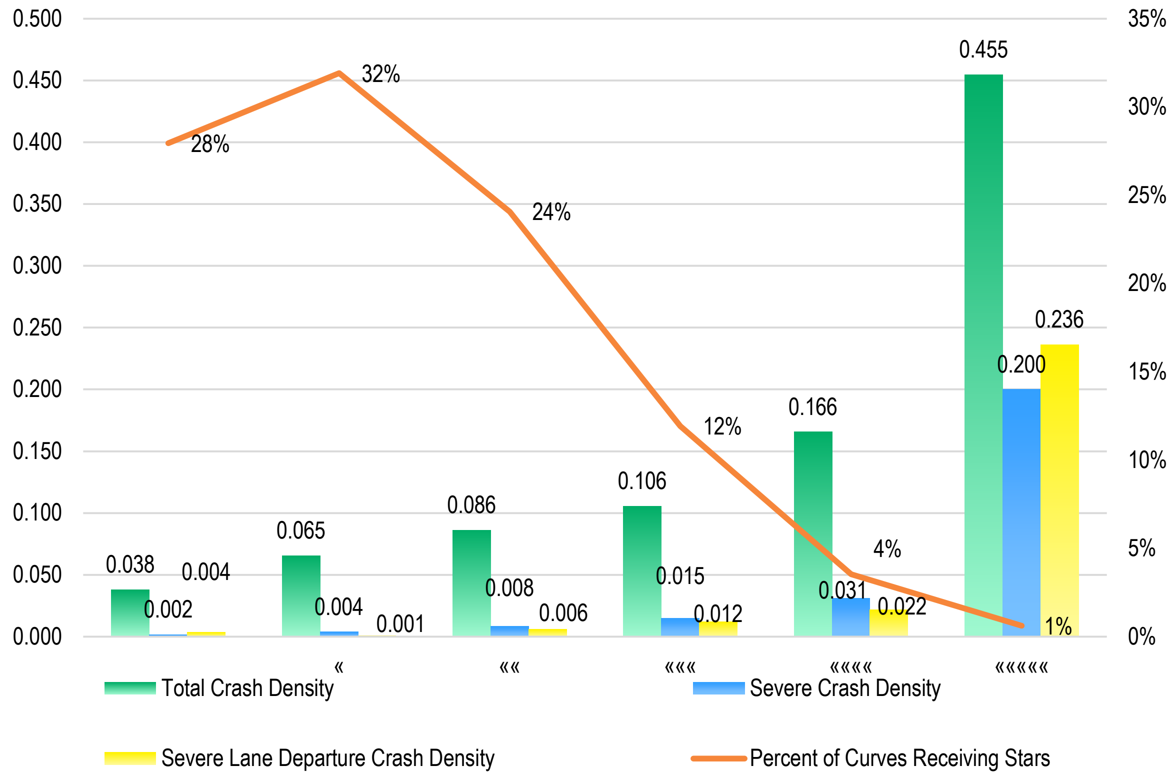
Identify network elements from the focus facility types which represent the locations where the focus crash types tend to occur. The elements are for use in network screening.

Description

- Rural roadway segments with three or more risk factors were considered high priority and had crash densities above the systemwide average (0.05) (Figure 15).
- This data supports the use of the adopted risk factors and the validity of the results of the evaluation. Crashes are not uniformly distributed across the system—the majority of severe lane departure crashes occurred along a minority of the rural county system (27% of miles).

Step 2: Screen and Prioritize Candidate Locations—Task 3: Prioritize Focus Facility Elements—Threshold for Selecting Candidate Locations (continued)

Figure 16. Rural Curve Risk Factor Ranking

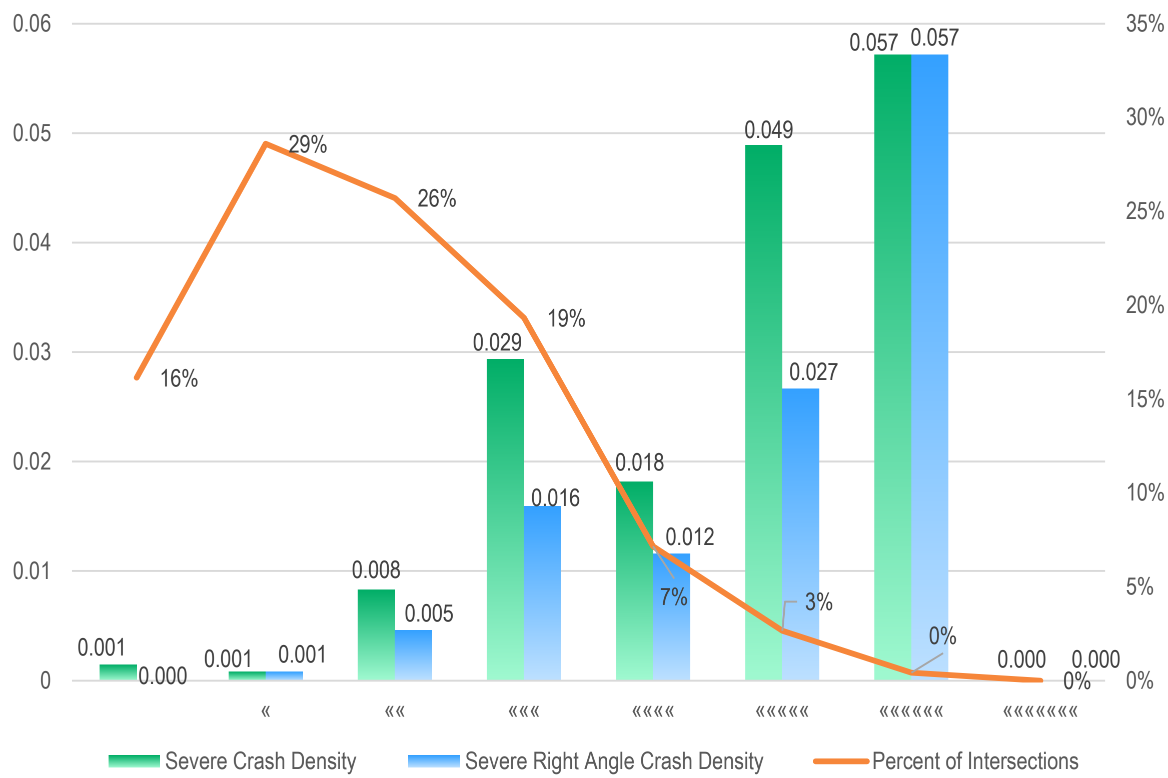


Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

- Rural County Horizontal Curves—1,811 horizontal curves were evaluated
  - 77 percent of these curves had no crashes during the study period and 14 percent had one crash; no curves along the local rural system averaged one severe crash per year.
  - The results also confirm the presence of intersections and visual traps as risk factors. Curves with these features had crash densities almost 50 percent higher than curves without.
  - The highest priority curves (those with all five risk factors present) totaled approximately 1 percent of the system and had crash densities more than five times greater than the system average (Figure 16).

Step 2: Screen and Prioritize Candidate Locations—Task 3: Prioritize Focus Facility Elements—Threshold for Selecting Candidate Locations (continued)

Figure 17. Rural Intersection Risk Factor Ranking



Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

- Rural Intersections—2,202 intersections were evaluated:
  - » 95 percent of rural, Thru/STOP intersections had no severe crashes and only 4 percent had one severe crash.
  - » The results also confirm the use of skew, the presence of commercial development, and distances greater than 5 miles (along the minor approaches) to the last STOP sign, as risk factors. The density of severe crashes at intersections with these features was consistently higher in all cases.
  - » Intersections with three or more risk factors were considered a priority and these intersections had crash densities 5 to 10 times higher than the statewide average (Figure 17).

Step 3: Select Countermeasures—Task 3: Select Countermeasures for Deployment

Table 4. Final List of Adopted Safety Countermeasures, Crash Reduction Factors, and Typical Installation Costs

Strategy	Crash Reduction Factor (Based on review of CMF Clearinghouse and other published research. ND DOT requested that the factors be stated as Crash Reduction Factors (CRFs))	Typical Installation Costs
Rural Segments		
4-inch latex edge line	Values not available at the time the project was conducted	$1,320 per mile
4-inch latex centerline	Values not available at the time the project was conducted	$660 per mile
6-inch latex edge line	10% to 45% all rural serious crashes	$1,980 per mile
Shoulder or edge line rumble strips	20% run off-road crashes	$5,850 per mile
Ground in wet-reflective markings	N/A	$36,000 per mile
Centerline rumble strips	40% head-on/sideswipe-crashes	$3,600 per mile
6-inch centerline	N/A	$1,020 per mile
Rural Curves		
Chevrons	20% to 30%	$3,960 per curve
Large arrow sign	N/A	$1,200 per curve
Advance warning sign and advisory speed plaque	N/A	$1,440 per curve
2-foot paved shoulder and shoulder rumble strips	20% to 30% run-off-the-road crashes	$54,000 per mile + $5,850 per mile

Purpose

Identify and select a few countermeasures for each focus crash type based on the evaluation of the countermeasures and consideration of agency priorities, practices and policies.

Description

- A list of potential safety countermeasures was compiled from the North Dakota SHSP and published safety research, primarily the NCHRP Report 500 Series (NCHRP, 2003-2009), FHWA Crash Modification Factors Clearinghouse, and the AASHTO Highway Safety Manual (AASHTO, 2010).
- The first level of screening of the countermeasures focused on identifying those that were associated with the identified focus crash types. The next level of screening focused on the general effectiveness (crash reduction) and typical implementation costs of the remaining countermeasures.
- The final list of countermeasures was consistent with the North Dakota SHSP (NDDOT, 2013) and with the priorities identified by NDDOT safety program managers (Table 4).

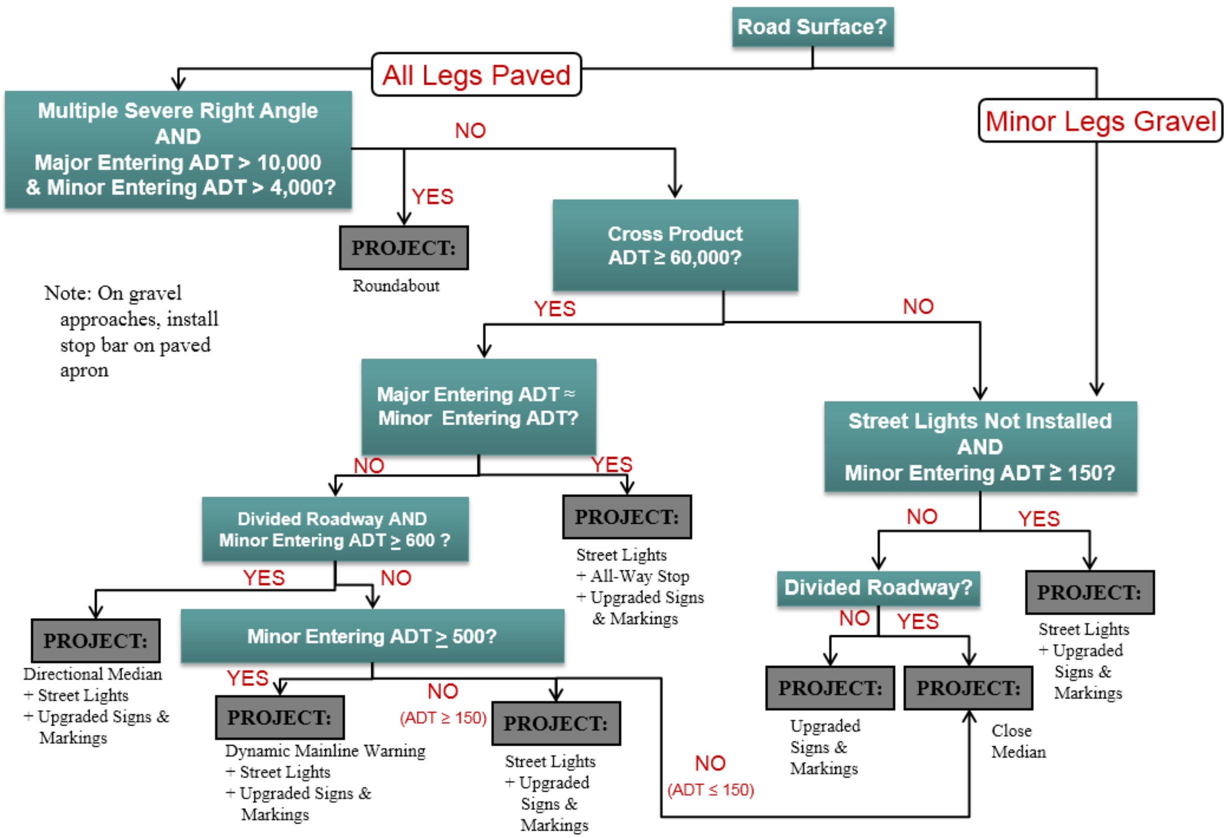
Table 4. Final List of Adopted Safety Countermeasures, Crash Reduction Factors, and Typical Installation Costs (continuation)

Strategy	Crash Reduction Factor (Based on review of CMF Clearinghouse and other published research. ND DOT requested that the factors be stated as Crash Reduction Factors (CRFs))	Typical Installation Costs
Rural Intersections		
Roundabout	20% to 50% all crashes/60% to 90% right-angle crashes	$4,200,000 per intersection
Directional median (RCI or J-Turn)	17% all crashes/ 100% angle crashes	$1,080,000 per intersection
Mainline dynamic warning sign	50% all crashes/ 75% serious right-angle crashes	$60,000 per intersection
Close median	N/A	$30,000 per intersection
Intersection lighting	25% to 40% nighttime crashes	$10,200 per streetlight
Upgrade signs and pavement markings	40% upgrade of all signs and pavement markings/ 15% for STOP AHEAD pavement marking	$2,640 per approach (Includes $540 per STOP sign, $540 per junction sign assembly, $600 per STOP AHEAD sign, $600 per STOP AHEAD pavement marking message, and $360 per stop bar)
Clear sight triangle	37% serious injury crashes (Reduction based on increasing sight distance triangle)	$2,940 per intersection (Inclusive of sign upgrades identified and materials and labor for clearing of sight triangle.)

Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Note: N/A = not applicable.

Figure 18. Sample Rural Intersection Project Decision Tree



Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Purpose

Develop a decision process to facilitate consistency in the selection of countermeasures.

Description

- Decision tress (Figure 18) were developed to identify basic roadway and traffic characteristics and, depending on the exact features present at specific locations, pointed safety professionals toward a specific countermeasure determined to be suitable for a specific combination of characteristics.
- For example, the approach to safety project development at rural intersections (Figure 18) focused on providing enhanced intersection recognition or a reduction in the number of intersection conflicts. At-risk, high-priority, low-volume intersections would receive less costly improvements (generally upgraded signs and pavement markings), higher volume intersections would receive more costly improvements (upgraded signs and markings, plus streetlights), and the highest volume intersections would receive the most costly improvements (dynamic warning signs or directional median treatments at intersections with multi-lane divided State highways).

Step 4: Prioritize Projects—Task 2: Develop Safety Projects

Figure 19. Sample Summary of Rural Intersection Projects in Bottineau County

Page	Intersection ID	Description	Risk Ranking	Directional Median	Mainline Dynamic Warning Sign	Close Median	Install Street Lights	Signs & Markings	Review Signs & Clearing/Grubbing	Project Cost ($)
1	6.07	103rd St NW/NE (Bottineau 6) & 1st Ave NE	★★★★★★	-	-	-	x	x	-	$15,480
2	28.02	82nd St NE (Bottineau 28) & ND 60	★★★★	-	-	-	-	x	-	$5,280
3	17.04	93rd St NW & ND 5/93rd St NW	★★★★	-	-	-	x	x	-	$12,840
4	503.01	13th Ave NE & ND 5/97th St NE	★★★★	-	-	-	-	x	-	$5,280
5	17.03	20th Ave NW (Bottineau 17B) & 90th St NW (Bottineau 20)	★★★★	-	-	-	x	x	-	$15,480
6	502.02	98th St NE & 13th Ave NE	★★★	-	-	-	x	x	-	$20,760
7	26.02	83rd St NW (Bottineau 26A) & 30th Ave NW/Laurel St	★★★	-	-	-	x	x	-	$15,480
8	26.03	83rd St NW (Bottineau 26A) & US 83/27th Ave NW	★★★	-	-	-	x	x	-	$15,480
9	49.02	Town Line Rd (Bottineau 49) & 98th St NE	★★★	-	x	-	-	x	-	$65,280
10	57.01	21st Ave NE (Bottineau 57) & ND 5/96th St NE	★★★	-	-	-	x	x	-	$15,480
11	6.03	103rd St NW/Railway Ave W (Bottineau 6) & US 83/3rd St E	★★★	-	-	-	x	x	-	$15,480
12	17.05	20th Ave NW & ND 5/20th Ave NW (Southern)	★★★	-	-	-	x	x	-	$12,840
13	17.06	20th Ave NW & ND 5/20th Ave NW (Northern)	★★★	-	-	-	-	x	-	$2,640
14	47.01	11th Ave NE (Bottineau 47) & ND 5/97th St NE/11th St E	★★★	-	-	-	-	x	-	$5,280
15	49.03	Town Line Rd/12th Ave NE (Bottineau 49) & ND 43/106th St NE	★★★	-	-	-	x	x	-	$15,480
16	503.02	Lake Rd/Lake Loop Rd W & ND 43/106th St NE	★★★	-	-	-	x	x	-	$15,480
17	504.03	Larson Beach Rd & ND 43/106th St NE	★★★	-	-	-	x	x	-	$12,840
18	508.01	Svingen Rd & ND 43/106th St NE	★★★	-	-	-	-	x	-	$5,280
19	2.02	107th St NW (Bottineau 2) & ND 256/27th Ave NW	★★	-	-	-	x	x	-	$15,480
20	17.01	20th Ave NW (Bottineau 17C) & 80th St NW (Bottineau 30)	★★	-	-	-	x	x	-	$15,480
21	20.06	88th St NE/Kramer Rd (Bottineau 20) & 10th Ave NE (Bottineau 47)	★★	-	-	-	-	x	-	$5,280
22	22.01	87th St NE & ND 60/19th Ave NE	★★	-	-	-	-	x	-	$2,640
23	502.01	98th St NE & 11th Ave NE	★★	-	-	-	-	x	-	$5,280
23 USC 409 NDDOT Reserves All Objections				0	1	0	14	23	0	$316,320

Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Purpose

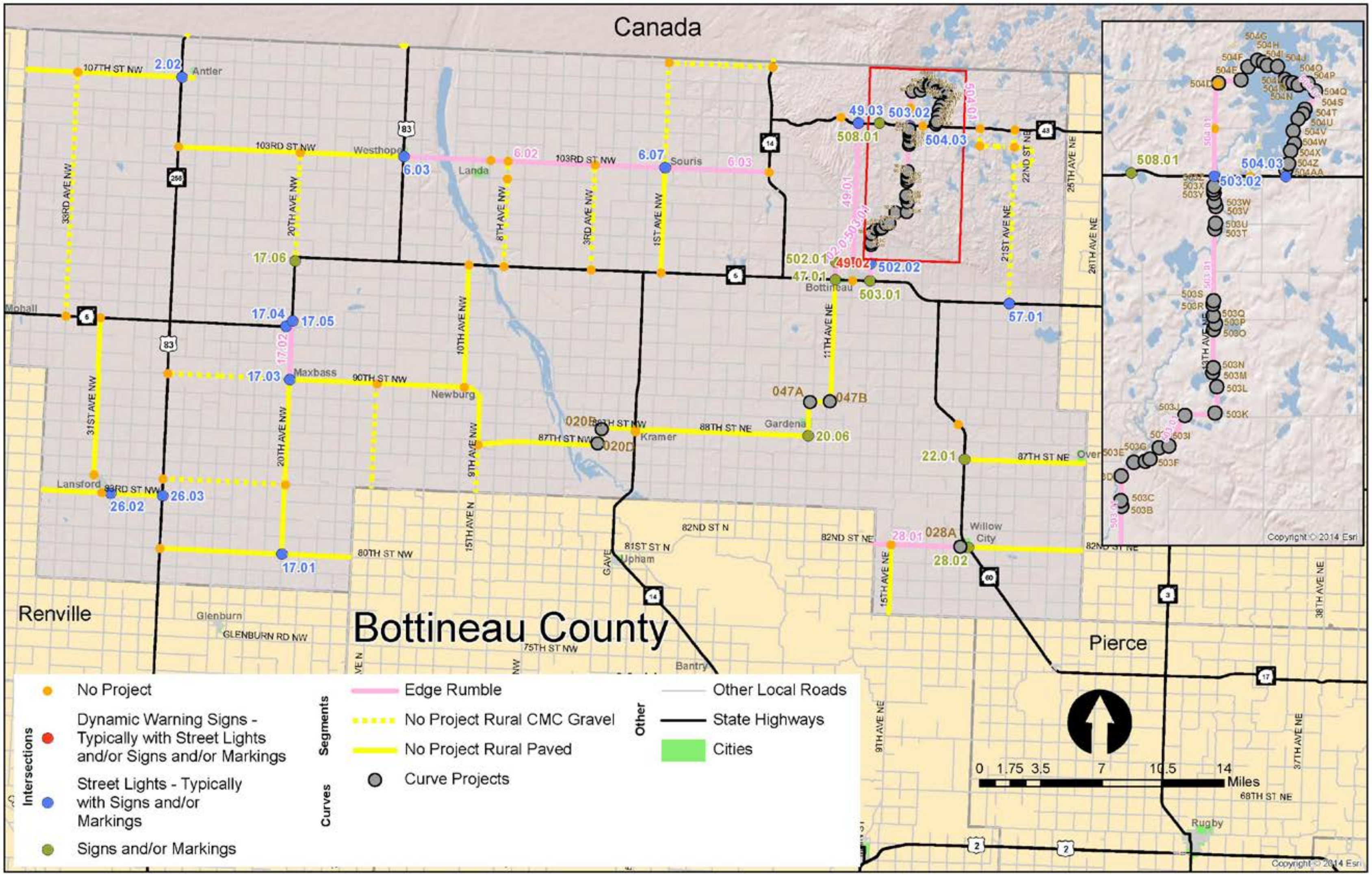
Apply decision process to develop specific safety projects for each candidate site selected for safety investment.

Description

- Results of the project development effort were reported to local agencies in a series of spread sheets (Figure 19) and maps (Figure 20).

Case Study 2

Figure 20. Sample Map of Suggested Safety Projects in Bottineau County



Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Step 4: Prioritize Projects—Task 3: Prioritize Safety Project Implementation

Figure 21. Local Road Safety Program Project Summary

Bottineau County
Rural Segment Projects

Page	Corridor ID	Route #	Start	End	Length	Risk Ranking	4" Edge Line	6" Edge Lines	Edge Rumble Strip	Center Line Rumble	6" Center Line	Project Cost ($)
1	504.01	No Designation	Intersection with ND 43 (W)	Intersection with ND 43 (E)	6.6	★★★★★	0.0	4.0	2.6	0.0	0.0	$23,285
2	503.01	No Designation	Intersection with 98th St NE	Intersection with ND 43	10.4	★★★★★	0.0	0.5	9.9	0.0	0.0	$58,828
3	6.02	Bottineau	Intersection with US 83	Intersection with Central Ave	14.0	★★★	0.0	0.3	13.7	0.0	0.0	$80,816
4	49.01	Bottineau	Intersection with 98th St NE	Intersection with ND 43	8.0	★★★	0.0	0.4	7.6	0.0	0.0	$45,252
5	502.01	No Designation	Intersection with ND 5	Intersection with 13th Ave NE	3.0	★★★	0.0	1.0	2.0	0.0	0.0	$13,719
6	6.03	Bottineau	Intersection with Central Ave	Intersection with ND 14	7.0	★★★	0.0	0.7	6.3	0.0	0.0	$38,241
7	28.01	Bottineau	McHenry County Line	Intersection with 19th Ave NE	5.0	★★	0.0	0.2	4.8	0.0	0.0	$28,476
8	17.02	Bottineau	Intersection with CR 21	Intersection with US 83 (S)	3.4	★★	0.0	0.5	2.9	0.0	0.0	$17,916
23 USC 409 NDDOT Reserves All Objections							**0.0**	**7.6**	**49.8**	**0.0**	**0.0**	**$306,533**

Bottineau County
Curve Projects

Page	Corridor ID	# of Curves	Route #	Start	End	Chevron	Arrow Board	Shoulder Paving	Edge Rumble Strips	Advanced Sign/Speed Plaque	Project Cost ($)
1	20.04	6	Bottineau	Intersection with CR 20	Intersection with ND 14	$ -	$ -	$ 40,444	$ 4,381	$ -	$ 44,826
2	28.01	1	Bottineau	McHenry County Line	Intersection with 19th Ave NE	$ -	$ 1,200	$ -	$ -	$ -	$ 1,200
3	47.01	2	Bottineau	Intersection with CR 20 NE	Intersection with ND 5 (W)	$ -	$ -	$ 18,264	$ 1,979	$ 2,880	$ 23,122
4	503.01	25	No Designation	Intersection with 98th St NE	Intersection with ND 43	$ 19,800	$ -	$ 125,837	$ 13,632	$ 20,160	$ 179,429
5	504.01	27	No Designation	Intersection with ND 43 (W)	Intersection with ND 43 (E)	$ 35,640	$ -	$ -	$ -	$ 25,920	$ 61,560
23 USC 409 NDDOT Reserves All Objections						**$ 55,440**	**$ 1,200**	**$ 184,544**	**$ 19,992**	**$ 48,960**	**$ 310,137**

Bottineau County
Summary of Rural Intersection Projects

Page	Intersection ID	Description	Risk Ranking	Directional Median	Mainline Dynamic Warning Sign	Close Median	Install Street Lights	Signs & Markings	Project Cost ($)
1	6.07	103rd St NW/NE (Bottineau 6) & 1st Ave NE	★★★★★★	-	-	-	x	x	$15,480
2	28.02	82nd St NE (Bottineau 28) & ND 60	★★★★	-	-	-	-	x	$5,280
3	17.04	93rd St NW & ND 5/93rd St NW	★★★★	-	-	-	x	x	$12,840
4	503.01	13th Ave NE & ND 5/97th St NE	★★★★	-	-	-	-	x	$5,280
5	17.03	20th Ave NW (Bottineau 17B) & 90th St NW (Bottineau 20)	★★★★	-	-	-	x	x	$15,480
Abridged version of complete table. Partial data shown.									
23	502.01	98th St NE & 11th Ave NE	★★	-	-	-	-	x	$5,280
23 USC 409 NDDOT Reserves All Objections				**0**	**1**	**0**	**14**	**23**	**$316,320**

Source: *North Dakota Local Road Safety Program*, CH2M, 2015.

Purpose

Identify the order in which projects will be implemented.

Description

The end result of the Local Road Safety Program (LRSP) effort was the production of a safety plan for each of North Dakota's 53 counties, 12 major cities, 4 Tribes, and Theodore Roosevelt National Park. These plans documented the results of the systemic risk analysis and identified approximately 3,000 safety projects with total estimated implementation costs approaching $55 million. A breakdown and summary of the suggested projects are provided for one county in Figure 21.

Summary

The lack of a complete and comprehensive data set did not prevent the completion of the systemic safety process for each of North Dakota's 53 counties, 12 major cities, 4 Tribes, and Theodore Roosevelt National Park and engaging the local agencies in the statewide safety planning effort. By combining the data that was available, along with the generated, surrogate, and default values discussed herein, the systemic risk assessment was successfully conducted resulting in the prioritization of the facilities and the development of approximately 3,000 safety projects. Even in a low-data environment where a variety of assumptions and field data collection techniques were devised, the systemic process still identified almost $55 million worth of safety projects with an average implementation cost in the range of $18,000.

These data support a conclusion that the LRSP achieved the initial objectives:

- A systemic risk evaluation of both rural and urban local systems was completed. The rural portion of the evaluation was shown in this case study for brevity.
- Segments, curves, and intersections along local systems were prioritized.
- Safety plans were completed for each of the counties, major cities, and Tribes.

The final measure of success for the LRSP will depend on implementation (which is just starting) and the results of a before versus after study that documents whether the safety investments along the local system bent the trend line and supported North Dakota's vision of working towards zero traffic-related fatalities.

Conclusion

The systemic approach to safety involves widely implemented improvements identified to address high-risk roadway features correlated with severe injury crashes. This approach to safety is a complementary analytical technique intended to supplement the traditional site analysis approach and results in a more comprehensive safety management program.

The Systemic Safety Project Selection Tool (*Systemic Tool*) provides a step-by-step process for conducting systemic safety planning, considerations for determining a reasonable distribution between the implementation of spot safety improvements and systemic safety improvements, and a mechanism for quantifying the benefits of safety improvements implemented through a systemic approach. The two case studies examined in this supplement demonstrate how the systemic analysis process can be successfully applied in urban areas and along systems with little supporting data.

Based on data produced as part of the risk evaluations performed for Greater Minnesota's urban road system and local systems in the Minneapolis/St. Paul Metropolitan area, MnDOT was able to leverage the systemic analysis process to overcome challenges and obtain useful results. The systemic analysis process assisted in identifying focus crash and facility types, adopting a set of risk factors, creating a short-list of safety countermeasures, and identifying more than $13 million worth of focused safety projects at designated high-risk locations.

NDDOT also implemented the systemic analysis process successfully, despite little supporting data, to produce a safety plan that benefits North Dakota's counties, cities, Tribes, and the Theodore Roosevelt National Park. By leveraging the systemic analysis process, NDDOT was able to overcome data gaps and identify almost $55 million worth of safety projects focused on low-cost countermeasures.

References

American Association of State Highway and Transportation (AASHTO). *Highway Safety Manual*. 2010. http://www.highwaysafetymanual.org/Pages/default.aspx.

CH2M. City of Saint Paul Roadway Safety Plan. January 2016. Unpublished.

CH2M. Minnesota County Road Safety Plans. January 2015. Unpublished.

CH2M. *North Dakota Local Road Safety Plans Program Summary*. April 2015. Unpublished.

Federal Highway Administration (FHWA). 2014. Crash Modification Factor (CMF) Clearinghouse. Access date: October 2014. http://safety.fhwa.dot.gov/tools/crf/resources/.

Federal Highway Administration (FHWA). 2013. *Systemic Safety Project Selection Tool.* http://safety.fhwa.dot.gov/systemic/fhwasa13019/.

Federal Highway Administration (FHWA). 2009 Version with Revisions Numbers 1 and 2 incorporated, dated 2012. *Manual on Uniform Traffic Control Devices.*: http://mutcd.fhwa.dot.gov/.

Minnesota Department of Transportation (MnDOT). 2007. *Strategic Highway Safety Plan*. http://www.dot.state.mn.us/trafficeng/safety/shsp/Minnesota-SHSP-2007.pdf.

Minnesota Department of Transportation (MnDOT). 2014. *Strategic Highway Safety Plan*. http://www.dot.state.mn.us/trafficeng/safety/shsp/Minnesota_SHSP_2014.pdf.

Minnesota Department of Transportation (MnDOT). Minnesota Traffic Safety Fundamentals Handbook. 2015. Unpublished.

National Cooperative Highway Research Program (NCHRP). NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan. *The National Academies of Sciences, Engineering, Medicine.* 2003-2009. http://www.trb.org/Main/Blurbs/152868.aspx.

North Dakota Department of Transportation (NDDOT). *Strategic Highway Safety Plan*. September 2013. https://www.dot.nd.gov/divisions/safety/docs/ND_SHSP_final_2013-09-09.pdf.

Appendix A. Glossary

AASHTO	American Association of State Highway and Transportation Officials
ADT	average daily traffic
CMF	crash modification factor
FHWA	Federal Highway Administration
HAWK	High-intensity Activated crossWalk
HSIP	Highway Safety Improvement Program
LRSP	Local Road Safety Program
MnDOT	Minnesota Department of Transportation
NCHRP	National Cooperative Highway Research Program
NDDOT	North Dakota Department of Transportation
SHSP	Strategic Highway Safety Plan

U.S. Department of Transportation
Federal Highway Administration (FHWA)
Office of Safety
1200 New Jersey Avenue, SE
Washington, DC 20590

http://safety.fhwa.dot.gov

Publication No. FHWA-SA-17-002

December 2016

This material is based upon work supported by the FHWA under contract number DTFH61-10-D-00020.

HSIP Highway Safety Improvement Program
Data Driven Decisions