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Local Rural Road Safety Audit Guidelines and Case Studies

Study SD2007-06
Final Report

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16. Abstract

The main goals of this project were to improve the safety performance of local rural roads in South Dakota by demonstrating Road Safety Audits and providing a Handbook of low-cost safety improvement strategies to County Highway Superintendents and other local highway agencies. As a part of the study, the Local Road Safety Handbook has been developed to provide information useful to local agencies for evaluating and improving safety using informal field reviews of safety issues on existing roadways to identify potential improvement actions.

The study conducted twelve Road Safety Audits at selected sites along county highways, city streets, township roads, and other locations deemed appropriate for the study. The study included three county roads, five sites in Highland Township on local gravel surfaced roads, two intersections at the City of Pierre, and two railroad crossings. Each case study includes photographs, a project description, a summary of key findings, and the lessons learned. The aim of the case studies is to provide local road agencies with examples and advice that can assist them in implementing RSAs in their own jurisdictions.

The Local Rural Road Safety Audit case studies have been well received by the participating highway agencies. In a short period of time since the RSAs were completed, numerous follow up actions have been taken to improve safety. Future RSAs on local rural roads will assist the local agencies to identify and prioritize safety improvements.

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Acronym	Definition
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
CFR	Code of Federal Regulations
FHE	First Harmful Event
FHWA	Federal Highway Administration
MP	Milepost
MUTCD	Manual on Uniform Traffic Control Devices
RSA	Road Safety Audit
SDCL	South Dakota Codified Law
SDACHS	South Dakota Association of County Highway Superintendents
SDDOT	South Dakota Department of Transportation
SDDPS	South Dakota Department of Public Safety
SDLTAP	South Dakota Local Transportation Assistance Program
SDHP	South Dakota Highway Patrol
SRD	State Radio Dispatch
TRAA	Towing and Recovery Association of America

1. EXECUTIVE SUMMARY

1.1 PROBLEM DESCRIPTION

The safety of local rural roads in South Dakota deserves attention. Road safety is now recognized as a major socioeconomic concern facing the state. Over the past six years (2004-2009) of approximately 50 deaths per year, or 25 percent of total state highway deaths and 19 percent of injuries, have occurred on local rural roads. Rollovers and fixed object crashes on local rural roads are two of the leading types of crashes, accounting for 43 percent of crashes and 70 percent of deaths and injuries on local roads. Significantly, the fatality rate of South Dakota local rural roads is higher than that of surrounding states and nearly 50 percent higher than the national average for similar roads.

The Road Safety Audit (RSA) process is a proactive approach that addresses road safety issues before crashes occur. Many of the safety improvements recommended from RSAs can be achieved at a relatively low cost. Improving the safety performance of local rural roads in South Dakota can be accomplished by aggressively promoting Road Safety Audits and providing a Handbook of low-cost safety improvement strategies to local highway agencies.

1.2 RESEARCH OBJECTIVES

The main goals of this project were to improve the safety performance of local rural roads in South Dakota by demonstrating Road Safety Audits and providing a Tool Box of low-cost safety improvement strategies to County Highway Superintendents and other local highway agencies.

1.3 RESEARCH APPROACH

RSA projects were recruited though promotion by the South Dakota Local Transportation Assistance Program (SDLTAP) and commitments from local agencies in South Dakota. RSA team members were selected according to the nature and location of each case study. All meetings and site visits for each case study were conducted in one day.

Each RSA typically began with a start-up meeting where the team met with the local Road Manager. Team members then reviewed the background information, crash data, and proposed plans furnished to them to gain insight into the road and to identify any preliminary areas of safety concern. Following the start-up meeting, the RSA team conducted a field review. The RSA team observed traffic characteristics (autos, trucks, pedestrians, agricultural vehicles, etc) and surrounding land use. The RSA team used a list of safety issues identified by the research team to be considered when doing a road safety field review. When available, historical crash data was used to identify specific locations of high risk. Crash types and severity were used to identify potential countermeasures. The team prioritized safety concerns and developed recommendations using historical crash records and an evaluation of risk.

After the field review, the RSA team and road manager reconvened for a preliminary findings meeting to orally report the key issues to be presented in the RSA formal report. Following the on-site portion of the RSA, the team leader drafted a report and provided an opportunity for each team member to review and comment. Every effort was made to complete the formal report within a relatively short time frame (two weeks). A final report was then sent to the local agency.

1.4 ROAD SAFETY AUDITS CASE STUDIES

The research team conducted eight Road Safety Audits that covered 12 different sites along county highways, city streets, township roads, and other locations deemed appropriate for the study. RSA projects were selected through SDLTAP promotion and commitments from South Dakota's local agencies.

The study included three county roads in Deuel, Lawrence, and Day Counties. Two were gravel roads, while the Day County road was paved. Each of the three roads had its own characteristic and presented a model case of safety features and problems. The study performed RSAs at five different locations in Highland Township, Day County on local gravel-surfaced roads. The study also performed Road Safety Audits at two intersections and two railroad crossings in the Pierre-Ft. Pierre area.

The results of the local RSAs are compiled in Appendix A "Case Studies Documents". Each case study includes photographs, a project description, a summary of key findings, and the lessons learned. The aim of the case studies is to provide local road agencies with examples and advice that can assist them in implementing RSAs in their own jurisdictions.

1.4.1 MAIN SAFETY ISSUES

RSA teams identified safety issues possibly contributing to crash risk among of the Road Safety Audits conducted in this study. Specific safety issues were identified and counter measurements have been explained. The main safety issues can be summarized as follows:

- roadside obstacles
- delineation
- cross section, alignment and accesses
- road surface and pavement
- pavement marking
- signs
- Inadequate maintenance.

1.4.2 ROAD SAFETY AUDITS FOLLOW UP AND FEEDBACK RESULTS

Since the RSAs were completed in May, 2009, several actions have been taken to improve safety. There has been a positive reaction on six of the eight sites audited, including installation of new signs, upgrades to current signs, speed limit changes, and long-term plans to improve alignment of roadways.

1.5 LESSONS LEARNED

1. This project has increased awareness of local road and street safety in SD. When a highway superintendent or local manager is invited to serve as a peer member of the road safety review team, he/she learns from the experience. They not only gain experience from working with a road safety team, but they return to their departments with a new perspective in analyzing traffic safety on their own highway system.
2. One of the key elements of RSA success is good preparation before performing the audit. All of the information including constraints, crash history, project environment, and operation of

the site, must be prepared and discussed during the start up meeting. It is crucial that the team members have a full understanding of the constraints in order to achieve practical and reasonable findings and recommendations.

3. One lesson learned is that local government in SD is very wary of the road safety audit process. The project proposal called for ten local road safety audits but only eight locations were completed. This was due to local agencies not wanting to come forward and ask for the service. SDLTAP promoted the project very aggressively. Three articles were done in the quarterly newsletter. A 15-minute promotional presentation was done at 29 locations in January through March, 2008 as part of another safety training activity. SDLTAP staff reached more than 850 people in local government agencies. In addition, the project was promoted at three state-wide conferences of local road and street officials. SDLTAP field staff also did personal promotion during routine field work. Despite this, very few came forward to request the service.
4. Some local officials are very opposed to the term "audit" which has a negative connotation in the minds of many people. This was discussed at the April, 2009 SDLTAP Advisory Board meeting. One of the advisory board members suggested using different terms such as "Road Safety Review" or "Road Safety Assessment". This may be a better approach in the future.
5. To help overcome the local reluctance to conduct formal RSAs, a local champion who understands the purposes and procedures of RSA is needed to encourage the local agency along with its elected officials to request a RSA.
6. It is good to have diversity on the RSA teams. The study recruited a highway superintendent from a neighboring county. One MUTCD expert is essential because many of the low-cost improvements are typically signing, delineation, and marking. (On the other hand, the study must follow the audit outlines; it is not a MUTCD compliance review.) A surface condition and pavement expert can also contribute expertise to the RSA team. Someone from local law enforcement can also provide great input, as can local emergency responders.
7. The team must understand the functional classifications of local roads in order to contribute sound input in prioritizing recommendations based on risk.
8. It is important to schedule the RSA field review during regular recurring traffic conditions. Where possible, the RSA team should visit the project site when traffic conditions are typical or representative. For example, the RSA on the Crystal Springs Rodeo route, which addressed the concerns about safety and operational issues related to the annual Crystal Springs Rodeo that is held during the last weekend in June, scheduled site visits during August. Attendance at the rodeo is estimated at 10,000 over 3 days, the RSA teams were not able to observe tourist traffic associated with the event. Although this did not significantly affect the RSA findings, the recommendations for this site were grouped to improve permanent signing of the route, and for additional signing during the rodeo event to improve safety for motorists not familiar with the route.
9. Many local managers feel that they don't have the money to make changes that might be recommended and consequently develop an automatic fear of an audit and may feel that without the sufficient funds it would be of little value. There is also a fear of having a document on record defining safety problems which they may not be able to quickly remedy and therefore could be used against them in litigation.

1.6 CONCLUSIONS

The results of the study can be summarized in the following main conclusions:

1. The Local Rural Road Safety Audit case studies sponsored by the FHWA through SDDOT have been well received by the participating highway agencies. In a short period of time since the RSAs were completed, numerous actions have been taken to improve safety.
2. The project exposed local governments to the concept and practices of road safety analysis and provided a good opportunity for local highway agencies and staff members to participate and gain experience from working with road safety teams.
3. The major issues that were identified by the audits related to intersections sight distance, angle of approach, signage, road alignment, vertical and horizontal curvature, culverts, table drains, and location, visibility, and legibility of signs.
4. Many of the recommended solutions were related to maintenance practices (e.g. maintaining the immediate roadside clear of vegetation to improve sight distance through curves), delineation (e.g. marking culverts with guideposts), and general sign improvement (e.g. installing signs to warn of particularly sharp or unexpected changes in the horizontal or vertical alignment).

1.6.1 IMPLEMENTATION RECOMMENDATIONS

Based on the results of this study, the following recommendations are made:

The products of this research effort can serve a valuable purpose to inform local agencies of the Road Safety Audit process and to illustrate its application in typical South Dakota situations. Familiarity with the process can be expected to increase interest and receptivity to performing additional RSAs and gaining the resulting benefits of improved highway safety. The costs of producing and distributing these documents would be well justified in consideration of the potential safety benefits.

It is therefore recommended that the South Dakota Department of Transportation's Office of Research should publish and distribute copies of this final report and the *Rural Road Safety Handbook* to all counties, cities, townships, and tribal governments in South Dakota.

2 PROBLEM DESCRIPTION

The safety of local rural roads in South Dakota deserves attention. Road safety is now recognized as a major socioeconomic concern facing the state. Over the past six years (2004-2009) of approximately 50 deaths per year, or 25 percent of total state highway deaths and 19 percent of injuries, have occurred on local rural roads. Rollovers and fixed object crashes on local rural roads are two of the leading types of crashes, accounting for 43 percent of crashes and 70 percent of deaths and injuries on local roads. Significantly, the fatality rate of South Dakota local rural roads is higher than that of surrounding states and nearly 50 percent higher than the national average for similar roads.

The Road Safety Audit (RSA) process is a proactive approach that addresses road safety issues before crashes occur. Many of the safety improvements recommended from RSAs can be achieved at a relatively low cost. Improving the safety performance of local rural roads in South Dakota can be accomplished by aggressively promoting Road Safety Audits and providing a Tool Box of low-cost safety improvement strategies to local highway agencies.

Documentation of each case study, including photographs, a project description, a summary of key findings, and lessons learned is also needed. The aim of the case studies is to provide local road agencies with examples and advice that can assist them in implementing RSAs in their own jurisdictions.

To further familiarize local government agencies with the RSA process and promote its use in South Dakota, it is recommended that the South Dakota Local Transportation Assistance Program should develop and offer RSA training targeting local road managers and elected officials.

Training that explains the RSA process, articulates its benefits, and demonstrates its application through discussion of the case studies conducted in this project would seem appropriate for presentation via SDDOT's videoconferencing system. Using videoconferencing would expand the potential training audience by reducing the need for and expense of travel to training locations.

The issue of marketing safety evaluations deserves special attention. The Department of Transportation can encourage local road agencies to pursue Road Safety Audits and Safety Assessment Programs by providing incentives to fund improvements identified through those programs.

It is therefore recommended that the South Dakota Department of Transportation's Offices of Project Development and Local Transportation Programs specifically inform local government agencies of opportunities available through the Highway Safety Improvement Program to fund safety improvements identified in Road Safety Audits.

3 OBJECTIVES

The main goals of this project were to improve the safety performance of local rural roads in South Dakota by aggressively promoting Road Safety Audits and providing a Handbook of low-cost safety improvement strategies to local highway agencies.

Aggressively Promote Road Safety Audits

The research team and SDLTAP staff encouraged local agencies to host RSAs throughout the duration of the study. A presentation on local rural road safety was given to an audience of the Region Local Roads Conference in October 2008 in Rapid City, SD. Road Safety Audits were promoted as a useful way to identify needed low-cost safety improvements. Also, RSA audits were promoted at county and township association meetings and at 29 safety workshops across the state.

The research team conducted twelve Road Safety Audits at selected sites along county highways, city streets, township roads, and other locations deemed appropriate for the study. RSA projects were selected through SDLTAP promotion and commitments from South Dakota's local agencies.

The aim of these case studies was to demonstrate the usefulness and effectiveness of RSAs for a variety of local rural road projects in a variety of agencies throughout the State. The study included three county roads, five sites in Highland Township, Day County, on local gravel-surfaced roads, two intersections in the City of Pierre, and two railroad crossings.

Provide a Handbook of low-cost safety improvement strategies for local highway agencies

A Handbook was developed from a survey of current literature on local road safety issues and Road Safety Audits. The purpose of this Handbook is twofold. The first is to provide information useful to local agencies for evaluating and improving safety using informal field reviews of existing roadways to identify potential improvement actions. The second is to outline a process for conducting formal Road Safety Audits.

4 TASK DESCRIPTION

To accomplish the study objectives, nine research tasks were defined in the original request for proposal. The tasks and the steps taken to perform them are described below.

4.1 DEVELOP RESOURCE LIBRARY

Task 1: Develop resource library of local road safety improvement strategies and specifically Road Safety Audit materials focused on NCHRP 321, FHWA Road Safety Audit for Local Agencies

Through review of relevant literature, important safety materials were identified. Appendix C presents a summary of each publication and describes its use in local road safety. The library consists of four main categories: Safety for Low Volume Roads; Road Safety Audit References; Safety Countermeasures; and Design Standards and MUTCD. Documents and research papers were located and used as the knowledge base for the study covered in this report. (See Chapter 5)

4.2 DEVELOP RSA MARKETING PLAN & GUIDELINES

Task 2: Develop marketing plan and guidelines for Road Safety Audits using LTAP newsletter, SDACHS partnership, SDDPS crash location maps, etc.

The research team and SDLTAP promoted the project very aggressively. Three articles were done in the quarterly newsletter. A 15-minute promotional presentation was done in 29 South Dakota cities in January through March 2008 as part of another safety training activity to over 850 people in local government. In addition, the project was promoted at three statewide conferences of local road and street officials. SDLTAP field staff also did personal promotion during routine field work.

4.3 MEET WITH PROJECT TECHNICAL PANEL

Task 3: Meet with the project's technical panel to review the resource library, marketing plan, and guidelines for Road Safety Audits.

The research team's principal and co-principal investigators met with the Technical Panel in Pierre on June, 2008. With the assistance of SDDOT Office of Research staff, the procedures for RSAs (adopted from FHWA guidelines) were identified. The research team presented the draft Handbook and the methodology for the Road Safety Audit site evaluation. Also during this meeting, the Technical Panel agreed to combine Tasks 4, 5 and 6, and allowed the research team to start the site evaluations. *(See Road Safety Audit Process in Chapter 6)*

4.4 CONDUCT ROADWAY SAFETY AUDITS

Task 4: Pilot Road Safety Audits in a county with FHWA Resource Center technical assistance to train an expanded core team of local Road Safety Audit individuals.

Task 5: Meet with the project's technical panel to advise them of the outcome of the pilot and to invite advice regarding possible modifications to the Road Safety Audit process

Task 6: Conduct Road Safety Audits in ten (10) sites.

The research team conducted eight Road Safety Audits involving twelve sites along county highways, city streets, and township roads deemed appropriate for the study. RSA projects were selected through SDLTAP promotion and commitments from South Dakota's local agencies.

The study included three county roads in Deuel, Lawrence, and Day Counties. Two were gravel roads, while the Day County highway was paved. Each of the county roads had its own characteristic and presented a model case of safety features and problems. The study performed RSAs at five different locations in Highland Township, Day County, on local gravel surfaced roads. The study also performed Road Safety Audits at two intersections at the City of Pierre, and two Railroad Crossings. (See Road Safety Audit Case Study in Chapter 7)

The results of the local RSAs are compiled in Appendix A "Case Studies Documents". Each case study includes photographs, a project description, a summary of key findings, and the lessons learned. The aim of this document is to provide local road agencies with examples and advice that can assist them in implementing RSAs in their own jurisdictions.

4.5 DOCUMENT LESSONS LEARNED

Task 7: Follow-up with Road Safety Audit. Document lessons learned including successes and failures.

Since the RSAs were completed in May, 2009, several actions have been taken to improve safety. There has been a positive reaction on six of the eight sites audited that ranged from installation of new signs, or upgrades to current signs and speed limit changes to long-term plans for improvement regarding realignment of roadways. The explanation of each RSA case feedback is briefly reported in Chapter 8.

4.6 EVALUATE CRASH DATA & SHARE RESULTS

Task 8: Evaluate the SD local rural road crash data to better target countermeasures. Share results with all 66 counties.

This task was addressed through an evaluation of SD local road crash data obtained from the SD Department of Public Safety. Due to the random nature of most crashes on low volume local rural roads, and the fact that there are not high numbers or clusters of crashes, it is nearly impossible to predict crash locations with reliability. However, crash types can be predicted based on historical system-wide data and strategies can be developed to address them.

Historic crash data for all local rural roads for a 6 year period (2004-2009) was analyzed by First Harmful Event (FHE). Crash types were consistent over the 6 years. The data showed that roadway departure rollovers and collision with fixed objects are the leading types of crashes in local rural road injuries and deaths. As a result of this evaluation, Chapters 2 and 3 in the Local Road Safety Handbook considered those two types in the safety Evaluation and Prioritization process. (See Chapters 2 and 3 in Local Road Safety Handbook). The evaluation results were also presented at both the 2008 and 2009 Region Local Road Conferences in Rapid City, SD.

4.7 CALCULATE PERFORMANCE MEASURES AND PREPARE REPORT

Task 9: Calculate output and outcome measures of success and prepare summary report.

This task was addressed by documenting Road Safety Audits conducted and lessons learned and by developing the Local Road Safety Handbook as a product of this study. The purpose of the Local Road Safety Handbook is to provide information useful to local agencies for evaluating and improving safety using informal field reviews of safety issues on existing roadways to identify potential improvement actions. The second purpose is to outline a process for conducting formal Road Safety Audits.

In both the study report and the Handbook, the overall emphasis was to focus on roadway departure rollover and fixed object crashes by promoting low-cost safety improvements to keep drivers on the road and to make roadsides safer. The goal was to increase awareness of safety issues and improvement opportunities. Specific to Road Safety Audits, the goal was to make realistic, implementable recommendations. The follow-up with local road managers found a high degree of acceptance of the recommendations of the RSA teams and a substantial number of follow-up actions taken.

5 LITERATURE REVIEW

5.1 INTRODUCTION

Road Safety Audits have been used successfully worldwide for a number of years and are beginning to catch on in the United States. A Road Safety Audit (RSA) is a proactive approach to improving highway safety, involving examination of an existing or proposed roadway by an independent and qualified team who prioritizes safety findings and reports on safety issues.

RSA concepts were originally developed and introduced in the United Kingdom (UK) in 1989 and made mandatory there by 1991. The benefits of such systematic checking were soon recognized around the world and many countries have since established similar systems. Through the 1990s, audits were introduced to other countries such as Australia, New Zealand and Canada. Audits have been conducted in the United States since the late 1990s. In the year 2000, Pennsylvania became the first state to formally adopt Road Safety Audits into its typical processes.

RSA is a process concerned with the safety of all road users. It is a formal examination which applies safety principles from a multi-disciplinary perspective. The NCHRP Synthesis of Highway Practice 321 *"Roadway Safety Tools for Local Agencies"* defines Road Safety Audit (RSA) an examination of a future roadway project plan by an independent, qualified audit team that then reports on safety issues raised during the examination. It also defines the Road Safety Audit review (RSAR) as an examination of an existing roadway in which an independent, qualified team of auditors reports entirely on safety issues, giving specific recognition to the functionality of the road being evaluated *(1)*. The Federal Highway Administration *"Road Safety Audit Guidelines"* combines both RSA and RSAR together. The FHWA defines RSA as a formal safety performance examination of an existing or future road or intersection by an independent audit team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users *(2)*. In this report only the term Road Safety Audit (RSA) has been used

The Association of Australian and New Zealand Road Transport and Traffic Authorities (Austroads) in Australia defines a road safety audit as a formal examination of an existing or future road or traffic project or any project that interacts with road users, in which an independent, qualified examiner looks at the project's accident potential and safety performance*(3)*.

The RSA is not a means to rank or rate a project, nor is it a check of compliance with standards. In addition, the RSA does not attempt to redesign a project. Instead, it results in recommendations or findings that should be considered when a project is reviewed.

The key elements of these definitions are that the RSA *(4)*

- is a formal examination with a structured process and not a cursory review;
- is conducted independently, by professionals who are not currently involved in the project;
- is completed by a team of qualified professionals representing appropriate disciplines; and
- focuses solely on safety issues.

5.2 ROAD SAFETY AUDITS BENEFITS

Even with the budget constraints faced by most local governments, many low-cost safety countermeasures are available to address the most common and predictable crash types: *run off the*

road rollovers and striking fixed objects. To make improvements, it is often useful to think about safety from a new perspective or point of view. Recognizing that most local road managers face increasing challenges of maintenance under difficult resource constraints, it can be productive to step back and think about safety of the roads from the perspective of those who use roads. A fresh look can identify safety improvements that may be accomplished at low cost.

By conducting a RSA, an agency can improve safety and demonstrate how it is taking action to reduce crashes. A number of benefits of Road Safety Audits have been identified, including:

- demonstrate a proactive approach to safety (i.e., the agency does not have to wait until accident history identifies a problem);
- provide an independent, unbiased perspective of safety issues and opportunities for improvement by involving outside expertise in the evaluation process;
- identify low-cost, high-value safety improvement opportunities;
- promote awareness of safe design and maintenance practices;
- potentially reduce costs by identifying safety issues and correcting them before projects are built;
- support requests for special safety funding

5.3 CANDIDATE LOCATIONS FOR ROAD SAFETY AUDITS

Road Safety Audits can be used to review existing roadways or on proposed improvement projects. For example, the RSA team could look at selected sections of roadway, an intersection, or a proposed improvement project and not necessarily an entire roadway with all of its components. RSAs can also be conducted on construction work zones, on roadway features prior to opening a project to traffic, on nighttime reviews of signing and delineation, or on sample locations of the local road system where safety is a concern.

If a future project is selected for review, the RSA should be conducted as early as possible in the project development stage so that findings can be incorporated in project plans. SDLTAP has been working and plans to continue working with local road managers to maximize the benefit of an RSA for any specific situation.

5.4 KEYS TO SUCCESS

Experience has shown that keys to success include agency support and willingness to implement findings. The use of small, independent, and knowledgeable teams comprising 3-5 members with expertise in design, safety, signing, law enforcement, construction, and maintenance has been proven successful.

The team carefully inspects a variety of roadway features. At the conclusion of the visit, the team may develop recommendations for improvements to roadway width, surface condition, pavement and shoulder drop-offs, short pipe and box culverts, signing and delineation deficiencies, unprotected obstacles within the clear zone, obstructions in the right of way, and sight distance issues, to name a few.

5.5 LEGAL LIABILITY ISSUES WITH ROAD SAFETY AUDITS

A concern with RSAs is that the results might increase an agency's liability by showing that it has identified safety issues but has not fully implemented improvements on its roads. However, creating a plan to improve safety within the constraints of available funding is a proactive approach and could be used to defend against tort liability claims. In addition, Federal law (23U.S.C.409) affords protections that help States and local highway agencies keep data and reports collected for various Federal safety programs from being used in tort liability actions.

While this information does not constitute legal advice, it is useful in discussing with legal counsel any concerns a road manager might have about undertaking RSAs.

6 ROAD SAFETY AUDIT PROCESS

The process of conducting a Road Safety Audit was managed by the RSA team leader in cooperation with the responsible road manager. The steps in the process are illustrated in Figure 1, and are discussed below with reference to the case studies.

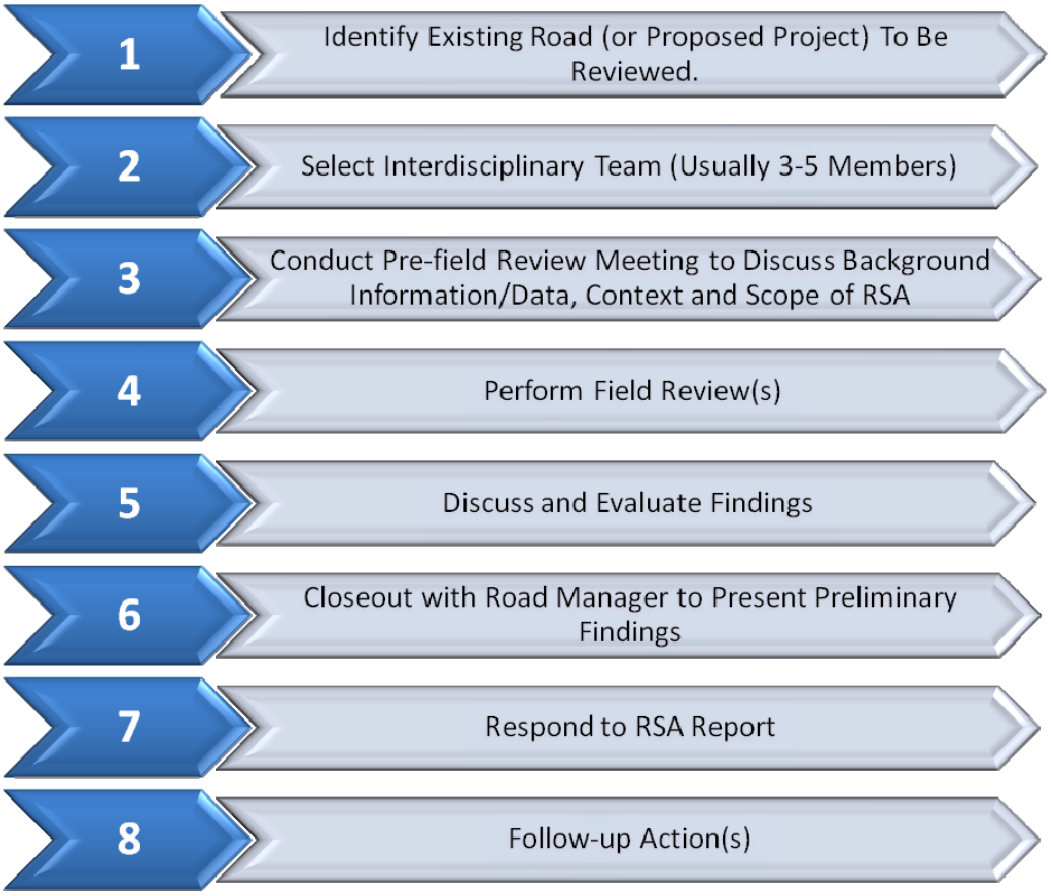

Figure 1: Road Safety Audit Steps

6.1 PROJECT IDENTIFICATION

RSA projects were selected through the SDLTAP communications and commitments from South Dakota's local agencies. The RSA team members were selected in each case study according to the nature and location of the project. All meetings and site visits for the RSAs in the case studies were conducted in one day.

6.2 TEAM SELECTION

A Road Safety Audit team must be an independent, qualified team that identifies and prioritizes safety findings and reports on safety improvement recommendations. To achieve this independence, the freedom, ability, and comfort of team members to comment frankly on potentially controversial safety issues is crucial to the success of a Road Safety Audit. FHWA RSA guidance recommends that while a team member may be selected from within the local highway agency, this individual must be able to truly act independently. To maintain this independence, the research approach was that the local road

manager would not be a member of the team. In most of the case studies of any county road, a neighboring Highway Superintendent was included in the RSA team.

In all cases, the teams included different types of expertise. Someone familiar with the road being reviewed (i.e. a school bus driver, a mail delivery person, a law enforcement officer, a road maintainer/blade operator, a truck driver, etc.), a multidisciplinary experience person who can bring synergy to the team effort, and at least one team member had professional experience in design, traffic operations, safety and was familiar with the design standards and the MUTCD.

The team leader was a SDLTAP staff member who was responsible for being familiar with the RSA process, coordinating the review, facilitating team communications, and preparing the written documentation for the team. The team leader, with the cooperation of the local road manager, selected team members, coordinated calendars, and notified the team of the dates for the field review. While the team size was 3-5 members, the actual composition of the team varied according to the specific focus and expectations of the review defined by the local road manager.

6.3 CONDUCT PRE-FIELD REVIEW MEETING

The RSAs typically began with a start-up meeting attended by the Road Manager. Team members then reviewed the background information, crash data, and, where available, proposed improvement plans furnished to them to gain insight into the road and identify any preliminary areas of safety concern. The team leader then described the RSA process. This included an overview of the RSA process with examples of safety issues that are typically encountered and mitigation measures to address them.

6.4 PERFORM FIELD REVIEWS

Following the start-up meeting, the RSA team conducted a field review to observe geometric and operating conditions for the roads. The RSA team observed road user characteristics (autos, trucks, pedestrians, agricultural vehicles, etc) and surrounding land uses.

The research team identified a list of safety issues to be considered when doing a road safety field review. It is not intended to be all inclusive, but used as the starting point. Figure 2 illustrates the main components of the review list and a detailed "Safety Issues Review List" is included in Appendix B. The review list asks a series of questions to stimulate thinking about potential safety issues. It is formatted as a checklist with space for notes to be taken during a review to identify specific safety issues for possible further consideration.

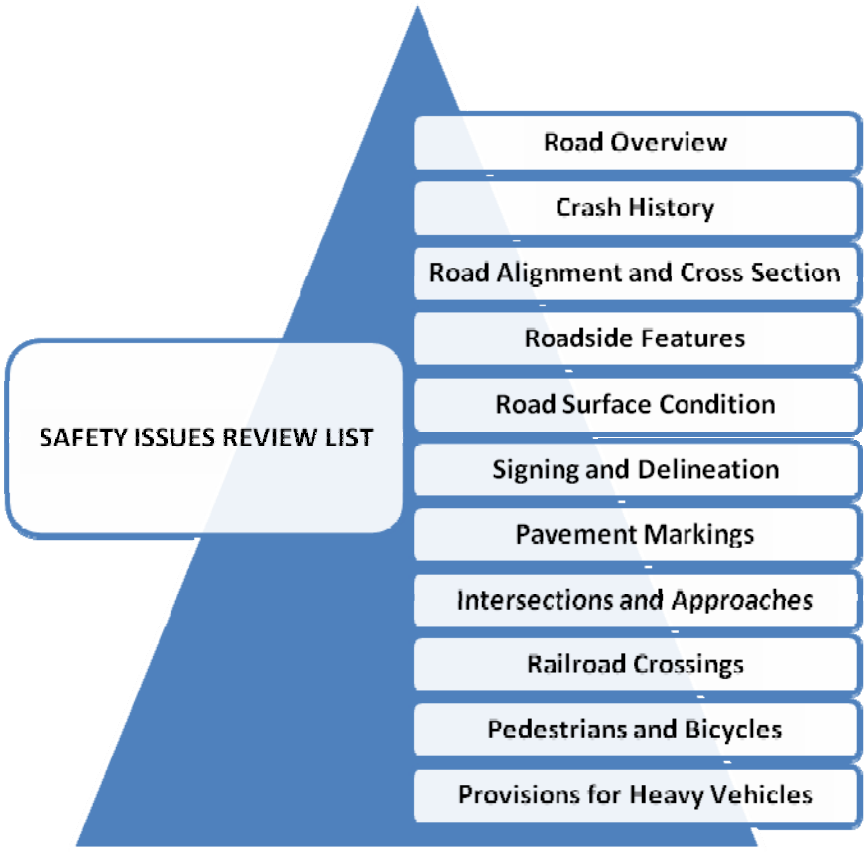

Figure 2: Safety Issues Review List

The team conducted the RSA analysis and gathered and recorded the main points of all findings. The team leader kept detailed notes of observations and a preliminary list of issues and proposed recommendations for inclusion in the RSA report.

Crash severity, which refers to fatality, personal injury, and property damage only crashes, was used to establish priorities. Severity is often the result of speed and the type of crash. Crash probability—the expectation of future crashes—was also considered by evaluating crash history. Locations with frequent and severe crashes were given the highest priority. Table 1 illustrates this concept. Due to the low traffic volumes of many rural roads and the infrequent and often random nature of crashes, this approach was used only if the crash data were available.

Table 1: Priority Based on Crash Severity and Frequency

		FREQUENCY		
		Frequent	Occasional	Rare
SEVERITY	Fatal	Urgent	High	Medium
	Serious (injuries)	High	Medium	Low
	Minor (PDO)	Medium	Low	Low

6.5 Discuss and Evaluate Findings

The team evaluated the risk and prioritized safety concerns and recommendations using historical crash records and the concept of risk. A RSA Safety Priority Evaluation Matrix form (Figure 3) was used to assess risk based on the likelihood of an event and its possible consequences. The form allowed RSA team members to discuss their reasons for identifying a safety issue as a risk and to develop team consensus on the highest priority recommendations.

6.6 Close-out with Road Manager

At the end of the analysis session the RSA team and road manager reconvened for a preliminary findings meeting. The objective of presenting RSA findings at a closeout conference was to report orally the key issues to be presented in the RSA formal report. The discussion started with a review. The review identified opportunities to improve safety and the team members' observations.

6.7 Respond to RSA Report

Following the on-site portion of the RSA, the team wrote and issued the RSA report. The report included the summary of the field review, identified and prioritized safety issues, risks, and recommendations. The team leader drafted the report and provided an opportunity for each team member to review and comment. Every effort was made to complete the formal report within a relatively short time frame (two weeks).

The Road Managers were encouraged to write a brief response letter after reviewing the final report and recommendations. The research team encouraged them to outline what actions will be taken to each safety concern listed in the RSA report. The Road Manager had the opportunity to agree or disagree with the recommendations. If there was disagreement the response "no action will be taken" was documented. Table 2 summarizes the RSA tasks descriptions and responsibilities.

Safety Priority Evaluation Matrix

Description of issue/hazard:

Location:

	Very Low	Low	Medium	High	Very High
Exposure					
Probability					
Consequence					

Comment on Safety Risk:

Recommendation:

Figure 3: RSA Safety Priority Evaluation Matrix

Table 2: Description of Steps in Conducting a Road Safety Audit

Step		Description	Responsibility
1	Identify existing road (or proposed project) to be reviewed.	Agree to scope of RSA and time schedule with Team Leader.	Road Manager
2	Select interdisciplinary team (usually 3-5 members)	Review available information (traffic data, roadway importance, functional classification, historical crash records, and future plans. (data support from DOT and DPS)	Team Leader with Road Manager
3	Conduct pre-field review meeting to discuss background information, context, and scope of RSA, and specific expectations		Team Leader with RSA team and Road Manager
4	Perform field review(s)	Identify safety issues	RSA Team
5	Discuss and evaluate findings	Agree on safety issues and prioritize countermeasures recommended to reduce the degree of safety risk	RSA Team
6	Closeout with road manager to present preliminary findings	Prepare written report summarizing findings, review and comment by team members, transmit to road manager	RSA Team Team Leader
7	Respond to RSA report	Outline actions to be taken by road manager, and why some suggestions could not be implemented	Road Manager
8	Follow-up action(s)	Corrective actions completed	Road Manager

7 ROAD SAFETY AUDIT CASE STUDIES

7.1 RSA CASE STUDY PROGRAM

The research team conducted eight Road Safety Audits involving twelve sites along county highways, city streets, township roads, and other locations deemed appropriate for the study. RSA projects were selected through SDLTAP promotion and commitments from South Dakota's local agencies. The research team and the SDLTAP staff encouraged commitments from local agencies to host RSAs during the study. A presentation on local rural road safety was made to an audience of the Region Local Roads Conference in 2008 in Rapid City; SD. Road Safety Audits were promoted as a useful way to identify needed lost cost safety improvements. Also, RSA audits were promoted at county and township association meetings and at 29 safety workshops across the state. There had been a very weak response from counties, cities, townships, and tribal governments.

RSA team members were selected in each case study according to the nature and location of the project. The eight RSAs conducted in this case study program are summarized in Table 3 Information on each of these RSAs, including background, a summary of safety issues, and a list of suggested improvements, is included in the Appendix A.

Table 3: Road Safety Audit Case Study Projects

Facility Owner	Project	Case Number	Surfacing Type	Comments
County Roads				
Deuel County	Clear Lake Rodeo Route	1	Gravel	Special event traffic
Lawrence County	Maitland Road	6	Gravel	Development occurring, increased traffic
Day County	Day County Route 1	7	Gravel	Sight distance; traffic speed
Township Roads				
Highland Township (Day County)	Township Road System	8	Gravel	Crest vertical curves and drainage
Intersections				
City of Pierre	Euclid & 4th Street	3	Paved	Day care center conflicts
City of Pierre	Harrison & Church	4	Paved	Pedestrian safety
Railroad Crossings				
Stanley County	Bad River Road / DM&E Railroad	2	Gravel	Skewed crossing
City of Pierre	Pierre Street Railroad Underpass	5	Paved	Low vertical clearance

7.1.1 COUNTY ROADS

The study included roads in Deuel, Lawrence, and Day Counties. Two were gravel roads, while the Day County one was paved. Each of the three roads has its own characteristics and presented a model case of safety features and problems.

Crystal Springs Rodeo Route

This Road Safety Audit addressed the concerns about safety and operation related to the annual Crystal Springs Rodeo, a three-day event held the last weekend in June. Attendance at the rodeo is estimated at 10,000 over 3 days. Daily traffic volume was estimated to exceed 2000 automobiles and heavy vehicles. In addition to rodeo attendees in automobiles and pick-up trucks, there are many supply and service trucks, livestock trucks and horse trailers. The road has a posted speed limit of 50 mph. The surface is asphalt concrete for the first mile, then gravel for four miles to the rodeo site.

Crash records for the previous three years were requested and reviewed. There were four reportable crashes, two of which were deer hits. There was no observable pattern of crashes that could be addressed by roadway safety improvements.

Maitland Road

There is a concern about the safety related to significant housing development adjacent to and primarily served by the road. Maitland Road is a gravel surfaced road of approximately 8.6 miles. The gravel surface is in very good condition throughout its length. The posted speed limit is 30 mph. The functional classification is major collector and the route is designated as a Federal-aid Secondary Route on the Forest Highway System.

There were 31 reported crashes in the last 3 years; (6 in 2005, 11 in 2006, and 14 in 2007). Of the total, there were no fatalities; 8 injuries; and 23 property damage only crashes. Although no recent traffic counts are available, traffic volumes are increasing. In addition, as supported by the crash history, safety is a growing concern. As the area becomes more fully developed, there will be increasing demands on Maitland Road with higher traffic volumes, and greater demands for routine maintenance, snow removal, and emergency services.

Day County Route 1

Day County Route 1 (447th Avenue) is a bituminous-surfaced major collector running south from the southeast corner of Waubay. The specific section of this road selected for this review was approximately two miles in length, beginning approximately 4 miles south of town. The surface was in very good condition and appeared to have been chip sealed within the last couple of years. Pavement markings were in good condition, including striped no passing zones. The posted speed limit is 55 mph.

This road serves not only local access and agricultural traffic, but acts as a recreational access to area lakes. A boat ramp and parking area for Bitter Lake lie within the project limits. Both the county and township have gravel pits adjacent to the road requiring gravel hauling trucks to enter, creating potential conflicts.

At the time of review, the team did not have historical records of reportable crashes. However, there have been a total of nine fatalities (six within the limits of this project review) in 2006 and 2008. Although there are no recent traffic counts, traffic volumes are increasing. Average Daily Traffic (ADT) was estimated, by the Day County highway superintendent, at 400+. In addition, as supported by the crash history, safety is a growing concern due to traffic speeds and limited sight distance due to the rolling terrain (both horizontal and vertical curves).

7.1.2 TOWNSHIP ROADS

The study performed RSAs at five different locations in Highland Township, Day County, on local gravel-surfaced roads. The first, second, and fifth sites were located on top of hills with limited sight distances. At the first site, the roadway narrows and shifts to south at the crest. A recent incident of two vehicles sideswiping was reported. For the second site, Highland Township supervisors were concerned that the roadway is too narrow at the crest. At the third and fourth sites, the roads narrow and pass through water.

7.1.3 INTERSECTIONS

The study performed Road Safety Audits at two intersections within the City of Pierre. The first has a daycare facility at one corner of the intersection of two major roads, while the second is a location without sidewalk on the North East corner of an intersection.

Intersection of Euclid and Fourth in City of Pierre

The purpose of the review was to address concerns about safety and operational issues related to vehicles picking up and dropping off children at the day care center located in the northeast quadrant of the intersection. The primary safety concern occurs during the morning and evening when drop-offs and pick-ups occur during the period of the heaviest traffic from work trips.

Pedestrian Safety at Local Intersection in City of Pierre

The intersection of Church and Harrison has been of interest to the City Safety Committee for several years. Citizens have voiced concerns about pedestrian safety because there is no sidewalk on the east side of Harrison north of Hilltop. The adjoining lot steeply slopes down to the street with a rock retaining wall adjacent to the curb and gutter on Harrison Avenue. The lot was developed before Harrison Avenue was extended to be a through street to the north serving the Pierre Mall and residential development. With the street extension, additional development, and subsequent growth in vehicular traffic, the potential for pedestrian conflicts has grown.

7.1.4 RAILROAD CROSSINGS

Bad River Road and DM&E Railroad Crossing

The primary safety concern is the potential for crashes at the railroad crossing due to the skewed angle of the crossing. The gravel-surfaced county road (Bad River Road) intersects the railroad track at a skewed angle making visibility in both directions difficult.

Underpass Pierre Street and DM&E Railroad

The primary safety concern is the number of vehicles hitting the low-clearance structure. The railroad structure over Pierre Street is mid-block between Sioux Avenue (to the south) and Pleasant Street (to the north). The structure has a vertical clearance of 11’3”. At this location, Pierre Street is signed as US14 and US83 through the city. The truck route eastbound continues east from Pierre Street on Sioux Avenue and Wells Avenue to Garfield Avenue then northerly to US14 and US83. Westbound, the truck route leaves US14 and US83 and turns south on Garfield thence westerly on Wells and Sioux Avenue past Pierre Street to the Missouri River. These routes connect with Sioux Avenue from the west, turn north on Pierre Street, turn east on Pleasant Street, and then north on Euclid to US14 and US83.

8 FINDINGS AND CONCLUSIONS

8.1 CASE STUDIES FINDINGS

RSA teams identified safety issues on most of the local roads where RSAs were conducted during this study. Below, explanations of each safety issue and the possible increase in accident risk are briefly reported.

8.1.1 ROADSIDE OBSTACLES

The main effect of roadside obstacle safety issues is not on accident probability but on accident severity. An unprotected culvert end next to the edge of the road, presents a higher risk if located on the outside of a curve just over a hill than if located on a straight section of roadway in plain view of oncoming drivers.

At several locations mailboxes are mounted on bases which are unsafe roadside obstacles. In South Dakota, total reported mailbox crashes have averaged 50 per year with an average of 10 per year reported on local rural roads. Consideration should be given to working with individual property owners to replace these installations with posts that will break away on impact. Roadside vegetation and limited lateral clearance to roadside objects presents a high potential for crashes, especially if close to an intersection or railroad crossing.

8.1.2 DELINEATION

Delineation of the road is a critical safety issue especially at nighttime, or in snowy or rainy conditions. Supplementary delineation is an important safety factor in any condition; especially on horizontal curves and isolated curves with a short radius. A safety approach that provides long-range delineation of the roadway alignment is needed. The chevron alignment sign is an important traffic control device used to warn drivers of the severity of a curve by delineating the alignment of the road around that curve. Missing or ineffective chevrons and damaged or missing delineators or barrier reflectors can lead to an accident risk increase.

8.1.3 CROSS SECTION

Roadway widths affect single vehicle, run-off-the-road and multiple vehicle, head-on, opposite-direction sideswipe and same-direction sideswipe accidents. Wider lanes and shoulder widths provide safer operation and fewer accidents. Inadequate sight distance on horizontal and vertical curves is a common accident contributory factor.

8.1.4 ALIGNMENT AND ACCESSES

The geometry and location of direct accesses to roads can significantly increase accidents. The wrong location of access points (such as accesses on horizontal or vertical curves) can be very dangerous. Driveway location and density also have a dramatic effect of accesses on road safety.

8.1.5 ROAD SURFACE AND PAVEMENT

Safe roads must provide uniformly smooth surfaces and require good routine maintenance. Gravel roads need to be built with quality gravel, have the proper cross-section, and provide for adequate drainage. On paved roads, the factor that has the greatest impact on road safety is friction. The skid resistance of the road surface is important, especially when the surface is wet. Several studies show an increase in crash risk when the friction decreases below certain threshold values.

8.1.6 PAVEMENT MARKING

Pavement markings play a large role in improving road safety and are cost-effective. Increase in crashers will result from missing or non-reflective edge lines and center lines especially at horizontal curves. Centerline pavement marking is considered minimal treatment for curve sections. Edge line pavement marking delineates the edge of the roadway providing a visual reference to prevent motorists from drifting onto the shoulder.

8.1.7 SIGNS

Road signs that have the greatest effect on traffic safety are warning signs. They call attention to unexpected conditions and to situations that might not be readily apparent to road users. Faded and vandalized signs do not provide needed information to drivers, especially at night. Regulatory signs, such as speed limit and stop signs, can affect road safety by conveying essential information on safe behavior.

8.1.8 MAINTENANCE

Because funding for maintenance has typically been constrained by limited overall budgets, limited funds are available to the counties and townships to reconstruct or do major reshaping on its road system. Consequently, RSA recommendations are intended to be as practical and cost effective as possible while enhancing safety. For example, the traveled way at the three sites in Highland Township, where sharp crests exist, can be widened to the local roads standard with a motor grader by doing some aggressive shoulder work and should not require actual reconstruction with earthmoving equipment.

Culverts under narrow roadways with steep side slopes create potential crash locations. Culverts should be extended to provide adequate clear zones and side slopes. Culvert ends that cannot be extended outside the clear zone should be marked with object markers.

8.2 ROAD SAFETY AUDITS FOLLOW UP AND FEEDBACK RESULTS

In a short time since the RSAs were completed in May, 2009, numerous actions have been taken to improve safety. There has been positive reactions on six of the eight sites ranging from installation of new signs or upgrades to current signs and speed limit changes to long-term plans for improvement regarding realignment of roadways. Below, an explanation of each RSA case feedback is briefly reported.

8.2.1 CRYSTAL SPRINGS RODEO ROUTE

Following the RSA report recommendations, Deuel County made changes in traffic control with added signs and a temporary reduced speed limit during the annual rodeo this year. The event was held on June 25, 26 and 27, 2009. No crashes were reported this year. This is a positive reaction to the RSA conducted in late August, 2008. In addition, due to one of the RSA recommendations, Deuel County requested assistance in obtaining accurate traffic counts during the three day annual special event as well as counts two days prior to and one day after the event. This will help decisions on any potential future safety improvements. The county highway superintendent commented very positively about the RSA, which helped him approach his commission with recommendations of outside expertise to make changes and enhance local road safety.

8.2.2 MAITLAND ROAD

As a result of RSA report recommendations, Lawrence County has requested safety funds from the FHWA Highway Safety Improvement Program (HSIP) to make alignment changes on the approaches to a low water crossing on Maitland Road. It was a positive reaction to recommendations made in the RSA done there in October, 2008.

8.2.3 DAY COUNTY ROUTE 1

On June of 2009, the county commission passed a resolution requesting funding assistance from the FHWA Highway Safety Improvement Program (or another source if feasible) through the SDDOT to make construction and operational improvements on Day County Route Number 1. The Road Safety Audit conducted there on April 9, 2009 and the final report along with the addendum submitted by SDDOT Region Traffic Engineer, are being used as the primary documents supporting this request.

8.2.4 BAD RIVER ROAD & DM&E RAILROAD CROSSING

Stanley County officials have placed new Advanced Warning Railroad Crossing signs. The new signs placed approximately 500 ft each side before the crossing. They are attempting to make contact with the railroad foreman in the area to resolve tree trimming in the railroad right of way to improve sight distances. The 35 mph speed limit has been extended approximately 1000 feet south to reduce speed northbound before entering the curve approaching the crossing.

8.2.5 CITY OF PIERRE EUCLID AND 4TH STREET INTERSECTION

With the help of SDDOT, the City of Pierre's Safety Committee redesigned the day care entrance and exit. The new design changed the main building access from the front to the rear. New "yield to pedestrians in crosswalk" signs have been placed in each leg of the intersection. These improvements were a part of the recommendations of the RSA conducted in August 2008. However, the City of Pierre is still limited in making additional improvements to signing and pavement markings.

8.2.6 PIERRE ST. & DM&E RAILROAD UNDERPASS

The City of Pierre intends to install low clearance detection devices and warning system. Funding has been approved for the project, which is now included in the South Dakota Department of Transportation's Statewide Transportation Improvement Program (STIP).

8.3 LESSONS LEARNED

1. This project has increased awareness of local road and street safety in SD. When a highway superintendent or local manager is invited to serve as a peer member of the road safety review team, he/she learns from the experience. They not only gain experience from working with a road safety team, but they return to their departments with a new perspective in analyzing traffic safety on their own highway system.
2. One of the key elements of RSA success is good preparation before performing the audit. All of the information including constraints, crash history, project environment, and operation of the site, must be prepared and discussed during the start up meeting. It is crucial that the team members have a full understanding of the constraints in order to achieve practical and reasonable findings and recommendations.
3. One lesson learned is that local government in SD is very wary of the road safety audit process. The project proposal called for ten local road safety audits but only eight locations

were completed. This was due to local agencies not wanting to come forward and ask for the service. SDLTAP promoted the project very aggressively. Three articles were done in the quarterly newsletter. A 15-minute promotional presentation was done at 29 locations in January through March, 2008 as part of another safety training activity. SDLTAP staff reached more than 850 people in local government agencies. In addition, the project was promoted at three state-wide conferences of local road and street officials. SDLTAP field staff also did personal promotion during routine field work. Despite this, very few came forward to request the service.

4. Some local officials are very opposed to the term "audit" which has a negative connotation in the minds of many people. This was discussed at the April, 2009 SDLTAP Advisory Board meeting. One of the advisory board members suggested using different terms such as "Road Safety Review" or "Road Safety Assessment". This may be a better approach in the future.
5. To help overcome the local reluctance to conduct formal RSAs, a local champion who understands the purposes and procedures of RSA is needed to encourage the local agency along with its elected officials to request a RSA.
6. It is good to have diversity on the RSA teams. The study recruited a highway superintendent from a neighboring county. One MUTCD expert is essential because many of the low-cost improvements are typically signing, delineation, and marking. (On the other hand, the study must follow the audit outlines; it is not a MUTCD compliance review.) A surface condition and pavement expert can also contribute expertise to the RSA team. Someone from local law enforcement can also provide great input, as can local emergency responders.
7. The team must understand the functional classifications of local roads in order to contribute sound input in prioritizing recommendations based on risk.
8. It is important to schedule the RSA field review during regular recurring traffic conditions. Where possible, the RSA team should visit the project site when traffic conditions are typical or representative. For example, the RSA on the Crystal Springs Rodeo route, which addressed the concerns about safety and operational issues related to the annual Crystal Springs Rode that is held during the last weekend in June, scheduled site visits during August. Attendance at the rodeo is estimated at 10,000 over 3 days, the RSA teams were not able to observe tourist traffic associated with the event. Although this did not significantly affect the RSA findings, the recommendations for this site were grouped to improve permanent signing of the route, and for additional signing during the rodeo event to improve safety for motorists not familiar with the route.
9. Many local managers feel that they don't have the money to make changes that might be recommended and consequently develop an automatic fear of an audit and may feel that without the sufficient funds it would be of little value. There is also a fear of having a document on record defining safety problems which they may not be able to quickly remedy and therefore could be used against them in litigation.

8.4 CONCLUSIONS

The results of the study can be summarized:

1. An ongoing commitment to conducting RSAs on local rural roads will assist the local agencies in identifying and prioritizing safety improvements. The audits can be used to implement plans that improve highway safety.
2. The Local Rural Road Safety Audit case studies sponsored by the FHWA through SDDOT have been well received by the participating highway agencies. In a short period of time since the RSAs were completed, numerous actions have been taken to improve safety.
3. The project exposed local governments to the concept and practices of road safety analysis and provided a good opportunity for local highway agencies and staff members to participate and gain experience from working with road safety teams.
4. The major issues that were identified by the audits related to intersections sight distance, angle of approach, signage, road alignment, vertical and horizontal curvature, culverts, table drains, and location, visibility, and legibility of signs.
5. Many of the recommended solutions were related to maintenance practices (e.g. maintaining the immediate roadside clear of vegetation to improve sight distance through curves), delineation (e.g. marking culverts with guideposts), and general sign improvement (e.g. installing signs to warn of particularly sharp or unexpected changes in the horizontal or vertical alignment).
6. Clearly safety has to be a part of the routine maintenance activities. However, there is a need for an occasional assessment through the eyes of someone other than the usual maintenance and management staff, particularly at locations with significant crash history or the potential for crashes. In developing the Local Rural Road Safety Handbook, as a product of this study, the study included a "safety issues review list" that could be used both by a RSA team or a local road manager for safety assessments.

9 IMPLEMENTATION RECOMMENDATIONS

Based on the results of this study, the research team offers the following recommendations.

9.1 PUBLISH RESEARCH PRODUCTS

The products of this research effort can serve a valuable purpose to inform local agencies of the Road Safety Audit process and to illustrate its application in typical South Dakota situations. Familiarity with the process can be expected to increase interest and receptivity to performing additional RSAs and gaining the resulting benefits of improved highway safety. The costs of producing and distributing these documents—estimated to be about $2,500—would be well justified in consideration of the potential safety benefits.

It is therefore recommended that the South Dakota Department of Transportation's Office of Research should publish and distribute copies of this final report and the *Rural Road Safety Handbook* to all counties, cities, townships, and tribal governments in South Dakota.

This recommendation is intended to supplement, not replace, the Office of Research's normal publication and distribution practices.

9.2 OFFER RSA TRAINING TO LOCAL GOVERNMENT AGENCIES

To further familiarize local government agencies with the RSA process and promote its use in South Dakota, it is recommended that the South Dakota Local Transportation Assistance Program should develop and offer RSA training targeting local road managers and elected officials.

Training that explains the RSA process, articulates its benefits, and demonstrates its application through discussion of the case studies conducted in this project would seem appropriate for presentation via SDDOT's videoconferencing system. Using videoconferencing would expand the potential training audience by reducing the need for and expense of travel to training locations.

9.3 PROVIDE INCENTIVES FOR FUNDING IMPROVEMENTS

The issue of marketing safety evaluations deserves special attention. The Department of Transportation can encourage local road agencies to pursue Road Safety Audits and by providing incentives to fund improvements identified through the audits.

It is therefore recommended that the South Dakota Department of Transportation's Offices of Project Development and Local Transportation Programs specifically inform local government agencies of opportunities available through the Highway Safety Improvement Program to fund safety improvements identified in Road Safety Audits.

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APPENDIX A: CASE STUDY DOCUMENTS

Road Safety Audit Number 1

Duel County Clear Lake Rodeo Access

Project: Traffic Operation Improvement during the Annual Crystal Springs Rodeo

Date of RSA:	August 26, 2008	
Project Environment:	Local Gravel Road Serves as Access to the Clear Lake Rodeo	
RSA team:	Alan Petrich	Regional Traffic Engineer, SDDOT, Aberdeen
	Larry Jensen	Highway Superintendent, Brookings County
	Chuck Atyeo	Clear Lake Township Supervisor
	Dave Solem	Deuel County Sheriff
	Ken Skorseth	Field Services Manager, SDLTAP
	Ron Marshall	Technical Assistance Provider, SDLTAP

SCOPE AND PURPOSE OF THE REVIEW

The purpose of the review was a request by Jamie Hintz, Deuel Co Hwy Supt, to address concerns about safety and operational issues related to the annual Crystal Springs Rodeo, a three-day event held the last weekend in June.

PROJECT BACKGROUND

The route reviewed serves as access to the Crystal Springs rodeo northeast of Clear Lake. This is a 5 mile route, beginning 1 mile north of the city, starting at the intersection with SD15 traveling east for 3 miles on 180th Street, then 2 miles north on 479th Avenue to the rodeo site.

Attendance at the rodeo is estimated at 10,000 over 3 days. Because of the uniqueness of the natural setting and the history of the rodeo event, it draws people from around the region, many coming from Minnesota. There are no accurate traffic counts for the event. However, daily traffic volume has been estimated to exceed 2000 ADT. The traffic mix is both automobiles and heavy vehicles. In addition to rodeo attendees in automobiles and pick-up trucks, there are many supply/service trucks, livestock trucks and horse trailers.

The route is maintained by Deuel County (4 miles) and Clear Lake Township (1 mile)

The functional classification of this road is Local.

The road has a posted speed limit of 50 mph. The surface is asphalt concrete for the first mile to the Tech Ord (munitions plant) entrance, then gravel for 4 miles to the rodeo site. At the time of this review, the gravel surface was in good condition.

Note: For purposes of this review, the location information is referenced from the west end of route (the intersection with SD15) increasing by miles going east and north to the rodeo site.

HISTORICAL CRASH RECORDS

A review of the crash records for the previous three years was requested and reviewed. There were four reportable crashes, two of which were deer hits. There was no observable pattern of crashes that could be addressed by roadway safety improvements.

FINDINGS AND RECOMMENDATIONS

Both Deuel County Highway Department and Clear Lake Township are commended for cooperative extra maintenance efforts of mowing prior to and performing daily blade maintenance during the event to safely accommodate rodeo traffic. Water is also hauled and applied to the road if dry conditions exist during the rodeo. Gravel surfaces at the time of this review were in good condition with an observable crown, no excess windrows and no secondary ditch at the edge of roadway. The review team recommends these activities be continued in the future.

The following recommendations are grouped to improve permanent signing of the route, and for additional signing during the rodeo event to improve safety for motorists not familiar with the route.

1. Permanent Traffic Signing

The RSA team suggested the sign locations shows in Figure 1-2,

- Speed limit (on 180th Street)

  Replace existing "Speed Limit 50 mph" (R2-1) with sign sheeting meeting current reflectivity requirements (recommend High Intensity Prismatic)

- Pavement Ends (on 180th Street)

  Replace existing "Pavement Ends" (W8-3) with sign sheeting meeting current reflectivity requirements (recommend High Intensity Prismatic)

- Intersection 180th Street and 479th Avenue

  Install standard intersection warning sign (W2-1) on 180th Street (EB) and 479th Avenue (SB)

  Install Stop sign (R1-1) for WB approach (180th Street) and NB approach (479th Ave)

- Intersection 479th Avenue. and 179th Street

  Install standard side road intersection warning sign (W2-2) with supplemental warning plaque, "1500 Feet ahead" in both directions on 479th Avenue. Note that location of SB intersection warning sign needs to consider the very limited site distance approaching from north.

Install Yield Ahead (W3-2) and Yield (R1-2) on SB approach

- Between MP 3 and 4

  Install Shoulder Drop Off warning sign (W8-9a) to alert motorists to narrow roadway with no shoulders

- Delineation

  MP 4.5 - Install Type 2 object markers to delineate ends of culvert

2. Temporary Signing and Delineation During Event

- Speed Limit

  To improve safety during the event, in particular for visitors from out of the area, it is suggested that the speed limit for the unpaved sections be reduced. Before the end of paved section (Mile 1.0 EB), install a "Reduced Speed Ahead - 35 mph" (W3-5). At the beginning of the gravel surface section, and spaced at 1 mile, Speed Limit Signs, "Speed Limit 35 mph" (R2-1).

- Temporary Delineation

  MP 4 to 5 – consider temporary delineation (such as lath with reflective tape) or reflectors on steel T-posts) during the event to alert motorists of narrow roadway and/or no shoulder. The existing fence is at the edge of roadway. If moving fence back is infeasible, also consider marking fence posts.

3. Permanent Pavement Marking

The paved section, recently seal coated, should be striped with centerline and edge line.

4. Vegetation removal to improve roadside safety and sight distance

- MP 0 (Intersection SD15) – trim/remove vegetation in NE corner
- MP 1.0 – (Intersection 477th Ave) - trim/remove vegetation in SE corner
- MP 3.6 – remove tree
- MP 3.8 – remove tree

5. Other

- Mailbox - MP 1.0+ on north side – recommend mail box location and support be relocated away from edge of roadway
- Other alternatives considered: The alternative of upgrading the entire roadway to current design standards was not considered due the cost of extensive regarding. Reconstruction of the entire roadway would require considerable grading and earthwork along the entire route, and in particular in several wetlands. The design criteria for minimum design standards from the SDDOT Secondary Road Plan are: lane width 10 ft; shoulder width 2 ft, clear zone 10 ft; and slopes 3:1.

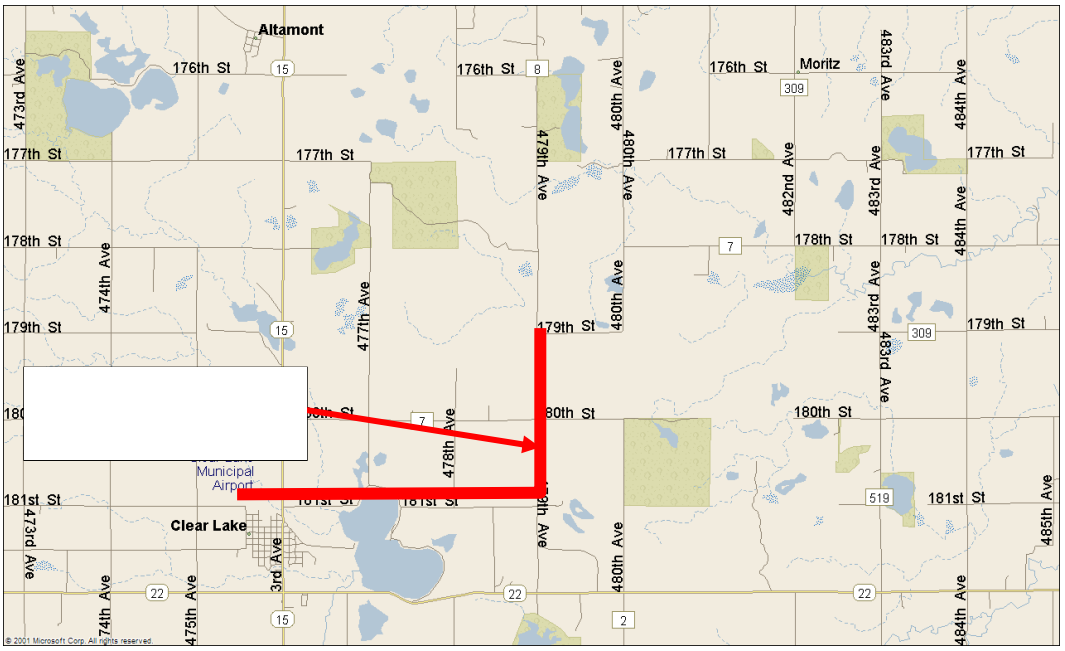


Figure A1-1: Access Road Location

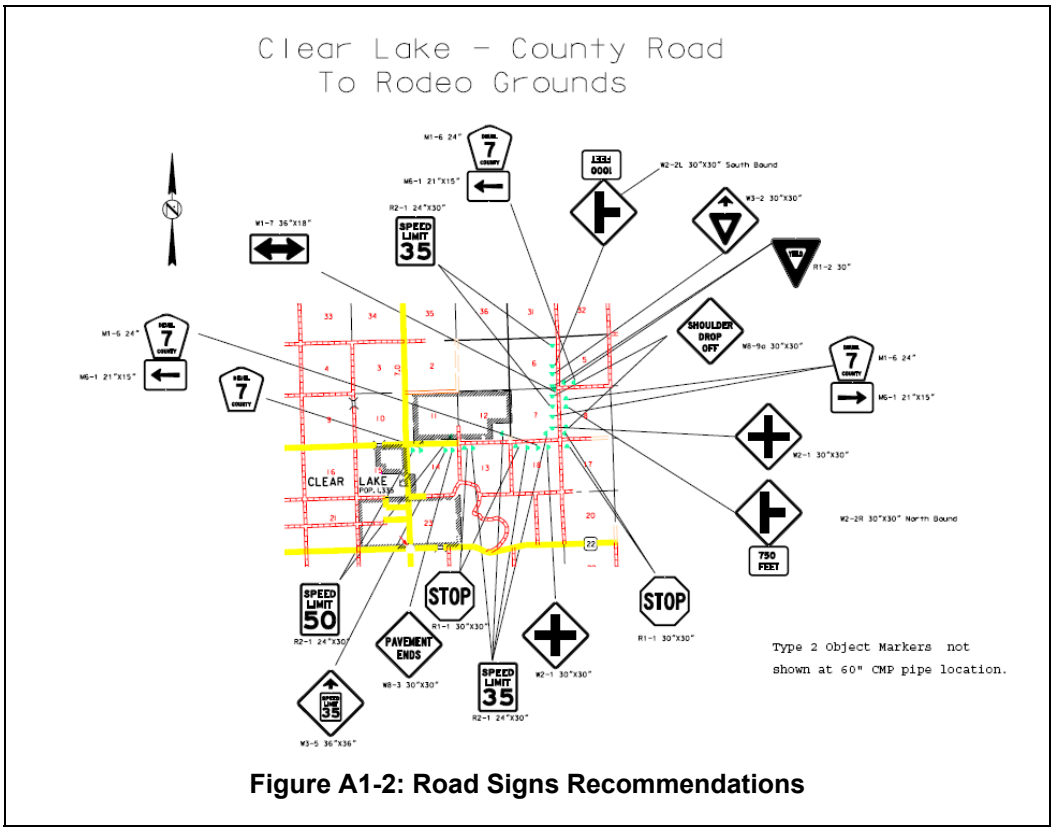


Figure A1-2: Road Signs Recommendations

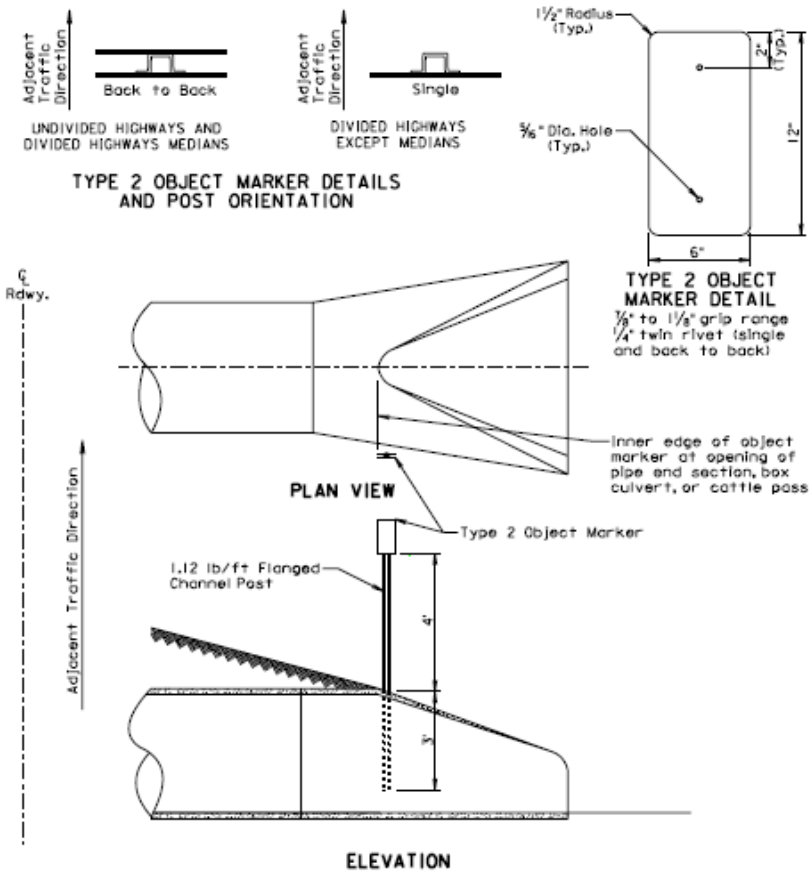


Figure A1-3: Type 2 Object Marker Installation Detail

Figure A1-4: Site during Rodeo Event

Figure A1-6: Heavy Agricultural Vehicle Using Road

Figure A1-5: Heavy Agricultural Vehicle Using Road

Figure A1-7: General View of Road Looking North

Figure A1-8: Road End & Rodeo Arena

Figure A1-9: Safety Concern, Mail Box Support

Figure A1-10: Safety Concern, Bad Sign

Road Safety Audit Number 2

Stanley County Bad River Road and DM&T Railroad Crossing

Project: Road and Railroad Crossing SW of Ft. Pierre

Date of RSA:	August 27, 2008	
Project Environment:	Intersection between Major Collector Road and DM&E Railroad	
RSA team:	Cliff Reuer	Traffic and Safety Engineer, SDDOT
	Lynn Patton	Construction Engineer, City of Pierre
	Larry Weiss	SDLTAP and City of Pierre Commissioner
	Ron Marshall	Technical Assistance Provider, SDLTAP

SCOPE AND PURPOSE OF THE REVIEW

The purpose of the review was to address concerns about safety and operational issues related to the at-grade railroad crossing of the Bad River Road and the DM&E Railroad south and west of Fort Pierre.

PROJECT BACKGROUND

The primary safety concern is the potential for crashes at the railroad crossing due to the skewed angle of the crossing. The county road (Bad River Road) is a gravel surface road that intersects the railroad track at a skewed angle making visibility in both directions difficult.

Existing Signing:

Approaching from US83 driving westbound there is a 35 mph Speed Limit sign (R2-1), followed by a Curve (to the left) Warning sign (W1-2), and the standard Highway-Rail Grade Crossing Cross buck (R15-1) at the crossing.

The eastbound approach has a Reduced Speed Ahead sign, a 35 mph Speed Limit sign (R2-1), followed by a Curve (to the right) Warning sign (W1-2), a Highway-Rail Grade Crossing Advance Warning sign (W10-1) and the standard Highway-Rail Grade Crossing Crossbuck (R15-1) at the crossing.

The functional classification of this road is a major collector.

Traffic volume is 308 vehicles / day @ the crossing and the average number of trains per day varies from 2 to 3.

HISTORICAL CRASH RECORDS

There were no motor vehicle train crashes reported at this crossing.

FINDINGS AND RECOMMENDATIONS

The following recommendations are offered to improve safety at this location.

1. **Vegetation Removal**

   In the north east quadrant, there is vegetation which partially obstructs sight for any west bound vehicle looking for a west bound train. This is compounded by the skew angle forcing the driver to look back to the right. This vegetation appeared to be mostly in the railroad right-of-way, and should be removed.

2. **Permanent Traffic Signing**

   Recommend placing Highway-Rail Grade Crossing Advance Warning signs (W10-1) with high intensity fluorescent yellow facing to draw additional attention to the crossing ahead. (Note: the Advance Railroad sign for westbound traffic was missing and should be replaced).

3. **Other Considerations**

   Another alternative discussed by the team included discussing with the DM&E Railroad the possibility of adding a train actuated flashing light on the advance warning signs. Approaching trains would activate a flashing light to give additional warning to approaching motorists.

Figure A2-1: Intersection Location

Figure A2-2: Crossing of Bad River Road and DM&E Railroad

Figure A2-3: Horizontal Curve at the Crossing with Buildings at the Line of Sight

Figure A2-4: Vegetation Blocking Clear View of Oncoming trains at the Crossing

Road Safety Audit Number 3

City of Pierre

Project: Local Intersection in City of Pierre

Date of RSA:	August 27, 2008	
Project Environment:	Intersection between two Major Roads in City of Pierre	
RSA team:	Cliff Reuer	Traffic and Safety Engineer, SDDOT
	Lynn Patton	Construction Engineer, City of Pierre
	Larry Weiss	SDLTAP and City of Pierre Commissioner
	Ron Marshall	Technical Assistance Provider, SDLTAP

SCOPE AND PURPOSE OF THE REVIEW

The purpose of the review was to address concerns about safety and operational issues related to vehicles picking up and dropping off children at the day care center located in the northeast quadrant of the intersection of Euclid and 4th Street in Pierre.

PROJECT BACKGROUND

The primary safety concern occurs during morning and evening when drop-offs and pick-ups occur at the day care facility located at the NE corner of the intersection. This is also the time of heaviest traffic from work trips. Concern centers on frustration from difficulty with re-entering Euclid or 4th Street due to volume of traffic during the short peak periods and also SB 4th Street vehicles turning left onto Euclid.

In the past, the city has discussed safety concerns and traffic circulation issues within the City Safety Committee [Larry Weiss, Chair], with the daycare center operator, and with SD Bureau of Information and Telecommunications who owns the parking lot behind the daycare. The owner has cooperated by improving access to the back side of the building to allow pickup of children from the BIT lot behind the building after 5:00P and discussed safe access with customers.

Since Euclid is the through route of US83 & US14, maintenance is the responsibility of SDDOT to include surface, regulatory signs, and speed limit. Traffic counts and speed monitoring has been done by Pierre Police Dept. In addition the Pierre Safety Committee Chair has requested DOT consideration of lowering the Euclid Avenue speed limit from 35 to 30 mph from 8th Street to 4th Street (north to south). This request was denied. Currently the speed limit changes from 35 to 30 mph at the intersection of 4th Street and Euclid.

Fourth Street is maintained by the City of Pierre.

The functional classification of this street is minor arterial.

Traffic volumes are as follow:

- 4th Street approaching Euclid intersection 3,330 ADT
- Euclid Avenue – (North of 4th Street 5,355 ADT; South of 4th Street 6,750 ADT)

No pedestrian volume counts are available.

HISTORICAL CRASH RECORDS

A review of the crash records for the previous 3 years was requested and reviewed. There were 2 reportable crashes between 2006 and 2008. Crash numbers are insufficient to make recommendations based on observable patterns or likely causes.

FINDINGS AND RECOMMENDATIONS

The following recommendations are offered to improve safety at this location.

1. Permanent Pavement Marking

- Because of the volume of traffic observed approaching from the east on 4th Street, consideration should be given to re-striping the approach for a left turn lane. This would require removing existing center line stripe and shifting it to the south to make room for a left turn only lane (minimum 9') and a thru and right turn lane (minimum 11'). In addition additional parking spaces on the south side will need to be removed.
- All pavement markings in the intersection should be reviewed and kept in good condition.

Other Alternatives Considered

Alternatives considered included:

- Traffic signalization

  Current traffic volumes do not meet warrants for a signal. Counts have been taken on a minimum of 2 occasions, most recently in the spring of 2007. Warrants were "nearly" met for 2 of 8 one hour periods. Traffic volumes should continue to be monitored.

- Reconfigure traffic pattern in day care center parking lot

  There is not sufficient room to develop a circulation plan. Team noted two vans owned by the center parked at either end of the parking area. Discuss with the owner not parking in front of the building to allow more room for pick-ups and drop-offs. This consideration was discussed with day-care owner in 2007 without action, follow up.

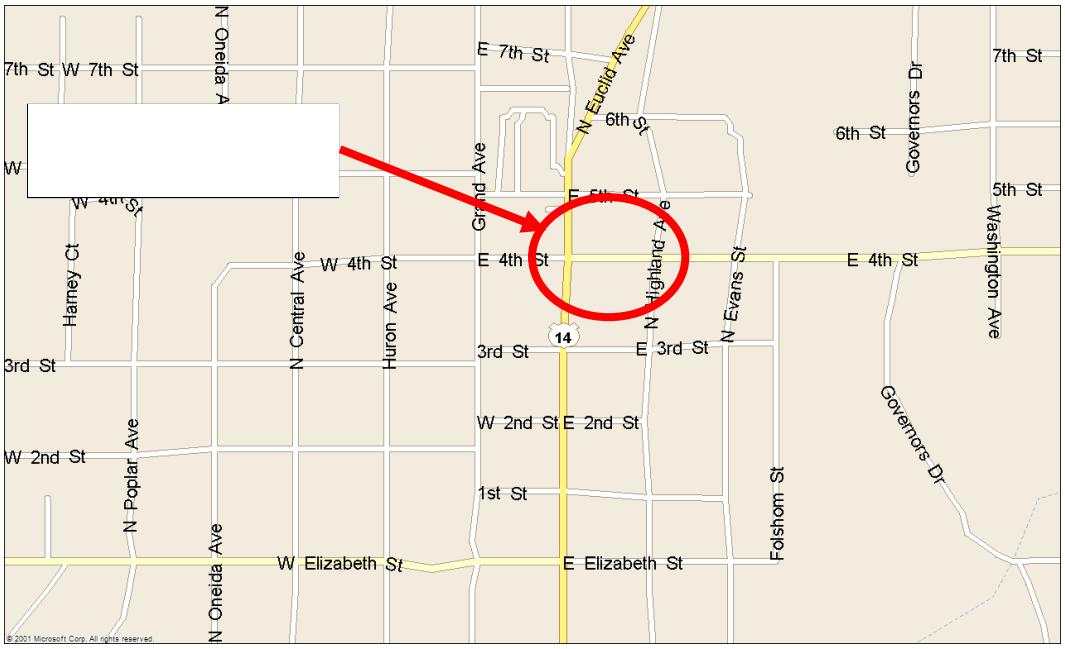


Figure A3-1: Intersection Location

Figure A3-2: Intersection of Euclid Avenue and 4th Street (looking north)

Figure A3-3: Pedestrian Crossing 4th Street

Figure A3-4: Crosswalk Signs Intersection at Euclid Avenue (looking south)

Figure A3-5: Day Care Center with Two Driveways at Euclid Avenue and 4th Street

Road Safety Audit Number 4

City of Pierre

Project: Pedestrian Safety at Local Intersection in City of Pierre

Date of RSA:	August 27, 2008	
Project Environment:	Intersection between two Major Roads in City of Pierre	
RSA team:	Cliff Reuer	Traffic and Safety Engineer, SDDOT
	Lynn Patton	Construction Engineer, City of Pierre
	Larry Weiss	SDLTAP and City of Pierre Commissioner
	Ron Marshall	Technical Assistance Provider, SDLTAP

SCOPE AND PURPOSE OF THE REVIEW

The intersection of Church and Harrison has been an issue of interest to the City Safety Committee for several years. Citizens have voiced concerns about pedestrian safety since there is no sidewalk on the east side of Harrison north of Hilltop.

PROJECT BACKGROUND

The primary safety concern is lack of a sidewalk on the NE corner of the intersection. The adjoining lot steeply slopes down to the street with a rock retaining wall adjacent to the curb and gutter on Harrison Avenue. The lot was developed before Harrison Avenue was extended to be a thru street to the north serving the Pierre Mall. With the street extension, additional development, and subsequent growth in vehicular traffic, the potential for pedestrian conflicts has grown.

The intersection and all approaches are maintained by the City of Pierre

The functional classification of this road is minor arterial. The traffic volume is 6247 vehicles per day. There are no pedestrian volume counts available.

The road has a posted speed limit of 30 mph.

HISTORICAL CRASH RECORDS

A review of the crash records for the previous 3 years was requested and reviewed. There were 4 accidents between 2005 and 2008. None involved pedestrians.

FINDINGS AND RECOMMENDATIONS

The following recommendations are to address pedestrian safety at the intersection. To avoid pedestrian conflicts at the intersection, pedestrians should be directed to the west side of Harrison Avenue at Flag Mountain Street to the north and Robinson Street to the south.

1. Permanent Traffic Signing

To inform and redirect pedestrians, appropriate signing should be placed to direct them to safely cross to west side of street. This recommendation is to install a crosswalk and use the yellow/green Pedestrian Crossing Sign (W11-2) with the SIGN AHEAD (W16-9p) and the Diagonal Down Arrow (w16-7p) in advance and at the crosswalk. Also there is a sign in Section 6 of the MUTCD that reads "Sidewalk Closed Ahead Cross Here with an Arrow (R9-11). This could be modified by changing "Closed" to "Ends".

2. Permanent Pavement Marking

A pedestrian cross walk should be placed with permanent pavement marking at the Flag Mountain and Robinson Street intersections.

3. Other Alternatives Considered

Alternatives considered included:

- Construct sidewalk at the back of curb

  A 7' sidewalk would be required, and would necessitate a retaining wall within street right-of-way). Winter maintenance and pedestrian safety would be an issue. Plowing snow on the street would deposit snow behind the curb. Also the potential of ice on the sidewalk with a cross slope towards the street could be a hazard to pedestrians. The estimated cost of this alternative in 2005 was in excess of $60,000.

- Construct sidewalk on slope at the back of street right-of-way (adjacent to property line).

  Because of the slope of the lot, and grade of Harrison Avenue, the team considered constructing the sidewalk across existing terrain to be infeasible since Americans with Disabilities Act (ADA) accessibility requirements could not be met. ADA requires a maximum of 12:1 grade on public sidewalks. The estimated cost of this alternative in 2005 was approximately $30,000.

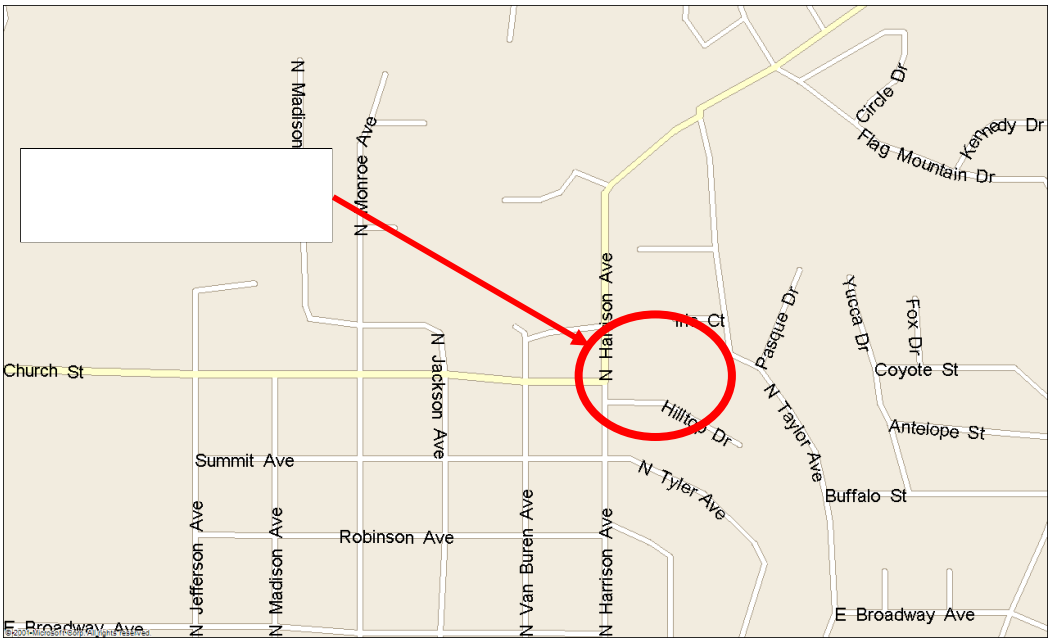


Figure A4-1: Intersection Location

Figure A4-2: Intersection of Harrison Avenue and Church Street (looking north)

Figure A4-3: Intersection of Harrison Avenue and Hilltop Drive

Road Safety Audit Number 5

Pierre Street DM&E Railroad Underpass

Project: Safety at Underpass Crossing in City of Pierre

Date of RSA:	August 27, 2008	
Project Environment:	Underpass Pierre Street and DM&E Railroad	
RSA team:	Cliff Reuer	Traffic and Safety Engineer, SDDOT
	Lynn Patton	Construction Engineer, City of Pierre
	Larry Weiss	SDLTAP and City of Pierre Commissioner
	Ron Marshall	Technical Assistance Provider, SDLTAP

SCOPE AND PURPOSE OF THE REVIEW

The purpose of the review was to address concerns about safety and operational issues related to vehicles hitting or being stuck under the DM&E Railroad underpass on S. Pierre Street in downtown Pierre.

PROJECT BACKGROUND

The primary safety concern is the number of vehicles hitting the structure. The RR structure over Pierre Street is a mid-block location between Sioux Avenue (to the south) and Pleasant Street to the north. The structure has a vertical clearance of 11'3". At this location, Pierre Street is signed as US14 & US83 through the city. The truck route eastbound continues east from Pierre Street on Sioux Avenue / Wells Avenue to Garfield then northerly to US14 & US83. West bound, the truck route leaves US14 & US83 and turns south on Garfield thence westerly on Wells and Sioux Avenue past Pierre Street to the Missouri River. These US routes connect w/Sioux Avenue from the west, turn north on Pierre Street, turns east on Pleasant Street, and then north on Euclid to US14 & US83.

EXISTING SIGNING

Route markers on Sioux Avenue are currently installed on an overhead sign approaching the intersection with Pierre Street direct US14/83 traffic to turn left (north). The truck by-pass (US14B) is signed straight through or easterly past Pierre St. On both sides of the structure there are yellow informational warning signs indicating low clearance (11 ft 3 in). In addition, the signs on both sides of the structure are equipped with permanent yellow flashing warning lights.

The functional classification of this road is arterial.

The traffic volume is 5,750 ADT (2007). Because of the route signing, numerous large trucks (including semis) and large recreational vehicles (5th wheel trailers and motor homes) travel this route following US14 & US83 in line of following the truck route.

HISTORICAL CRASH RECORDS

A review of the crash records for the previous 3 years was requested and reviewed. There were 6 reportable crashes in 2007. Additionally there are other non-reported crashes such as those involving recreational vehicles (with appurtenances such as air conditioning units mounted on the roof) which have been damaged. Also, due to investigation reporting by City Police and SD Highway Patrol some reports may not have been found due to filing procedures. There were some accidents in 2008. In each case, in addition to the property value loss, there is a burden on local law enforcement that is called to the scene to direct traffic.

FINDINGS AND RECOMMENDATIONS

The following recommendations are to improve safety at this location

1. **Permanent Traffic Signing**
   - A vehicle height detection system is recommended to be further investigated. The system would involve a detection device mounted on poles (existing utility or light poles if possible) on Pierre Street both between the RR structure and the nearest intersection to the north (Pleasant Street) and south (Sioux Avenue). The detectors would activate warning lights on the structure.
   - It would also be desirable to further investigate more visible warning lights on the structure. For example the possibility of red flashing lights or more intense or visible yellow or red lights could be looked into.
2. **Other alternatives considered:**
   - **Increase the vertical clearance**

     The city has investigated the possibility and feasibility of lowering the grade on Pierre Street. Due to the location of subsurface utilities, only approximately 1 foot of additional clearance could be obtained.
   - **Future plans for the structure**

     Visual observation of the underside of the structure shows extensive deterioration of concrete. With DM&E Railroad's proposals to upgrade this line across the State, the DM&E should be approached to determine what their future plans are for this structure.
   - **Changing signing of US14 & US83**

     A possibility discussed was to sign all US14 & 83 traffic to the truck by-pass on the east side of Pierre. This change would minimize the through, unfamiliar traffic making

the turn onto Pierre Street. Apparently accomplishing this would require a jurisdictional transfer from SDDOT to the City of Pierre. This option may be worthy of additional discussions between the City and SDDOT.

FIELD NOTES

The existing signing and warning lights were in good condition. The flashing warning lights were continuously flashing.

During a recent incident involving a semi, the truck driver reported to the investigating officer that he never saw the structure as he was paying attention to the instructions from his on-board GPS device. The team discussed the increasing use of these devices to guide and direct all motorists. The increased dependence on these devices and the information they provide seems to have contributed to the increasing numbers of hits on the structure. The problem seems to be that the information used to direct motorists is not sensitive to restraints such low vertical clearance. The team assumed that the information used by the GPS vendors is taken from State Highway maps showing State routes. This may be an area that needs further exploration.

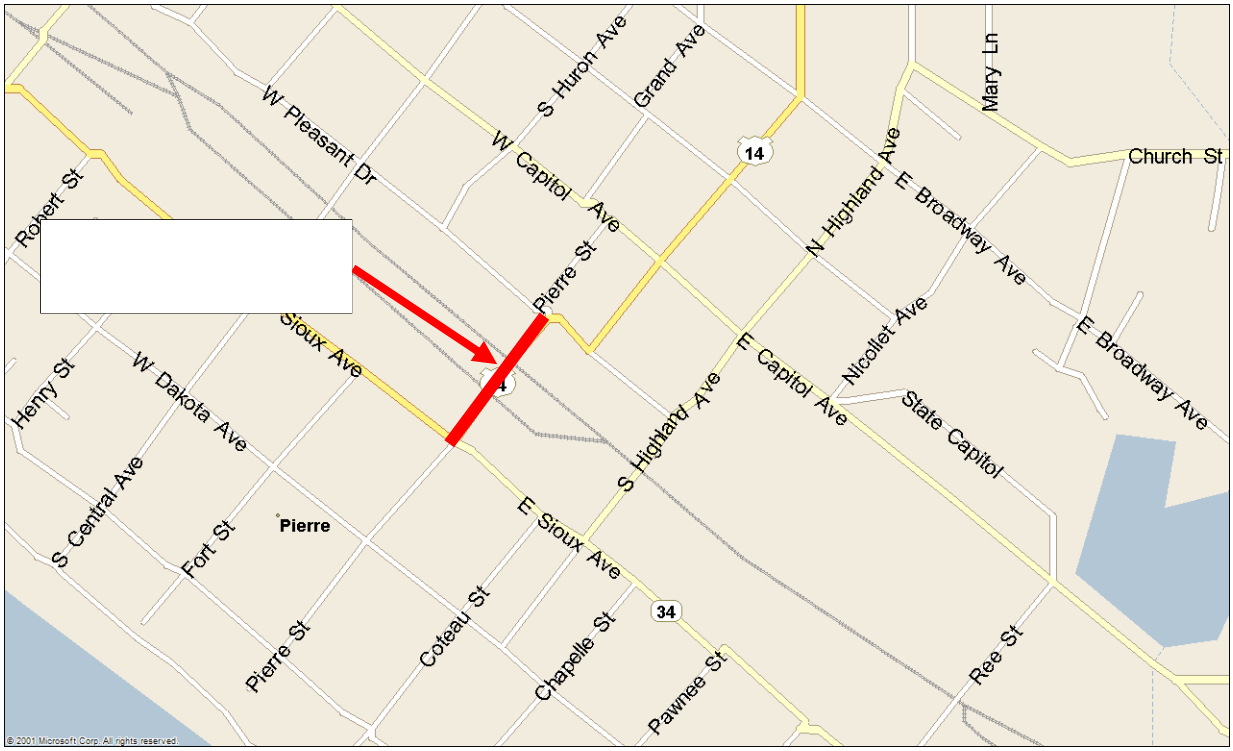


Figure A5-1: Intersection Location

Figure A5-2: Underpass Location

Figure A5-3: Horizontal Curve North of the Underpass

Figure A5-4: Signing at the Underpass

Road Safety Audit Number 6

Lawrence County Maitland Road

Project: Safety and Operation of Local County Gravel Road

Date of RSA:	October 21, 2008	
Project Environment:	Maitland Road, a county highway south of City of Spearfish	
RSA team:	Cliff Reuer	Traffic and Safety Engineer, SDDOT
	Tavis Little	Deputy Sheriff, Lawrence County Sheriff's Office
	Ken McGirr	Highway Superintendent, Meade County
	Ron Marshall	Technical Assistance Provider, SDLTAP

SCOPE AND PURPOSE OF THE REVIEW

The purpose of the review was to address concerns about safety and operational issues on Maitland Road, a county highway running southerly from the city of Spearfish (beginning at Christensen Drive) to Central City (US85) between Lead and Deadwood.

PROJECT BACKGROUND

Maitland Road is a gravel surfaced road running from Christensen Drive at the south limits of Spearfish south to the intersection of US85 at Central City, a distance of approximately 8.6 miles. The gravel surface has been treated with MagWater and is in very good condition throughout its length.

Posted speed limit is 30 mph.

Functional Classification is major collector and the route is designated as a Federal-aid Secondary Route and is on the Forest Highway System.

Specific issues raised by project owner

There has been significant development adjacent to and near Maitland Road. At the south end there are 2 subdivisions with reportedly 260 lots platted. At the north end, another subdivision on the east side is Eagle Ridge.

Although there are no recent traffic counts, traffic volumes are increasing. In addition, as supported by the crash history, safety is a growing concern. As these developments become more fully developed, there will be increasing demands on Maitland Road with higher traffic volumes, and greater demands for routine maintenance, snow removal, and emergency services.

Note: For purposes of this review, the location information is referenced from the north end of route (the intersection with Christensen Drive in Spearfish) increasing by miles (to the closest 0.1 mile) going south to Central City.

HISTORICAL CRASH RECORDS

There were 31 reported crashes in the last 3 years; (6 in 2005, 11 in 2006, and 14 in 2007). Of the total, there were 0 fatalities. 8 injury, and 23 property damage only crashes. Selected highlights:

- Roadway departure (fixed object and overturn) 19/31 = 61% of total, and 6/8 = 75 % of injury crashes
- Intersection 4 (13%) (1 injury)
- Animal 4 (13%) (no injuries)
- Excessive speed (over limit or over safe) 14 (45%)
- Curve 16 (52%)
- Day light 19 (62%)

FINDINGS AND RECOMMENDATIONS

The Lawrence County Highway Department is commended for its efforts to maintain the condition of the gravel driving surface. The gravel surface at the time of this review was in very good condition for the entire length of the route.

In addition to these general recommendations, there are detailed field notes attached (See Attachment 1) with specific comments and recommendations offered for consideration.

Recommendation: Priority Location

On the basis of the field review, input from law enforcement, and a review of historical crash records, one specific location was identified as a priority: the low water crossing approximately 2.2 miles from the south end of the project. Due to a short vertical curve following a horizontal curve adjacent to the low water crossing, the potential exists (and confirmed by observation from law enforcement) for overdriving for conditions. There have been several crashes at this location.

Recommendations:

1. **Increase delineation through the area by adding delineators, spaced at 50', for 200' before and after the crossing.**

   Evaluate the safe allowable speed and provide an appropriate Advisory Speed plaque (W13-1) informing road users of the recommended safe speed. (see MUTCD Section 2C-36)

   Note: A possible alternative set of signs for Low Water Crossings adopted by SDDOT is attached for consideration.

2. **A permanent improvement, and obviously more costly alternative would involve improving road geometry by eliminating the vertical curve and designing and constructing a culvert or bridge to eliminate the sag.**

General Recommendations

Due to the winding roadway alignment, narrow roadway and restricted clear zones, the following recommendations are grouped to enhance driver safety by calling attention to unexpected or changing conditions, need to reduce speed, or alert to roadside hazards.

3. **Need for additional Delineators and Object Markers**

   Due to the narrow roadway and curving alignment with numerous roadside obstructions or drop-offs, there are numerous locations where enhanced delineation could contribute to improving safety of the route. Delineators used through curves are effective guidance devices, especially at night or in bad weather. (See detailed notes for specific locations and the MUTCD Section 3D.01 for guidance).

4. **Warning signs with Advisory Speed plaques**

   There are several locations with Warning Signs: Curve (W1-2), Winding Road (W1-5), or Turn (W1-1 or W1-4) that have Advisory Speed plaques attached. The recommended speed on these signs should be verified with an engineering study. (See MUTCD Section 2C-36)

5. **Intersections/driveways: vegetation removal to improve sight distance and roadside safety**

   There are several locations where the sight distanced for entering traffic is restricted by trees, tree branches or bushes. Trimming or removing vegetation at these locations, especially where the entering angle of vehicles is not 90 degrees to through traffic would improve sight distance. (See specific locations in detailed notes).

6. **Driveways/entrances: flatten slopes**

   There are locations along the route where entering driveways have culvert ends with steep slopes creating an unsafe obstacle adjacent to the roadway. Flattening these slopes, in some cases by extending culverts, would improve safety for vehicles departing the roadway.

7. **Keep Right signs**

   At several locations along the route, there are “Keep Right” signs. With a posted speed limit of 30 mph, these signs appear to be of questionable value. The standard application of the Keep Right sign (see MUTCD Section 2B.33) indicates that this sign “shall not be installed on the right side of the roadway in a position where traffic must pass to the left of the sign.” Consideration should be given to removing these signs.

8. Curve Chevrons

There were locations on reverse curves where Chevrons (Chevron Alignment Sign, W1-8, MUTCD section 2C.10) for both directions were mounted on a single post and visible from both directions. To minimize confusion to motorists, consideration should be given to realigning the chevrons to more directly face oncoming traffic, or mounting chevrons on separate posts. (See detailed notes for specific locations).

9. Mailboxes

There are several locations of mailboxes mounted on bases which are unsafe roadside obstacles. Consideration should be given to working with individual property owners to replace these installations with posts that will break away on impact.

Note Regarding Road Safety Audits

One issue with RSAs is that the results could possibly increase an agency's liability by showing that an agency has identified but not fully implemented safety issues identified on its roads. However, implementing a plan to improve safety is a proactive approach to safety and could be used to defend against tort liability claims. Also safety concerns can be identified and prioritized within the constraints of available funding. In addition, Federal law (23USC409) affords protections that assist State and local highway agencies in keeping data and reports collected for various Federal safety programs from being used in tort liability actions. Note that while this information is not legal advice, it should be useful in discussing with legal counsel any concerns about releasing this information.

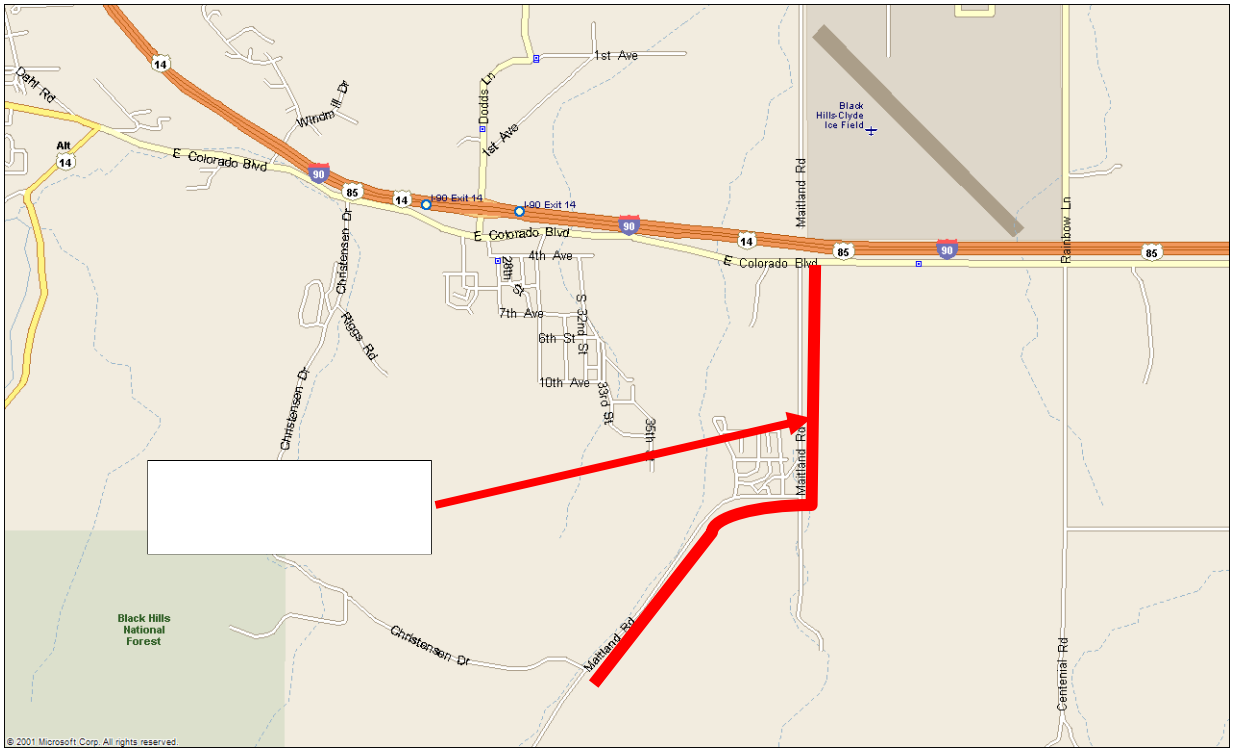


Figure 6-1: Maitland Road Location

Figure A6-5: Narrow Bridge on Maitland Road

Figure A6-1: Horizontal Curve Approaching Low Water Crossing

Figure A6-2: Sharp Horizontal Curve on Maitland Road

Figure A6-3: Sharp Horizontal Curve in Residential Area

Attachment 1

MP	Detailed Observations (Field Notes)
0.0	Begin at Christensen Drive
0.1	Drop-off right side within clear zone – mark with delineator
	Culvert right side – mark with delineator
0.3	Driveways – vegetation restricting site distance entering roadway
	Curve left – less than 600' to curve, consider placing reverse curve sign
0.5	Eagle Ridge subdivision entrance
0.5+	Curve left sign with 15 mph advisory sign – recommend Reverse Curve sign
0.6	Curve sign with 30 mph advisory plate – recommend remove adv. plate
0.6+	Bridge–recommend replace object markers
0.6+	Burns Gulch Road – recommend combine 2 entrances
	Culvert east side – recommend add Type 2 delineators east side
	Unsafe mailboxes
1.1	Talon Road
1.2	Recommend trim vegetation restricting site distance on entrance, east side
	Unsafe Mailbox –in rock basket (left side)
1.3	Keep Right sign
1.4	School Bus sign NB – if an active bus stop, recommend replace with fluorescent green high visibility sign
	Winding Road with 25 mph advisory plaque – recommend verify safe speed on curve
1.5	Unsafe mailbox
	Trim trees for site distance
1.5+	Trim trees for site distance
1.6	Curve chevron
	Power pole left – recommend add object marker/delineation
1.6+	Steep drop-off right – recommend add delineators for +/- 75'
1.7	Steep drop-off right – recommend add delineators
1.7+	Add object marker
1.8	Add object marker
	Steep drop-off just beyond entrance (right) – add delineators
1.9	Add object marker right
2.0+	Add object marker right

MP	Detailed Observations (Field Notes)
2.2	Low water crossing Note: discussed the safety of this location. Due to a hump (short vertical curve following a horizontal curve), adjacent to low water crossing, the potential exists (and confirmed by observation from law enforcement) for overdriving for conditions. There have been several crashes at this location. Recommendations: • Verify the safe speed with Ball Bank Indicator to establish accuracy of advisory plaques and sign accordingly • Further evaluate eliminating the short crest approaching the crossing • Add delineators, spaced at 50', for 200' before and after crossing • High cost alternative would be to reconstruct with a bridge/culvert to eliminate low spot with designed approaches
2.5	Recommend adding Curve right sign Note: there is an existing sign indicating this is MP 6
2.6	Culvert end should be delineated Extend delineation
3.0	Keep Right Sign
3.5	On NB side, add object markers to trees adjacent to roadway
3.8	Private driveway (right) – recommend flatten approach to culvert end
3.8+	Delineators (left) – need to be replaced and placed at proper height Flatten approach to driveway left
3.9	Steep driveway approach left – recommend clear vegetation to improve sight distance
3.9+	Unsafe mailboxes right side Private driveway left (new construction) with poor site distance
4.0	Driveway left (20600 Maitland Road) – steep with a bad approach angle making site difficult
4.1	Utility pole (left) – recommend place Type 2 Object Marker
4.2	Utility pole (right) – recommend place Type 2 Object Marker
4.2+	Utility pole (right) – recommend place Type 2 Object Marker Private driveway with rock endwalls
4.2++	Double culvert – recommend add delineators
4.4	Curve left sign – recommend move back proper distance from curve, add curve chevron
4.8	Add Windy Road sign SB; NB OK
4.9	Culvert ends need markers Recommend add delineators right
5.3	Culvert end left needs delineation Utility pole (right) abandoned – recommend it be removed

MP	Detailed Observations (Field Notes)
5.6	Carbonate Road – in future could be modified to be a single tee-intersection (Note: also existing sign – Mile 3 at this location) Existing Trucks Entering sign – one each direction – consider removing if no longer an active truck location
5.8	Bellefish Road (right) - recommend a Stop sign
5.9	Existing sign Do Not Pass – evaluate the need for this sign New driveway (left) enters at a severe angle
6.0	Dep ditch right edge of roadway (both sides) – recommend delineation
6.2	Chevrons – recommend to increase visibility use mounting height 5' to bottom
6.3	Chevrons – some existing chevrons are double mounted on a single post and visible from both directions; recommend mount on separate posts or possibly turn so they only visible from one direction
6.4	Winding Road sign (W1-5) with 30 mph advisory plaque – recommend verify safe speed
6.5	Culvert ends – recommend delineator Morningstar Road – (left) recommend Stop sign
6.6	Klondike Road - recommend Stop sign
6.8	Chevrons – recommend extend Chevrons to north; note: also recommend a nighttime visual inspection of reflectivity
6.9	Chevrons – some existing chevrons are double mounted on a single post and visible from both directions; recommend mount on separate posts or possibly turn so they only visible from one direction
6.9	NB existing signs: Reverse Turn (W1-3) with 25 mph advisory plaque followed by Turn (W1-1) with 15 mph advisory plaque – recommend 2 signs be combined with appropriate speed advisory plaque Left side – downhill grade with steep drop-off – recommend add delineators
7.0	Chevrons – some existing chevrons are double mounted on a single post and visible from both directions; recommend mount on separate posts or possibly turn so they only visible from one direction
7.2	Tetro Rock Road intersection- consider realigning approach to 90 degree angle Molmer Road intersection – limited sight distance; consider Stop sign
7.7	Culvert – recommend Type 2 Object Markers both sides
7.8	Delineators on bridge too low – recommend raising delineators to 4' Recommend add delineators to left side of roadway Recommend add Type 3 Object Marker
7.9	Existing sign Side Road (W2-2) with Hidden Approach advisory plaque – recommend only need one sign
8.0	Add delineator for steep hole adjacent to driveway
8.6	Existing Curve sign with 15 mph advisory plaque – recommend evaluate safe speed, a 10 mph advisory plaque appears to be needed
8.6+	Stop – US85

Road Safety Audit Number 7

Day County Route 1

Project: Safety and Operation of Local County Paved Road

Date of RSA:	April 29, 2009	
Project Environment:	Day County Route 1 (447th Avenue), a county paved highway running southerly from the city of Waubay	
RSA team:	Wes Williams	Director of Emergency Management, Day County
	Rick Small	Highway Superintendent, Codington County
	Ken Skorseth	Program Manager, SDLTAP
	Hesham Mahgoub	SDSU Civil Engineering
	Don Hosek	Technical Assistance Provider, SDLTAP
	Ron Marshall	Technical Assistance Provider, SDLTAP

SCOPE AND PURPOSE OF THE REVIEW

The purpose of the review was to address concerns about safety and operational issues on Day County Highway No. 1, a county highway running southerly from the city of Waubay.

PROJECT BACKGROUND

Day County Route 1 (447th Avenue) is a bituminous surfaced road running south from the southeast corner of Waubay. The specific section of this road selected for this review is approximately two miles in length, beginning approximately 4 miles south of town (see map). The surface was in very good condition. It appeared to have been chip sealed within the last couple of years. Pavement marking was in good condition, including striped no passing zones.

Roadway width varied over the length of the project. Driving surface width was 22' (two 11' lanes), but shoulder width was variable. In areas where there the original grading was in a cut section there were generally better shoulders and side slopes. In fill sections, shoulders were narrower and slopes steeper.

Posted speed limit is 55 mph.

Functional Classification is major collector and the route is designated as a Federal-aid Secondary Route.

SPECIFIC ISSUES RAISED BY PROJECT OWNER

This road serves not only local access and agricultural traffic, but as recreational access to area lakes. There is a boat ramp and parking area for Bitter Lake within the project limits. In addition, both the county and township have gravel pits adjacent to the road requiring gravel hauling trucks to enter, creating potential conflicts.

Although there are no recent traffic counts, traffic volumes are increasing. From most recent traffic counts, Average Daily Traffic (ADT) was estimated at 400+. In addition, as supported by the crash history, safety is a growing concern due to speeds and limited sight distance due to the rolling terrain (both horizontal and vertical curves).

Note regarding traffic volumes: The most recent traffic counts from SDDOT, obtained following the date of this review, for this route are from the area of 153rd Street & 154th Streets. The stations show Average Daily Traffic (ADT) of 366 and 498 respectively for the year 2003. An average of these two counts is 432 ADT

HISTORICAL CRASH RECORDS

At the time of review, the team did not have historic crash records of all reportable crashes for recent years. However there have been a total of nine fatalities (six within the limits of this project review) in recent years. (See photo 1)

Note: additional information obtained from SDDOT:

- The multiple fatality crash was a head-on crash of two vehicles in August of 2003. A southbound vehicle attempted to pass another vehicle and hit a northbound vehicle head on at the top of a crest.
- From 1/1/2004 to present there have been 3 crashes reported in the audit area: two overturned off roadway and one fixed object hit off roadway.

FINDINGS AND RECOMMENDATIONS

The Day County Highway Department is commended for its efforts to maintain the condition of the driving surface and pavement markings. The surface, markings, and signs at the time of this review appeared to be in very good condition for the entire length of the route.

In addition to these general recommendations, there are detailed field notes attached (See Attachment 1) with specific comments and recommendations offered for consideration.

Note: For purposes of this review, the location information is referenced from the south end of the route (the field entrance on the east side, across from residence). Distances measured in feet (and computed miles, to the closest 0.1 mile) traveling north.

General Recommendations

Due to the winding roadway alignment, limited sight distances, narrow roadway and restricted clear zones, the following recommendations are grouped to enhance driver safety

by calling attention to unexpected or changing conditions and need to reduce speed, or alert to roadside hazards.

1. Need for additional Delineators and Object Markers

Due to the narrow roadway and curving alignment with several roadside obstructions or drop-offs, there are several locations where enhanced delineation could contribute to improving safety. Delineators used through curves are effective guidance devices, especially at night or in bad weather when pavement markings are not visible. (See MUTCD Section 3D.01 for guidance).

2. Chevrons

There were locations on reverse curves where Chevrons (Chevron Alignment Sign, W1-8, MUTCD section 2C.10) could be added to emphasize and guide drivers through changing horizontal alignment. As a supplement to advance curve warning signs, Chevron Alignment signs in view of the motorist can effectively define the direction and sharpness of the curve.

3. Wider edge stripes

In areas with narrow shoulders and steep side slopes, wider (six inch versus the normal four inch) edge stripes could be used to emphasize the curve section and provide a visually stronger guide to motorists.

4. Warning signs with Advisory Speed plaques

There are several locations where Warning Signs: Curve (W1-2) or Winding Road (W1-5) could have Advisory Speed plaques attached to advise motorists of the safe speed through the curve (it is not the legal speed limit). The recommended speed on these signs should be verified with an engineering study. (See MUTCD Section 2C-36)

5. Driveways/entrances: flatten slopes

There are locations along the route where entering driveways have culvert ends with steep slopes creating an unsafe obstacle adjacent to the roadway. Flattening these slopes, and in some cases extending culverts, would improve safety for vehicles departing the roadway.

Specific site recommendations (Short term/low-cost, prioritized based on safety risk)

6. Township road east (146th Street) - angle approach (Mile 0.59)

This is a T-intersection entering from the east at a severe angle, (estimated 30 degrees) onto the county road. (See photo nos. 3 and 4) In addition to local traffic, the Township reportedly hauls gravel from a pit located to east. Any traffic turning south on County Road 1 , and especially trucks, cannot safely make the left turn without crossing center line. Restricted sight distance makes this an extremely hazardous maneuver as southbound traffic is not visible to entering traffic. This is particularly hazardous for fully loaded gravel trucks starting from a dead stop.

Correcting this issue would require realigning the intersection to 90 degrees to the county road. The terrain and need for additional right-of-way makes realigning this intersection difficult. It appears that relocating/realigning the approach to the north side of county gravel site would be the best alternative, although a further engineering study should be undertaken.

Low-cost recommendations include:

- Place advance Intersection Warning Sign (W2-3) approaching intersection from the north (see MUTCD Section 2C.37 for guidance)
- Use temporary warning sign "Trucks Entering" during times when gravel trucks are actively hauling

7. b. 40 inch concrete pipe culvert (Mile 0.37)

- Narrow top (shoulders estimated +/- 3', and steep side slope (2.5:1) make this a potentially high risk location. Culvert should be extended to provide adequate clear zone and side slope. (See photos 5 & 6).
- A low-cost recommendation is that culvert end should be marked with delineator

3. Recommended long term solution for route:

Due to the nature, speed, and growth of traffic, and the limited sight distances due to the roadway following existing terrain, the team recommends the alternative of upgrading the roadway to current design standards. The speed of traffic and nature of traffic entering contribute to the safety risk. In addition history of the tragic multiple fatality crash demonstrates the safety justification for improvements. The addition of chevrons, speed advisory plates, intersection warning signs and additional striping would better alert the traveling public, but it would not eliminate the sight distance problems that exist.

Reconstruction of the entire roadway would require considerable grading and earthwork along the entire route. The design criteria for minimum design standards from the SDDOT Secondary Road Plan are: lane width 10 ft; shoulder width 2 ft, clear zone 10 ft; and slopes 3:1. Selecting the appropriate design speed would control required sight distances and determine the needed alignment.

Note Regarding Road Safety Audits

One issue with RSAs is the results could possibly increase an agency's liability by showing that an agency has identified but not fully implemented safety issues identified on its roads. However, implementing a plan to improve safety is a proactive approach to safety and could be used to defend against tort liability claims. Also safety concerns can be identified and prioritized within the constraints of available funding. In addition, Federal law (23USC409) affords protections that assist State and local highway agencies in keeping data and reports collected for various Federal safety programs from being used in tort liability actions. Note while this information is not legal advice, it should be useful in discussing with legal counsel any concerns about releasing this information.

RSA Attachment 1

Detailed Observations (Field Notes)

NB distance (feet)	NB Distance (0.01 miles)	Description
0	0	Begin - field entrance east (across from farm residence)
275	0.05	Curve warning sign NB
365	0.07	
1950	0.37	short culvert - 40 inch concrete pipe measurements - 22' pavement surface width 2:1 slope east end 11' to end east, 9' west (west end section separated with gap at top)
2410	0.46	
2500	0.47	field entrance west - curve sign east
3110	0.59	recreation access west
4020	0.76	township road east - angle approach this is a T-intersection to the east entering at a severe angle, estimated 30 degrees to county road. Township reportedly hauls gravel from a pit located to east. Any traffic, and especially trucks, turning south on County Road, cannot safely make left turn without crossing center line. Restricted sight distance makes this an extremely hazardous maneuver.
4527	0.86	County gravel pit entrance east County Highway Superintendent indicated that temporary Trucks Entering warning signs are placed when gravel is being hauled from site)
4610	0.87	
5810	1.10	steep slope east
7450	1.41	culvert - narrow top, steep slopes
9015	1.71	No passing Zone Sign (SB)
9190	1.74	Township Road - tee intersection east
9740	1.84	top of crest vertical curve - end of no passing zone
10990	2.08	No passing Zone Sign (SB)

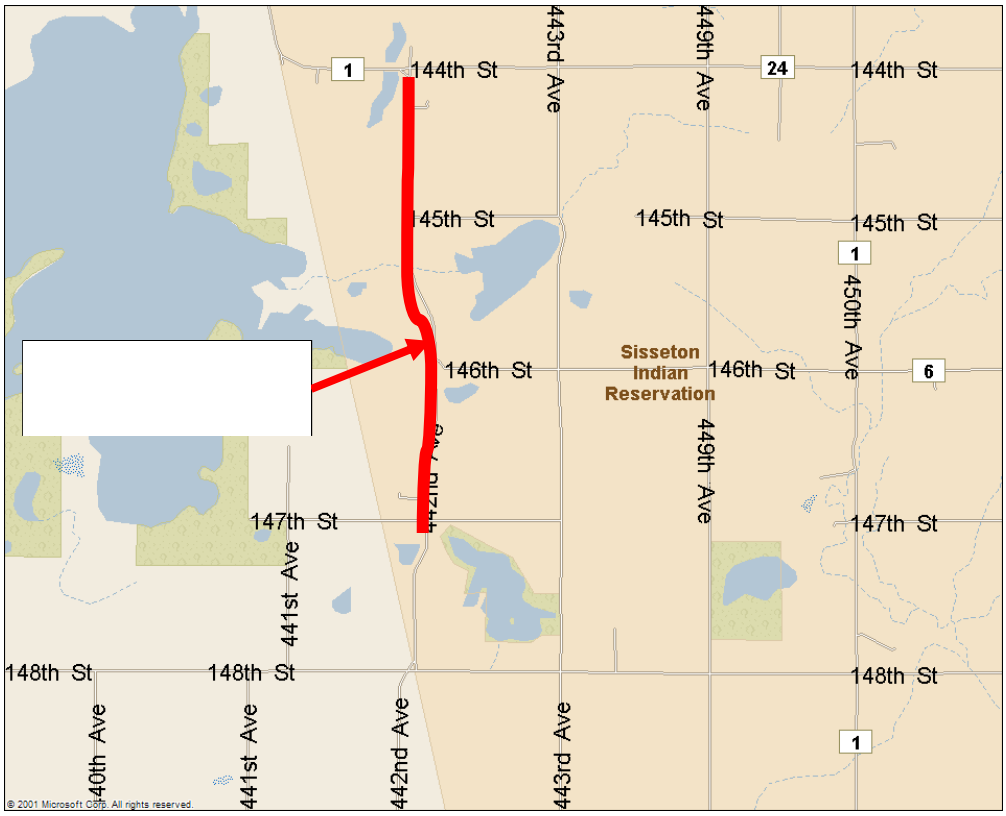


Figure A7-1: Day County Route 1 Location

Figure A7-2: Multiple Fatality Crash Location Just North of County Gravel Pit

Figure A7-3: Intersection of Township Road (146th Street) East and Recreation Access Road to Bitter Lake West

Figure A7-4: Township Road Intersection with Restricted Sight Distance Right

Figure A7-5: Township Road intersection and County Gravel Pit at Top of Hill

**Intersection is barely visible just this side of gravel stockpile;
note restricted sight distance to the north.**

Figure A7-6: View of Culvert End with Steep in Slope

Figure A7-7: Close-up View of Culvert End on East Side of Road

Figure A7-8: Measurement of in Slope in Fill Section Which was Determined to be 2.5:1 at this Location

Figure A7-9: Beginning Point of Reference for Locations Noted in the Audit Report (looking south)

Road Safety Audit Number 8

Day County Highland Township Roads

Project: Safety and Operation of Local Township Service Road

Date of RSA:	April 29, 2009	
Project Environment:	Highland Township Local Gravel Service Roads	
RSA team:	Wes Williams	Director of Emergency Management, Day County
	Rick Small	Highway Superintendent, Codington County
	Chuck Frommelt	Highway Superintendent, Day County
	Ken Skorseth	Program Manager, SDLTAP
	Hesham Mahgoub	SDSU Civil Engineering
	Don Hosek	Technical Assistance Provider, SDLTAP
	Ron Marshall	Technical Assistance Provider, SDLTAP

SCOPE AND PURPOSE OF THE REVIEW

The purpose of the review was to address concerns about safety and operational issues at five sites on Highland Township roads.

All the sites were on gravel surfaced roads. Five locations as shown in Figure 8-1

SITE DESCRIPTION AND RECOMMENDATION

Site No. 1	151st Street, approximately 1/4 mile east of 430th Ave
Description	Site on top of hill, limited sight distance. Roadway narrows and shifted to south at crest. A recent incident of two vehicles sideswiping was reported.
Recommendation	Reshape the shoulders, particularly on the north side of the road to achieve greater width of traveled way, straighten alignment and reestablish roadway crown. Example photos are shown on attachments to give guidance in doing this on sites 1, 2 and 5.

Site No. 2	149th Street, +/-1/2 mile east of 431st Avenue
Description	Site on top of hill, limited sight distance. Highland Twp is concerned that roadway is too narrow at the crest.
Recommendation	Reshape of the shoulders, particularly on south side of road to widen the traveled way traveled way to enhance safety. Reestablish roadway crown.

Site No. 3	149th Street, +/-1/4 mile east of 432nd Avenue
Description	Road narrows and passes through water.
Recommendation	Oversized rock can be side-dumped over edge of roadway to stabilize shoulder and in-slope of roadway. If FEMA assistance is available, this site should be submitted for repair since flood damage is the primary cause of this safety problem.

Site No. 4	150th Street, +/-1/4 mile east of 433st Avenue
Description	Road narrows and passes through water.
Recommendation	Oversized rock can be side-dumped over edge of roadway to stabilize shoulder and in-slope of roadway. If FEMA assistance is available, this site should be submitted for repair since flood damage is the primary cause of this safety problem.

Site No. 5	150th Street, 1/2+ mile east of 433st Avenue
Description	Site on top of hill, limited sight distance. Roadway narrows and shifts slightly to south at crest.
Recommendation	Reshape of the shoulders, particularly on north side of road along and either side of the field approach to widen the traveled way to enhance safety. The field entrance may need to be shaped to match edge of roadway. Reestablish roadway crown.

SUMMARY RECOMMENDATIONS:

The audit team wishes to compliment the Highland Township Board for its proactive approach to safety. The team also recognizes the very limited funds available to the township to reconstruct or do major reshaping on its road system. Consequently, the recommendations are intended to be as practical and cost effective as possible; yet will enhance safety at the sites selected for safety review. It should be noted that SD Codified

Law (SDCL 31-13-4) states in part: "*Plans and specifications for contracts let by the board of township supervisors shall provide that all highway grades shall be not less than twenty feet in width".* The definition of width of the highway grade includes not only the traveled way, but the width of the shoulder as well. While this may not seem adequate for modern agricultural traffic, it meets the requirement of state statute. The traveled way at the three sites where sharp crests exist can be widened to that standard with a motor grader by doing some aggressive shoulder work and should not require actual reconstruction with earthmoving equipment.

This will bring the road up to a standard common on, or perhaps better than, thousands of miles of similar township roads in SD.

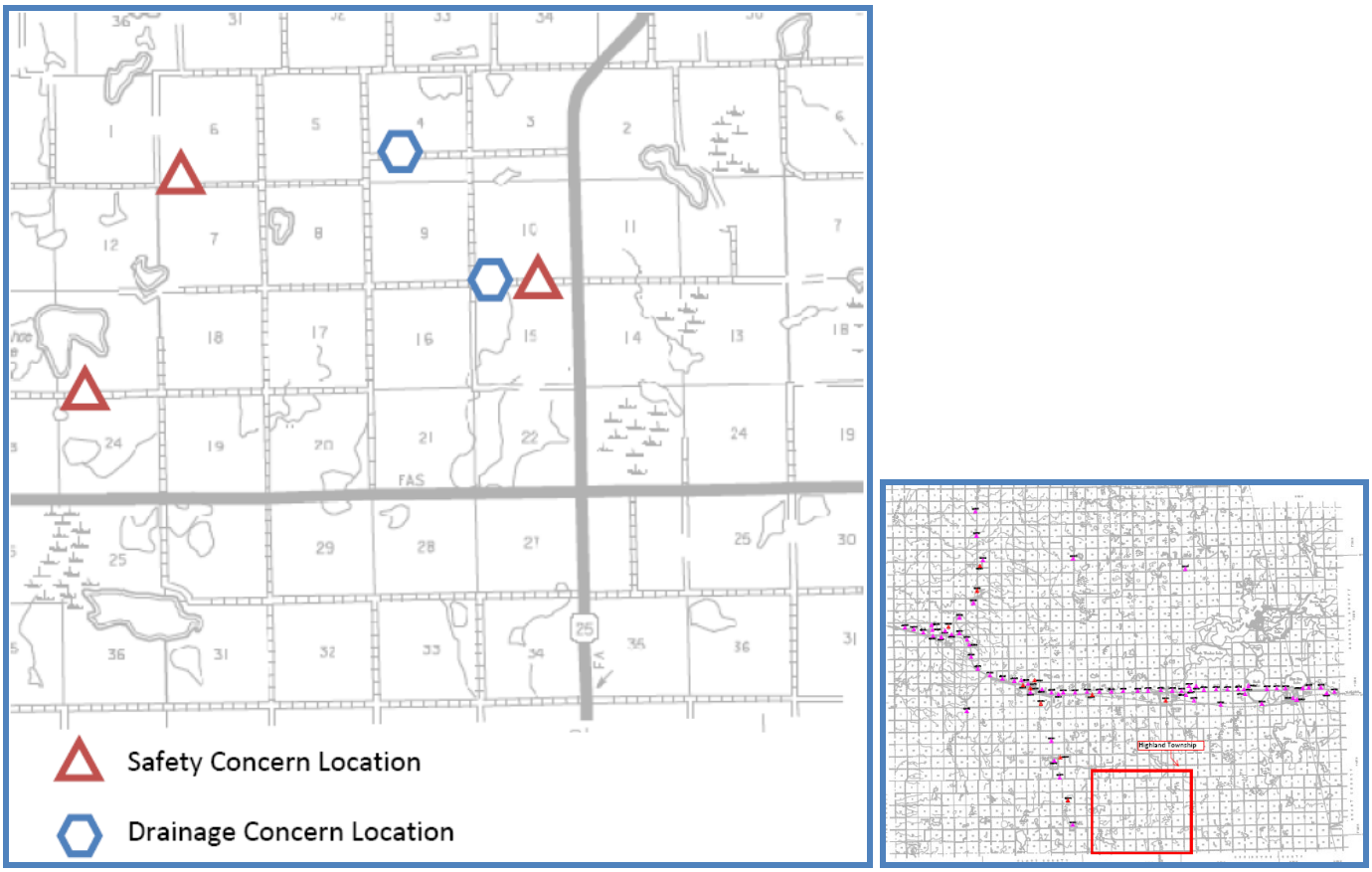


Figure A8-1: Day County and Highland Township Study Locations

Figure A8-2: Site No. 1 (151st Street) where Road Deviates from Section Line

Figure A8-3: Man Standing where the Team Felt the Center of the Road Should Be

Figure A8-4: Shoulder Can Be Reshaped to Create Wider Roadway

Figure A8-5: Similar Situation on Another SD Gravel Road

Motor grader operator slightly widened the road approaching the crest of hill to enhance safety.

Figure A8-6 Another Example of Correcting Roadway Width by Shoulder Widening

Figure A8-7: Close-up of Shoulder Work with Motor Grader Widen Roadway

APPENDIX B: SAFETY ISSUES REVIEW LIST

	Roadway Features	Yes/No	Comments
Overview	1. Are there changes in land use or roadside environment that affect the volume or type of traffic (new subdivision, commercial business, agricultural traffic, large trucks, pedestrians, etc)?		
	2. Consistency – Is the road free of inconsistencies (narrow bridges, changes in width) that could cause safety problems?		
	3. Violations of driver expectancy – Are there locations (reverse superelevation, sharp curves at end of long tangent sections, etc.) that could cause drivers a problem?		

	Roadway Features	Yes/No	Comments
Crash History			
	2. Is there physical evidence of unreported crashes or close calls (crash debris, damage to trees or guardrails, tire skid marks, etc)?		

	Roadway Features	Yes/No	Comments
Road Alignment and Cross Section	1. Is sight distance adequate for speed of traffic and at intersections?		
	2. Is speed limit compatible with road function, geometry, and land use?		
	3. Are there elements that may cause confusion (alignment, curves, and visual obstructions)?		
	4. Are lanes, shoulders, clear zone widths adequate for traffic volumes, speed, and mix?		

	Roadway Features	Yes/No	Comments
Road Surface Condition Unpaved Roads			
	4. Are lanes, shoulders, clear zone widths adequate for traffic volumes, speed, and mix?		

	Roadway Features	Yes/No	Comments
Roadside Features	1. Clear zones Free of obstructions? Obstructions delineated or protected? Non-traversable side slopes protected with safety barriers? Drainage features in the clear zone traversable?		
	2. Are shoulders wide enough to allow drivers to regain control?		
	3. Is right-or-way free of fixed objects or other hazards that could be removed, relocated, made traversable or breakaway, or otherwise made safer?		
	4. Do guardrails and end treatments meet current standards or in need of repair?		
	5. Mailboxes - Are mail boxes safely located with adequate clearance and visibility from the traffic lane? Are mailbox supports a safety hazard?		

	Roadway Features	Yes/No	Comments
Road Surface Condition – Paved Roads			
	3 Is the surface free of potholes, result in the loss of steering control?		
	locations that appear to have inadequate skid resistance that could result in safety problems, particularly on curves, steep grades, and approaches to intersections?		
	6. Are shoulders adequate for conditions (stable, smooth, slope)?		

	Roadway Features	Yes/No	Comments
Intersections	1. Are intersections free of sight restrictions that could result in safety problems?		
	2. Skewed intersections - Do intersection alignment angles (desirable 75 – 105 degrees) allow drivers to see oncoming traffic?		
	3. Are intersections free of abrupt changes in elevation or surface condition?		
	4. Are advance warning signs installed when intersection traffic control cannot be seen a safe distance ahead of the intersection?		

	Roadway Features	Yes/No	Comments
Signing and Delineation – MUTCD	1. Are signs effective for existing conditions?		
	2. Can signs be read at a safe distance (both daytime and night visibility)?		
	3 Are there locations where additional signing is needed to improve safety?		
	and directory signs conspicuous?		
	6. Is there improper or unnecessary signing which may cause safety problems?		
	7. Is the road free of signing that impairs safe sight distances?		
	8. Is the road free of locations with improper or unsuitable delineation (post delineators, chevrons, and object markers)? Are there locations where additional delineation is needed?		

	Roadway Features	Yes/No	Comments
Pavement Markings	1. Are pavement markings in good condition? (Clearly visible day and night?)		
	markings?		

	Roadway Features	Yes/No	Comments
Pedestrians and Bicycles	1. Are travel paths and crossing points for pedestrians and cyclists properly signed and/or marked?		

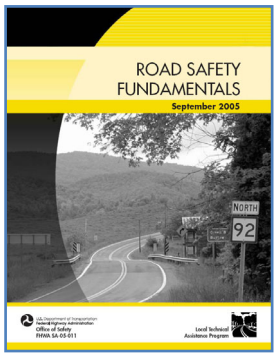
	Roadway Features	Yes/No	Comments
Railroad Crossings	1. Are railroad crossing (cross bucks) signs used on each approach at railroad crossings?		
	2. Are railroad advance warning signs used at railroad crossing approaches?		
	3. Are railroad crossings free of vegetation and other obstructions that have the potential to restrict sight distance?		
	4. Are roadway approach grades to railroad crossings flat enough to prevent vehicle snagging (any evidence of scrape marks, gouging)?		

	Roadway Features	Yes/No	Comments
Provisions for Heavy Vehicles	1. Is access to and from roadway adequate (turning radii, width of approaches/intersections, sight distance, etc.)?		
	2. Is there need for special considerations (operational design features, signing, and pavement structure) to safely accommodate large vehicles?		
	3. Is there evidence of operational and/or safety problems?		

APPENDIX C: LOCAL RURAL ROAD SAFETY REFERENCES

A. SAFETY FOR LOW VOLUME ROADS

1. ROAD SAFETY FUNDAMENTALS

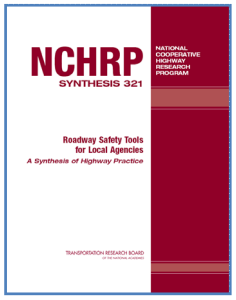


FHWA Office of Safety, FHWA-SA-05-011, September, 2005

"Roadway Safety Fundamentals" is a guidebook developed for FHWA's LTAP program from work done by the Cornell University LTAP Center and the NYDOT. This guidebook is designed to help local and Tribal road agency professionals understand the critical relationships between roads, roadside, road user behavior, and safety. Because many of these agencies have no licensed professional engineers on staff, this publication reviews the proper use of common traffic control devices such as signs, lane markings, and lighting. It also addresses the use and effectiveness of roadside barrier systems, especially different guardrail systems. "Road Safely Fundamentals" identifies the core concepts local and tribal road agency professionals can use to evaluate and improve their safety operations. Throughout the process, the guidebook encourages agencies to document decisions and actions for future agency reference and as safeguards against potential litigation. Information in the guidebook will help road agency professionals use a systematic approach to improve safety and roadways in a manner that makes best use of resources and manpower.

http://www.t2.unh.edu/nltapa/Pubs/Road_Safety_Fundamentals_Field_Reference_Guide.pdf

2. NCHRP 321 - ROADWAY SAFETY TOOLS FOR LOCAL AGENCIES, A SYNTHESIS OF HIGHWAY PRACTICE



TRB, 2003

Local governments face significant challenges in implementing road and street safety improvements. They are responsible for local roadway networks, which can vary from a few city blocks to thousands of miles of paved, dirt, or gravel roads. Most local governments have substantial resource limitations in terms of financial support and personnel. As a result, many local agencies have not developed safety programs. This synthesis focuses on identifying safety tools that can be used by these agencies in formulating safety programs. It recognizes the wide variation in the parameters of operation and responsibilities of local agencies. Also, it acknowledges that expertise in transportation safety analysis varies widely among local agencies.

This synthesis was prepared for easy use by local agencies as they select their safety tools and develop safety programs. In the broad context of the synthesis, "tools" came to be defined as any ideas, practices, procedures, software, activities, or actions beneficial in aiding local agencies to improve the safety of their roadway network. However, these tools cannot reduce crashes if they are not applied. Anything and everything that works was considered for the synthesis. Therefore, a guiding principle of this synthesis was to examine the tools and procedures that are practical and relatively easy to apply.

The development of this synthesis was based in part on information collected in a series of surveys. State departments of transportation (DOTs), Local Technical Assistance Program centers, local agencies, and professional organizations were contacted and asked to provide information on best safety practice ideas. The safety tools were grouped into reactive and proactive safety tools, and basic and advanced analysis approaches were considered for each group. The individual tools were linked to

a series of user-friendly appendixes that provide detailed information on the specific tool, its application, or references to additional documentation.

The best practices of reactive crash analysis of state DOTs using Highway Safety Improvement Programs (the front-end-loaded identification of safety needs for a given system) are presented. The emerging proactive safety tools of the Road Safety Audit and the Road Safety Audit Review, which assess the issues of safety using an independent team approach, are discussed as tools to structure many of the best practices. Most local agencies do not employ either of these proactive approaches, whereas state DOTs are just beginning to apply these concepts.

The overriding message of this synthesis is that safety practices should be tailored to the problems and resources of an agency and that there is no one-size-fits-all safety solution.

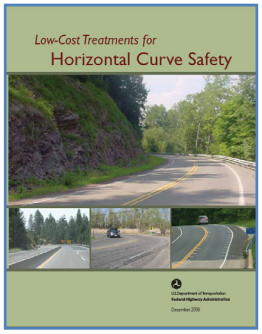
Emphasis is placed on the use of tools that will give local agencies a practical and affordable toolbox, with a stronger safety program as the result.

Achieving buy-in and persuading local authorities to spend time and money directly on safety improvements were the objectives of this synthesis. Large financial commitments and complex analysis are not always necessary. Historically, liability issues have deterred local agencies from systematically identifying safety concerns, because they are fearful that they will be left vulnerable to tort liability simply by acknowledging that safety deficiencies exist on their local roadways. This synthesis emphasizes that the documentation of an agency's safety agenda is a necessary defense against tort liability. It is important to note that many sound safety ideas are implemented at local levels without a specific acknowledgment of a safety program.

It is essential to recognize that improving the local crash picture will require an increased effort by both experienced and inexperienced professionals. Providing guidance for the local agency to become a more professional safety organization by applying the best and most appropriate tools to meet its needs is the key. Helping local agencies to implement safety improvement is the goal. The conclusion of the synthesis is that a documented local roadway safety program is "the best safety tool." Recognizing the need to implement even a rudimentary safety program is the first step. The selection of safety tools to meet the individual local agency's needs comes next. Developing the selected tools into a continuing program and implementing safety improvements are identified as the keys to local roadway safety.

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_321.pdf

3. LOW-COST TREATMENTS FOR HORIZONTAL CURVE SAFETY



FHWA Report No: FHWA-SA-07-002, December, 2006

Nearly 25 percent of fatal crashes occur at or near a horizontal curve. Hence, addressing the safety problem at horizontal curves is one of the 22 emphasis areas of the Strategic Highway Safety Plan prepared by AASHTO. Also, crashes at horizontal curves are a big component of the road departure crash problem, which is one of FHWA's three focus areas. This publication was prepared to provide practical information on low-cost treatments that can be applied at horizontal curves to address identified or potential safety problems. The publication concisely describes the treatment; shows examples; suggests when the treatment might be applicable;

provides design features; and where available, provides information on the potential safety effectiveness and costs. The treatments include:

- Basic traffic signs and markings found in the MUTCD
- Enhanced traffic control devices
- Additional traffic control devices not found in the MUTCD
- Rumble strips
- Minor roadway improvements
- Innovative and experimental treatments

The publication concludes with a description of maintenance activities that should be conducted to keep the treatments effective.

http://safety.fhwa.dot.gov/roadway_dept/horicurves/fhwasa07002/

4. GOOD PRACTICES: INCORPORATING SAFETY INTO RESURFACING AND RESTORATION PROJECTS

FHWA Report No: FHWA-SA-07-001, December, 2006

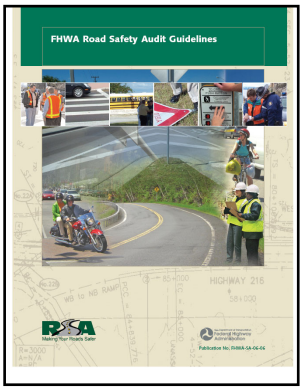
Integrating safety improvements into resurfacing and restoration projects is a subject of long-standing interest by Federal, State, and local transportation agencies. A Scan Tour was conducted to identify and subsequently observe good practices in this area. The scan team visited Colorado, Iowa, New York, Pennsylvania, Utah and Washington State. The Scan Team met with each State DOT and county agencies in three States and observed completed projects in all States. Despite wide variations in agency operating environments (e. g., funding levels and flexibility, public expectations, environmental regulations), the report identifies a set of common issues host agencies confronted in developing integrated resurfacing-safety improvement programs, and also observed a set of common success factors.

Good practices are reported within institutional and technical categories. Good institutional practices include commitment to integrate safety into pavement preservation projects, establishing a system that allows for multifunded projects (pavement, safety) and allocates cost items by fund, allowing for flexible project development cycles, strengthening State-local relationships, developing an expedient procedure for acquiring minor rights-of-way, and engaging safety experts in the project development process. Good technical practices include identifying targeted safety countermeasures, making selective geometric improvements, installing traffic control devices and guidance features, improving roadsides, and improving private and public access points.

http://safety.fhwa.dot.gov/roadway_dept/strat_approach/fhwasa07001/

B. ROAD SAFETY AUDIT REFERENCES

1. FHWA ROAD SAFETY AUDIT GUIDELINES



FHWA Report No: FHWA-SA-06-06, September, 2006

A Road Safety Audit (RSA) is a formal safety performance examination of an existing or future road or intersection by an independent audit team. RSAs are a comprehensive and effective tool for proactively improving the safety performance of a road while it is still in the planning or design stage, or for identifying and mitigating safety concerns on existing roads and intersections.

http://safety.fhwa.dot.gov/rsa/guidelines/

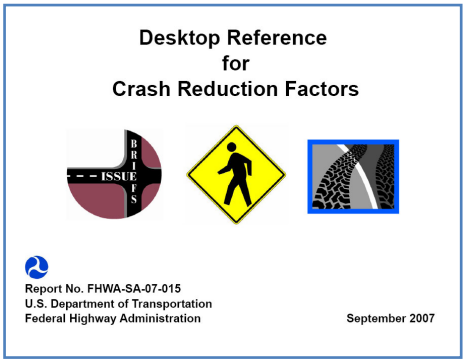
2. ROAD SAFETY AUDITS BROCHURE

The U.S. Federal Highway Administration has released an online brochure that provides information on benefits, legal issues, and training associated with road safety audits. The brochure also provides information on conducting road safety audits as well as links to additional resources.

http://safety.fhwa.dot.gov/rsa/brochure/

C. SAFETY COUNTERMEASURES

1. DESKTOP REFERENCE FOR CRASH REDUCTION FACTORS

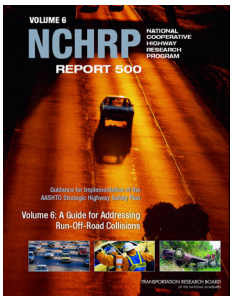


FHWA Report No: FHWA-SA-07-015, September, 2007

This Desktop Reference documents the estimates of the crash reduction that might be expected if a specific countermeasure or group of countermeasures is implemented with respect to intersections, roadway departure and other non-intersection crashes, and pedestrian crashes. The estimates of crash reduction are known as Crash Reduction Factors (CRFs), and represent the information available to date. Where available, the Desktop Reference includes multiple CRFs for the same countermeasure to allow the reader to review the range of potential effectiveness. The CRFs are a useful as a guide, but it remains necessary to apply engineering judgment and to consider site-specific environmental, traffic volume, traffic mix, geometric, and operational conditions which will affect the safety impact of a countermeasure.

http://safety.fhwa.dot.gov/tools/crf/desk_ref_sept2008/

2. Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 6: A Guide for Addressing Run-Off-Road Collisions



TRB, 2003

This report deals with ROR crashes associated with vehicles that leave the travel lane, encroach onto the shoulder and beyond, and hit one or more of any number of natural or artificial objects, such as bridge walls, poles, embankments, guardrails, parked vehicles, or trees. ROR crashes usually involve only a single vehicle, although a ROR vehicle hitting a parked vehicle could be considered a multivehicle crash. A ROR crash, which consists of a vehicle encroaching onto the right shoulder and roadside, can also occur on the median side where the highway is separated or on the opposite side when the vehicle crosses the opposing lanes of a non-divided highway. Reducing the likelihood that a vehicle will leave the roadway through roadway design (e.g., flattening curves or installing shoulder rumble strips) can prevent deaths and injuries resulting from ROR crashes. When an errant vehicle does encroach on the roadside, fatalities and injuries can be reduced if an agency can either (a) minimize the likelihood of the vehicle crashing into an object (e.g., through object removal or relocation) or overturning (e.g., through side slope flattening or improved ditch design) or (b) reduce the severity of the crash (e.g., installing breakaway devices).

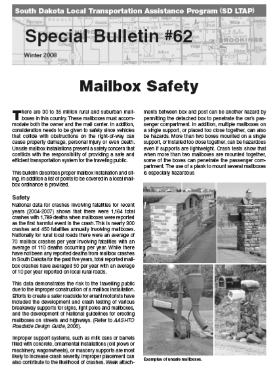
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v6.pdf

3. SOUTH DAKOTA LOCAL TRANSPORTATION ASSISTANCE PROGRAM (SD LTAP),

SPECIAL BULLETIN #62

MAILBOX SAFETY

WINTER 2008

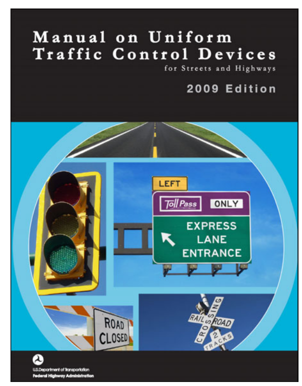


This bulletin describes proper mailbox installation and sitting. In addition a list of points to be covered in a local mailbox ordinance is provided.

http://www3.sdstate.edu/classlibrary/page/information/datainstances/17373/files/54434/sd_ltap_special_bulletin_62_.pdf

D. DESIGN STANDARDS AND MUTCD

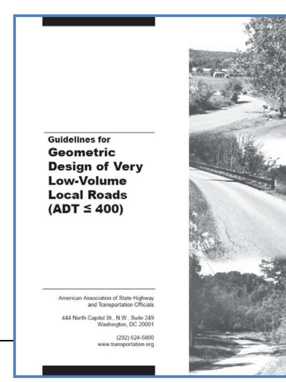
1. MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD)



2009 Edition, Federal Highway Administration, Washington, DC 2009

The MUTCD defines the standards for all traffic control devices (signs, signals, and pavement markings) installed and maintained to help regulate, warn, and guide driver's safely on the Nation's roadways and streets. The MUTCD is published by FHWA. All States are required to adopt either the Federal MUTCD or a State MUTCD that is in substantial conformance to the Federal MUTCD. http://mutcd.fhwa.dot.gov/kno_2009.htm

2. GUIDELINES FOR GEOMETRIC DESIGN OF VERY LOW-VOLUME LOCAL ROADS (ADT<400)



American Association of State Highway and Transportation Officials, 2001

These guidelines for very low volume roads were developed to address the unique challenge of low volumes and reduced frequency of crashes

make designs normally applied to higher volume roads less cost effective. The guidelines offer a range of values for critical dimensions, and encourage flexibility in application.

https://bookstore.transportation.org/Item_details.aspx?id=157