NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP SYNTHESIS 336

Road Safety Audits

A Synthesis of Highway Practice

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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FOREWORD

By Staff
Transportation Research Board

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice*.

The synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

This synthesis report provides a review of the state of the practice of road safety audit (RSA) and road safety audit review (RSAR) applications for U.S. states and Canadian provinces. Transportation safety professionals with these agencies and with local and regional entities, as well as others in both the public and private sectors, may be interested in this documentation of international, state, and some local agency approaches to the use of these tools in comprehensive safety programs. This synthesis of the Transportation Research Board places emphasis on North American applications. However, this document also discusses international practice as RSAs were first introduced in the United Kingdom more than 20 years ago, and RSAs have been extensively applied in New Zealand and Australia since the 1990s. This document promotes the use of RSAs and RSARs. The increased use of these applications may help reduce roadway crashes and fatalities.

For this synthesis report of the Transportation Research Board survey responses were received from 38 state departments of transportation (DOTs) and 6 Canadian provinces. The state of the practice was developed based on this 2003 survey, state, and local agency practices, Federal Highway Administration- and National Highway Institute-sponsored training for state DOTs, local agency training experiences, international practices, literature, and personal contacts.

A panel of experts in the subject area guided the work of organizing and evaluating the collected data and reviewed the final synthesis report. A consultant was engaged to collect and synthesize the information and to write this report. Both the consultant and the members of the oversight panel are acknowledged on the title page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

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ROAD SAFETY AUDITS

SUMMARY

Road safety audits (RSAs) and road safety audit reviews (RSARs) are two safety tools that offer promise to help reduce roadway crashes and fatalities. Globally, these tools have been used by transportation safety professionals since the 1980s and are beginning to emerge as proactive safety tools in U.S. practice.

The purpose of this synthesis is to describe RSA and RSAR processes and to summarize their current usage. It is anticipated that this document will promote increased use of RSAs and RSARs and, as a result of the increased use, a reduction in roadway crashes and fatalities.

The internationally accepted definition of an RSA as used in this synthesis comes from *The Canadian Road Safety Audit Guide* and is as follows: "An RSA is a formal and independent safety performance review of a road transportation project by an experienced team of safety specialists, addressing the safety of all road users." An RSAR is defined for use in this synthesis as "an evaluation of an existing roadway section by an independent team, again focusing solely upon safety issues" and comes from NHI Course 380069 ("Road Safety Audits and Road Safety Audit Reviews").

Internationally, the distinction between the evaluation of a plan or a design (RSA) and the evaluation of a roadway section or intersection (RSAR) either just before opening or already open to traffic is becoming more pronounced. Terms such as RSAR, road infrastructure assessment, road review, roadway assessment, and roadway inspection have been used to differentiate an RSAR of an existing roadway from an RSA of a plan.

RSAs were introduced in the United States in 1996 as a result of an FHWA-sponsored scanning tour of Australia and New Zealand. The FHWA contacted all state departments of transportation (DOTs) to solicit interest in applying the concepts as a pilot study. In 1997, it sponsored a workshop in St. Louis to discuss the practice and pilot activities. Thirteen states and two local governments participated in this pilot project, marking the beginning of U.S. practice.

This synthesis was developed using a comprehensive literature review, a survey of state and provincial DOTs by means of a structured questionnaire, and the authors' personal contacts and experiences in providing RSA team leadership and training worldwide.

The questionnaire was designed to elicit responses related to key RSA issues defining DOT practices and to clarify and identify possible DOT concerns when agencies consider implementing these proactive safety tools. The survey responses indicated that by mid-year 2003, only seven state DOTs were using both RSAs and RSARs in their safety programs. An additional 10 states indicated that they were using one but not both of these tools. Most of these states indicated that their use was best described as a beginning program to determine the benefits of incorporating the tools into their safety programs. That is not surprising, for the initial exposure of most state DOTs to RSAs was relatively recent, in 1997, compared with international practices, which date from the 1980s.

The survey identified several issues that affect the use of RSA processes and the way in which they are applied, including

- Institutional issues—agency culture, staff interests, manpower, expertise availability, financial resources, liability, and management acceptance.
- Audit team composition—size of team (three to five members were recommended) and team skills—most states identified a core related to traffic operations, design, and safety, with additional skills related to construction, maintenance, law enforcement, planning emergency medical services, and human factors depending on the audit stage and scope of the project.
- In general, the benefits of conducting RSAs during an early project stage were identified as a key to maximizing their impact or effectiveness. The advantage of identifying the safety issues before the project's footprint has been developed was seen as an important benefit of the RSA approach.

Several states have advanced beyond the initial assessment stage. Specifically, Iowa, Pennsylvania, New York, South Carolina, and South Dakota were identified as having developed programmed approaches for including proactive safety assessments.

Training was a major component of the South Carolina program, and two workshops were held to provide a core group of trained auditors.

The number of countries worldwide using the tools of RSAs and RSARs is growing rapidly. Historically, the most advanced countries have been involved in applying these techniques since the mid-1980s. The United Kingdom, Australia, and New Zealand are leaders in refining and advancing the state of the practice. It is noteworthy that these three countries have active and extensive programs, are requiring audits to be undertaken, and are conducting RSAs during different project stages. In some cases, multiple audits are required, and the monitoring of RSA audited projects is becoming a mandatory activity in the United Kingdom program. Auditor certification is beginning to emerge as an international issue.

In the United States, more and more states are learning of RSAs through a National Highway Institute training course. Local agencies are also beginning to explore and develop programs based on applying RSARs. The value added in using RSAs and RSARs will continue to grow in the United States as more state DOTs and local agencies try these safety tools on their roadways.

CHAPTER ONE

INTRODUCTION

Roadway crashes and fatalities in the United States continue to be a major health and safety issue. In 2002, almost 3 million injuries and 42,815 fatalities occurred on U.S. roads. In all, the 6 million crashes in the United States in that year resulted in an estimated $230 billion financial loss (*1*). Worldwide the estimates of annual road fatalities are in excess of 1 million. Road safety audits (RSAs) and road safety audit reviews (RSARs) are two safety tools that offer promise in reducing roadway crashes and fatalities. Globally, these tools have been in safety practice since the 1980s and are beginning to emerge as proactive safety tools in the United States.

PURPOSE AND METHODOLOGY

This synthesis provides a review of the state of the practice of RSA applications for state departments of transportation (DOTs) in the United States and provincial transportation agencies in Canada. Also included are summaries of some local agency approaches to the use of these tools in comprehensive safety programs. The purpose of this synthesis is to describe RSA and RSAR processes and to summarize their current usage. Emphasis is placed on applications in North America. However, this document also discusses international practice, because RSAs were first introduced in Great Britain more than 20 years ago, and have been extensively applied in New Zealand and Australia since the early 1990s. In those countries, the extent of application and the level of maturity of usage exceed that of the United States. Practices are evolving in the United States as more states receive training and are beginning to implement audit programs. It is anticipated that this document will promote increased use of RSAs and RSARs and, as a result of the increased use, a reduction in roadway crashes and fatalities.

The state of practice was developed based on the following:

- A 2003 survey of state DOTs and Canadian provinces,
- State and local agency practices,
- Training for state DOTs sponsored by the FHWA and the National Highway Institute (NHI),
- Local agency training experiences,
- International practices, and
- Literature and personal contacts.

The survey questionnaire is contained in Appendix A. A list of the 38 states and 6 governmental agencies in Canada that responded to the survey is included in Appendix B.

International practices are described to illustrate the global acceptance of RSA practices and advancements that have been made worldwide. Recent progress in countries that have a long history of applying RSAs is highlighted. Examples of other countries where RSA and RSAR practices are in the initial stages are provided. The most current information on these international practices was obtained from presentations delivered at an international forum on RSAs sponsored by the Institute of Highways and Transportation (IHT) held in London, England, in October 2003.

Chapter four provides an update on international applications. Included in that chapter are survey inputs from Canadian cities and provinces that also responded to the DOT survey. The final chapter contains a summary of key issues associated with these safety tools. References, a bibliography, and appendixes conclude the report. The appendices include the synthesis DOT survey, sample RSA and RSAR reports, sample RSA and RSAR checklists, and an example of a DOT RSA program.

INTERNATIONAL DEFINITION OF ROAD SAFETY AUDITS AND U.S. DEFINITION OF ROAD SAFETY AUDIT REVIEWS

The internationally accepted definition of an RSA as used in this synthesis is as follows: "An RSA is a formal and independent safety performance review of a road transportation project by an experienced team of safety specialists, addressing the safety of all road users" (*2*). An RSAR is defined as "an evaluation of an existing roadway section by an independent team, again focusing solely upon safety issues" (*3*). Internationally, this distinction between the evaluation of a plan and the evaluation of a roadway already open to traffic is becoming more pronounced. Terms such as RSAR, road infrastructure assessment, road review, roadway assessment, and roadway inspection have been used to differentiate an RSAR of an existing roadway from an RSA of a plan.

In 1996, an FHWA-sponsored U.S. scanning tour visited Australia and New Zealand to investigate their applications of RSAs and to determine if that tool would have added value in advancing U.S. safety practices. The proactive RSA practice and its wide acceptance were recognized by the team as adding value to road safety practices. It is hoped that this synthesis will continue to advance U.S. acceptance and implementation of both safety tools.

CLARIFYING EXISTING U.S. SAFETY PRACTICE

There is a great deal of confusion and misunderstanding regarding these proactive tools and existing safety practices. Although most state DOTs currently include some elements of these tools, implementation of the RSA and RSAR processes to achieve full benefit is not occurring. The following are typical first reactions to the application of the process to an audit of a plan and an audit of an existing roadway.

- "We already do RSAs and RSARs."

  The perception of many individuals involved with roadway safety in the United States is that they are already applying RSA processes in their work. However, most are not. Although most DOTs are conducting comprehensive project scoping reviews that include many of the aspects of the RSA or RSAR process, those scoping reviews do not involve review examinations by an independent team focusing solely on safety. A common response from individuals who have received RSA and RSAR training has been that those two tools are best used in the early stages of a project. Another primary response to the training is that the RSA would provide excellent input into project scoping and preliminary project design.

- "We already do RSARs."

  Most state DOTs have a reactive component in their safety programs that focuses on high-crash locations. Although these analyses may include evaluations and input from several people, they do not constitute an RSAR. An RSAR is not a reactive tool drawing conclusions from crash histories. Instead, it focuses on safety issues associated with the roadway, all road users (e.g., drivers, pedestrians young and old, and bicyclists), operating under all environmental conditions (e.g., day versus night and wet versus dry), to identify the safety issues associated with the existing facility. It includes evaluations from an independent team and results in a formal report. Iowa, New York, and South Dakota are three DOTs leading RSAR activities. Iowa and New York have incorporated RSARs into their resurfacing, restoration, and rehabilitation/resurfacing, restoration, rehabilitation, and reconstruction (3R/4R) programs.

U.S. ROAD SAFETY AUDIT AND ROAD SAFETY AUDIT REVIEW CONCERNS

There are many implementation issues identified by state DOTs and local agencies in the United States. First and foremost is a general concern about the rigidity of the process as practiced internationally. Second is a concern about how best to integrate the audit approach into existing safety practices and programs. Related are concerns about liability, audit process and procedures, identifying projects to audit, and auditor skills and training. These issues and the details associated with conducting both RSAs and RSARs are addressed in chapters two and three. Chapter two provides a detailed discussion of the RSA and RSAR process. An overview of the survey results from state DOTs in the United States is presented in chapter three. A section focusing on local agency issues concludes that chapter. A more complete focus on local safety tools is provided in *NCHRP Synthesis of Highway Practice 321*, published in 2003 (*4*).

U.S. ROAD SAFETY AUDIT AND ROAD SAFETY AUDIT REVIEW STATUS IN 2003

The application of RSAs and RSARs is in its infancy in the United States, with only a few states having safety programs that include either an RSA or RSAR component. However, as a result of training, more states appear to be willing to try these approaches to enhance safety. In Canada, RSAs are being evaluated for use in value engineering processes and in design-build projects.

The philosophy behind RSAs and RSARs is to be proactive in independently evaluating safety issues and recommending alternative applications or technologies where appropriate. At the completion of the audit process comes the implementation of selected alternatives to improve the safety of the roadway and then to evaluate the benefits associated with those safety improvements.

FUTURE ISSUES OF ROAD SAFETY AUDIT AND ROAD SAFETY AUDIT REVIEWS

The application of RSAs is in its earliest stages in the United States. To advance and expand the application of the concept and to enhance safety benefits the following activities are needed:

- Training programs should be continued to introduce more state DOT personnel to RSA practices and how these safety tools can be applied.
- A compendium of best practices could be developed and disseminated to state DOTs, cities, and local road agencies. Local transportation assistance program (LTAP) centers or technology transfer (T^2) centers could assist in the distribution of this information.
- RSA training courses might be developed to focus on urban applications such as at intersections or on RSA and RSAR aspects of access management.

- A study is needed to establish the benefits of audits based on U.S. practice. This could include a quantitative evaluation to establish the economic benefits of audits.
- A forum on RSA and RSAR to advance U.S. practice could be held.

Time, training, and a record of successful applications will be the keys to making RSAs and RSARs a common safety practice in the United States. Agencies can stay up to date on RSA and RSAR activities by visiting the website www.roadwaysafetyaudits.org.

CHAPTER TWO

ROAD SAFETY AUDIT PROCESS

WHAT IS A ROAD SAFETY AUDIT?

An RSA as applied in the United States is a formal examination of a future roadway plan (or project plan) by an independent, qualified audit team, which then reports on safety issues. The key elements of this definition are that the RSA

- 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.

The RSA is proactive, done before a crash history indicates a problem exists. It considers all road users—for example, drivers, pedestrians, and bicyclists—and it considers all environmental conditions, including daylight, nighttime, and inclement weather.

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; it results in recommendations or findings that should be considered when a project is reviewed. Audits conducted early in the life of a project—in the planning or initial design stages—have been shown to be the most beneficial and the easiest to integrate with an agency's existing safety program.

WHAT ARE THE BENEFITS OF ROAD SAFETY AUDITS?

The safety benefits of RSAs have been documented primarily in international applications, which are summarized in chapter four. International assessments focus on the value added by proactively implementing the RSA findings. Several studies compared benefits of similar projects where RSAs were conducted with projects in which RSAs were not conducted. In the United States, where RSA tools have only recently been introduced, the quantitative benefits of RSAs have been difficult to document because the RSA is a proactive rather than a reactive safety tool. An analogy can be made to the medical field. It may be difficult to prove the benefits of preventive medicine, yet it is generally accepted that exercise, proper diet, and other measures can help reduce long-term medical costs.

Nevertheless, in an unpublished study of RSA pilot studies assessed in 1997 by the FHWA, a number of important benefits were identified. Audits were found to

- Provide safety beyond established standards;
- Identify additional improvements that can be incorporated into the projects;
- Create consistency among all projects;
- Encourage personnel to think about safety in the course of their normal activities, throughout all stages of a project;
- Invite interdisciplinary input;
- Enhance the quality of field reviews;
- Provide learning experiences for the audit team and design team members;
- Provide feedback to highway designers that they can apply to other projects as appropriate;
- Provide feedback that helps to affirm actions taken and to work through outstanding issues; and
- Ensure that high quality is maintained throughout a project's life cycle.

WHAT ARE THE STAGES OF A ROAD SAFETY AUDIT?

RSAs can be performed at one or more stages of a new roadway project (*3*):

- Planning,
- Draft design,
- Detail design,
- Traffic control device (TCD) construction planning, and
- Construction.

The different emphasis at each stage principally relates the level of detail addressed. Each stage is described in the following sections.

Planning

RSAs conducted during the planning stage occur early in a project and generally evaluate the basic project scope, route location and layouts, intersection types, access control, interchange locations and types, and impacts on the existing infrastructure. Some of those items also receive attention during audits conducted during other stages. As more details of the project become available, safety considerations become more focused.

Draft Design

During the draft—or preliminary—design stage, the audit team evaluates general design standards. Some factors that the team might consider include horizontal and vertical alignment; intersection and interchange type and layout; sight distances; lane and shoulder widths; superelevation; and provisions for pedestrians, including children, the elderly, the disabled, and bicyclists.

Detail Design

All elements of the final design should be in place during the detail design stage. During this stage, the audit team reviews the final geometric design features; traffic signing and pavement marking plans; lighting plans; landscaping; and intersection and interchange details such as tapers, lengths of acceleration and deceleration lanes, and turning radii. The team also reviews provisions for special users such as elderly pedestrians, children, the disabled, and bicyclists; drainage, guardrails, and other roadside objects; and constructability.

TCD Construction Planning

An RSA conducted during this stage focuses on the development and implementation of the traffic control plan. It evaluates the implications of alternative TCDs, use of various types of devices, impact of temporary geometric changes, and implementation of changes that might occur as the project progresses.

Construction

During this stage, the audit team focuses on safety issues during construction and looks at how a new construction project interacts with utilities, railroads, businesses, maintenance, and other parts of the existing infrastructure. The team also considers the safety impacts of alternative staging plans.

HOW IS A ROAD SAFETY AUDIT CONDUCTED?

Conducting an RSA requires that a formalized, systematic process be followed. However, each agency may tailor the process to satisfy specific organizational and safety goals. Generally, the following steps are followed in conducting an audit.

Select the RSA Team

The RSA team consists of trained and experienced transportation professionals and others with special skills. The team members also should be chosen independent of the project being audited and therefore able to look at the project without bias. A team leader who has experience in conducting audits is identified. A core team comprising a highway and traffic safety specialist, highway designer, and traffic engineer is usually used effectively on most projects. To that core team others may be added as needed to provide expertise pertinent to the project being audited. Specific disciplines that can be added include experts in planning, enforcement, pedestrians and bicyclists, and human factors, as well as local residents. Diverse perspectives of the team members foster the exchange of ideas that can enrich the audit. Of utmost importance, the audit team members should have the time and desire to conduct the audit.

Provide Relevant Data and Documentation

The project designer or an appropriate internal client who is requesting the audit provides all available relevant data and documents to the audit team, as well as a statement of the scope of the audit. The individual supplying the information reflects the type of project being audited, the stage of the audit, and the organization of the audit process within each agency.

Relevant data and documentation include, but are not limited to the following:

- Plans and drawings;
- Design standards used;
- Traffic volume data;
- Crash records, if applicable (only on a redesign or an RSAR);
- Public input;
- Videotapes; and
- Data concerning utilities, railroads, schools, and businesses, among others.

Hold Kick-Off Meeting

The project designer or internal client calls the kick-off meeting to launch the audit. The audit team members, designer or internal client, and any others who have knowledge of the project that the audit team needs should attend. During this meeting, the designer or client turns over the relevant data and documents. The participants discuss the purpose and conduct of the audit, scope, roles, and responsibilities, as well as the desired presentation format for the audit report.

Assess Data and Documents

After the kick-off meeting, the audit team reviews the data and documentation, records its initial impressions, and plans the site inspection(s). Team members consider appropriate checklists and prompt lists to refer to during the site visit. From these data and documents, the team begins to identify safety-related issues and concerns.

Inspect Site

After reviewing the relevant data and documentation, the RSA team inspects the site. Team members bring the data and documentation with them and review the site from all possible perspectives (e.g., planning, design, construction, and maintenance), considering all possible road conditions (e.g., sunshine, darkness, rain, snow, sleet, and hail), and users (e.g., motorists, both elderly and inexperienced drivers, motorcyclists, bicyclists, children, and elderly pedestrians). Any checklists or prompt lists selected are used during the site visit to assist in evaluating safety issues. The team also considers factors such as glare from headlights and the sun, external lighting, and existing infrastructure (e.g., railroad crossings, industry, schools, businesses, parks, and recreation). The team looks at adjacent roadways that transition into the site as well. More than one visit might be necessary, with both nighttime and daytime visits beneficial.

Discuss Audit Safety Issues with the Designer or Internal Client

There are two alternative formats to presenting the audit report. First, before writing the report, the audit team and designer or internal client meet to discuss the issues and concerns raised during the audit. Doing so establishes an atmosphere of cooperation and encourages the sharing of knowledge and perspectives on the project being audited. This gives everyone an opportunity to brainstorm conclusions, solutions, and recommendations and have input into the audit report. The second approach is to write the report and then to present the audit report findings. Whatever format is used should be defined in the initial meeting with the client.

Write RSA Report

The audit report documents the results of the RSA. Several examples of RSA and RSAR reports are included in Appendix C. These are actual reports that have been edited to eliminate references to specific agencies or locations. In general, the RSA report

- Identifies all safety issues and deficiencies, noting those that require immediate attention; and
- Draws conclusions in the form of recommendations or suggestions for possible corrective actions if requested.

An audit report has no set format, but at a minimum it should include the following sections:

- Project description—Describe the project being audited, summarize its background, and state why the audit is being performed.
- Audit team members—Identify each team member by name and title. If consultants are used, describe their credentials.
- Data and documentation—Identify all data and list all documentation reviewed. If appropriate, indicate the usefulness of each.
- Assumptions—List any assumptions relied on, if applicable.
- Site visits—Identify the dates and times when visits have been conducted. Also, identify any conditions present at the time of the visit (e.g., bright sunshine versus clouds and heavy versus light traffic flow). Describe the site's layout and physical characteristics. Identify anything that the site inspection reveals that the data and documentation do not. Identify any checklists or prompt lists that were used.
- Findings—Clearly state safety-related observations, identifying in detail all safety issues and concerns.
- Conclusions—State the recommendations, suggestions, alternatives, implementation strategies, etc., that relate to the scope of the audit. Present the content in a format established by the agency. Some agencies prefer to include recommendations, whereas others prefer findings.

Hold Completion Meeting

During the completion meeting, the audit team presents its findings orally and answers any questions that the stakeholders might have. To get the most from the meeting, the report should be distributed in advance so that it can be reviewed by the attendees who can then formulate their questions and comments. The meeting should be an open, positive, and constructive discourse that is free of criticism. All parties should work together to be proactive, not adversarial, in their approach to safety.

Respond to Report

The project designer, internal client, or other stakeholder responds to the audit report. Audit reports generally include corrective actions; for example, recommendations or suggested safety improvements. A written documented response indicates which corrective actions are accepted and which are rejected, as well as reasons associated with the decisions made. Including an implementation plan may also be of value. An official with authority to make decisions should sign the report.

Implement Agreed-on Changes

Because the whole point of conducting an RSA is to improve safety, an important step is to actually implement the changes that the audit team and stakeholders agree to implement. That implementation also should be documented and made part of the total audit file.

Share Lessons Learned

The final step of an RSA is to share the lessons learned with all the stakeholders and with the planning, design, construction, operations, and maintenance teams. Those lessons then can be applied to all future projects as appropriate. A project that has been audited also should be monitored to determine if the audit and implementation of findings have been successful. The agency that requested the audit maintains the audit records

KEY ISSUES TO CONSIDER IN AUDIT REPORTS

Because the audit report is important, it deserves special attention. The audit report should be concise and to the point. It should contain at least the elements that were listed earlier. However, the audit report need not be too long; 2 to 10 pages would be ideal for most projects. Agencies appear to be divided on whether the reports should contain findings or recommendations. Recommendations suggest further specific actions or improvements, whereas findings address the results of the audit. It is important that the report's contents be discussed during the kick-off meeting to determine the objectives of the client. Sample audit reports are included in Appendix C.

Another consideration is the disposition of the report after the audit has been completed. Each agency should establish procedures for maintaining RSA reports. If the agency has a central RSA coordinator, that person should maintain the records. Another option is to house the reports at a district office. In all cases, a copy of the audit report should be included with the documentation of the specific project that is audited.

USING CHECKLISTS AND PROMPT LISTS

One tool that has been a key component in conducting RSAs is a checklist. Checklists have been developed to aid auditors in reviewing projects to ensure that all issues that can affect safety are addressed. Both *Road Safety Audit* from Austroads (*5*) and *Guidelines for the Safety Audit of Highways* from IHT (*6*) contain extensive checklists that can be used for each audit stage. In the United States, Pennsylvania has developed checklists for use in its audit process. These checklists can be viewed at the previously mentioned website, www.roadwaysafetyaudits.org.

Checklists should not be used so rigidly that the audit team allows the checklist to dictate the audit. Instead, the checklists should be flexible guidelines and reminders of things to look for in steering the team to a comprehensive evaluation of the project. Checklists should be viewed as only one tool available to the audit team, just as the project data and documentation are tools.

Many international agencies are now using prompt lists. Those tools are less prescriptive than checklists and identify broader areas for the audit team to examine during the field review. *The Canadian Road Safety Audit Guide* (*2*) contains an example of a prompt list.

It is recommended that an audit team develop a checklist or prompt list tailored to the specific project and stage of the audit being conducted. This should be accomplished during the kick-off meeting and the list then taken to the site inspection. The team can use an existing list and modify it to fit the project. Appendix D contains samples of audit checklists. Checklists have been developed for specific audit stages and for specific types of projects. The appendix provides several different RSA checklist styles. Essential to using a checklist or prompt list is to include relevant local safety concerns and issues. Tailoring a checklist to specific facility types or project types may have benefits in advancing the application of RSAs and RSARs.

WHAT IS A ROAD SAFETY AUDIT REVIEW?

An RSAR is a safety assessment of an existing street or roadway section or a newly completed section before opening. An independent, qualified audit team reports, in an RSAR, on the safety issues of these road or street sections. The RSAR is a practical safety tool for local rural road agencies with typically limited resources, whose primary responsibilities are the maintenance and operation of existing roadway networks. The RSAR can also be used as part of an agency's overall safety program or in conjunction with other ongoing activities such as a 3R/4R program. The RSAR differs from the conventional safety analysis and scoping study because it is proactive and not dependent solely on crash statistics. The RSAR concentrates on a specific roadway section to address safety issues and therefore is different from traditional U.S. and Canadian scoping studies. RSARs may be used as planning tools to identify safety issues to be considered in improvement projects.

State DOTs and local agencies are continuously faced with the need to consider how the safety of an existing road or street may be enhanced. Because the uses of a roadway change over time, roads that fully complied with all safety standards at the time they were built may no longer provide a high degree of safety for the traveling public. Typical approaches used by most DOTs include an analysis of crash data, generally focusing on high-crash locations. Applying proactive evaluations through the use of the RSAR is another method. The RSAR may be performed

- During the preopening stage of a new project to ensure that the safety concerns of all road users have been addressed,
- On a road section just opened to traffic, and
- On an existing road to identify safety deficiencies.

The concept of the RSAR is based on an analysis technique that formalizes documentation of safety issues. Proactively considering safety is the value of the RSAR tool. Iowa, New York, and South Dakota have integrated RSARs into their safety programs. In Michigan, an RSAR approach is being used to evaluate safety issues in regard to urban intersections.

The use of the RSAR by rural local agencies was identified in Arizona, South Dakota, and Wyoming in surveys used to develop an NCHRP synthesis on safety tools for local agencies (*4*). The RSAR concept is being used by more local agencies each year. Depending on resources, there are a number of different ways to use the RSAR concept to develop a local safety program.

An important subject in the low-volume rural road environment is that improving so many miles of roadway to current standards would be neither economical nor practical. For rural local governments, a proactive program involving a functional classification of their rural roadway system and the use of an independent peer group of auditors is both practical and affordable.

The classification system helps to guide the improvements of the identified safety issues into alternatives by considering the use of the roadway section being evaluated and the ability to apply the improvements incrementally. Such decisions are made in light of the classification and the safety issue involved, as well as by applying a value judgment to the urgency of the improvement and the resources available.

Because there are several key elements to the RSAR that provide value beyond an unstructured safety review, locally needed modifications to the concept are encouraged. The RSAR results in a formal written report that is short, simple, and proactive. Orally communicating the report is also important, as is the local agency's formal written response to the report. Independence is another key to the RSAR. The local agency becomes the client for the RSAR report and provides the review team with the roads and streets to be audited, plus information on their functional classification.

The review team reflects a blend of background and expertise. Core knowledge is generally considered to be knowledge of local road safety and maintenance skills. Other skills of team members may vary depending on the issues associated with the road users and/or the complexity of the facility. Review team member's skills could include traffic engineering, human factors, construction, design, and operations. Team members may also have knowledge about pedestrians, bicyclists, and trucks.

There are a number of different ways to undertake an RSAR and to develop a team. One suggested methodology is that one county audit another county's network. A system to classify existing roads, examine their current usage, identify deficiencies, and prioritize needed safety improvements is the goal of an RSAR program. The premise is that local agencies can best achieve needed safety improvements by prioritizing activities and chipping away at problems as resources allow.

CHAPTER THREE

U.S. PRACTICE OF ROAD SAFETY AUDITS AND ROAD SAFETY AUDIT REVIEWS

EARLY DEVELOPMENT IN THE UNITED STATES

The initial exposure to RSAs and RSARs in the United States was the result of the 1994 FHWA safety management scanning tour and the 1996 RSA FHWA scanning tour that assessed the practice in Australia and New Zealand. The FHWA then contacted all state DOTs to determine interest in applying the concepts as a pilot study. In 1997, a workshop was held in St. Louis to discuss the practice and pilot activities. The pilot DOTs were from 13 states, with local governments in 2 states also participating in the pilot program. That marked the beginning of U.S. practice.

The pilot studies identified issues, concerns, successes, and limitations pertaining to the application of RSA concepts in the United States. In an unpublished assessment of the pilots performed for the FHWA Office of Highway Safety, issues and challenges identified included how to obtain a funding commitment, costs associated with performing the audits, costs of implementing suggested changes, costs associated with liability, and ways to best balance costs of safety with costs of other project factors?

Concerns were also expressed about the environment in which the audit would be conducted. Questions included

- Is an audit a criticism of the design?
- Will the designer feel threatened by audit findings?
- What is expected in an audit?

Other concerns were associated with administrative and personnel matters. Administratively, issues such as the unknown value and benefits of an audit, selling management on audits, overcoming such reactions as “the way we always have done it” or “we are already doing it,” and the control of the design process were identified. Personnel issues reflected the availability of staff time, peer-to-peer problems, and training and education in the process. One principal issue raised was the training of auditors.

Collectively, these responses indicated that agencies needed additional information and guidance concerning the application of an RSA. In response, the FHWA developed a training course to raise awareness of the concepts, identify RSA issues, and provide ways to make the RSA and RSAR practice work for state DOTs. The FHWA course was initially presented in Kentucky in August 2000. It was also later presented in Georgia, Mississippi, Missouri, New York, South Dakota, Utah, and Vermont. In 2001, that course was then developed into an NHI course (*3*). The pilot of the NHI RSA course was held in Maine in June 2002. By the end of 2003, the course had been presented in Delaware, Indiana, Maine, Massachusetts, South Carolina (twice), and Wyoming, as well as in Puerto Rico. By the end of 2003, this training course had been given to 13 different state DOTs.

Additional training has taken place in the United States, including a rural course for local county governments in three states and other training provided by international RSA experts in several other states. Courses have also been presented in Kansas and Maryland by internationally based instruction and locally by the Pennsylvania DOT (PennDOT). Local rural RSAR training courses have been presented in Arizona, South Dakota, and Wyoming.

Awareness presentations have also been made at both the local rural RSAR workshop and the DOT workshop in a number of different forums, both internationally and within the United States. It is generally recognized that the proactive RSAs and RSARs, internationally, have the potential to advance safety in the United States.

To assess the current state of the practice, a survey was developed and distributed to all state DOTs. Surveys were also sent to Canadian provinces and selected local governments. Canadian responses are discussed in chapter four.

The survey was designed to determine the extent to which safety audits were being used, identify advancements since 1997, determine if states that received training have implemented RSA or RSAR processes, and gather information on issues that were raised in the summary of the pilot programs. The survey questionnaire is contained in Appendix A.

SUMMARY OF SURVEY RESPONSES

Thirty-eight states and six Canadian agencies responded to the survey. Seven states indicated that both RSAs and RSARs were being conducted by their DOTs. Ten states indicated that either RSAs or RSARs, but not both, were being used by their DOTs. A total of 22 states responded that neither safety tool was being used. Responses to the survey are discussed in the following sections and summarized according to by the key issues. A list of states and Canadian provinces that responded to the survey is contained in Appendix B.

Also included in the following sections is information provided from various states that hosted RSA training courses. These state responses are not specifically referenced, but all information provided has an origin of a training course, either during the course or follow-up activities or as given in survey responses.

Institutional Issues

All respondents were asked to complete the section on institutional issues. Seventeen states indicated that safety management planning was part of their safety program. Of these, only five states indicated that RSAs or RSARs were part of their safety management plan.

Sovereign Immunity

In regard to this issue, there appeared to be no specific trend in applying RSAs and RSARs and whether or not the state had sovereign immunity. Two states that were applying both tools indicated full immunity and three indicated partial immunity. For states that apply one of the tools but not both, two indicated full immunity, four had partial immunity, and four had no immunity.

The issue of using the RSA tools and not implementing the changes was also raised. It is related to organizational issues addressed later in this chapter. This issue has been a major focus during the training courses. Local legal staffs have presented a variety of positive statements supporting the use of RSAs and minimizing the fear of liability. Common responses by the DOT legal staffs are that RSAs will help in the defense of tort liability, engineers should do the engineering and leave the liability issues to the legal staff, and RSAs can only help the DOT.

Measurable Safety Goals

Most states indicated that measurable safety goals were associated with rate-based crash statistics, although several states noted that crash numbers or both were included in their measures of accountability. The following list gives several examples of specific state responses:

- South Dakota indicated a desire to keep the crash rate below 200 per 100 million vehicle miles traveled and 2 crashes per 1 million vehicles entering or leaving a spot location.
- Michigan stated that their goal was to "ensure that highway safety is considered in the development and implementation of all department projects for the purpose of reducing deaths, injuries, and total accidents occurring on the state's highways. All actions should result in an average annual reduction of 1,500 crashes occurring at identified high crash locations."
- The Alabama DOT adopted the FHWA goal of a 20% reduction in crashes and fatalities in 10 years.
- The Washington State DOT tied its safety goals to a benefit–cost ratio method that considers projected versus actual benefit–cost aimed at reducing societal costs of collisions at both specific locations and statewide.
- Louisiana stated that their goal was to reduce the crash rate for fatal and injury crashes by 4% each year.
- Iowa's goal was to have a 10% reduction in run-off-the-road crashes on roadways on which 4-ft paved shoulder and shoulder rumble stripes are installed.

Institutional Barriers

Overcoming institutional barriers associated with the practice of implementing RSAs or RSARs was an important consideration for many states. States implementing both RSAs and RSARs highlighted issues such as agency culture, staff interests, manpower, expertise, and financial factors. One response was that "Questions were raised if we were duplicating the efforts of our Roadway Safety Improvement (RSI) program. Once the difference was defined, the barriers seemed to disappear." Another response was that "Some local governments had reservations about identifying safety concerns and not doing anything about them for an extended period of time."

Other issues were raised by states that applied one but not both of the tools. Comments included questions and statements such as:

- When is an audit most beneficial?
- Is this a necessary addition to the core project team?
- Is a formal implementation policy needed?
- Where are the staff resources?
- There is a need for more timely crash data.
- There is a competition issue with present practice.
- RSAs need to have champions with the facts.
- We don't have sovereign immunity.
- Turf issues are a problem.
- Design and operation conflicts will expand.
- How does the prior investment in current safety needs process fit into the practice?

- There is a lack of a clear link from RSA to tort liability issues.

States that do not apply either tool provided these comments:

- What are these tools?
- NHTSA (National Highway Traffic Safety Administration) program assessment and annual plan already requires this.
- There is no requirement to do them.
- There is a perception that we already have a relative safe roadway system.
- Behavioral factors account for 85% of the crashes; these tools will not provide a good return given this fact.
- Training is inadequate.
- Labor is lacking.
- We don't need another layer of bureaucracy.
- We do safe design.
- Limited funds exist to respond to audits.
- What is the appropriate lead agency?

All of these issues, whether raised by states applying the tools or not, point to the continuing need to raise awareness, to provide benefit assessments when the tools are used, to provide models of how various states have developed a framework for applying the tools, and to provide training and share experiences. Only three state DOTs that had some RSA training indicated that neither safety tool was being applied in their DOT safety practice. One of those states indicated a local application focus and another indicated the training was not based on U.S. practice. The training developed in the NHI course addressed these issues as well as the concept that both tools need to be examined in light of how they can be made to work for a given agency. Several examples of the latter are provided here to show how these issues have been addressed and how the RSAs and RSARs have been tailored to fit and improve current safety practices. The following two sections address specific issues for states that indicated that RSAs or RSARs are part of their safety tools.

Road Safety Audit Issues

Only 11 states indicated that RSAs were being used. Most of these states were in the initial stages of assessing the benefits and had conducted only a handful of audits. Most indicated that fewer than six audits had been conducted by the time the survey was taken in the summer of 2003. The primary stages audited were planning and preliminary design. One state indicated that after evaluating different stages of audits, future audits would focus on preliminary design stage audits. Three states had conducted one final design stage audit. Pennsylvania has conducted the most audits. That state started a program to evaluate the benefits and issues in 1997, had management support, and selected two districts in the state to evaluate the issues. Although only one of the districts became a proponent of the tool, today the RSA is being used as a statewide safety tool and this state (Pennsylvania) has an RSA coordinator.

Audit Team Size and Skills

Audit team size and skills were of interest. Many states indicated that large teams were used, perhaps associated with the desire to have a broad base of evaluation for future applications. Teams ranged from 4 to 10 members. Team member skills included traffic engineering, final design, construction, maintenance, local law enforcement, human factors, and Americans with Disabilities Act and emergency medical service specialists. The audit team members were from the FHWA, state DOT headquarters and districts, local governments, and transportation consultants. Six states indicated that audits were conducted by in-house personnel, and five states indicated the use of both in-house personnel and consultants in conducting audits.

Types of RSA Projects

Projects audited included interchange modifications, expressway widening projects, reconstruction and expansion projects, intersections, bridge projects, and railroad grade crossing projects. Most audits involved projects to improve existing facilities. There were also RSAs for projects involving urban arterial cross sections and alternative rural highway cross sections.

Implementation of Audit Findings

Most states responded that the audit recommendations were used in scoping the project for some of the planning stage audits, were carried over to the final design stage for some preliminary stage audits, or were implemented. An important finding was that the audit did raise issues and present recommendations that would most likely have not been considered without an audit.

RSA Checklists and Prompt Lists

RSA checklists and prompt lists were used by most of the audit teams. Additional information used in various audits included:

- Crash data;
- Past plans;
- Scoping reports;
- Field visits;

- Alternative layouts;
- Area maps;
- Traffic volume data, including, when appropriate, current and projected average daily traffic;
- Turning movement counts;
- Zoning information;
- Program funding;
- Accident analysis and plans from previous projects; and
- Modal data.

Furthermore, all states indicated that the needs of pedestrians and bicyclists were specifically considered in the audits. Also, all states noted that other modes of transportation were considered by addressing access and public input and by using a multidisciplinary audit team.

Organizational Issues

Internal organizational issues were also investigated, such as those posed here by the following questions:

- How supportive is top management to the audit process?
- Does your state have an audit coordinator?
- How are RSA reports maintained?
- How are projects selected for audits?
- How is the audit program administered in your agency?
- How is the audit program funded?
- How are institutional issues addressed?
- What are the benefits of RSAs?
- What is your program's biggest success?
- What are the shortcomings of RSAs?
- What are the liabilities of RSAs?

How Supportive Is Top Management to the Audit Process? Top management support was indicated by all states that are conducting RSAs. "Yes, the director of program development said that we should do RSAs for all roadway projects"; "Believe so, they have agreed to RSA training of more than 15 individuals"; "Approval of the program implementation and approved funding for the effort was given after a presentation was made to the state highway engineer, deputy director for strategic planning, finance and administration, and the FHWA division engineer."

Does Your State Have an Audit Coordinator? Only two states, Pennsylvania, which has the longest history of RSA involvement in its safety program, and South Carolina, which developed an organizational framework for their RSA program, have RSA coordinators.

How Are RSA Reports Maintained? RSA reports are maintained at a wide variety of locations. They may be with the safety management coordinator, division traffic safety engineer, project manager, headquarters traffic engineering department, roadway design, or RSA coordinator.

How Are Projects Selected for Audits? Criteria used to select projects to be audited varied by state, with project size as one criterion. Among others were large projects with complex traffic control; regionally requested projects; controversial projects; projects with a high rate of accident and/or congestion problems; and projects with internal DOT differences of opinion as to the safest alternative.

How Is the Audit Program Administered in Your Agency? Program administration varied widely. In one state, the traffic safety engineer was the coordinator and responsible for assembling an audit team. In other states, the audit activities were driven by the regional traffic or district safety engineers or by the state's assistant chief engineer for preconstruction. Most states did not have an audit coordinator.

How Is the Audit Program Funded? Funding for audits came from a variety of sources, including maintenance program funds, FHWA support of audits on any federally participated projects, federal safety set-aside funds, and funding of the consultant/team leader using contractual services funds. On occasion, no separate special funding was provided because the project is charged as a preliminary engineering expense or as an overhead expense.

How Are Institutional Issues Addressed? Responses pertaining to institutional barriers to implementation of audit recommendations included the expected issues of funding as well as environmental and political considerations. One response was "The town did not want the improvement." Another response, however, was very positive and also demonstrated the benefit of an audit: "We have not encountered any institutional barriers. The DOT has been receptive to the audit findings and has made changes to designs of projects accordingly. The biggest barriers are budget constraints."

Two states indicated that RSAs were formally included in their programs. Pennsylvania responded that audits were included in its design manual, and South Carolina reported that audits were included in the safety office's business plan. The newness of audit activities in most states brought in responses that indicated the audits were not being used to check against safety performance goals.

What Are the Benefits of RSAs? The newness of the audit process was also a factor in assessing the benefits. Factors under consideration were to assess benefits using a benefit–cost approach, evaluating accident reductions, before-and-after analysis, and evaluating potential cost savings of implementing audit findings. One state commented that it did not have any formal assessment of success to date, except the positive responses associated with the revised plans. Another stated, “None yet, except doing what is right within ultimate budgetary and other constraints.”

What Is Your Program’s Biggest Success? The following were responses that addressed the program’s biggest success:

- “Explicit consideration of safety for the projects and being able to portray the safety considerations to other engineers, the public, and public officials.”
- “Having issues identified that were not thought of before because we had outside eyes looking at the project.”
- “Cooperation among the division and districts to determine the best options for roadway improvements.”
- “Reduced fatalities and crashes.”
- “Since we are in the first year of our program I think the biggest success is gaining agencywide support for the effort, including the commitment of time for RSA team members to travel the state to conduct audits.”
- “Only one done and the recommendations were accepted.”

What Are the Shortcomings of RSAs? The following responses addressed some of the more common shortcomings of RSAs:

- “Finding time to do more audits may be a problem.
- “Not enough RSAs being conducted due to funding issue.”
- “Need to have formal RSA training and knowledgeable people to do this specialized analysis.”
- “Following through to determine the benefits and successes; not done on a mass basis.”
- “Would like to see the program formalized as a valid project activity.”

What Are the Liabilities of RSAs? Liability assessment resulted in the following typical responses:

- “Liability is one of the major driving factors in performing a good audit.”
- “It demonstrates a proactive approach to identifying and mitigating safety concerns.”
- “When findings cannot be implemented an exception report is developed to address liability and mitigating measures.”
- “Our attorneys say that once safety issues are identified, and if we have financial limitations on how much and how fast we can correct the issues, then the audit will help us in defense of liability.”
- “Liability is not considered as an issue.”
- “The RSA process is not discoverable in court as excluded from evidence by 23 USA Code 409.”
- “Chief Counsel has reviewed the process and checklists.”

Although the number of states conducting RSA activities is small, the responses as summarized illustrate a very positive acceptance of the concept. The agencies’ comments also indicated the need to expand the training to more states and to promote the benefits of RSAs in the United States to help heighten the awareness and ability of state DOTs to assess their own acceptance of RSAs in their safety programs.

Road Safety Audit Review Issues

Thirteen states indicated that RSARs were part of their state’s safety program. This section highlights the questionnaire responses of these state DOTs. The modifications of RSAR practice in Iowa, New York, and South Dakota are detailed in the next section. Those states have tailored their programs for 3R/4R projects.

Types of RSAR Projects

RSARs have been conducted on transportation corridors, intersections, interchanges, and special areas such as school zones. Facility types ranged from two-lane county roads to multi-lane divided urban freeways. Among the bases for selection of roadway sections for RSARs were general safety concerns, sections with high crash levels, high traffic volumes, geometric roadway and associated design issues, sections scheduled for overlay projects, and including an RSAR as part of the project scoping process. Four states indicated that they had safety performance planning and that their RSAR activities were part of that process. One state was evaluating RSARs to determine if they should be part of its program.

RSAR Team Expertise

The various skills reported for the team members included traffic engineering, design, maintenance, and safety engineering, as well as expertise in pedestrians and bicyclists, young and older pedestrians, older drivers, local knowledge, human factors, law enforcement, and project scoping. There were also representatives from local and federal government.

Typically, teams were tailored to the type of facility being reviewed. In South Dakota, a review team for county road sections consisted of FHWA and state DOT traffic safety engineers, an independent county highway superintendent, and a representative from the LTAP. The review team for state roads consisted of a visiting regional traffic engineer, visiting area engineer, road design engineer, South Dakota Highway Patrol officer, and traffic safety engineers from the DOT and FHWA. In another state, a three-person team consisted of a specialist in highway design, one in traffic operations with expertise in pedestrians and bicyclists, and one in project scoping.

Administration of RSAR Activities

RSAR activities were administered by the state traffic engineer, regional and local traffic engineers, and a statewide RSA coordinator. There was no consensus about any specific location within the DOT. The RSAR reports were maintained at both headquarters and district levels of the DOT. Generally, the branch involved traffic engineering or safety engineering, although in some states the roadway design division maintained the RSAR reports.

Number of RSAR Projects, Team Size, and Data Issues

Various numbers of audits were conducted in the last 5 years, with Pennsylvania conducting the largest number. Most respondents indicated that fewer than a dozen RSARs were undertaken. Most states indicated that only a few audits had been conducted because they were just beginning to assess the use of RSAs and RSARs. Typical responses indicated on the order of four to six audits during the initial year.

Audit teams consisted of both in-house teams and consultants. Seven states reported using only in-house teams. In some cases, a consultant was added to the team to provide specialized input. Consultant activities included leading the team, writing the report, and providing expert input on issues related to older drivers.

Team sizes vary from state to state and for different projects. RSAR teams had as few as 2 and as many as 6 members. Typically, an RSAR team has 4 to 5 members, although several states indicated that teams can be made up of as many as 12 to 15 individuals. These were teams most likely formed to assess the issues of an RSA practice or involved in a learning exercise.

Ten states indicated that they used prompt lists and/or checklists during their reviews. Other information used by various states included detailed geographic information system crash data, collision diagrams, detailed traffic volume data, past plans, and site evaluations.

RSAR Implementation Issues

Various states indicated that their RSARs identified a number of ways to make safety issue improvements, which were then implemented. Spot improvements, such as signing, markings, and the addition of turning lanes were made. Other states indicated that low-cost safety improvements were added to maintenance activities and resurfacing projects. Still others mentioned that the RSAR resulted in design alternatives that addressed the findings. The major limitations to implementing an RSAR program were a lack of funding, manpower issues, and project schedules. One state identified the idea of another district telling them what to do as a point of controversy. In another state, the effects of budget cutting had limited its ability to continue the RSAR activity to the desired level. Top management was identified as supporting the RSAR activities in all but two of the states using the RSAR process.

RSAR Liability Issues

Liability was addressed in a number of different ways. Among the statements received were that there is no liability concern, the reports include a disclaimer statement, reports are not discoverable, the legal department handles this issue, and the agency has discretionary immunity.

Benefits and Successes of RSARs

The evaluation of the successes and benefits of RSARs brought responses that pertained to the willingness of agencies to incorporate the safety improvements suggested in the audit and that there are repeat requests for more RSARs. In one case, a benefit–cost analysis was undertaken before recommendations were finalized through historical data associated with the recommended improvements. Another response reported that safety has acquired greater emphasis; there is now a better understanding of law enforcement and human resource issues.

As for the success of RSAR activities, district and central office design staffs are now looking for opportunities to incorporate low-cost safety improvements following RSA and RSAR training. Personnel now have a better understanding of why specific safety enhancements are being suggested.

The diversity of the team was viewed as both a benefit and success of the program. One state reported, specifically as a result of the RSAR, "being able to identify a location with an accident problem or potential safety issue and recommending changes to actually reduce the number of accidents."

ROAD SAFETY AUDIT AND ROAD SAFETY AUDIT REVIEW PRACTICES OF MODEL STATES

Five states that have adapted either an RSA or RSAR program or have developed a tailored approach for their DOTs to assess those safety tools are highlighted in this section. These states provided specific details that should help others considering developing RSA and RSAR programs.

Iowa

Iowa has developed a modified approach to employing RSA concepts. The program is administered by the Office of Traffic and Safety. The state safety engineer has program responsibility. Audits are conducted in conjunction with corridors scheduled for resurfacing. The audits focus on 3R projects. Project concept statements are reviewed and a detailed summary of the corridor's crash history is prepared. The crash history in each corridor includes geographic information system analyses of fatal and injury crashes, fixed-object crashes, crashes grouped by roadway characteristics, crashes linked to geometric features, and crashes by type—single vehicle, rollover, right angle, etc. Collision diagrams are also prepared.

The audit consists of a field review by central office safety staff and district personnel. A typical team may consist of safety personnel from the DOT and FHWA, as well as district design, maintenance, and construction staffs. Local law enforcement is asked to identify any perceived safety deficiencies, but those officials are not part of the audit team. In addition, an older driver (an outside paid consultant who is a retired safety engineer) is added to the team to provide a unique perspective. A trip summary is prepared for the FHWA district administrator and the DOT district engineer. The FHWA safety engineer has the lead program responsibility.

Before initiating the RSAR program, district staff participated in a 3R safety workshop. This workshop was developed and is presented in-house by Iowa DOT and Iowa State University Center for Transportation Research and Education staff.

Both the proposed and recently completed 3R projects are reviewed in each district. These district RSARs are proposed as being completed once every 3 years in each district.

Among the safety deficiencies and recommended treatments identified in the audits are

- Substandard curves—add or correct superelevation, add pavement, remove fixed objects, delineate curves, pave shoulders, install shoulder rumble strips, and use larger or brighter chevrons.
- Safety dikes (escape ramps)—install opposite "T" intersections and remove fixed objects.
- Daylighting of intersections and driveways—cut vegetation, remove fixed objects, and flatten driveway cross slopes.
- Other intersection needs—add turn lanes and signal enhancements.
- Roadside features—add or undertake guardrails, culvert and inlet modifications, cattle crossings, tree removal, and improvements of cross slopes, and riprap; relocate and delineate utility poles.
- Other—install larger stop signs and center and shoulder rumble strips.

The audit team uses a checklist to identify key safety issues to be evaluated during the field inspection.

The audits have identified low-cost safety improvements. As a result, district and central office personnel have a greater awareness about safety.

The 3R safety workshop will be offered to county staff. Iowa has also proposed to conduct an RSA of a major corridor project at the planning stage.

New York

The state of New York has developed and implemented a comprehensive, modified RSAR process to incorporate safety considerations in its existing pavement preventive maintenance program. The program, SAFETAP (Safety Appurtenance Program), involves maintaining existing safety features and adding appropriate, implemental, low-cost safety features at preventive maintenance project locations before, during, or after resurfacing as part of a joint effort (*7*).

The impetus for the project was the observation in the 1980s that simple resurfacing without roadside improvements contributed to increases in the number of crashes in the 3 years following resurfacing. The program existing at the time did include a safety screening process, but safety improvements were not implemented so that funds would be conserved for maximizing the number of miles resurfaced.

The SAFETAP initiative included the following elements:

- Team of auditors with the expertise to assess existing and potential crash problems,
- Review of existing crash data and a site inspection,
- Recommendations of cost-effective solutions by the audit team to agency leaders with the responsibility for implementing crash countermeasures, and
- Reports to the Traffic Engineering and Highway Safety Division describing the disposition of recommendations and implemented actions.

Program Implementation Issues

Given the limited resources and the competing concerns of different elements within the New York State DOT, an implementation strategy was developed to obtain management buy-in for the program. The chief engineer's support was an essential factor in the program's success. The program was first presented to main office managers, then to regional managers, and then to executive management. In this manner, the supporters of the program were able to address the concerns of affected parties.

Audit Process

Projects are selected in accordance with the criteria established for pavement resurfacing priorities. When a site is selected, the regional director assigns an RSA team consisting of experts from the regional traffic, design, and maintenance groups and others as appropriate. The team analyzes crash data, makes a site visit, and develops recommendations for safety work. The team uses a checklist for guidance in identifying potential safety issues. Safety treatments identified include those necessary to avoid degrading safety and those that are practical and necessary to address existing and potential safety problems. Procedures are established for conducting the audit and reporting the audit results. The audit forms become part of the paving project file and are also maintained at regional offices.

The timing of safety work is coordinated with the paving process on the basis of need, complexity, and resource availability. In general, recommendations pertaining to sign replacement are done before paving. Superelevation, shoulder treatments, and edge of pavement drop-off problems are addressed during the paving contract; pavement markings, rumble strips, guiderails, delineation, fixed objects, and new signing are done during or as soon as possible after completion of paving. Other items such as guide signing, major treatment of fixed objects, and other features of concern not specifically covered are done in a timely manner following the completion of paving.

SAFETAP Results

During the first year of the program, 216 safety treatment sites were identified, and 107 safety improvements were implemented. Predictions based on past safety activities were that the program would cost from \$15 to \$25 million each year, would result in 1,000 fewer crashes per year, and would result in a savings of \$25 to \$50 million in crash costs. The actual results after the first few years indicated that the estimated savings were conservative. Crash reductions occurred at more than 300 high-crash locations treated with low-cost improvements; crash reductions ranged from 20% to 40% depending on the type of improvement implemented (*8*).

South Dakota

Since South Dakota received RSA and RSAR training in July 2001, its DOT has conducted three RSAs on projects during the preliminary design stage and two RSARs on projects in the planning stage on the state trunk and Interstate systems. The South Dakota DOT has also assisted in five RSARs on county road systems since the initial training. The region traffic engineer initiated and organized the RSAs on the state trunk and Interstate systems, and has been the keeper of the master report and file. The county highway superintendents initiated RSARs through the South Dakota LTAP (SDLTAP). The SDLTAP in turn asked for assistance from the DOT traffic and safety engineer in the DOT Office of Local Government Assistance. A checklist as an inspection guide was used to ensure that safety issues were not overlooked when observing any of the roadway features.

The South Dakota DOT has conducted three RSAs on projects during the design stages. One was on a U.S. highway in an urban setting; one on an Interstate interchange and a state highway, where the state highway portion of the project intersects the interchange in an urban setting; and one on a state highway in a rural setting. The teams consisted of the DOT region traffic engineer, DOT road design engineer, FHWA traffic and safety engineer, city engineering staff member, city commissioner, business owner, city traffic engineer, guest region traffic engineer, assistant public works director, FHWA pavement and materials engineer, law enforcement, and DOT traffic and safety engineer. Not all of those individuals participated in each RSA, but a team of five to six people with the such backgrounds were selected for each RSA. The information gathered from RSAs was given to the DOT road designer or the consultant engineer designing the project. In all cases, there were changes made in the design as a result of the RSA inspection.

The South Dakota DOT has conducted two RSARs for planning purposes. One was on an Interstate interchange, which is in the long-range State Transportation Improvement Program (STIP). The Interstate interchange RSAR was organized by the region traffic engineer with the team consisting of the region traffic engineer, DOT operations engineer, DOT traffic and safety engineer, FHWA traffic and safety engineer, county highway superintendent, city engineer, and city council member. The crossroad over the interchange is a city street feeding an industrial area on one side of the interchange, and a county road through a housing area along a lake on the other side of the interchange. The information from the RSAR will be used as input into the planning process.

The second planning RSAR was on a tourist-oriented/scenic road in the Black Hills. The RSAR was organized by a region traffic engineer from a different region than the one mentioned earlier. The team consisted of a guest region traffic engineer, guest area engineer, FHWA traffic and safety engineer, DOT road design engineer, DOT traffic and safety engineer, and South Dakota Highway Patrol officer. As a result of this RSAR, there was a project incorporated into the STIP. The information from the RSAR is to be used as a design guide for the improvements to be done on the project.

There were five RSARs conducted on the local county road systems. They were organized by the SDLTAP after being contacted by the county highway superintendent. The SDLTAP requested assistance from the DOT traffic and safety engineer in the DOT Office of Local Government Assistance. That engineer served as the team leader with the remainder of the team consisting of an SDLTAP representative, FHWA traffic and safety engineer, and a guest county highway superintendent. The county highway superintendent responsible for the roadway classifies the roadways to be inspected using the local classification as given in the RSAR section of *NCHRP Synthesis of Highway Practice 321*(*4*). For the final report, the team classified the items for improvement:

- Items where immediate safety improvements should be made,
- Items where low-cost improvements could have a positive impact on safety and should be considered in a reasonable period of time, and
- Items identified as high-cost improvements that should be considered as funds become available for a major rehabilitation or reconstruction of the roadway.

Ultimately, the items listed in the report are reviewed in a closeout meeting with the highway superintendent responsible for the roadway. The traffic and safety engineer then writes the final report and forwards it to the highway superintendent. The traffic and safety engineer keeps the master copy in the files at the Office of Local Government Assistance.

Pennsylvania

PennDOT began a pilot program of RSAs in 1997. The goals of this program were to answer these questions:

- Does the RSA process add value?
- Can the RSA process be implemented by using existing resources?
- Will the RSA process delay project delivery?

The pilot project was initiated in one district with procedures developed based on the Australian audit model. Particular attention was paid to developing a process that differentiated the audit process from safety reviews.

For the pilot projects, a safety audit team of five people was selected from the following six discipline areas: traffic engineer (coordinator), construction services, project design, highway safety maintenance, risk management, and comprehensive safety (human factors). All were in-house, except for the human factors person. Projects to be audited were selected by the RSA coordinator and the assistant district engineer for design. Eleven projects were selected in all phases of project development. To date, 60 projects have been audited.

Typical safety issues identified in the audits included the need for left-turn lanes, daylighting of intersections, presence of fixed objects, roadway realignment, lengths of acceleration and deceleration lanes, pedestrian needs, and sight distance. The estimated costs of the audits, exclusive of the cost of the improvements, ranged from $2,000 to $5,000.

The recommendations developed by the audit team were submitted to the audit coordinator, who reviewed the report, forwarded the report to the assistant district engineer for design, and met with the project manager to discuss concerns and possible improvements.

Numerous benefits were identified as a result of the audit process, including

- Maintaining a safety focus,
- Identifying safety concerns early in the design process,
- Achieving interdisciplinary cooperation,
- Developing consistency in design,
- Enhancing communication, and
- Recognizing safety improvements that were beyond the scope of the original project.

The pilot projects generated a number of challenges and opportunities related to implementation of the audit process. Some of the major challenges were time demands on the coordinator, team members' changing positions, the need for audits to be conducted early in the design process, dealing with changes that affect the project's environmental footprint, dealing with stakeholders and controversial recommendations, identification and selection of projects to be audited, liability concerns, and gaining buy-in from top administrators and others involved in the process.

A set of recommendations was developed that included the following:

- Get buy-in at all levels early in the process,
- Establish a coordinator's position,
- Select an audit team that is interdisciplinary and has the required expertise,
- Provide training to team members,
- Separate the audit process from safety reviews,
- Conduct the audits early in the design process,
- Cite audit safety concerns and not provide recommendations, and

- Ensure that the process involves multiple opportunities for communication.

The pilot audit project concluded that:

- The RSA process definitely added value by identifying safety issues,
- RSAs could be completed without draining existing resources—not accounting for the additional cost of the safety improvements that were identified, and
- RSAs will not affect project delivery time if conducted early in the process.

Since the pilot program, PennDOT has continued its audit program. The agency has conducted audits in its 11 districts. The central office has an RSA coordinator who provides training to the districts. There is also an open-ended consulting contract to provide assistance to the districts. Funding difficulties have constrained the conducting of more RSAs but, with FHWA's commitment to the program, PennDOT anticipates expanding the program.

South Carolina

The RSA program in South Carolina is administered by the South Carolina DOT safety office. The program has buy-in from top administrators, because they approved implementation and funding for the effort. The director of safety is responsible for the overall program administration. The program is housed in the safety program unit of the safety office and the director of safety is responsible for the overall administration of the program. The RSA coordinator handles the day-to-day operations of the program. The RSA program is supported by an RSA advisory committee that includes the deputy state highway engineer, the engineering directors (e.g., traffic, construction, maintenance, pre-Construction, etc.), and the director of safety. The committee approves operating procedures for the program and selects projects for audit.

The South Carolina DOT has established a procedures manual for the audit process. That manual includes information on the management of the process, procedures for selecting projects to be audited, and instructions for distributing audit results.

The program is funded with federal set-aside monies. Projects are solicited annually by the RSA coordinator from the deputy state highway engineers, the engineering directors, the district engineering administrators, and the director of safety. The RSA coordinator compiles a list of the project's along with additional information on the project cost and crash history, if available. The coordinator prepares a prioritized list of recommended projects for approval by the RSA advisory committee. Project selection includes new infrastructure projects, projects under construction, and existing infrastructure projects. Projects include Interstate projects, rural and urban system upgrades, and innovative projects listed in the STIP pertaining to existing roads.

The RSA plan calls for 10 audits to be conducted each year; 11 audits were conducted in 2003. These were in the process of being finalized. Five audits were conducted on projects under construction, two on new infrastructure projects in the final design stage, and four on existing roadways (RSARs). Each audit involved a team of four to five people representing construction, road design, traffic engineering, maintenance, and safety. The teams used checklists to aid in conducting the audits. Because the projects have not yet been finalized, benefits have not been documented. However, it is anticipated that the response to the audit reports will address benefits. A more complete discussion of the South Carolina RSA program is provided in Appendix E.

CHAPTER FOUR

INTERNATIONAL PRACTICE OF ROAD SAFETY AUDITS AND ROAD SAFETY AUDIT REVIEWS

INTRODUCTION

The first documented use of RSA practices was in the United Kingdom in the 1980s. It involved the modification of a tool used by railway engineers at the turn of the century to examine safety issues on railways. The United Kingdom published the first set of road safety guidelines in the early 1990s. The use of RSAs followed shortly after in Australia and New Zealand. It was the applications in these countries that attracted the attention of the United States and other countries. They perceived the RSA as a tool that could enhance safety and reduce the number and severity of roadway crashes.

During the past decade, the global application of RSAs has expanded. The United Kingdom, Australia, and New Zealand have continued to refine, modify, and enhance their RSA practices. Much of the information provided in this chapter is based on an international conference sponsored by the United Kingdom's IHT held in London, England, in October 2003. Although information on international practices has come from a variety of sources, that conference provided an excellent assessment of the state of practice in many countries around the world.

UNITED KINGDOM

It is important to remember that RSAs have been used for more than 20 years, beginning with the United Kingdom. There are consulting firms in the United Kingdom that have conducted literally thousands of RSAs. The United Kingdom has advanced the applications of RSAs to the point where it is mandatory for all trunk road highway improvement projects and also mandatory to conduct an RSA monitoring process of all projects that have involved an RSA. Monitoring the effects of RSAs on those facilities began in 1990. The requirement to monitor the effects of RSAs was added to the 2003 edition of the *Design Manual for Roads and Bridges* in the "Road Safety Audit" section, HD 19/03, which became effective in November 2003 (*9*). Projects are now required to be monitored after 12 and 36 months.

Several practice issues of the HD 19/03 section on RSAs are briefly highlighted here. There are three stages of audits required separately or in combination for improvement projects, unless excluded for small projects within the same alignment. The required U.K. audit stages are

- Completion of the preliminary design,
- Completion of the detailed design, and
- Completion of construction (in the United States, referred to as an RSAR).

In addition to those three types of audits, an interim stage audit has been being introduced as a new concept for RSA application anytime during the first two audit stages. The interim audit is not a requirement. The concept is to provide input into the design process while the plans are being developed. The independence of the formal audit process is still stressed. The trial applications of an interim audit have been found to aid in reducing road safety problems earlier and thereby reducing program and design costs.

The requirements for an accident monitoring report using both 12- and 36-month crash data have also been introduced as part of HD 19/03 (*9*). Such a monitoring process focuses on linking crash characteristics and audits to help future RSA activities to reduce crashes.

Through HD 19/03, many issues of practice can be recognized that should aid in RSA applications worldwide. HD 19/03 also offers samples of all audit stage reports, stage checklists, issues and monitoring reports. The checklists for each audit stage are contained in Appendix D.

In the United Kingdom, audit teams are identified as requiring minimum of two members. Suggested guidelines specify that the team leader have these qualifications:

- A minimum of 4 years of accident investigation or road safety engineering experience;
- Completion of at least five audits in the past 12 months;
- A minimum of 2 days of continuing professional development in the field of RSA, accident investigation, or road safety engineering in the past 12 months; and
- Meets the requirements of a team member.

Suggested guidelines concerning qualifications for team members are:

- A minimum of 2 years of the previously cited associated skills;
- Completion of at least five audits in 24 months as a member, leader, or observer in the past 24 months. The audit team member should have undertaken at least 10 days of the previously cited skills; and
- A minimum of 2 days of professional development.

Two additional categories of expertise are identified to assist in auditing, although they are not specifically identified as being possessed by team members. They are an observer and a specialist. It is suggested that the observer have a minimum of 1 year experience and a minimum of 10 days of formal training. The observer assists in the audit process; the intent is to develop the pool of new audit team members. In addition, there is provision for specialist advisors. The use of a specialist requires approval of the project sponsor. The specialist is not a member of the team but advises the team on matters relating to their expertise. Such requirements indicate that the audit process is very formal, which certainly is the case (*9*).

The design team provides a brief to the project sponsor, who may instruct the design team to delete unnecessary items or to add information. Any changes must be documented. In the United Kingdom the RSA information proceeds from the team that designs the project to a supervisor or project sponsor. The brief consists of the following 10 items:

1. The alternative design showing full geographical extent and including areas beyond the project;
2. Details of the approved departures and relations from standards; that is, design exceptions;
3. General details, purpose, speed limits, forecasts of traffic flow, nonmotorized flows, and desired lines and environmental constraints;
4. Other relevant factors such as adjacent land uses, proximity to schools, and emergency vehicle accesses;
5. Accident data for design alternative and adjacent sections;
6. Details of changes introduced at previous audits;
7. Plan sheets;
8. Previous RSA reports and a copy of the interim file if an interim audit has taken place;
9. Contact details for transmitting maintenance defects (telephone call or separate written message from audit report); and
10. Details of appropriate police contact (*9*).

The audit team submits the RSA report to the project supervisor, not directly to the design team. The initial submittal is in draft form so that any issues agreed to be outside the scope of the project can be identified and removed. The audit team includes only issues relevant to safety. Any items such as observed maintenance defects are addressed separately.

The detailed requirements of the audit report are also specified in 10 separate items:

1. Brief project description;
2. Audit stage team members and other members;
3. Site details, who was present, and conditions of weather and traffic on day of site visit;
4. Specific road safety problems identified, with supporting documentation;
5. Recommended actions for removal and mitigation;
6. Location maps marked and referenced to problems;
7. Statement signed by the audit team leader, in a required format;
8. List of documents and diagrams considered for the audit;
9. Separate statement for each identified problem describing the location, nature, and types of accidents likely to be considered as a result of the problem; and
10. Associated recommendations (checklists are not to be included) (*9*).

An example of the audit report from HD 19/03 is included in Appendix C. Integral to the audit process are the implementation of the audit recommendations and identification of the exceptions, to ensure that the problems raised by the audit team were given consideration.

> The project team may wish to consult the design team at this stage of the audit. If the Project Sponsor considers any problem to be outside the scope of the project or not suitable given the relevant environmental or economic constraints, the project sponsor shall prepare an Exception Report giving the reasons and proposed alternatives for submission to the Director, with whom the final decision rests. The project sponsor shall provide copies of each approved Exception Report to the Design Team and to the Audit Team Leader for action and information respectively (*9*).

Finally, the project sponsor instructs the design team with respect to any changes required resulting from the audit. Prompt action and continued communication are required. Closing the loop is feedback to the auditors regarding the actions taken as a result of the audit.

This brief overview of U.K. practice indicates the strong history, continuing belief in the benefits of the RSA safety tool, and continued commitment to advancing the state of the practice. For additional information, a 2001 U.K. publication entitled *Practical Road Safety Auditing* (*10*) as well as other works previously mentioned (*6,9*). In the United Kingdom, RSA practice has continually led to safety improvements implemented in projects as an initial safety benefit and not as a needed safety retrofit after a project has been completed.

The following snapshots of various countries' experiences raise key issues for advancing the U.S. practice of RSAs and RSARs.

AUSTRALIA AND NEW ZEALAND

The experiences of Australia and New Zealand formed the basis for audit practices in the United States. It is interesting to follow the development in those countries and contrast their progress with that of the United States. In 1990, Transit New Zealand (Transit), which is responsible for managing the national road network (state highways), began examining the RSA. The initial efforts emphasized awareness programs, which were followed by pilot RSA exercises. Experienced auditors from the United Kingdom and Australia assisted the pilot audits, which were used as training exercises. Australia underwent a similar but earlier development in the states of Victoria and New South Wales.

U.S. states were encouraged to pilot the RSA. Approximately 20% of the states did so in the first years after the FHWA's 1996 scanning tour in Australia and New Zealand. The scanning tour focused on the development activities of the states of New South Wales and Victoria in Australia and of Transit in New Zealand (*11*). New South Wales, VicRoads, and Transit all had RSA Manuals, and by 1993 had all adopted RSA practice. Australia and New Zealand worked together in 1994 developing the Austroads *Road Safety Audit Manual*, which was the focus of the U.S. scanning tour. The second edition of the Austroads guide, Road Safety Audit, was completed in 2002 (*5*).

Transit's policy in 1993 was to apply RSAs to a 20% sample of its state projects. By 1993, the United Kingdom, New South Wales and Victoria in Australia, and Transit were the world leaders in RSA practice. That statement applies today, although other countries including the United States are actively following similar paths to RSA development. Other international activities are highlighted later in this chapter.

As RSA development continued in New Zealand, there was no initial requirement for local agencies to undertake audits. However, Transit demonstrated RSAs using several local authority projects in the early learning stages (pre-1993) and encouraged local agencies to adopt RSAs. Transit has incorporated a revision to its early RSA practice by now referring to RSAs as audits of projects being developed to project construction; audits of existing roads are now excluded in the revised manual. This is similar to the current U.S. philosophy and the use of the term "RSAR" for the audits of existing roadways.

Today in New Zealand, the current policy of Transit is to apply RSAs to all projects and to allow for exceptions if the project manager believes that an RSA is not necessary. Documentation is required if the decision not to conduct an RSA is made. In the United Kingdom, the RSA Standard HD 19/03 has a similar provision.

The similarities of development patterns for those countries that are the world leaders in RSA practice is continuing. Today, auditor certification, continuing requirements for auditor training, and liability are common issues.

A major reason for the international acceptance of RSA activities is that accident investigators initially found design faults that should have been identified before new facilities were built. The added value of proactively preventing crashes is the primary reason that the two Australian states and the United Kingdom continue to apply RSAs as an operational practice. In New Zealand, the RSA is recognized as an essential safety management tool.

CANADA

Canada has been a leader in North America in the implementation of RSA concepts. The first formal audit was completed in Vancouver, British Columbia, in 1997. Since that initial audit, several provinces and local governments have conducted audits. One impetus for their use was the support of the Insurance Corporation of British Columbia in the development and application of audit techniques as a tool to reduce the number and severity of traffic crashes. The Transportation Association of Canada (TAC) has developed *The Road Safety Audit Guide* to aid safety professionals in the application of the audit process (*2*).

For this synthesis, four Canadian provinces and two Canadian cities completed and returned survey questionnaires. One city and two provinces have conducted RSAs, and two cities and two provinces have conducted RSARs. One province indicated that it had conducted many safety reviews, although not by an independent team. Those agencies that conducted audits reported that the number they did varied from a single preliminary design stage audit to 10. The audits were done about equally during the planning, preliminary design, and design stages. Two current issues of concern in Canada are using RSAs in design-build projects and in value engineering.

Institutional Issues

Only one agency had a safety management plan and only one other agency had measurable safety goals. None of the provinces or cities reporting had sovereign immunity. Major barriers to implementation that were identified included inadequate funding, lack of staff, and difficulty in achieving buy-in, although two agencies did indicate support from senior management. Four of the agencies had used modified concepts of RSAs or RSARs, and three used the RSA guide developed by the TAC as the basis for their work (*2*). Four agencies had participated in some training provided in-house, by consultants, or by the TAC.

Additional Findings

Audit Team Size and Skills

The typical size of an audit team was five to six people. Disciplines represented included planning, design, construction, and traffic engineering. Consultants were used by one agency as part of the audit team.

Types of RSA Projects

Projects audited included interchange design, freeway design, and upgrading a two-lane arterial to a four-lane arterial.

Implementation of Audit Findings

Agencies indicated that some of the recommendations were implemented and that concepts identified in the audits were incorporated into the design.

Use of Checklists

One province used checklists and two used prompt lists.

Organizational Issues

The resources made available to the team included staff time and funding for external consultants. Two agencies used consultants. Two agencies maintained audit reports locally, and one city had an RSA coordinator. Projects were selected both on an ad hoc basis and according to a defined selection process. Institutional barriers mentioned included the lack of staff resources and difficulty in implementation if the recommendations were considered too costly or impractical. The audits did address the needs of pedestrians and bicyclists, except on freeway projects. Road user input was part of the audit process for three agencies. No agency used cost-effectiveness procedures to evaluate the benefits of the RSA process. Success was measured by increased awareness of safety and the establishment of a process for identifying tangible safety benefits. Shortcomings mentioned were inadequate funding and a lack of integration with other safety programs. Programs were funded through a municipal tax base and capital budgeting.

Administration of RSAR Activities

Most of the RSARs were conducted in urban areas, with two agencies focusing their reviews on intersections. The size of the audit teams varied from two to eight individuals. Disciplines included traffic operations, planning, police, and consultants with RSA expertise. Two agencies used prompt lists rather than checklists in their RSARs.

The RSARs were carried out with both local staff and consultants and resulted in spot improvements. Projects were selected on the basis of crash data and operational concerns. Institutional barriers encountered included inadequate resources, some confusion among the various existing safety programs, resistance to accept a new procedure, and concerns over legal implications.

Only one agency had RSARs as part of its overall safety program. In one city, the audit included input from motorists, bicyclists, pedestrians, and the handicapped as observers.

Benefit–cost evaluations of RSARs are just beginning to be developed, but one agency uses published data on projected safety benefits resulting from various safety enhancements. All established RSAR programs have top management support. The biggest successes identified to date included buy-in from engineers and management, identification of tangible safety benefits, and increased visibility and acceptance by the public and at the political level.

IRELAND

In Ireland nationally and 33 major cities in the country, the design manual procedures have incorporated RSAs. The RSA process is required for all projects involving a change, and approximately 75 projects are audited each year. Training of auditors is stressed in the program. The subject of international auditor training is presented in a separate section in this chapter.

ITALY

In 2000, a pilot program to assess RSAs in Italy was undertaken. From 2001 to 2003, the emphasis has been on existing routes. Currently, a process is being developed to combine crash data and safety inspections. Design stage audit RSAs are required for urban areas with populations of greater than 30,000 and in high-risk areas. Education is another major area of focus.

OTHER COUNTRIES WITH ROAD SAFETY AUDITS

A number of other countries are involved in conducting RSAs. The World Bank has championed the use of RSAs, providing funding for consultants, performance of audits, and training. The following list is not intended to be all inclusive, but is provided to indicate global acceptance of the practice. Other RSA participants include

- India, Thailand, and others in Southeast Asia;
- South Africa;
- Eritrea in Northeast Africa; and
- Denmark, Finland, Germany, Italy, Norway, The Netherlands, and Switzerland in Europe.

ROAD SAFETY AUDIT BENEFITS

RSAs are internationally viewed as inexpensive to conduct (*5*). Furthermore, studies of the benefits of RSAs have indicated high positive benefits. At the 2003 IHT Conference on Road Safety Audits, Phillip Jordan of VicRoads in Australia summarized the studies of RSA benefits as part of his presentation. Highlights of his presentation follow.

- Typical costs of audits were estimated to range from $1,000 to $8,000 U.S. dollars, depending on the size of the project. Several examples of benefits were based on the analysis of similar projects with before-and-after crash data. One report examined crash data over a 2-year period for 19 audited and 19 nonaudited project sites in the United Kingdom. The audited sites had a casualty savings of 1.25 per annum, whereas the nonaudited sites exhibited a savings of only 0.26 per annum. In another U.K. study that examined 22 audited trunk road sites, the cost of implementing the recommendations was compared with the cost of rectifying the sites after the project was constructed. The average savings per site was 11,373 British pounds sterling or about $19,600 per site.
- Austroads described an analysis of nine audit sites reporting 250 different design stage audit findings that resulted in benefit–cost ratios ranging from 3:1 to 242:1. As for audits of existing roads, benefit–cost ratios ranged from 2:1 to 84:1.
- In other studies that presented the audit results in the form of a rate of return, figures such as a 120% rate of return in the first year were reported. In Denmark, analyses of 13 projects provided a first-year rate of return of 146%. Recognizing that these types of analysis are often questioned, a sensitivity analysis of input data was conducted. That analysis involved multiplying the input data by magnitudes of 2 and 4. The following conclusions were given: With a sensitivity of input estimate of 4, a 7% positive benefit still occurred. When a factor of 2 was applied as a multiplier to the input estimates, the analysis resulted in a positive benefit of 37%.
- If one life is saved as a result of an audit, the benefits will far exceed the audit costs. It is, however, difficult to attribute saving lives to any one audit or audit recommendation or action. Over time, monitoring audited projects and the actions taken should help to reinforce the value of an audit.

When the benefits and costs of audits were discussed during the IHT 2003 conference, several factors were generally accepted. Analysis of audit costs generally included the audit fee or personnel costs, costs of changes required as a result of the audit, and any costs associated with additional project delays and audit time. To date, studies that have used benefit–cost analyses have compared the accident characteristics of designs that have audit recommendations with those of designs that do not have such recommendations. The approach of monitoring, which is beginning to occur in the United Kingdom, should advance the state of RSA benefit–cost project analysis. The crash data from the U.K. requirement to monitor RSA projects after 12 and 36 months should become key input to future analyses and to providing the benefits of the RSA, at least internationally.

It is important to note that no negative benefit–cost analysis results of RSAs were presented during the IHT conference. Internationally, there is increasingly strong acceptance of the benefits of audits.

INTERNATIONAL TRAINING

The following points primarily highlight the RSA training as reported at the 2003 U.K. conference. It is included to show the importance that various countries have placed on audit activities as well as the level of effort. Several courses have been offered in Australia, and New Zealand has a 5-day course. In the United Kingdom there are courses for basic and advanced audits consisting of 3-day workshops for each; in Germany a 10-day training program over a 6-month period; and in Ireland 3-day courses on auditor training.

Two related topics being discussed are auditor skills requirements and certification of auditors. Several countries have skill guidelines for auditors, which are similar to those discussed previously in the U.K. section.

CHAPTER FIVE

CONCLUSIONS

This synthesis provides a snapshot of the state of the practice for road safety audits (RSAs). It was developed through a comprehensive literature review, a survey of state and provincial departments of transportation (DOTs) by using a structured questionnaire, and the authors' personal contacts and experiences in providing RSA team leadership and training worldwide.

The questionnaire was designed to elicit responses related to key RSA issues defining DOT practices. It was also designed to clarify and identify possible DOT concerns considered in implementing this proactive safety tool, as well as the road safety audit review (RSAR). The survey responses indicated that by mid-year 2003, only seven state DOTs were using both RSAs and RSARs in their safety programs. An additional 10 indicated that their state was using one but not both of the tools. Most of these states indicated that their use was best described as a beginning program to determine the benefits of incorporating these tools into their safety programs. Exposure of most state DOTs to RSAs was relatively recent and came about as the result of a 1996 international scanning tour by the FHWA to Australia and New Zealand. The scanning report was published in 1997, and the first U.S. conference on this topic was held that year.

Several states have advanced beyond the initial assessment stage. Specifically, Iowa, New York, Pennsylvania, South Carolina, and South Dakota have developed programmed approaches for including proactive safety assessments. Kentucky, Maine, and Mississippi are others that have participated in audit training and then conducting RSAs.

A major concern of RSAs and RSARs is the issue of liability. The National Highway Institute training course clarifies the liability issues associated with conducting RSAs and RSARs. In all states where training was provided, local DOT legal counsels sounded a common message—that audits are a positive approach and do not increase the agency's liability.

Ideal or required auditor skills were identified when a team approach was taken to conducting RSAs and RSARs. Core disciplines specifically included on the team were identified by most DOTs as traffic operations, design, and safety. Additional team members included individuals with expertise in construction, maintenance, law enforcement, planning, Americans with Disabilities Act, emergency medical services, pedestrians, and bicyclists. Individuals with local knowledge and other expertise were included on teams depending on the type of project and audit stage. The recommended size of an audit team was three to five persons.

In general, there were advantages to conducting RSAs at an early project stage and identifying the safety issues before the project's footprint has been developed. Using the RSA tool at multiple stages of the same project was not identified as a U.S. practice—perhaps owing to the relatively recent introduction of the concept in this country. Management buy-in and support of the tools and practice were viewed as necessary ingredients for successful programs.

The number of countries worldwide using the tools of RSAs and RSARs is growing rapidly. Historically, the most advanced countries have been involved in applying these techniques since the mid-1980s. The United Kingdom, Australia, and New Zealand are leaders in refining and advancing the state of practice.

Other countries are actively advancing their safety practices by using RSAs and RSARs. No country was identified as abandoning the use of these proactive safety tools nor were any negative benefits identified during this state-of-practice assessment. However, liability issues are a concern both within the United States and worldwide. At the international level, the most important statement concerning liability repeated by many RSA users is that these safety tools add value to the decisions being made in projects and the consideration of safety when projects are implemented.

Documentation of the audit findings and requiring a response from the client to the issues identified were commonly used and recommended practices internationally. Detailed record keeping was common practice in international RSA activities; however, the reporting documentation is kept simple. Building a knowledge base by continuing to learn from the application of audit findings was also identified as adding value to improving project design and safety considerations. It is widely accepted that RSAs reduced the need for adding safety improvements at a later date. The independence of the RSA is a common feature of international audits. Recent analytical studies have identified the benefit–cost ratio of RSA applications to be as low as 3:1 for some RSAs and RSARs to as high 240:1 for others.

Local U.S. agency applications have generally concentrated on using the RSAR. Most rural local agencies have many miles of roadway in need of a large number of safety improvements. Rural U.S. governments are becoming increasingly aware of the value of the proactive tools. Applications by rural agencies are being advanced by training.

The application of RSAs is in the earliest stages in the United States. To encourage and expand the application of the concept and to enhance safety benefits the following actions are needed:

- Training programs should be continued to introduce more state DOT personnel to RSA practices and how the safety tools can be applied.
- A compendium of best practices could be developed and disseminated to state DOTs, cities, and local road agencies. Local transportation assistance program centers [also known as technology transfer (T^2) centers] could assist in the distribution of this information.
- RSA training could be developed to focus on urban applications such as at intersections or on RSA and RSAR aspects of access management issues.
- A study is needed to establish the benefits of audits based on U.S. practice. It could include a quantitative evaluation to establish the economic benefits of audits.
- A forum on RSA and RSAR could be held to advance U.S. practice.

Time, training, and a record of successful applications will be the keys to making RSAs and RSARs a common safety practice in the United States. Agencies can stay up to date on RSA and RSAR activities by visiting the website www.roadwaysafetyaudits.org.

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APPENDIX A

Survey Questionnaire

TRANSPORTATION RESEARCH BOARD
NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
Project 20-5, Topic 34-02

Road Safety Audits: State of the Practice
Questionnaire

Name of respondent: ______________________________

Agency: ______________________________

Title: ______________________________

Telephone: ____________ Fax: ____________ E-mail: ____________

INSTRUCTIONS

The information collected will be used to develop a National Cooperative Highway Research Program (NCHRP) synthesis report on "Road Safety Audits: State of the Practice." If you or your agency has conducted any Road Safety Audits or Road Safety Audit Reviews, or conducted related safety assessments, please review and respond to this survey.

The purpose of this survey is to document information on existing experiences and planned activities in the application of road safety audits and related proactive safety programs. For the purpose of this survey, the following definitions are used:

Road Safety Audit—An RSA is a formal examination of a future roadway project by an independent, qualified audit team that then reports on potential safety issues.

Road Safety Audit Review—An RSAR is a road safety audit of an existing roadway made by a qualified independent audit team that reports on the potential safety issues on the existing roadway section.

There are three parts to this survey. All DOTs are asked to please respond to Part I (10 questions). Please respond to Parts II and III if your state is using RSAs or RSARs.

The survey should be completed by the person(s) with knowledge of the agency's activities related to safety evaluations. You may skip any questions that are not applicable. Attach additional sheets, if necessary. Please send the completed survey and additional documentation to:

Eugene M. Wilson
3212 Reynolds Street
Laramie, WY 82072

If you have any questions, please contact Dr. Wilson by telephone: (307) 766-3202 or by e-mail at: wilson@uwyo.edu, or Dr. Martin Lipinski by telephone: (901) 678-3279 or by e-mail at: mlipinsk@memphis.edu.

WE APPRECIATE YOUR RESPONSE—THANK YOU

PART I—INSTITUTIONAL ISSUES

1. Does your agency have a safety management plan? ___ Yes ____ No
   (Please provide a copy if possible.)

2. Is a road safety audit/road safety audit review program part of the safety management plan? ____Yes ___ No

3. Does your state have sovereign immunity? _____ Full ____ Partial _______ None

4. Does your agency have measurable safety goals? Are these goals specific to reduction in numbers of fatalities_____ or are these goals rate-based _____? (Please provide a copy if possible.)

5. What are the measures of accountability used for the achievement of these goals?

6. What are the institutional barriers to implementing a road safety audit/road safety audit review program?

7. If your agency has developed and used modified concepts of road safety audit and road safety audit reviews, please provide examples of these changes.

8. Has your agency participated in any road safety audit training? Please describe.

9. Please provide any additional information that you feel would be helpful to improve the understanding of the state of the practice of road safety audits and road safety audit reviews.

10. Does your agency have case studies of actual audits/reviews that you would provide for use in the synthesis? If Yes, please check if you want them returned________. Please return all information provided to:

PART II—ROAD SAFETY AUDITS

Road Safety Audit—An RSA is a formal examination of a future roadway project by an independent, qualified audit team who then reports on potential safety issues.

11. Has your agency conducted any road safety audits?
☐ Yes
☐ No

If No, go to question 35.

12. How many audits have you conducted in the past five years?
____

13. How many were conducted in the following stages of the design process?
____________ Planning
____________ Preliminary Design
____________ Final Design
____________ Traffic Control Planning During Construction
____________ Construction

14. How many people were on the audit teams and what disciplines did they represent?
___Planning Stage Audit ____
___Preliminary Design Stage Audit ____________________________________
___Final Design Stage Audit ____
___Traffic Control Planning Audit _____________________________________
___Construction Stage Audit ____

15. What types of projects were audited?
____
____
____
____

16. Did the team use the following?
☐ Checklists
☐ Prompt Lists
☐ Neither

17. Were the results of the audit implemented? Please explain and if possible please provide sample audits. (If provided, these will be used only in a generic fashion.)
____
____
____
____

18. What resources were made available to the audit program?
____
____
____
____

19. Where are the audit reports maintained? (Is there a central road safety audit coordinator?)

20. Were the audits done in-house or with outside consultants, or both?

21. How are audit projects selected? (Please provide any selection criteria used and/or any overview characteristics of audit projects.)

22. What are the institutional barriers encountered that hindered implementation of audit findings?

23. Is there a road safety audit component specified in your agency's safety performance plan? (Please provide a copy if possible.)

24. Are the results of the audits checked against safety performance goals?
____Yes_____ No. Please explain.

25. Do the audits address the needs of pedestrians, bicyclists, or other road users?
____Yes_____ No. Please explain.

26. How do you gain knowledge of road users' needs on projects being audited?

27. How is the audit program administered in your agency?

28. How do you evaluate the success/benefits of the road safety audit program? Do you use any cost-effectiveness or cost–benefit methods of analysis? Please explain.

29. Does your agency have buy-in from the top administration for the road safety audit program?

30. How are liability issues addressed in your road safety audit program?

31. What is your biggest success with the road safety audit program?

32. What is the major failure or shortcoming of your road safety audit program?

33. How is the road safety audit program organized in your state?

34. How is your road safety audit program funded?

PART III—ROAD SAFETY AUDIT REVIEWS

Road Safety Audit Review—An RSAR is a road safety audit of an existing roadway made by a qualified independent audit team that reports on the potential safety issues on the existing roadway section.

35. Has your agency conducted any road safety audit reviews?
    - ☐ Yes
    - ☐ No

    If No, please return your responses and thanks for your help!

36. How many audit reviews has your department of transportation conducted in the past five years? (Please provide a best guess.)
    ____

37. What types and locations of roadways were reviewed?
    ____
    ____
    ____
    ____

38. How many people were on the audit review and what disciplines did they represent?
    ____
    ____
    ____
    ____

39. Did the team use the following?
    - ☐ Checklists
    - ☐ Prompt Lists
    - ☐ Neither

40. Were the results of the audit review implemented? (Please explain; for example, did the road safety audit review result in a project or were spot improvements made?)
    ____
    ____
    ____
    ____

41. What resources were made available to the audit review program?
    ____
    ____
    ____
    ____

42. Where are the audit reviews maintained?
    ____
    ____
    ____
    ____

43. Were the audit reviews done in-house or with outside consultants, or both?
    ____
    ____
    ____
    ____

44. How are roadway sections to be reviewed selected? (For example, are crash data considered in the roadway selection?)

45. What are the institutional barriers encountered that hindered implementation of the review program?

46. Is the audit review program part of your agency's safety performance plan?

47. Are the results of the audit reviews checked against safety performance goals?
____Yes_____ No. Please explain.

48. Do the audit reviews specifically address the needs of pedestrians, bicyclists, or other road users?
____Yes_____ No. Please explain.

49. How do you gain knowledge of road users' needs on roadway sections being reviewed?

50. How is the road safety audit review program administered in your agency?

51. How do you evaluate the success/benefits of the road safety review program? Do you use any cost-effectiveness or cost–benefit methods of analysis? Please explain.

52. Does your agency have buy-in from the top administration for the road safety review program?

53. How are liability issues addressed in your road safety review program?

____
____
____
____

54. What is your biggest success with the road safety review program?

____
____
____
____

55. How is the road safety review program organized in your state?

____
____
____
____

Thanks for your cooperation and assistance. If you know of any other agency within your state or international contacts that you feel would provide information that would improve the synthesis, please provide contact information.

APPENDIX B

Survey Respondents

State DOT Survey Respondents	
Alabama	Missouri
Alaska	Nebraska
Arizona	Nevada
Arkansas	New Hampshire
Colorado	New York
Connecticut	North Carolina
Delaware	North Dakota
Hawaii	Oregon
Idaho	Pennsylvania
Illinois	Rhode Island
Indiana	South Carolina
Iowa	South Dakota
Kansas	Tennessee
Louisiana	Texas
Maine	Vermont
Maryland	Virginia
Michigan	Washington
Minnesota	West Virginia
Mississippi	Wyoming

Canadian Survey Respondents
Alberta Transportation
Calgary
New Brunswick
Newfoundland and Labrador
Saskatchewan
Toronto

APPENDIX C

Sample Audit Reports

The following four audit reports are included in this appendix:

1. Sample road safety audit report, National Highway Institute
2. HD 19/03 reports
3. Sample road safety audit tool kit
4. Sample state road safety audit reports

Sample RSA Report

The following is a sample RSA report. This sample has been created using reports submitted by students of the RSA course.

Road Safety Audit Report on the Preliminary Design of the Proposed Widening of Route 60 between Milepost 8.7 and 10.4

PROJECT DESCRIPTION

Route 60 is currently a two-lane rural/suburban highway that traverses a two-mile portion of Henderson. The existing speed limit on Route 60 is 45 miles per hour. Adjacent land uses include industrial, commercial, and farming. Major intersections along the corridor include:

- US 60/Borax Drive/US 41A
- Ohio Drive/Collier Spur Road
- Old Corydon Road/Community Drive/Route 60
- Dana Drive/Route 60.

There are numerous driveway accesses and "wide open" driveways on this section of Route 60. Concerns have been raised in terms of the number of crashes throughout the corridor. Crashes in parts of this section are substantially greater than the statewide average.

We have reviewed the three alternative designs to upgrade Route 60 from east of Dana Drive to west of US 41A. All alternatives assume an upgrade of Route 60 from a two-lane section to a five-lane, curb and gutter section (four through lanes plus one two-way center left-turn lane). The proposed typical section also includes a five-foot sidewalk on both the north and south sides of the highway.

AUDIT TEAM MEMBERS

The following members comprise the audit team.

- John Smith, Highway Designer
- Mary Jones, Transportation Engineer
- Juan Lopez, Highway/Traffic Safety Specialist
- Sue Ling, Project Manager

DATA AND DOCUMENTATION

We have reviewed the following data and documentation during the conduct of this audit:

- Transportation Cabinet Conceptual/Location Plan for the Corridor/Aerial Mosaic
- Typical Section
- Profiles
- Crash Data

ASSUMPTIONS

We have based our audit on the following assumptions:

- The existing highway is built to design standards current at the time.
- The plans for the proposed widening are according to current design standards.
- Some entrances and driveways to Route 60 will be eliminated.
- Utilities are outside clear zone or underground.
- Project can be extended to highway 425.
- Pedestrian and bike traffic have been considered.
- All major intersections will be signalized.

SITE VISIT

From the documentation, we have identified the following potential safety concerns to concentrate on during the site visit:

- The number of accesses
- Center turn lane
- Railroad crossings
- Surface drainage
- Lack of pullout area for bus service
- Speed limit
- Pedestrian mobility

We visited the site on May 2, 2001 from approximately 1 PM to 3 PM to extrapolate the effects of the proposed plans in light of the current roadway. The weather at the time of our visit was partly cloudy.

The existing roadway appears to be well maintained. It is located in an area that is a mix of residential, commercial, and industrial. In fact, the area is transitioning from a rural to urban development. Trucks account for 15 percent of total traffic volume. Pedestrian and bicycle traffic is moderate.

In two groups, we drove the two-mile stretch of the proposed project several times and walked portions of it. We then compared and contrasted our observations before compiling this report.

FINDINGS

Our findings and observations are identified below. These findings are the consensus of the team.

- Overall Concerns
- Two-Way Center Left Turn. This type of design is used in highly developed, urban commercial areas. Historically, this design type has higher crash rates, including a higher level of head on collisions.
- Five feet of separation between sidewalk and through traffic lane. Our concern is that pedestrian separation is inadequate.
- No shoulders for disabled vehicles to pull off.
- The team does not have any background information to justify the provision of sidewalks in the corridor.

- Due to the flat grade of profile, a curb and gutter drainage system might not be adequate and, consequently, water might spread into traffic lane.
- Morning and evening sunlight glare interferes with traffic signals due to east-west alignment.
- Existing parking adjacent to the mainline causes potential sight distance issues.
- Snow removal and future maintenance issues might arise due to lack of shoulders.
- Better access management would minimize number and width of driveways.

US 60/Borax Drive/US 41A

Blue Alignment

- Offset to Borax Avenue. The creation of two intersections within close proximity has the potential to increase traffic conflicts.
- Separate access to Wye Road. Numerous private access points onto Relocated roadway.

Green Alignment

- Skew to Borax Drive
- Reverse curve
- Spur from US 60 is not permanently closed
- Skewed left turn from eastbound US 60 to northbound Borax Drive

Red Alignment

- Access Road from US 41A is too close to the Borax Drive/US 60 intersection.

Borax Drive to Ohio Drive

- Too many driveways
- Develop collector road between Station 1075 and Ohio Drive for 6 properties (north side of US 60)
- South side of US 60 buildings, utilities, signs, objects are within clear zone.

Ohio Drive/Collier Spur Road

- Traffic queuing due to railroad grade crossing.
- No major differences between red and green alternatives.
- Review detailed traffic studies to determine turning lane requirements.
- The entrance to Audubon Metals is within the Route 60 intersection.
- Railroad crossing has no cross arms.
- Need access management. Reduce wide-open entrances.

Community Drive/Old Corydon/US 60

- Entrance to Gibbs into Community Drive is too close to US 60 intersection.
- Proposed intersection alignments do not eliminate skew.

Community Drive to Dana Drive

- Eliminate church accesses onto US 60. Consider access on Dana Drive.
- Access Management Needed. Eliminate wide-open entrances.
- Move entrance to Service Tool and Die Company as northwesterly as possible.

CONCLUSIONS

In our judgment, consideration of the findings should improve the overall safety of the US 60 corridor in Henderson. We also suggest that a subsequent road safety audit take place after the preliminary plans have been completed.

ANNEX E:

ILLUSTRATIVE REPORT
A795 AMBRIDGE BYPASS
ROAD SAFETY AUDIT STAGE 2

EWING AND BARNES PARTNERSHIP **November 2004**

1 INTRODUCTION

1.1 This report results from a Stage 2 Road Safety Audit carried out on the A795 Ambridge Bypass at the request of the Design Organisation: Ambridge Bypass Design Team, DLS Partnership (Highways Division), 12-14 Cathedral Close, Borchester. The Audit was carried out during November 2004.

1.2 The Audit Team membership was as follows:

I K Brunel	(Ms) BSc, MSc, CEng, MICE, MIHT Ewing and Barnes Partnership (Traffic and Accident Investigation Division)
T MacAdam	IEng, FIHIE Ewing and Barnes Partnership (Traffic and Accident Investigation Division)
Eur Ing. C Chan	MEng, CEng, MICE Road Safety Engineering Consultant

1.3 The audit took place at the Erinsborough Office of The Ewing and Barnes Partnership on 17 and 18 November 2004. The audit was undertaken in accordance with the audit brief contained in Highways Agency letter reference HA/11.10.04/001. The audit comprised an examination of the documents provided by the Highways Agency's Project Sponsor, South Midlands Regional Office, and listed in the Annex. These documents consisted of a complete set of the draft tender drawings, a summary of the general details of the scheme including traffic flows, predicted queue lengths, non-motorised user counts and desire lines, an A3 plan for the Audit Team's use, a copy of the Stage 1 Road Safety Audit Report dated June 2003, details of the response to the issues raised in the Stage 1 Audit, details of other changes to the design since June 2003 and a schedule of Departures from Standards and the relevant approvals contained in the design. A visit to the site of the proposed bypass was made on the morning of Wednesday 17 November 2004. During the site visit the weather was fine and sunny and the existing road surface was dry.

1.4 The terms of reference of the audit are as described in HD 19/03. The team has examined and reported only on the road safety implications of the scheme as presented and has not examined or verified the compliance of the designs to any other criteria.

1.5 All comments and recommendations are referenced to the detailed design drawings and the locations have been indicated on the A3 plan supplied with the audit brief.

1.6 The proposed A795 Ambridge Bypass incorporates the provision of 2.3km of 7.3m wide single carriageway between Station Road to the south of the A827 and Ambridge Road to the north east of Ambridge village. The scheme includes the provision of 5 priority junctions and a roundabout at the A827 dual carriageway junction. The improvement also encompasses the provision of two lay-bys, the diversion of a footpath and the stopping up of Old Church Lane.

2 ITEMS RAISED AT THE STAGE 1 AUDIT

2.1 The safety aspects of the Ambridge Road Junction were the subject of comment in the June 2003 Stage 1 Road Safety Audit Report. (Items A3.1 and A3.2) These items remain a problem and are referred to again in this report (paragraph 3.13 below).

2.2 All other issues raised in the Stage 1 Audit have been resolved.

3 ITEMS RAISED AT THIS STAGE 2 AUDIT

3.1 GENERAL

3.2 PROBLEM

Locations: A and N (drawing RSA/S2/001) —Adjacent to the Ambridge railway station.

Summary: Risk of an accident between a pedestrian and a vehicle due to potential shortcut to bus stop.

A cross-section departure (in that there is no room for provision of a footway) on the existing railway bridge at location A has been reported. The departure has been introduced since the Stage 1 Audit. Although pedestrians have been rerouted to cross the railway using the renovated station footbridge they may still be tempted to use the road bridge as this will provide a much shorter route to the adjacent bus stop (location N). Pedestrians using the road bridge would have to walk on the carriageway and therefore there would be an increased risk of an accident between a vehicle and a pedestrian.

RECOMMENDATION

Relocate the bus stop currently on the bypass to Station Road. In addition provide pedestrian deterrent paving on the verges on the immediate approaches to the bridge (both sides).

3.3 PROBLEM

Locations: B and C (drawing RSA/S2/001)—Northern verge of Home Farm Road.

Summary: Open ditch is a potential hazard to an errant road user.

An open ditch is proposed to run along the side of Home Farm Road on the outside of the bend. This ditch is the main outfall for the storm water drainage from much of the bypass and in places is more than 1.5m deep. It is likely to carry substantial quantities of water following heavy rainfall and represents a danger to errant motorists and cyclists. This problem could increase the severity of an accident involving a vehicle or cyclist leaving the carriageway in this location.

RECOMMENDATION

Provide a safety fence at the back of the grass verge between location B and location C.

3.4 PROBLEM

Locations: D and E (drawing RSA/S2/001)—Lay-bys north of Old Church Lane.

Summary: Lay-by positions provide an increased risk of shunt and right turn accidents.

Drivers travelling north will reach the lay-by at location D on their right before the lay-by at location E on their left. Similarly vehicles travelling south will reach the lay-by at E on their right first. Since the lay-bys are not inter-visible and there are no advance signs, drivers could be tempted to cross the carriageway to use the first lay-by that they reach. This problem would increase the number of right turning manoeuvres and therefore increase the potential for accidents between right turning vehicles and vehicles travelling ahead in the opposite direction. It could also increase the likelihood of shunt accidents involving vehicles running into the back of other vehicles waiting to turn right into the lay-by.

RECOMMENDATION

Reposition the lay-bys so that drivers encounter a lay-by on their nearside first. When relocating the lay-bys ensure that adequate visibility is provided for a driver both entering and leaving the facility. In addition, provide advance signing of both facilities.

3.5 PROBLEM

Location: F (drawing RSA/S2/001)—Junction between Old Church Lane and the bypass.

Summary: Downhill gradient and limited visibility on sideroad approach increases the risk of overshoot type accidents.

The realigned section of Old Church Lane where it meets the bypass has a downhill longitudinal gradient of 7% and limited forward visibility. There is danger of traffic failing to stop at the give way line and skidding into the bypass in bad weather conditions. This feature could result in vehicles on Old Church Lane overrunning the give way line and colliding with through traffic on the bypass.

RECOMMENDATION

Provide the realigned section of Old Church Lane with a high grip surfacing and additional signs to warn traffic of the give way junction ahead.

3.6 PROBLEM

Location: G (drawing RSA/S2/001)—On the bypass midway between Old Church Lane and Home Farm Road adjacent to the northbound lane.

Summary: Unprotected embankment could increase the severity of an accident in this location.

The safety fence on the west side of the bypass between chainage 1+550 and 1+650 leaves some embankment unprotected. This could increase the severity of an accident involving a vehicle or cyclist leaving the carriageway.

RECOMMENDATION

Extend the safety fence back to chainage 1+500.

3.7 PROBLEM

Locations: H to I (drawing RSA/S2/001)—On the bypass adjacent to the Westlee dairy.

Summary: Headlights of vehicles on the parallel dairy access road could distract and disorientate drivers on the bypass.

The access road to the Westlee Diary Depot runs parallel to the bypass for about 250m. We understand that there is considerable vehicular activity on this road at night. The headlights of traffic using this road could be very confusing when viewed from the bypass. This could distract and disorientate drivers on the bypass to the extent they lose control of their vehicles.

RECOMMENDATION

Provide earth bund, solid fence or similar screen adjacent to Westlee Diary boundary.

3.8 PROBLEM

Location: Q (drawing RSA/S2/001)—Entrance to the electricity sub-station north of Home Farm Road.

Summary: No provision for service vehicles to stop off the bypass when accessing the sub-station.

The entrance gates to the electricity sub-station at chainage 1+900 (location Q) are located such that drivers wishing to enter the compound would have to park on the bypass whilst they unlock the gate. This could result in a vehicle travelling on the bypass colliding with the parked vehicle. It could also encourage vehicles to overtake parked vehicles increasing the risk of head-on collisions.

RECOMMENDATION

Relocate the gates further back from the edge of the carriageway. If, however, the location of equipment in the compound precludes the relocation of the gates, provide a lay-by or hardstanding area to allow vehicles to wait off the road while the gates are being opened or secured.

3.9 THE ALIGNMENT

3.10 PROBLEM

Location: J to L (drawing RSA/S2/001)—Crest to the north of Old Church Lane.

Summary: Proposed hazard road marking is not sufficient to discourage drivers from overtaking in this area.

The entire length of the bypass between the Ambridge Road Junction (location J) and the Bull Roundabout (location L) is marked with hazard lines (to Traffic Signs Regulations and General Directions diagram 1004.1) indicating the lack of full overtaking sight distance. The meaning of this lining is not understood by the general public and there is no indication that the visibility reduces appreciably over the crest at chainage 1+250. This problem could increase the potential for accidents involving inappropriate overtaking.

RECOMMENDATION

Provide 1m carriageway hatch markings (to Traffic Signs Regulations and General Directions diagram 1013.1B) over the crest. The use of this marking must be coordinated with recommendation 3.13 below.

3.11 THE JUNCTIONS

3.12 PROBLEM

Location: L (drawings RSA/S2/001 and RSA/S2/002)—North from the Bull Roundabout.

Summary: Confusion over the layout of road north of the roundabout may result in inappropriate overtaking.

Traffic originating from the existing dual carriageway A827 Borchester Road (which has a mature quickthorn hedge in the central reserve) and turning onto the new bypass (northbound) may be confused into thinking that the new bypass is a dual carriageway, particularly as the old field hedge to the west could be assumed to be in a central reserve and concealing a northbound carriageway. Traffic on the access road to the Westlee Diary could further confuse traffic in this location unless the recommendation at paragraph 3.7 above is implemented. This problem could increase the potential for accidents involving vehicles overtaking in an inappropriate location.

RECOMMENDATION

Redesign the splitter island and associated hatch markings shown on drawing RSA/S2/002 to accentuate that the bypass is a single carriageway. In addition provide two-way traffic signs (to diagram number 521 of The Traffic Signs Regulations and General Directions) on the northbound bypass immediately after the roundabout.

3.13 PROBLEM

Location: J (drawings RSA/S2/001 and RSA/S2/003)—Northbound approach to Ambridge Road Junction.

Summary: The road layout on the approach to the junction does not discourage overtaking on this straight downhill section of the bypass.

The approach to this junction along the proposed bypass from the south is via a straight downhill section of about 1km length and traffic speeds are likely to be high. The necessity of making sure that overtaking manoeuvres are complete in good time before the central reserve at the junction commences was flagged at the Stage 1 Audit. The current design does not adequately address this issue. As a result there is a potential for overtaking accidents and side impact accidents as overtaking vehicles abruptly move back into the northbound lane before the junction.

RECOMMENDATION

(a) Provide a continuous prohibitory double white line to diagram 1013.1 from the southern end of the central reserve (location M drawing RSA/S2/003) for a distance of about 340m uphill (FOSD/4 before the nosing), to replace the proposed hazard marking. This will force drivers into a single line well before the junction. Coordination with the recommendation in paragraph 3.10 above is necessary.
(b) Reposition the advanced direction sign ADS6 approximately 150m from the junction to warn traffic travelling at higher speeds.
(c) Provide “SLOW” carriageway markings on the approaches to the junction from both the north and south direction to moderate speeds through the junction.
(d) Provide hatching within the hard strip to further discourage drivers from attempting to overtake in the short single lane dual carriageway section through the junction.

3.14 NON-MOTORISED USERS

3.15 PROBLEM

Locations: O and P (See drawing RSA/S2/001)—Former line of the footpath at the crest to the north of Old Church Lane.

Summary: The former footpath alignment may still attract pedestrians to cross at a location with limited visibility.

The scheme allows for the diversion of Footpath No 12 so that it crosses the bypass away from the crest curve at location K. The old route may, however, be more attractive to pedestrians. This could result in an accident between a vehicle and pedestrian due to the reduced visibility at the crest curve.

RECOMMENDATION

Modify landscaping with heavy planting to block old route at the edge of the bypass (location O) and remove the old stile at the field boundary (location P) and replace with solid wall to match existing.

3.16 PROBLEM

Location: Throughout the length of the bypass.

Summary: The proposed raised ribbed edge line may be hazardous to cyclists at junctions.
It is not uncommon for cyclists to use the marginal strip provided along busy bypasses to avoid being intimidated by other vehicles. The drawings indicate that road markings to Diagram 1012.3, raised ribbed markings, will be used as edge line markings. These markings may cause difficulties for cyclists entering or leaving the marginal strip near junctions and result in cyclists losing control of their bicycle.

RECOMMENDATION

Replace markings to Diagram 1012.3 by those to Diagram 1012.1 for a length of 20m on the approach and exit sides of any junction.

3.17 SIGNING AND LIGHTING

3.18 PROBLEM

Location: L (drawings RSA/S2/001 and RSA/S2/002)—westbound approach to the Bull Roundabout.

Summary: The risk of errant vehicle colliding with a lighting column located in front of the safety fence.
On the A827 Borchester Road dual carriageway approach to the Bull Roundabout a length of safety fence is proposed to protect a large advance direction sign in the nearside verge. The drawings provided show a lighting column approximately 60 metres from the roundabout located in front of the proposed safety fence. A vehicle leaving the carriageway in this location could run along the length of safety fence into the lighting column, this could significantly increase the severity of an accident occurring in this location.

RECOMMENDATION

Relocate the proposed lighting column behind the length of safety fence.

4 AUDIT TEAM STATEMENT

I certify that this audit has been carried out in accordance with HD 19/03.

AUDIT TEAM LEADER

Ms I K Brunel BSc, MSc, CEng, MICE, MIHT	Signed *I K Brunel*
Principal Highway Engineer	
Traffic and Accident Investigation Division	Date *22/11/04*
Ewing and Barnes Partnership	
Albert Square	
Erinsborough	
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AUDIT TEAM MEMBERS

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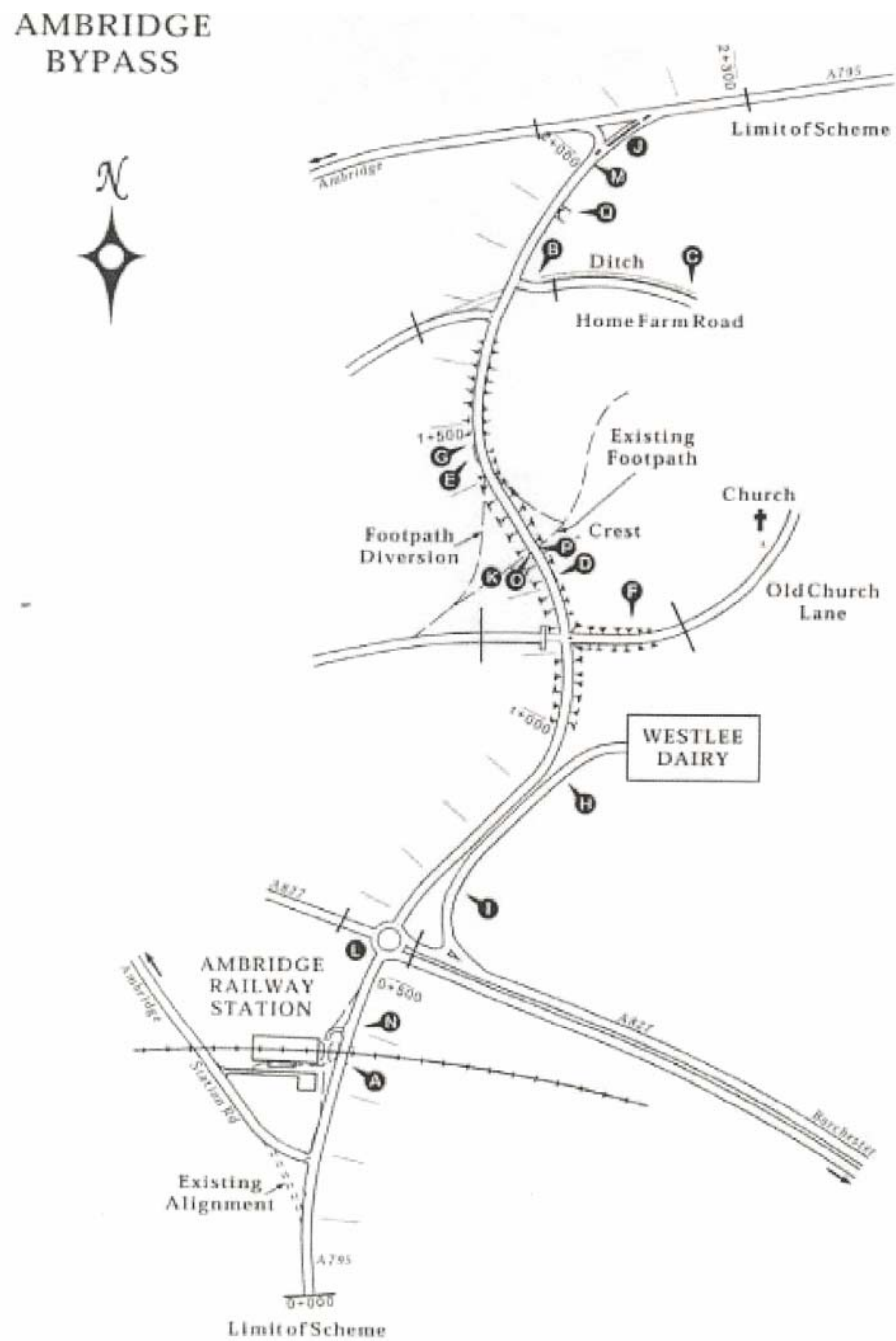

AMBRIDGE
BYPASS
N
2+500
A795
Limit of Scheme
Ambridge
2+000
Ditch
Home Farm Road
1+500
Existing
Footpath
Church
Crest
Footpath
Diversion
Old Church
Lane
1+000
WESTLEE
DAIRY
A827
AMBRIDGE
RAILWAY
STATION
0+500
A827
Station Rd
Borchester
Existing
Alignment
A795
0+000
Limit of Scheme

ANNEX F:

ILLUSTRATIVE REPORT
A795 AMBRIDGE BYPASS
ROAD SAFETY AUDIT STAGE 4
12 MONTH MONITORING REPORT

DLS PARTNERSHIP

May 2007

1 INTRODUCTION

1.1 This report results from the Road Safety Audit Stage 4 - 12 month monitoring carried out on the A795 Ambridge Bypass Scheme as part of DLS Partnership (Maintenance Division) maintenance agreement with the Highway Agency. The report has been produced as part of a routine accident monitoring/Road Safety Audit procedure and the terms of reference for this monitoring report are described in HD 19/03.
1.2 A site visit was conducted on Monday 7th May 2007, during which the road surface was wet as it was raining heavily.

2 SCHEME DETAILS

2.1 The A795 Ambridge Bypass was completed in March 2006 and involved the provision of 2.3km of 7.3m wide single carriageway between Station Road to the south of the A827 and Ambridge Road to the north east of Ambridge village.

2.2 The scheme included the provision of 5 priority junctions and a roundabout at the A827 dual carriageway. The improvement also encompassed the provision of two lay-bys, the diversion of a footpath and the stopping up of Old Church Lane.

2.3 The scheme was subjected to a Stage 1 Road Safety Audit in June 2003, a Stage 2 Audit in November 2004 and a Stage 3 audit prior to opening in March 2006.

3 ANALYSIS OF ACCIDENTS

3.1 During the period 1st April 2006 to 31st March 2007 a total of 3 personal injury accidents were recorded throughout the 2.3km length of the scheme. The severity of all three accidents was slight.

3.2 The accident frequency on Ambridge bypass has been briefly compared with values predicted in the Design Manual for Roads and Bridges COBA manual. The COBA manual predicts an accident frequency of 3.48 accidents a year based on the Annual Average Daily Traffic (AADT) flow of 18500 vehicles in 2006.

3.3 All three accidents have occurred at different locations throughout the scheme. The location and a brief description of each accident has been included below:

- Accident Ref. 1—A827/A795 roundabout. Vehicle 1 from A827 fails to give way at roundabout and
- runs into vehicle 2.
- Accident Ref. 2—N/bound approach to Old Church Lane. M/cycle loses control on a patch of oil.
- Accident Ref. 3—S/bound lay-by north of Old Church Lane. Vehicle 2 travelling north waiting to turn
- right into lay-by struck in rear by vehicle 1.

3.4 Two of the accidents (references 2 and 3) occurred during the daytime in fine weather on a dry road surface. The remaining accident (reference 1) occurred during the daytime in a period of rain on a wet road surface.

4 TRAFFIC CONDITIONS

4.1 Traffic count data has been obtained from an Automatic Traffic Counter (ATC) located on the A795 north of Home Farm Lane. The ATC indicates that the traffic flows along the A795 are 18500 vehicles AADT in 2006.

4.2 No significant congestion has been recorded throughout the scheme in its first year of opening. However, some queuing has been observed on the A827 westbound approach to the A827/A795 roundabout during the am peak period.

5 CONCLUSIONS

5.1 A brief assessment of the 12-month accident history of the Ambridge Bypass has indicated that the accident frequency is lower than the predicted national average and no common factors or trends have been identified in the data. However, it has been noted that one of the three accidents that have occurred has resulted from a vehicle travelling northbound waiting to turn right into the southbound lay-by being struck from behind. This problem was raised in the Stage 2 Audit report, however there were difficulties in acquiring the land necessary to relocate the lay-by so an Exception Report was approved.

5.2 As this report considers only 12 months of accident data and no common factors or trends have been identified at this early stage no firm conclusions can be drawn from the accident information.

ANNEX G:

ILLUSTRATIVE REPORT
A795 AMBRIDGE BYPASS
ROAD SAFETY AUDIT STAGE 4
36 MONTH MONITORING REPORT

DLS PARTNERSHIP **May 2009**

CONTENTS

1 INTRODUCTION

1.1 Background to the study

1.1.1 This report results from the Road Safety Audit Stage 4 - 36 month monitoring carried out on the A795 Ambridge Bypass Scheme as part of DLS Partnership (Maintenance Division) maintenance agreement with the Highways Agency. The report has been produced as part of a routine accident monitoring / Road Safety Audit procedure and the terms of reference for this monitoring report are described in HD 19/03.

1.1.2 A site visit was conducted on Friday 8th May 2009, during which the weather was overcast and the road surface was dry.

1.2 Study purpose

1.2.1 The purpose of this study is as follows:

- to undertake an in-depth study of the accidents that have occurred on the scheme during the three years since opening;
- to identify any road accident problems;
- to suggest possible measures that would contribute to accident reduction on the scheme;
- to review the recommendations from the Road Safety Audit Reports at Stages 1 to 3 and the Exception Reports to identify if they had any effect on the scheme.

2 SCHEME DETAILS

2.1 Description of the scheme

2.1.1 The A795 Ambridge Bypass was completed in March 2006 and involved the provision of 2.3km of 7.3m wide single carriageway between Station Road to the south of the A827 and Ambridge Road to the north east of Ambridge village.

2.1.2 The scheme included the provision of 5 priority junctions and a roundabout at the A827 dual carriageway. The improvement also encompassed the provision of two lay-bys, the diversion of a footpath and the stopping up of Old Church Lane.

2.1.3 The road is subject to the national speed limit and with the exception of the A827 / A795 Bull Roundabout the scheme is unlit.

2.1.4 The scheme was subjected to a Stage 1 Road Safety Audit in June 2003, a Stage 2 Audit in November 2004, a Stage 3 Audit prior to opening in March 2006 and a Stage 4 12 month monitoring report in May 2007.

3 ANALYSIS OF ACCIDENTS

3.1.1 During the 36 month period between 1st April 2006 to 31st March 2009 a total of 11 personal injury accidents were recorded throughout the 2.3km length of the scheme. There have been 2 (18%) serious accidents and 9 (82%) accidents that were slight in severity. No accidents involving fatalities have been recorded during the 36 month period. These figures are generally consistent with national average values taken from the DfT publication "Road Accidents in Great Britain" (RAGB) which indicates that on major roads with a 60mph speed limit 4% of accidents were fatal, 21% were serious and 75% were slight in severity.

3.1.2 Stick diagrams for these accidents together with a breakdown of accident types are included in Appendix I.

3.1.3 Appendix II shows a plot of the location of each of the accidents. Generally this diagram shows that the accidents are evenly distributed throughout the scheme, however there is a cluster of 4 accidents at the A827/A795 roundabout and two accidents at the lay-by north of Old Church Lane.

3.1.4 The information contained in the accident data has been compared to national averages from the DfT publication "Road Accidents in Great Britain" (RAGB) and the "Design Manual for Roads and Bridges COBA manual" below and in Appendices III to V:

3.1.5 Accident Frequency (see Appendix III)

	Year (01/04/06 to 31/04/09)			Total
	2006/2007	2007/2008	2008/2009	
Number of Accidents	3	3	5	11

3.1.6 The above table indicates that there have been on average 3.67 personal injury accidents a year along the Ambridge bypass. The COBA manual predicts an accident frequency of 3.76 a year based on the year 2008 AADT traffic flow of 19000 vehicles.

3.1.7 **Accidents by Weather, Road Surface and Light Conditions (see Appendices IV & V)**

Weather Conditions	Ambridge Bypass		National Average (RAGB)	
	No. of Accidents	%	No. of Accidents	%
Fine	8	73%	40173	75%
Rain	3	27%	10568	20%
Snow	0	0%	338	1%
Fog	0	0%	580	1%
Unknown	0	0%	1726	3%
Total	**11**	**100%**	**53385**	**100%**

Road Surface Conditions	Ambridge Bypass		National Average (RAGB)	
	No. of Accidents	%	No. of Accidents	%
Dry	7	64%	27660	52%
Wet	4	36%	23301	44%
Snow/Ice	0	0%	1751	3%
Unknown	0	0%	673	1%
Total	**11**	**100%**	**53385**	**100%**

Light Conditions	Ambridge Bypass		National Average (RAGB)	
	No. of Accidents	%	No. of Accidents	%
Daylight	8	73%	38788	73%
Darkness	3	27%	14597	27%
Total	**11**	**100%**	**53385**	**100%**

3.1.8 The above tables indicate that the weather conditions, road surface conditions and lighting conditions recorded in the accident data for the Ambridge bypass are generally consistent with national averages for 2008. Statistical tests carried out for the weather, road surface and lighting condition information indicate that there are no significant differences between the site data recorded in the personal injury accident reports and national data.

3.1.9 Accidents by Manoeuvre

Manoeuvre	No. of Accidents	%
Loss of control	2	18%
Side impact—failed to give way	2	18%
Nose to tail shunt impact	4	36%
Side Impact—Changing lanes	2	18%
Car hit Pedestrian	1	9%
Total	**11**	**100%**

3.1.10 Further analysis of the accident types indicate that 1 of the nose to tail shunt accidents and 1 of the failure to give way accidents occurred on the A827 dual carriageway approach to the A827/A795 roundabout. In addition, 2 of the nose to tail impacts occurred at the lay-by north of Old Church Lane while a vehicle was waiting to turn right into the facility. Finally, 2 of the 4 accidents that have occurred at the A827 / A795 roundabout have involved cars leaving the roundabout crossing the path of pedal cyclists negotiating the circulatory carriageway.

4 TRAFFIC CONDITIONS

4.1 Traffic Flows

4.1.1 Traffic count data has been obtained from an Automatic Traffic Counter (ATC) located on the A795 north of Home Farm Lane. The ATC indicates that the traffic flows along the A795 in 2008 were 19,000 vehicles AADT. This compares to the AADT flow recorded in 2006 of 18,500 vehicles.

4.1.2 The daily flow profile suggests that the Ambridge bypass has pronounced peaks in both the AM and PM periods and the traffic volumes are tidal, the high volumes occur in the southbound direction in the AM period and in the northbound direction in the PM period.

4.2 Traffic Speeds

4.2.1 Traffic speeds were measured during January 2009 and the results are shown below:

	Southbound		Northbound	
Location of Survey	85% ile speed (mph)	Speed range (mph)	85% ile speed (mph)	Speed range (mph)
100 m South of Old Church Ln	52	41–65	51	41–62
100 m North of Old Church Ln	54	44–66	55	40–66

4.2.2 The results show that speeds along the Ambridge Bypass are typical of those with a 60mph speed limit. A small proportion of drivers exceed the speed limit by more than 5mph.

4.2.3 No significant congestion has been recorded throughout the scheme. However, some queuing has been observed on the A827 westbound approach to the A827 / A795 roundabout during the am peak period. This congestion generally occurs between 08:30 and 09:00 in the morning on weekdays and extends for a length of approximately 15 vehicles in each lane.

5 STATEMENT OF SAFETY PROBLEMS ON THE AMBRIDGE BYPASS

5.1 Problems Identified

5.1.1 Although the accident rate along the Ambridge bypass is consistent with the national average for the type of road, this study has shown that there are a number of specific safety problems along the route:

- Two accidents on the A827 dual carriageway approach have involved drivers failing to appreciate the
- A827/A795 roundabout.
- Two accidents at the A827/A795 roundabout have involved car drivers exiting the junction across the
- path of cyclists.
- A cluster of two accidents have occurred at the lay-by north of Old Church Lane.

5.2 Review of Previous Road Safety Audit Reports and Exception Reports

5.2.1 None of the previous Road Safety Audits raised a specific problem in respect of either the potential for accidents involving drivers approaching from the A827 not appreciating the A827/A795 roundabout or for accidents involving car drivers exiting the junction across the path of cyclists. However, the potential for accidents involving vehicles turning right into the lay-by to the north of Old Church Lane was identified in the Stage 2 Road Safety Audit undertaken in November 2004.

5.2.2 The following problem and recommendation was raised in the Stage 2 Road Safety Audit report:

PROBLEM

Locations: D and E (drawing RSA/S2/001) – Lay-bys north of Old Church Lane.

Summary: Lay-by positions provide an increase risk of shunt and right turn accidents.

Drivers travelling north will reach the lay-by at location D on their right before the lay-by at location E on their left. Similarly vehicles travelling south will reach the lay-by at E on their right first. Since the lay-bys are not inter-visible and there are no advance signs drivers could be tempted to cross the carriageway to use the first lay-by that they reach. This problem would increase the number of right turning manoeuvres and therefore increase the potential for accidents between right turning vehicles and vehicles travelling ahead in the opposite direction. It could also increase the likelihood of shunt accidents involving vehicles running into the back of other vehicles waiting to turn right into the lay-by.

RECOMMENDATION

Reposition the lay-bys so that drivers encounter a lay-by on their nearside first. When relocating the lay-bys ensure that adequate visibility is provided for a driver both entering and leaving the facility. In addition, provide advance signing of both facilities.

5.2.3 The recommendation of repositioning the lay-bys was not implemented by the Project Sponsor as it would involve the costly acquisition of third party land and therefore an Exception Report was prepared by the Project Sponsor and approved by the Director. However, in mitigation, the design was amended to include the provision of signing of the lay-bys ½ mile in advance of each of the facilities.

6 OPTIONS FOR TREATMENT

6.1 Accidents Occurring on the A827 dual carriageway approach to the A827/A795 roundabout

6.1.1 Two of the accidents that have occurred on the A827 westbound approach to the roundabout appear to have involved a driver travelling too fast or not comprehending the junction layout ahead. A remedial measure option to reduce this problem would be to provide Transverse Yellow Bar markings on this approach. This road marking has been shown to have a significant effect in reducing accidents associated with inappropriate approach speeds.

6.1.2 Economic Assessment

The cost of providing Transverse Yellow Bar markings is estimated to be £4000. A study undertaken by the TRRL(1) has shown that this improvement could result in an overall reduction in speed related accidents in the order of 57% on fast dual carriageway approaches to junctions. However, the TRRL study does identify that the accident saving in relation to accidents occurring during the hours of darkness would be less. Therefore as one of the two accidents on the A827 westbound approach to the junction has been during the hours of darkness an accident saving of 25% has been assumed. Therefore this measure could provide a saving of 0.17 accidents per year, which is equivalent to £18,697 based on the national average cost of £109,983 for an injury accident (including an allowance for damage only accidents) taken from Highways Economic Note No. 1 (HEN1).

6.1.5 The First Year Rate of Return (FYRR) for this improvement is estimated at 467%.

6.2 Accidents Involving Cyclists at the A827/A795 roundabout

6.2.1 Two of the four accidents that have occurred at this junction have involved car drivers leaving the roundabout across the path of cyclists negotiating the circulatory carriageway. Site observations have indicated that numerous cyclists use the roundabout to access the Westlee Dairy from the residential areas to the west and south. It is therefore recommended that a segregated off-road route is provided around the junction to assist these vulnerable road users.

(1) Transport Research and Road Laboratory Report LR 1010 "Yellow bar experimental carriageway markings – accident study"

6.2.2 Economic Assessment

The estimated cost of providing a segregated cycle track/footpath around the junction would be £60,000. Both the Department for Transport publication “A Road Safety Good Practice Guide”[(2)] and the MOLASSES[(3)] database indicate that cycle schemes have produced a 58% reduction of injury accidents overall. As some cyclists will continue to use the circulatory carriageway it is estimated that this improvement could save 50% of the accidents involving cyclists coming into conflict with motorised vehicles on the carriageway. Therefore this measure could provide a saving of 0.33 accidents per year, which is equivalent to £36,294 based on the national average cost of £109,983 for an injury accident (including an allowance for damage only accidents) taken from HEN1.

6.2.3 The First Year Rate of Return (FYRR) for this improvement is estimated at 60%.

6.3 Accidents Occurring at the Lay-by

6.3.1 The accident data indicates that there have been 2 accidents involving northbound vehicles waiting to turn into the lay-by north of Old Church Lane. The potential for this type of accident was identified in the Stage 2 Road Safety Audit Report. As highlighted in Section 5.2 above the Project Sponsor was unable to implement the full recommendations as included in the Audit Report due to problems with land ownership. However the design did include the provision of signing of the lay-bys ½ mile in advance of each of the facilities.

6.3.2 It is considered that on both approaches to the lay-bys some drivers may mistake the lay-by on the other side of the road as the facility signed at ½ mile. Therefore it is recommended that a second advance sign is placed on the opposite side of the road to each lay-by informing drivers of the distance to the lay-by on their side of the road.

6.3.3 Economic Assessment:
The cost of providing the two extra signs is estimated to be £500. It is estimated that this improvement could save 10% of the accidents involving vehicles turning right into the lay-bys. This saving equates to a reduction in 0.07 accidents per year, which in turn is equal to a saving of £7,699 based on the national average cost of £109,983 for an injury accident (including an allowance for damage only accidents) taken from HEN1.

6.2.4 The First Year Rate of Return (FYRR) for this improvement is estimated at 1539%.

7 CONCLUSIONS

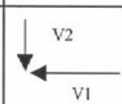
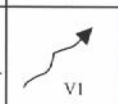
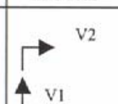
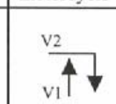
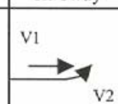
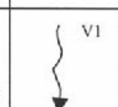
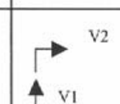
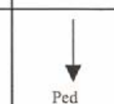
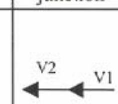
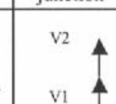
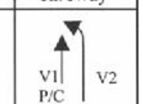
7.1.1 An analysis carried out on the 3-year period 1 April 2006 to 31 March 2009 has revealed a total of 11 reported personal injury accidents.

7.1.2 The study has shown that there are a number of specific safety problems on the route and that there are several options for treatment. As all the measures considered give a high First Year Rate of Return it is recommended that all are considered for implementation.

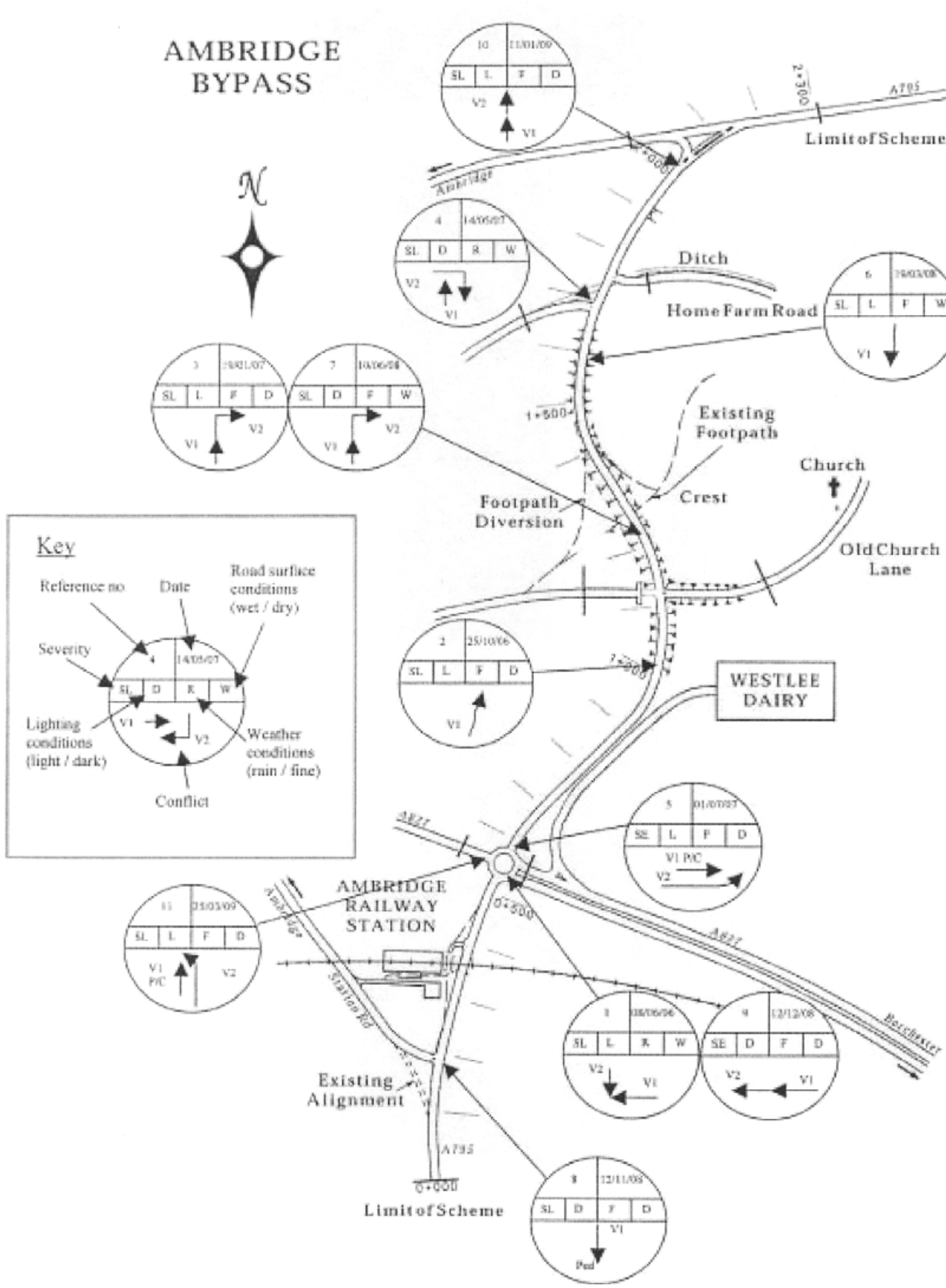
[(2)] A Road Safety Good Practice Guide, First Edition: Department for Transport, June 2001
[(3)] Monitoring Of Local Authority Safety Schemes, County Surveyors’ Society & Highways Agency

APPENDICES

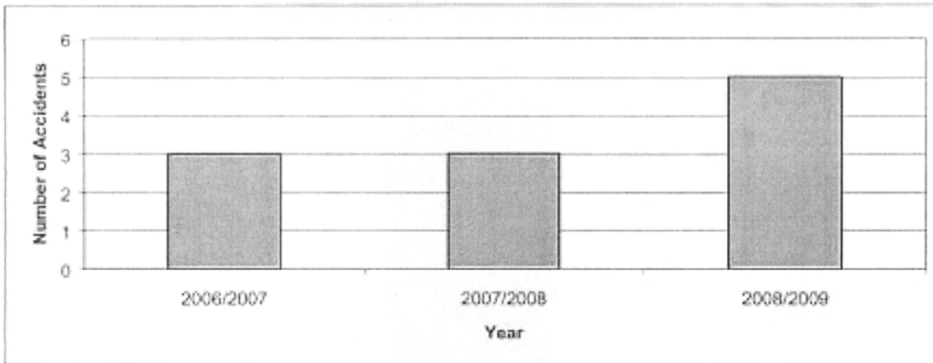
Appendix I—Accident Record 1st April 2006 to 31st March 2009

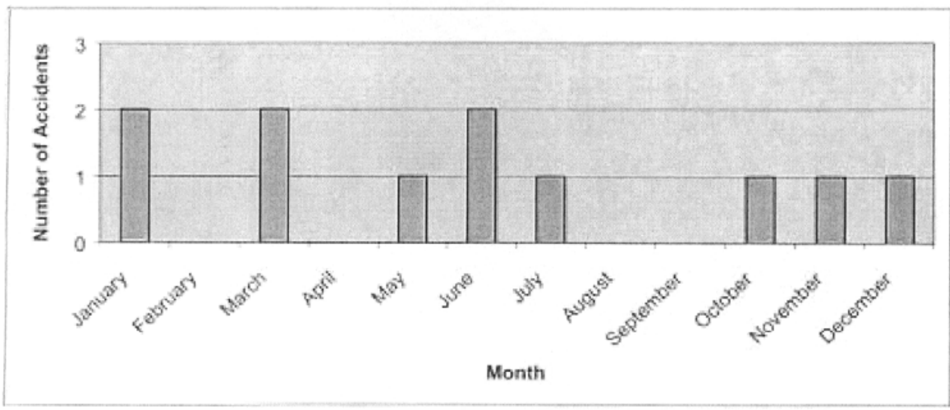
Reference:	1	2	3	4	5	6	7	8	9	10	11
Accident No.	T39195	T12495	T56395	T32196	T22396	T34596	T43196	T55296	T11297	T37897	T56797
Year	2006	2006	2007	2007	2007	2008	2008	2008	2008	2009	2009
Month	June	October	January	May	July	March	June	November	December	January	March
Date	8	25	19	14	1	19	10	12	12	11	25
Day	Thursday	Wednesday	Friday	Monday	Sunday	Wednesday	Tuesday	Wednesday	Friday	Sunday	Wednesday
Time	10:40:00	09:10:00	13:15:00	19:25:00	16:10:00	12:15:00	15:15:00	21:20:00	16:45:00	11:15:00	17:00:00
Severity	Slight	Slight	Slight	Slight	Serious	Slight	Slight	Slight	Serious	Slight	Slight
Dark/Light	Light	Light	Light	Dark	Light	Light	Light	Dark	Dark	Light	Light
Weather	Rain	Fine	Fine	Rain	Fine	Fine	Rain	Fine	Fine	Fine	Fine
Road Surface	Wet	Dry	Dry	Wet	Dry	Wet	Wet	Dry	Dry	Dry	Dry
No. Vehicles	2	1	2	2	2	1	2	1	2	2	2
Vehicle 1	Car	M/C	Car	M/C	P/C	Car	Car	Car	Car	Car	P/C
Vehicle 2	Van		Car	Car	Car		Van		Van	Car	Car
Vehicle 3											
No. Casualties	1	1	2	1	1	1	1	1	2	1	1
Casualty 1	Driver V1 Male 25	Rider V1 Male 34	Passenger V2 Female 54	Rider V1 Male 27	Rider V1 Male 54	Passenger V2 Female 65	Driver V2 Male 32	Pedestrian V1 Male 22	Driver V1 Male 23	Driver V1 Male 72	Rider V1 Female 48
Casualty 2			Driver V1 Male 43						Driver V2 Male 44		
Causation	Veh 1 failed to give way and pulled out across path of veh. 2	Rider lost control of machine on oil patch	Veh. 2 waiting to turn right into Lay-by, veh 1 skids into rear	Veh 2 turns right out from junction in path of motorcycle	V2 exits rbt to A795 across path of P/C V1 negotiating cir/cway	Veh. 1 lost control – distracted by passenger	Veh. 1 skids into rear of Veh. 2 turning right into lay-by	Ped. drunk in road hit by car	Veh 1 runs into the back of Veh 2 on approach to junction	Veh 1 runs into the back of Veh 2 on approach to junction	V2 exits rbt to A827 across path of P/C V1 negotiating cir/cway
Manoeuvre											
Location	A827/A795 Rbt	N/B approach to Old Church Lane	S/B lay-by north of Old Church Lane	A795/Home Farm Road Junction	A827/A795 Rbt	South of Home Farm Road	S/B lay-by north of Old Church Lane	South of Station Road	A827/A795 Rbt	A795 Ambridge Rd junction	A827/A795 Rbt

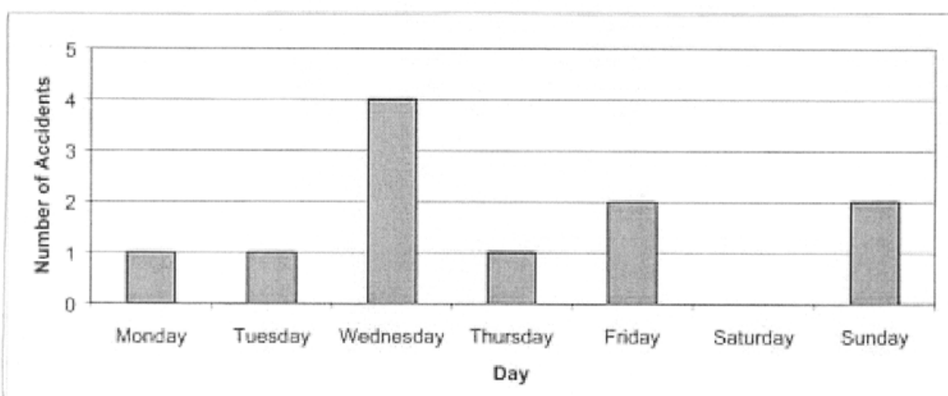
Appendix II—Accident Plot 1st April 2006 to 31st March 2009



Appendix III—Accident Frequency by Year, Month & Day of Week

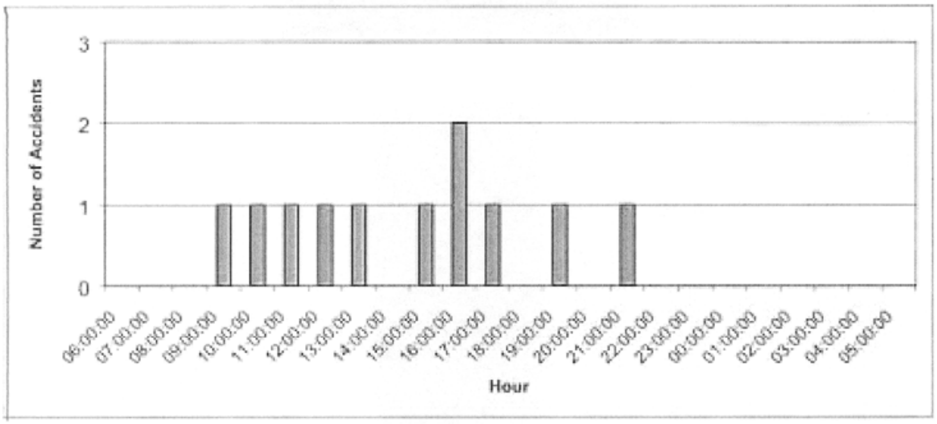


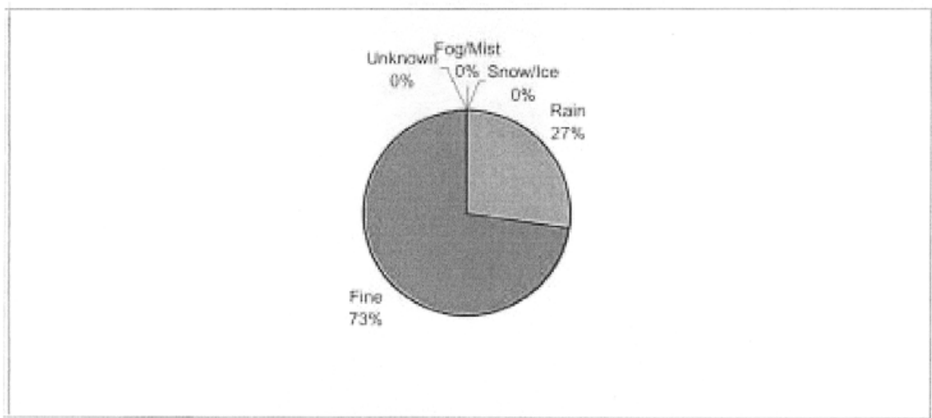


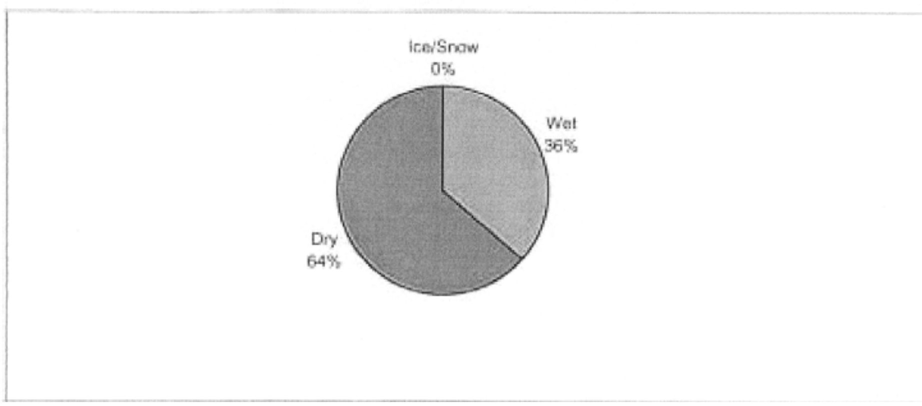


Appendix IV—Accident Frequency by Hour of the Day, Weather Conditions & Road Surface Conditions

Ambridge Bypass from 01/04/2006 to 31/03/2009

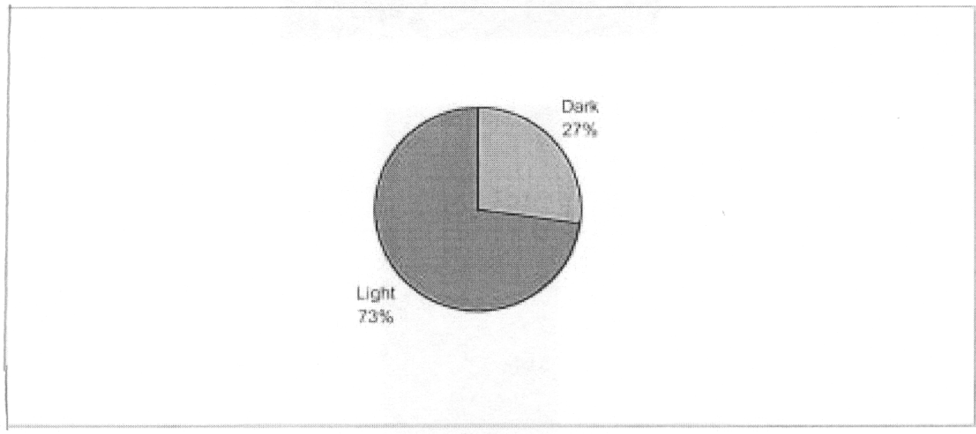






Appendix V—Accident by Light Conditions

Ambridge Bypass from 01/04/2006 to 31/03/20009



RSA TOOL KIT

Developed by Eugene M. Wilson, Ph.D., PE, PTOE

LOCAL RURAL GOVERNMENT RSAR PROCESS

Functional Local Rural Road Classifications

RSAR Form

Instructions for Local Rural Road Safety Audit Review Program

Safety Issues to LOOK FOR

Sample Report of RSAR Findings

"The key to safety is implementing
improvements for safety issues identified as urgent."

SAMPLE REPORT

County Road Safety Audit Reviews

Roadways reviewed and the recommendations resulting from the reviews are as follows (specifics on exact locations and more details are provided in the review notes):

Local/Rural Major High Speed Road

Several items were noted that could be improved if the road was ever reconstructed. However, considering the classifications of the road and the cost of improvements, many items were recommended to leave as they are. Included are parallel drainage pipe blunt ends, trees, power poles, mailbox supports, and some relatively steep side slopes.

The following items were thought to be of a relatively low cost improvement that could have positive safety benefits and should be considered for improvement within a reasonably short time frame:

Westbound:

- Relocate curve sign further upstream
- Delineate roadside where roadway narrows at horizontal curve and a relatively steep slope exists (2 locations)
- Replace non-standard speed limit signs

Eastbound:

- Replace curve sign with a curve/intersection warning sign
- Relocate mailboxes
- Relocate curve sign further upstream
- Replace curve warning advisory speed plate to be consistent with opposite direction
- Add delineation to clearly define edge of roadway cross-section
- Install a STOP sign

The following item was thought to be of such a nature that we recommend the improvement be initiated as soon as possible:

- Install delineation where roadway alignment is not consistent with the power pole alignment

The following items were considered to be of such a nature that they would have relatively high safety benefit if corrected, but are of relatively high cost for this classification of roadway. Therefore, it is recommended that they be considered for improvement if major reconstruction occurs on the roadway at or near these locations.

- Driveway approach in poor location
- Westbound view blocked by fence, restricted sight distance
- Driveway approach grades cause restricted sight distance

Local/Rural Local Road

- Numerous potential safety concerns exist on this roadway. However, due to the classification of the roadway, it is recommended that no improvements be made except to install a STOP sign.

Local/Rural Low Volume Local Road

Several items were noted that could be improved if the road was ever reconstructed at those specific locations. However, considering the classification of the road and the cost of improvements, many items were recommended to leave as they are. Included are relatively steep slopes and ditches, vertical and horizontal alignment creating sight restrictions, no notification of road ending, and power poles.

The following item was thought to be a relatively low cost improvement that could have positive safety benefits and should be considered for improvement within a reasonably short time frame:

- Pull ditches and remove large rocks

The following four audit reports are examples of how audits will vary with different audit teams. The first two audit reports are for the same facility, but performed by two different audit teams; the last two are for another facility, again performed by two different audit teams.

Road Safety Audit Report on the Preliminary Design of the County Road (State Route 51) and Slade Street Intersection Improvements

August 27, 2002

Project Description

The signalized intersection of Route 51 (County Road) and Slade Street is currently a high crash location with over 50 crashes in the latest three (3) year crash history. In addition, this intersection operates at failing levels of service during peak times of the day. The existing speed limits vary from 35 MPH on Slade Street to 40 MPH on County Road.

Adjacent land use in the area is primarily commercial in nature with a residential neighborhood located in the northeast quadrant of the intersection.

Numerous full movement entrances in the vicinity of the intersection exacerbate the existing over-capacity conditions and contribute to the high crash location status.

The alternatives presented include primarily the addition of a travel lane on each of the approaches with reconstruction to provide for the receiving lanes. In addition, raised bituminous islands with sloped granite curbing will be constructed to reduce the existing number of turning movements at adjacent entrances and residential streets.

Purpose of Audit

Conduct a review of the preliminary design with emphasis on vehicle and intersection safety. Visit the project site and make suggestions to enhance the safety of the intersection

Audit Team

Members of the audit team are as follows:

Division 3 Traffic Engineer; Designer, Urban and Arterial Program; Division 6 Traffic Engineer; Safety Engineer, FHWA; and Resident Inspector, Regional Program, Division 7.

Data and Information Used

We reviewed the following data and information during the conduct of this audit.

- Preliminary plan
- Typical sections
- Profiles
- Crash data
- State Access Management Rules
- Manual on Traffic Control Devices (MUTCD)
- State Highway Design Guide

General Findings

- The existing intersections operate at low levels of service with turning movements into/out of the driveways/entrances/streets in the immediate vicinity.
- Vehicles use shoulders inappropriately.
- Existing insufficient truck turning radii.

SPECIFIC FINDINGS

County Road Westbound Approach

- Receiving lanes on the east leg of the intersection appear to be short prior to the lane drop. The concern is that the contributing westbound through or southbound dual left turn lanes will not be fully utilized. Extend the two eastbound receiving lanes to station 1+420 before starting lane drop. Ideally, the two-lane section should be extended to the intersection of County Road and the Exit 7A connector road.

- The westbound approach right and through lanes need to be extended to Station 1+420. The lane transition length appears to be the same as the lane drop transition; this should be one half the lane drop distance.

- Consider a frontage road to connect Cottonwood Street with Elm Street. This configuration will reduce the number accesses onto County Road.

County Road Eastbound Approach

- The proposed median opening on Route 51 at Station 1+100 to 1+120 should be closed and the access to the CMP substation be restricted to right in and right out only.

Slade Street Northbound Approach

- Narrow the proposed median opening on Slade Street at approximately Station 5+320 Lt to 5+340 Lt to allow passenger cars only. The shared entrance narrowed to 30-foot wide and signed to prohibit truck traffic and direct them to Lance Drive.

Intersection Signal

- The phasing of the intersection indicates the southbound (SB) dual left turns will operate concurrently with the northbound (NB) left-turn lane. There does not appear to be sufficient room within the intersection for this to occur.

Speed Limit

The speed zones on County Road and Slade Street should be reviewed. A speed reduction may reduce the number of crashes

Conclusions

In our judgment, consideration of the findings should improve the overall safety of the signalized intersection of Route 51 (County Road) and Slade Street in Layton. We also suggest that a subsequent road safety audit take place after final design plans have been completed.

Although we still have concerns with the Elm Street and County Road intersection, there does not seem to be a feasible solution that would not significantly alter the scope of the project while allowing for safe and efficient traffic flow at this location.

Respectfully submitted,

Team Leader

Road Safety Audit Report on the Preliminary Design of the Intersection Improvement at Route 51 and Slade Street in the Town of Layton

Project Description

The Route 51 and Slade Street intersection is a suburban intersection surrounded by commercial and residential land use. The intersection is in a major commuter route from the surrounding communities to the Turnpike/Interstate as well as the mall area. It is believed that capacity issues are the driving forces behind this improvement.

The existing intersection is classified a high crash location by the state Department of Transportation, with 50 accidents in the years 1999–2001.

We have reviewed the preliminary plan, which includes widening of the intersection to separate turning movements and provide dedicated left-turn lanes as well as additional thru lanes at the intersection.

Audit Team Members

The following members comprise the audit team:

- Division 2 Traffic Engineer
- Division Engineer, Division 4
- Division 7 Traffic Engineer
- DOT Traffic
- Division 7 Regional Program
- Assistant Engineer, Division 6

Data and Documentation

We have reviewed the following data and documentation during the conduct of this audit:

- Preliminary Plan titled Layton, Project No. 1452, Produced by Smith Consulting Engineers, Dated PDR August 9, 2002.
- Crash data produced by state DOT.

Assumptions

We have based our audit on the following assumptions:

- The existing highway is built to design standards at the time of construction.
- The plans for the proposed intersection improvements are according to current design standards.
- Utilities will be moved outside of the clear zone.
- Pedestrian and bicycle traffic has been considered.
- Turning movements and capacity issues have been considered.
- All traffic signals and signage will be according to the MUTCD.

Site Visit

We visited the site on August 29, 2002, from approximately 8 AM to 10 AM to review field conditions and traffic flows. The weather at the time of the visit was partly cloudy. The intersection was viewed from all quadrants during the site visit. The existing intersection is located in a mix of residential and commercial land uses. There are a few entrances located within the project limits, which should be considered for access management. Pedestrian and bicycle use was non-existent during our visit. Drainage did not appear to be an issue at this time, but storage for winter snow appeared to be limited due to the narrow shoulders in the intersection.

Findings

The group identified the following issues as potential safety problems:

- The left turns on both legs of Slade Street are allowed to run at the same time, under the proposed signal phasing. There does not appear to be enough room in the intersection for these movements to be made at the same time without conflict. Increasing the space in the intersection for these opposing left-turning movements is one possible solution. The other solution would be to not allow the left turns to run concurrently.
- Left-turning trucks from County Road onto Slade Street need additional room to make the turn due to the acute angle involved. This occurs on both legs of the County Road. Additional room should be given for these truck movements.
- Access management should be strongly considered around Wren's Auto Repair and the local side streets (Cottonwood and Elm Streets). We feel that consideration should be given to combining Cottonwood and Elm Streets at Elm Street and eliminating the present Cottonwood Street entrance onto Route 51. The connection should be located as far from Route 51 as possible to provide the maximum comer clearance. The Wren's Auto Repair lot should only have access off from Cottonwood Street. We also feel that the little house behind Wren's Auto Repair on Slade Street should be purchased so that the present entrance can be eliminated.
- Is the proposed left-turn pocket long enough for expected traffic? We feel that a refuge may be appropriate for left-turning vehicles into and out of Elm Street. Left-turning traffic would only have to cross half of the roadway at a time if a refuge was provided.
- No lighting was shown on the plans. We recommend that additional overhead lighting should be installed at the intersection.
- There are numerous trees around the intersection that inhibit sight distance. These trees should be removed and any new plantings should be small enough or located such that sight distance is not impaired.
- The No Parking ordinance should be maintained in the area around the intersection after construction.
- All utilities should be moved outside of the clear zone.
- The island on Slade Street at Station 5+200 does not appear to be wide enough on the plans. This island needs to be wide enough to accommodate keep right signs.
- The tapers entering into the intersections do not appear to be long enough for the proposed transition zones. These transition zones should be lengthened to meet existing standards.
- The group feels that the entrance at 5+330 right on Slade Street should be moved across from the drive at 5+370 left. This would eliminate some turning conflicts at the two locations. It would also eliminate the median cut at this location.

Conclusions

In our judgment, considerations of the findings should improve the overall safety of the intersection improvement at the intersection of Route 51 and Slade Street in Layton. We also feel that a subsequent Road Safety Audit should be conducted later on in the design phase to provide additional feedback on any design changes that are made.

ROAD SAFETY AUDIT REPORT

for the design of the

Route 197 Project in Stanford

August 29, 2002

Project Description

The proposed project is on State Route 197 from the intersection of Castle Road to the state DOT compact urban line, approximately 1.2 miles from the intersection heading toward Douglas. The project also involves several intersections beyond Castle Road. This includes Maple Drive, Hill Road, and Stanford Road/Clay Drive (a 4-way signalized intersection).

This particular area has experienced residential/commercial growth and will continue to experience more growth in the future. From the increase in traffic volume, geometries have become a concern for safety. This road has a variety of vertical curve elements that need addressing. In combination with the geometries, driver inattention has contributed to the largest population of crashes for the current speeds in this corridor. To address some of the crashes and pedestrian uses, 12-foot lanes are being proposed with 6-foot shoulders. In conjunction with these modifications, sidewalks with an esplanade are being implemented to accommodate the expanding bedroom community here.

Purpose of Audit

The purpose of the audit is to review preliminary plans for safety issues. A field review was also conducted. The field review and plan review will be combined for recommendations and proposed changes to plans and/or specifications for the purpose of improving safety on this project.

Audit Team

Members of the Audit Team are as follows:

Safety and Traffic Engineer, FHWA; Designer, Urban and Arterial Program; Major Project Studies, Bureau of Planning; Traffic Engineer, Bureau of Planning; Assistant Engineer, Bureau of Planning; Resident Inspector, Regional Program, Division 7; and Project Administrator, Urban and Arterial Program.

Data and Information Used

We reviewed, or used information from, the following sources while conducting this audit:

- Preliminary plan
- Crash data
- Cover letter from Designer that included additional project information
- State Access Management Rules
- Manual on Uniform Traffic Control Devices (MUTCD)
- State Highway Design Guide

General Findings

There are currently inadequate shoulders throughout the length of this project. The lack of shoulders appears to contribute to many of the crashes along this section.

Sight distance is a problem throughout this project. Unimproved horizontal and vertical alignment in conjunction with the numerous residential and light commercial properties creates safety concerns throughout the length of the project.

The intersection just before the southern project terminus (Castle Road Intersection) is a relatively high-volume intersection that is likely to see significant increases in volume due to development of adjacent property for high-use commercial purposes. This intersection also has a fairly high accident cluster over the past 3 years. As such, this intersection was included in our review.

The project also includes another signalized four-way intersection at Stanford Road. This intersection involves many traffic movements and will require realignment, increased turning radii, and construction of exclusive left-turn lanes in all directions.

Specific Findings

Review stopping and intersection sight distances throughout the project. For example, the Credit Union area between 0+420 to 0+580 and all other intersections.

School bus was observed making a wide turn onto Maple Street. Please review all turning radii at intersections.

Crash data indicate a problem in the Credit Union area. Consider adding turning lanes if warranted.

Consider adding a protected left-turn phase at both intersections if warranted.

Consider exclusive left-turn lanes at Castle Road if warranted, while R/W is more readily available.

Consider pedestrian signals at all signalized intersections.

Improve “landing area” at Hill Street as much as possible. Verify guardrail length of need and all end treatments throughout project. Use guardrail along sidewalk even if outside designated clear zone (as opposed to chain-link fence), because of the severe slopes.

Coordinate design effort with Bridge Design to ensure adequate treatment of structure at north terminus of project.

Eradicate poison ivy before construction.

The proposed design will severely impact homes in the northeast and southwest corners of the intersection at Stanford Road/Clay Drive; consider realigning the intersection (Clay Drive) southerly (20 m) to improve traffic operations. By taking one property this will eliminate sever impacts to both residences.

Conclusions

The Review Team strongly recommends consideration of all recommendations in this report. This is an unimproved roadway that has high traffic volumes and currently connects two improved sections of roadway that appear to meet all current standards. The proposed design will significantly improve safety in the vicinity with the construction of the 12-foot travel lanes along with 6-ft shoulders. The inclusion of a 5 ft sidewalk from Castle Road to Stanford Road on the west side of the roadway (including a 4 ft esplanade) and a 5 ft sidewalk on the east side between Hill Road and Stanford Road will also significantly increase safety along this stretch of roadway. To further improve safety in this area, we have made several recommendations that relate to further improving the sight distance along the project. In addition, we recommend that a complete guardrail review be completed to ensure that adequate protection is provided in areas where the slopes are not traversable and hazards are present. Other recommendations relate specifically to the intersections at Castle Road and Stanford Road.

State Department of Transportation

Road Safety Audit
Route 197 Stanford
Preliminary Plan Review

Tuesday, August 27, 2002

Project Description

Route 197 is currently a two-lane rural/suburban minor arterial highway extending one mile north of the intersection with the Castle Road. The existing speed limit on Route 197 is 35 miles per hour. Adjacent land uses include residential and commercial. Intersections along the corridor include:

- Castle Road/Route 197
- Maple Street/Route 197
- Hill Street/Route 197
- Stanford and Clay Road/Route 197

There are numerous driveway accesses and wide driveways on this section.
We have reviewed a preliminary proposal to use a two-lane curb and gutter section with additional left- and right-turn lanes at intersections. The proposed typical section is assumed to include 5-foot sidewalks on the east and west side of the road north of the Clay and Stanford Roads, with a 4-foot grass esplanade separating the shoulder and sidewalk on the west side.

Audit Team Members

The following members comprise the audit team:

- Division 1 Traffic Engineer
- Division 2 Traffic Engineer
- Assistant Project Manager
- Transportation Analysis
- FHWA
- Urban and Arterial Designer

Data and Documentation

We have reviewed the following data and documentation while conducting this audit:

- Preliminary alignment plans and profile entitled Improvements to Route 197 Stanford by Smith Engineering.
- Crash data for 1999–2001 produced by state DOT for this section of road.
- Letter re: Route 197 Stanford, Plans for Safety Training Course.

Needs

The following data will be needed to adequately address safety:

- Design AADTs, including truck counts;
- Present timing and phase layout of existing signals;
- Turning movements at intersections;
- Design speed;
- Typical cross sections;
- Maintenance concerns could possibly be addressed by including a maintenance person on the Road Safety Audit teams; and

- Law enforcement input should be encouraged.

Assumptions

We have based our audit on the following assumptions:

- The plans for the proposed section are according to current design standards.
- Some entrances and driveways on Route 197 will be eliminated.
- Intersections presently signalized will remain signalized.
- Curbing will be used at the sidewalks and esplanade.
- Utilities will be moved outside the clear zone or underground.
- Pedestrian and bike traffic have been considered.
- Parking will be regulated.
- Center lanes are typically left-turn lanes and far right lanes are right-turn lanes when shown on the plan.

Site Visit

We visited the site on August 27, 2002, from approximately 1:30 PM to 4 PM to evaluate the proposed plans in relation to present use of the current roadway. The weather was mostly sunny.

The existing roadway appears to have drainage deficiencies with excessive rutting along sections with the greater grades. This area is a mix of commercial and residential uses. This area transitions from rural to recently completed urban development. Trucks were observed to account for a significant portion of the traffic volume. Pedestrians and bicyclists are assumed to be significant here as well, although very little was observed during our review. The 85th percentile speeds appeared to be between 40 and 45 miles per hour.

We walked the entire proposed project while reviewing the proposed plans. We then compared and contrasted our observations with those we anticipated before compiling this report.

We were not able to visit the site after dark or under differing weather conditions, which may reveal additional safety needs beyond those outlined below. Safety needs determined because of these different conditions should be considered in the design of this project and may normally require additional visits to the sites during road safety audits.

Findings

Our findings and observations are identified below. These findings are the consensus of the team.

Overall Concerns

- Queue lengths of proposed left-turn and right-turn lanes should be designed to be adequate for design AADTs and turning movements.
- Sidewalk south of this project near Red Creek is on the east side of Route 197. Sidewalk should be extended from this project to that area. Presently, no sidewalk is shown on the east side of the proposed plan from Hill Street south. Schools are on the east side of this route. These factors should be considered in determining whether the sidewalk should be on the east, west, or both sides throughout and along the project.
- All utilities should be moved outside the proposed clear zone. Numerous utility poles and fire hydrants were observed inside the proposed clear zone.
- Sight distance concerns were observed at numerous accesses and intersections near the vertical curve crests.
- The speed limit sign at 0+240± right is a 35 mile per hour sign, not 25 miles per hour as shown on the plan.
- Slope stability needs to be considered at a number of locations including:
  - 0+240± right
  - 1+540± right
  - 0+740± left.
- Guardrail end treatments should reflect current standards.
- Proposed locations of guardrails should be considered when evaluating sight distances. Remember to consider the location of the guardrail in relation to the proposed edge of shoulder as it will be built.

- Numerous drainage deficiencies were observed and need to be addressed.
- Excessive rutting was observed at numerous locations including:
  - 0+700 southbound lane
  - 0+890 southbound lane.
- Left-turn tracking was observed beyond the existing pavement at a number of locations including:
  - 0+450
  - 1+740 –1+780
  - 1+400
  - commercial establishments, in general.
- Entrances should be offset directly across from each other as much as possible.
- Phases and timing of signals should be re-evaluated in relation to lane and shoulder modifications (including sidewalk and crosswalk needs).

Specific Concerns

- The existing entrance at 0+120 should be considered for elimination, since it appears this parcel may be able to enter on to the Leighton Road, with lower expected volumes and level of service needs.
- Sight distance at 0+200, right, access may not meet design speed criteria.
- Maple Street should be re-oriented at the intersection with Route 197 to intersect at a 90º angle.
- The entrance at 0+280 left should be considered for modification to allow entrance on to Maple Street or more significantly entering on to Route 197 at a right angle.
- Sight distance at 0+380, left, access may not meet design speed criteria and should be considered for elimination. Excavation of the bank to the north needs to be evaluated in relation to sight distance needs at this entrance if it is not eliminated.
- The entrance at 0+450± right should be considered for placement opposite the entrance at 0+430± left.
- The entrance at 0+500± right should be considered for placement opposite the entrance at 0+480± left or being shared with the Credit Union entrance.
- Sight distance at 0+570, left, access may not meet design speed criteria and modifications to vertical profile of the road or movement of the entrance location should be considered to meet the criteria.
- Entrances at 0+620 and 0+640 left appear to have tracked in to each other and will need some means of positive separation to maintain access management in the future.
- Sight distance at 0+620, right, access may not meet design speed criteria. Excavation of the bank to the north and/or movement of the entrance needs to be evaluated in relation to sight distance needs here.
- Evidence of spinning tires was observed at a number of entrances including 0+780±right. Level landings of these entrances at the road should be provided.
- Sight distance at 0+780, right, access may not meet design speed criteria.
- Sight distance at 0+850, right, access may not meet design speed criteria. Excavation of the bank to the north and/or movement of the entrance needs to be evaluated in relation to sight distance needs here.
- Sight distance at 0+920, right, access may not meet design speed criteria. Excavation of the bank to the south and/or vegetation interferences need to be evaluated in relation to sight distance needs here.
- Sight distance at 0+930, left, access may not meet design speed criteria and modifications to vertical profile of the road and/or elimination of vegetation interferences should be considered to meet the criteria.
- Hill Street is presently closed. The grade on the approach and the width of the opening is excessive and a utility pole, creating the need for an island in the middle of the opening, is undesirable. Sight distances may not meet design speed criteria. Keeping the road closed should be considered. If not kept closed, the grade should be reduced and approach profile raised, width of the opening reduced, and the island and utility pole eliminated at the present approach.
- The entrance at 1+140 right should be considered for elimination.
- Drives and parking from1+140 to 1+200 left should be designed to eliminate vehicles backing in to the roadway.
- The angle of intersection at the Stanford Road and Route 197 intersection creates vehicle tracking and sight distance problems. The stop line is presently located a considerable distance back from the intersection. Modification of this approach should be considered to eliminate these problems. The most significant tracking problem was observed for vehicles turning left off the Stanford Road on to Route 197.
- Sight distance at 1+330, left, access may not meet design speed criteria and elimination of such should be considered.

- Sight distance at 1+360, left, access may not meet design speed criteria. Excavation of the bank to the north and/or movement of the entrance needs to be evaluated in relation to sight distance needs here. A level landing of the entrance should be provided at the road.
- Parking needs at 1+410 right exceeded parking available off the road. Three cars were parked along the shoulder of the road when we passed by. This will create traffic flow problems along the project if parking is allowed along the shoulders.
- Entrance at 1+610 right allows for vehicles to enter road at excessive speeds. This should be configured to constrict their entrance to be more perpendicular to the road.

Conclusions

In our judgment, consideration of the findings should improve the overall safety of the Route 197 corridor in Stanford. We also suggest that a subsequent road safety audit take place after the preliminary plans have been completed.

Signed by:

____Division 1 Traffic Engineer

____Division 2 Traffic Engineer

____ Assistant Project Manager

____Transportation Analysis

____FHWA

____Urban and Arterial Designer

APPENDIX D

Audit Checklists

FHWA Study Tour for ROAD SAFETY AUDITS

Part 2

October 1997

Prepared by the Scanning Team:

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and by
American Trade Initiatives, Inc.

Prepared for:
Federal Highway Administration
U.S. Department of Transportation
October 1997

3.1 Sample Checklists from Transit New Zealand: MASTER and STAGE 1

Excerpts are reprinted with permission from Transit and Transfund New Zealand.

M

MASTER CHECK LIST - ALL STAGES

STAGE 1-FEASIBILITY (AF@)	STATE 2-PROJECT ASSESSMENT (AP@)	STAGE 3-FINAL DEIGN (AD@)	STAGE 4-PREOPENING (AO@)
F1a General Topics: 1. Scope of Project, function, traffic mix 2. Type and degree of Access to Property and Developments 3. Significant adjacent Developments 4. Influence of staging 5. Future widening &/or Realignments 6. Wider network effects	P1a. General Topics: 1. Changes since Stage 1 2. Drainage 3. Climatic Conditions 4. Landscaping 5. Services 5. Access to Property and Development 7. Emergency vehicles and Access 8. Future widening &/or Realignments 9. Staging of scheme 10. Staging of works 11 Significant adjacent Developments 12. Stability of cut & fill—surface effects	D1a General Topics: 1. Changes since Stage 2 2. Drainage 3. Climatic Conditions 4. Landscaping 5. Services. 6. Access to Property and Development 7. Emergency vehicles and Access 8. Future widening &/or Realignments 9. Staging of scheme 10. Staging of works 11. Significant adjacent Developments 12. Batter stability—surface effects	O1a. General Topics: 1. Changes since Stage 3 & Transition of Design 2. Drainage 3. Climatic Conditions 4. Landscaping 5. Services 6. Access to Property 7. Emergency vehicles & Access 11. Significant adjacent Developments 12. Batter Treatment 17. Shoulders & edge delin. 20. Signs and markings 21. Surface, skid resistance 22. Contrast with markings 23. Installed hazards 24. Natural features
F1b Design Approach 7. Route Choice 8. Impact of continuity with existing network 9. Broad design standard 10. Design speed 11. Design Volume, traffic characteristic	P1b Design Approach 13. Geometry of horizontal and Vertical Alignment 14. Typical Cross Sections 15. Effect of Cross Sectional Variation 16.Roadway Layout 17. Shoulders and edge treatment 18. Effect of Departure from Standards & guidelines	D1b Design Approach 13 Geometry of horizontal and Vertical Alignment 14. Typical Cross Sections 15. Effect of Cross Sectional Variation 16. Roadway Layout 17. Shoulders, edge treatment 18. Effect of Departure from Standards & guidelines 19. Visibility, sight distances 20. Signs and markings	
F2 Intersections 1. Number and Type of Intersections	P2 Local Alignment 1. Visibility 2. Layout, including appropriateness of type 3. Readability by drivers	D2 Local Alignment 1. Visibility 2. New/Existing Road Interface 3. Readability by drivers 4. Detailed Geometric Design 5. Treatment—bridges & culverts	O2. Local Alignment 1. Visibility, sight distances 2. New/Existing Road Interface 3. Readability by drivers 5. Treatment at Bridges and Culverts
F3. Environmental Constraints 1. Safety Aspects, including weather, natural features	P3. Intersections 1. Visibility 2. Layout, including appropriateness of type 3. Readability by drivers	D3. Intersections 1. Visibility 2. New/Existing Road Interface 3. Readability by drivers 4. Detailed Geometric Design 5. Traffic signals 6. Roundabouts, islands 7. Other intersections	O3. Intersections 1. Visibility 3. Readability by drivers 5. Traffic Signals 6. Roundabouts, islands
F4. Any Matter not covered above 1. Safety aspects not already dealt with	P4. Non-Vehicular provision 1. Adjacent Land 2. Pedestrians 3. Cyclists 4. Equestrians/stock	P4. Non-Vehicular provision 1. Adjacent Land 2. Pedestrians 3. Cyclists 4. Equestrians/stock	O4. Non-vehicular provision 1. Adjacent Land 2. Pedestrians, incl. refuges 3. Cyclists 4. Equestrians/stock

	P5 (6). Signs and Lighting 1. Lighting 2. Signs 3. Markers, edge delineation	D5. Signs and Lighting 1. Lighting 2. Signs 3. Markers, edge delineation	O5. Signs and Lighting 1. Lighting 2. Signs, visibility & position 3. Markers, edge delineation
		D6. Physical Objects (poles, barriers, etc.) 1. Median barriers 2. Poles & other obstructions 3. Guardrailing 4. Bridge & culvert parapets	O6. Physical Objects (poles, barriers, etc.) 1. Median Barriers 2. Poles & other obstructions 3. Guardrailing
Note: This stage is the only checklist not to conform with the standard sequential numbering and topic descriptions. All subsequent safety audit checklists have a standard format and text	P7. Construction and Operation 1. Buildability 2. Operation 3. Traffic Management 4. Network Management 5. By-law requirements	D7. Construction and Operation 1. Buildability 2. Operation 3. Traffic Management 4. Network Management 5. Temporary traffic control/ management	O7. Construction and Operation 2. Operation 3. Traffic Management in pract 6. Temporary Traffic Control/Management, change to permanent
The narrow columns are for the use of Safety Auditors in any way they see fit.	P8. Any other matter 1. Safety aspects not already covered	D8. Any other matter 1. Safety aspects not already covered	O8. Any other matter 1. Safety aspects not already covered

F

STAGE 1 - FEASIBILITY (AF@)

REFERENCE	TOPIC	NO.	ITEM
F1a	General Topics: Broad issues to be addressed	1 2 3 4 5 6	Scope of Project, function, traffic mix Type and degree of Access to Property and Developments Significant adjacent Developments Influence of staging Future widening &/or Realignments Wider Network effect
F1b	General Topics: Design approach	7 8 9 10 11	Route Choice Impact of continuity with existing network Broad design standard aimed at Design speed Design Volume, traffic characteristics
F2	Intersections	1	Number and Type of Intersections
F3	Environmental	1	Safety Aspects, including weather, natural constraints features
F4	Any Matter not covered above	1	Safety aspects not already dealt with

Note: This is the only checklist not to conform with the standard sequential numbering and topic descriptions.
All subsequent safety audit checklists have standard format and text.

F1a

STAGE 1 - FEASIBILITY (AF@)

Check list F1a: General Topics: Broad Issues to be Addressed

ITEM	ISSUES TO BE CONSIDERED	CHECK
1 Scope of Project Function Traffic Mix	A broad appreciation of the scope of the project will assist in addressing topics further on in this check list. What is the general type of project for which the design has been carried e.g: Motorway or major arterial, or simply a minor improvement? Is the road intended to carry high speed traffic or possibly serve local access needs only? What kind of traffic is to be carried, ranging from high speed mixed traffic (i.e. including a significant number of heavy goods vehicles) or for more general use including for instance, cycles and significant pedestrian foot traffic?	
2 Type and degree of accessed property and developments	Check the general layout of the scheme, including (a) Questions of visibility and speed, related to the number and type of intersections and accesses to property alongside. (b) Check the width of the right of way, or the detailed design within that width, as affected by access requirements.	
3 Significant adjacent developments	Check major generators of traffic, including housing or shopping centres, that may have a significant influence on the form of the design. Check for distance of accesses from intersections and visibility of and from accesses to significant traffic generators.	
4 Influence of staging	Check the design against staging requirements. Will this scheme be one stage of several? Will future schemes be either linear extensions of the scheme, or will possible redundancies be caused by widening?	
5 Future widening and/or realignments	What is the likelihood of (a) Future widening? (b) The addition of a complete second carriageway? (c) Later realignments? (d) Introductions of major geometric changes at intersections?	
6 Wider network effects	Are there any harmful or beneficial safety aspects within the proposed project or on the surrounding network?	

F1b

STAGE 1 - FEASIBILITY (AF@)

ITEM	ISSUES TO BE CONSIDERED	CHECK
7 Route Choice	Consider the broad concept involved in the choice of a route or alignment Does the route follow existing roads or is it a "Green fields Project" and what are the effects of this? Does the scheme fit in with the physical constraints of the landscape and major network considerations?	
8 Impact of continuity with the existing network	Check for potential problems where the proposed roading scheme blends with or adjoins the existing network.	
9 Broad design standard aimed at	Check that the appropriate design standards have been used having regard to the scope of the project, its function in relation to the traffic mix.	
10 The design speed	Check the design speed for horizontal and vertical alignment, visibility, merging, weaving, and decelerating or accelerating traffic at controlled intersections. Check the effects of sudden changes in the speed regime or posted speed limit. Check the appropriateness of both the design speed and designated speed limit, if any, on the proposed roading project.	
11 Design volume traffic characteristics	Check the appropriateness of the design for the volume and traffic characteristics (including the effects of unusual proportions of heavy vehicles, cyclists and pedestrians, or side friction effects). Check the possible effects of unforeseen or large increases in traffic volume or changes in the traffic characteristics.	

F2,3

STAGE 1 - FEASIBILITY (AF@)

ITEM	ISSUES TO BE CONSIDERED	CHECK
1 Number and type of intersections	Check the appropriateness of intersections with respect to the broad concept of the project, its function and traffic mix and also the need to serve intersecting roads appropriately to their function. Check the number and type of intersections, including the relationship both of spacing and type of one intersection with another. Are there any traffic or safety aspects of the scheme or of the traffic in the area which would favour or disfavour any particular layout? Are there any physical or visibility constraints which would influence the choice or spacing of intersections? Are all of the proposed intersections necessary or essential, or can the surrounding network be modified beneficially? Does the vertical, geometry or horizontal alignment have any influence on the style or spacing of inter-sections?	

Check List F3 - Environmental Constraints

ITEM	ISSUES TO BE CONSIDERED	CHECK
1 Safety aspects, including weather and natural features	Check the surrounding terrain for physical or vegetation defects which could affect the safety of the scheme—for instance, heavy planting or forestry, deep cuttings, physical features such as steep or rocky bluffs which constrain design. Check the scheme for the effects of wind. Check for the effects of mist or ice. Do the gradients, curves and general design approach fit in with the likely weather or environmental aspects of the terrain?	

F4

STAGE 1 - FEASIBILITY (AF@)

Check List F4: Any Matter Not Covered Above

ITEM	ISSUES TO BE CONSIDERED	CHECK
1 Safety aspects not already dealt with	Check any aspects which do not readily fall into any of the above categories. e.g.: (a) The absence of electric power limiting the form of warning notices, (b) Flooding, (c) Moving stock, (d) The country may be unstable, (e) Low flying aircraft or advertising could be distracting to drivers. (f) Laybys or parking may be needed (e.g. for tourist routes, picnic or rest areas). (g) The potential of the route to attract roadside stalls, (h) Special events creating unusual or hazardous conditions, (i) Any other matter which may have a bearing on safety.	

3.2 Sample Checklist from Roads and Traffic Authority: STAGE 2

Excerpts are reprinted with permission from the Roads and Traffic Authority of New South Wales.

	N/A	YES	NO	COMMENTS
STAGE 2: DRAFT DESIGN At this stage, issues like intersection or interchange layout and the chosen design standards are addressed. Where land acquisition is required, the draft design stage audit is undertaken before title boundaries are finalized. It should be noted that the auditor may not be able to answer some questions at this point. Where the question cannot be given a >Yes' due to lack of detail at this stage, it should be answered >No= with the comment simply indicating that the auditor cannot determine that issue at this stage. **2.1 GENERAL TOPICS** **1 Changes Since Stage 1 (Feasibility)** 1A Do the conditions for which the route was originally designed still apply? (i.e., there have not been significant changes to the surrounding network or area to be served or traffic mix.) 1B Has the project design remained unchanged, in principle, since a Stage 1 audit (if any) was carried out? **2 Drainage** 2A Will the new road drain adequately? 2B Has the possibility of surface flooding been adequately addressed, including overflow from surrounding or intersecting drains and water courses? **3 Climatic Conditions** 3A Has consideration been given to weather records or local experience which may indicate a particular problem? (eg., snow, ice, wind, fog). **4 Landscaping** 4A Has safety been adequately considered in the landscaping design or planting? (eg. Will road traffic see pedestrians and vice versa; etc). 4B Has safety been adequately considered for when vegetation is mature or growth is seasonal (eg. through loss of visibility, obscuring signs, shading or light effects, leaves, flowers or seeds dropping onto the highway)? 4C Has the use of "frangible" vegetation been considered? **5 Services** 5A Does the design adequately deal with buried and overhead services (especially in regard to overhead clearances)? 5B Has the location of fixed objects or furniture associated with services been checked, including the position of poles? **6 Access to Property and Developments** 6A Can all accesses be used safely? (entry and exit/merging). 6B Is the design free of any down-stream or upstream effects from accesses, particularly near intersections? 6C Have rest areas and truck parking accesses been checked for adequate sight distances, etc.? **7 Emergency Vehicles and Access** 7A Has provision been made for safe access and movements by emergency vehicles? 7B Does the positioning of medians and vehicle barriers allow emergency vehicles to stop & turn without unnecessarily disrupting traffic?				

	N/A	YES	NO	COMMENTS
8 Future Widening and/or Realignment 8A If the scheme is only a stag towards a wider or dual carriageway: - is the design adequate to impart this message to drivers? - is the signing adequate to impart this message to drivers? 8B Is the transition from single to dual carriageway handled safely? 8C Is the transition from dual carriageway to single carriageway handled safely? (this is especially important in transition from freeway to 2 lane-2 way highway.) **9 Staging the Scheme** If the scheme is to be staged or constructed at different times: 9A Are the construction plans and program arranged to ensure maximum safety? 9B Do they include specific safety measures for any temporary arrangements? (e.g. signing; adequate transitional geometry; etc.). **10 Staging of the Works** 10A If the construction is to be split into several contracts, have each of these been arranged for maximum safety? **11 Adjacent Developments** 11A Does the design handle accesses to major adjacent generators of traffic and developments safely? 11B Is the driver's perception of the road ahead free of adverse effects of lighting and/or traffic signals on adjacent roads? **12 Stability of Cut and Fill** 12A Has a satisfactory report on the geological stability of the country through which the road is to be constructed (and resulting cut and fill) been completed? **13 Maintenance** 13A Can maintenance vehicles be safely located? **2.2 DESIGN ISSUES (GENERAL)** **1 Geometry of Horizontal and Vertical Alignment** 1A Does the horizontal and vertical design combination of the road provide a suitable alignment for drivers? 1B Do the combinations of horizontal and vertical design elements conform to design practice? (ie. there shouldn’t be undesirable combinations of horizontal and vertical design) 1C Is the design free of cues that would cause a driver to misread the road characteristics? (eg. visual illusions, subliminal delineation such as lines of trees, poles, etc.) 1D Does the alignment selected ensure speed consistency? 1E Are overtaking/climbing criteria met? **2 Typical Cross Sections** 2A Are the lane widths, shoulders, medians and other cross section features in accordance with standard design and adequate for the function of the road? 2B Is the width of traffic lanes and carriageway suitable in relation to: - alignment? - traffic? - vehicle dimensions? - speed environment? - combinations of speed and traffic volume?				

	N/A	YES	NO	COMMENTS
3 The Effect of Cross Sectional Variation 3A Is the design free of variations in cross section design that may have an adverse affect on road safety? 3B Are cross falls safe? (particularly where sections of existing highway have been utilised or there have been compromises to accommodate accesses, etc.) 3C Are cross falls safe where compromises have been made such as narrowing at bridge approaches or to avoid physical features? **4 Roadway layout** 4A Are all traffic management features (in addition to horizontal and vertical alignment and cross section) designed so as to avoid creating unsafe conditions? 4B Is the layout of road markings and reflective media (both on the road and on the surrounds) able to deal satisfactorily with changes in alignment? (particularly where the alignment may be substandard.) **5 Design Standards** 5A Has the design speed been selected in keeping with the terrain and importance of the road? 5B Is the design speed commensurate with the intended speed limit? **6 Shoulders and Edge Treatment** 6A Are the following safety aspects of shoulder provision satisfactory: - provision of sealed or unsealed shoulders? - width and treatment on embankments? - cross fall of shoulders? 6B Are the shoulders likely to be safe if used by slow moving vehicles or cyclists? 6C Have the safety aspects of rest areas and truck parking areas been checked in regard to shoulders? **7 Effect of Departures from Standards or Guidelines** 7A Are there any approved departures from standards which affect safety? 7B Have all hitherto undetected departures from standards been brought to the attention of the designer? **2.3 ALIGNMENT DETAILS** **1 Visibility; Sight Distance** 1A Are horizontal and vertical alignments consistent with the visibility requirements? 1B Will the design be free of sight line obstructions due to: - Safety fences? - Boundary fences? - Street furniture? - Parking facilities? - Signs? - Landscaping? - Bridge abutments? - parked vehicles in laybys? - parked or queued traffic? 1C Are railway crossings, bridges and other hazards all conspicuous? 1D Is the design free of any other local features which may affect visibility? **2 New/Existing Road Interface** 2A Have implications for safety at the interface been considered? (Include the accident rate and severity on the adjacent network, and the effect of sudden changes in the speed regime, or access, or side friction characteristics.) 2B Does the interface occur well away from any hazard? (eg. a crest, bend or where poor visibility/ distractions may occur.) 2C Is the change affected safely at any location where carriageway standards differ?				

	N/A	YES	NO	COMMENTS
2D Are transitions where the road environment changes safe? (eg. urban to rural; restricted to unrestricted; lit to unlit.) 2E Has the need for advance warning been considered? **3 >Readability= for the alignment by drivers** 3A Will the general layout, function and broad features be recognised by drivers in sufficient time? 3B Are the approach speeds and general likely positions of vehicles as they track through the scheme satisfactory? **2.4 INTERSECTIONS** **1 Visibility to and visibility at intersections** 1A Are horizontal and vertical alignments at the intersection or on the approaches to the intersection consistent with the visibility requirements? 1B Will drivers be aware of the presence of the intersection? 1C Will the design be free of sight line obstructions due to: - Safety fences? - Boundary fences? - Street furniture? - Parking facilities? - Signs? - Landscaping? - Bridge abutments? 1D Are railway crossings, bridges and other hazards all conspicuous? 1E Will the design be free of any local features which adversely affect visibility? 1F Will sight lines be unobstructed by permanent or temporary features such as parked vehicles in laybys, or by parked or queued traffic generally? **2 Layout, including the appropriateness of type** 2A Is the type of intersection selected (cross roads, T, roundabout, signalised, etc) appropriate for the function of the two roads? 2B Are the proposed controls (Stop, Give Way, Signals, etc.) appropriate for the particular intersection being considered? 2C Are junction sizes appropriate for all vehicle movements? 2D Are the intersections free of any unusual features which could affect road safety? 2E Are the lane widths and swept paths adequate for all vehicles? 2F Is the design free of any upstream or downstream geometric features which could affect safety? (eg. merging of lanes.) 2G Have public transport facilities been catered for? 2H Are the approach speeds commensurate with the intersection design? 2I Where a roundabout is proposed: - have pedal cycle movements been considered? - have pedestrian movements been considered? - are details regarding the circulating carriageway sufficient? **3 Readability by Drivers** 3A Will the general layout, function and broad features be perceived by drivers adequately? 3B Are the approach speeds and general likely positions of vehicles as they track through the scheme satisfactory? 3C Is the design free of sunrise or sunset problems which may create a hazard for motorists?				

3.3 Sample Checklist from Austroads: STAGE 4

Excerpts are reprinted from Road Safety Audit, Austroads, 1994.

ITEM	ITEMS TO BE CONSIDERED	CHECK	COMMENTS
1	Carry out a general check -- particularly for matters changed at previous audits.		
Changes since Stage 3 and translation of design into practice	Check the translation of the design into its physical form and any changes that could affect safety.		
2 Drainage	Check drainage of road and surrounds is adequate.		
3 Climatic conditions	Check effectiveness of any facilities put in place to counter climatic conditions.		
4 Landscaping	Check that planting and species selection is appropriate from safety point of view.		
5 Services	Check that boxes, pillars, posts and lighting columns are located in safe positions. Are they of appropriate materials or design?		
6 Access to property and developments	Check that accesses are safe for intended use. Check on adequacy of design, location and visibility in particular.		
7 Emergency vehicles and access	Check that provision for emergency vehicle access and stopping is safe.		
8 Significant adjacent developments	Check effectiveness of screening of adjacent developments and other special features.		
9 Batter treatment	Check that batter treatment will prevent or limit debris falling on to the carriageway.		
10 Shoulders and edge delineation	Check that all delineators and pavement markings are correctly in place.		
11 Signs and Markings	Check that all signs and pavement markings are correctly in place. Check that the appropriate sign has been used (especially Chevron Alignment Markers). Check that they will remain visible at all times. Check that old delineation (signs, markings) have been removed and are not liable to confuse.		
12 Surface treatment, skid resistance	Check all joints in surfacing for excessive bleeding or low skid resistance. Check all trafficked areas for similar problems, including loose stones.		
13 Contrast with markings	Check that the road markings as installed have sufficient contrast with the surfacing and are clear of debris.		
14 Roadside hazards	Check that no roadside hazard has been installed or overlooked.		
15 Natural features	Check that no natural feature (e.g., a bank rock or major tree) creates danger by its presence or loss of visibility.		

ITEM	ISSUES TO BE CONSIDERED	CHECK	COMMENTS
1 Visibility, sight distances	Check that sight lines are not obstructed.		
2 New/existing road interface	Check the need for additional signs and/or markings.		
3 Readabilty by drivers	Check that the form and function of the road and its traffic management are easily recognized under likely operating conditions (e.g. under heavy traffic or poor visibility conditions). Check transition between old and new alignment, that the road is >readable= and does not create uncertainty at the point of transition.		
4 Treatment at bridges and culverts	Check that all markings and signs are in place and readable.		

ITEM	ISSUES TO BE CONSIDERED	CHECK	COMMENTS
1 Visibility of intersection	Are drivers aware of the presence of the intersection (especially if facing a Stop/Give Way sign)?		
2 Visibility at intersection	Check that all visibility splays or parts of the right of way required for visibility are clear for cars, trucks and vehicles with restricted visibility (e.g. vans, cars towing caravans).		
3 Readability by drivers	Check by driving each approach that the form and function of the intersection is clear to all drivers. Check that the stop/give way line is clear, and that the driver is given sufficient cues to stop before protruding into conflicting traffic.		
4 Traffic signals	Check alignment and general correctness of installation and that all aspects are visible from each approach lane at the appropriate distances. Check the safe operation of signals and associated equipment for all road users. Check markings for right turning vehicles.		
5 Roundabouts and approach islands	Check that the roundabout or island is fully visible and recognisable from all approaches and that signs, markings and lighting are correctly in place.		

ANNEX A: STAGE 1 CHECKLISTS—COMPLETION OF PRELIMINARY DESIGN

List A1 – General

Item	Possible Issues
• Departures from Standards	What are the road safety implications of any approved Departures from Standards or Relaxations?
• Cross-sections	How safely do the cross-sections accommodate drainage, ducting, signing, fencing, lighting and pedestrian and cycle routes?
• Cross-sectional Variation	What are the road safety implications if the standard of the proposed scheme differs from adjacent lengths?
• Drainage	Will the new road drain adequately?
• Landscaping	Could areas of landscaping conflict with sight lines (including during windy conditions)?
• Public Utilities/Services Apparatus	Have the road safety implications been considered?
• Lay-bys	Has adequate provision been made for vehicles to stop off the carriageway including picnic areas? How will parked vehicles affect sight lines?
• Access Can all accesses be used safely?	Can multiple accesses be linked into one service road? Are there any conflicts between turning and parked vehicles?
• Emergency Vehicles	Has provision been made for safe access by emergency vehicles?
• Future Widening	Where a single carriageway scheme is to form part of future dual carriageway, is it clear to road users that the road is for two-way traffic?
• Adjacent Development	Does adjacent development cause interference/confusion e.g. lighting or traffic signals on adjacent road may affect a road user's perception of the road ahead?
• Basic Design Principles	Are the overall design principles appropriate for the predicted level of use for all road users?

List A-2 Local Alignment

Item	Possible Issues
• Visibility	Are horizontal and vertical alignments consistent with required visibility? Will sight lines be obstructed by permanent and temporary features e.g. bridge abutments and parked vehicles?
• New/Existing Road Interface	Will the proposed scheme be consistent with standards on adjacent lengths of road and if not, is this made obvious to the road user? Does interface occur near any hazard, i.e. crest, bend after steep gradient?
• Vertical Alignment	Are climbing lanes to be provided?

List A3-Junctions

Item	Possible Issues
• Layout	Is provision for right turning vehicles required?
	Are acceleration/deceleration lanes required?
	Are splitter islands required on minor arms to assist pedestrians or formalise road users movements to/from the junction?
	Are there any unusual features that affect road safety?
	Are widths and swept paths adequate for all road users? Will large vehicles overrun pedestrian or cycle facilities?
	Are there any conflicts between turning and parked vehicles?
	Are any junctions sited on a crest?
• Visibility	Are sight lines adequate on and through junction ap proaches and from the minor arm?
	Are visibility splays adequate and clear of obstructions such as street furniture and landscaping?

List A4 – Non Motorised User Provision

Item	Possible Issues
• Adjacent Land	Will the scheme have an adverse effect on safe use of adjacent land?
• Pedestrian /Cyclists	Have pedestrian and cycle routes been provided where required?
	Do shared facilities take account of the needs of all user groups?
	Can verge strip dividing footways and carriageways be provided?
	Where footpaths have been diverted, will the new alignment permit the same users free access?
	Are footbridges/subways sited to attract maximum use?
	Is specific provision required for special and vulnerable groups i.e. the young, elderly, mobility and visually impaired?
	Are tactile paving, flush kerbs and guard railing proposed? Is it specified correctly and in the best location?
	Have needs been considered, especially at junctions?
	Are these routes clear of obstructions such as signposts, lamp columns etc?
• Equestrians	Have needs been considered?
	Does the scheme involve the diversion of bridleways?

List A5 – Road Signs, Carriageway Markings And Lighting

Item	Possible Issues
• Lighting	Is scheme to be lit?
	Has lighting been considered at new junctions and where adjoining existing roads?
	Are lighting columns located in the best positions e.g. behind safety fences?
• Signs	Are sign gantries needed?
• Poles/Columns	Will poles/columns be appropriately located and protected?
• Road Markings	Are any road markings proposed at this stage appropriate?

ANNEX B: STAGE 2 CHECKLISTS—COMPLETION OF DETAILED DESIGN

The Audit Team should satisfy itself that all issues raised at Stage 1 have been resolved. Items may require further consideration where significant design changes have occurred.

If a Highway Improvement Scheme has not been subject to a Stage 1 Audit, the items listed in Lists A1 to A5 should be considered together with the items listed below.

List B1: General

Item	Possible Issues
• Departures from Standards	Consider road safety aspects of any Departures granted since Stage 1.
• Drainage	Do drainage facilities (e.g. gully spacing, flat spots, crossfall, ditches) appear to be adequate? Do features such as gullies obstruct cycle routes, footpaths or equestrian routes? Do the locations of features such as manhole covers give concern for motorcycle/cyclist stability?
• Climatic Conditions	Is there a need for specific provision to mitigate effects of fog, wind, sun glare, snow, and icing?
• Landscaping	Could planting (new or when mature) encroach onto carriageway or obscure signs or sight lines (including during windy conditions)? Could mounding obscure signs or visibility? Could trees (new or when mature) be a hazard to a vehicle leaving the carriageway? Could planting affect lighting or shed leaves on to the carriageway? Can maintenance vehicles stop clear of traffic lanes?
• Public Utilities/Services Apparatus	Can maintenance vehicles stop clear of traffic lanes? If so, could they obscure signs or sight lines? Are boxes, pillars, posts and cabinets located in safe positions? Do they interfere with visibility? Has sufficient clearance of overhead cables been provided? Have any special accesses/parking areas been provided and are they safe?
• Lay-bys	Have lay-bys been positioned safely? Could parked vehicles obscure sight lines? Are lay-bys adequately signed? Are picnic areas properly segregated from vehicular traffic?
• Access	Is the visibility to/from access adequate? Are the accesses of adequate length to ensure all vehicles clear the main carriageway? Do all accesses appear safe for their intended use?
• Skid Resistance	Are there locations where a high skid resistance surfacing (such as on approaches to junctions and crossings) would be beneficial? Do surface changes occur at locations where they could adversely affect motorcycle stability?
• Agriculture	Have the needs of agricultural vehicles and plant been taken into consideration (e.g. room to stop between carriageway and gate, facilities for turning on dual carriageways)? Are such facilities safe to use and are they adequately signed?
• Fences and Road Restraint Systems	Is there a need for road restraint systems to protect road users from signs, gantries, abutments, steep embankments or water hazards? Do the restraint systems provided give adequate protection? Are the restraint systems long enough?

• Adjacent Developments and Roads	Has screening been provided to avoid headlamp glare between opposing carriageways, or any distraction to road users? Are there any safety issues relating to the provision of environmental barriers or screens?

List B2: Local Alignment

Item	Possible Issues
• Visibility	Obstruction of sight lines by: i. safety fences ii. boundary fences iii. street furniture iv. parking facilities v. signs vi. landscaping vii. structures viii. environmental barriers ix. crests x. features such as buildings, plant or materials outside the highway boundary Is the forward visibility of at-grade crossings sufficient to ensure they are conspicuous?
• New/Existing Road Interface	Where a new road scheme joins an existing road, or where an on-line improvement is to be constructed, will the transition give rise to potential hazards? Where road environment changes (e.g. urban to rural, restricted to unrestricted) is the transition made obvious by signing and carriageway markings?

List B3: Junctions

Item	Possible Issues
• Layout	Are the junctions and accesses adequate for all vehicular movements? Are there any unusual features, which may have an adverse effect on road safety? Have guard rails/safety fences been provided where appropriate? Do any roadside features (e.g. guard rails, safety fences, signs and traffic signals) intrude into drivers’ line of sight? Are splitter islands and bollards required on minor arms to assist pedestrians or formalise road users' movements to/from the junction? Are parking or stopping zones for buses, taxis and public utilities vehicles situated within the junction area? Are they located outside visibility splays?
• Visibility	Are the sight lines adequate at and through the junctions and from minor roads? Are visibility splays clear of obstruction?
• Signing	Is the junction signing adequate and easily understood? Have the appropriate warning signs been provided? Are signs appropriately located and of the appropriate size for approach speeds? Are sign posts protected by safety barriers where appropriate?
• Road Markings	Do the carriageway markings clearly define routes and priorities?

	Are the dimensions of the markings appropriate for the speed limit of the road?
	Have old road markings and road studs been adequately removed?
• T, X, Y-Junctions	Have ghost islands and refuges been provided where required?
	Do junctions have adequate stacking space for turning movements?
	Can staggered crossroads accommodate all vehicle types and movements?
• All Roundabouts	Are the deflection angles of approach roads adequate for the likely approach speed?
	Are splitter islands necessary?
	Is visibility on approach adequate to ensure drivers can perceive the correct path through the junction?
	Is there a need for chevron signs?
	Are dedicated approach lanes required? If provided, will the road markings and signs be clear to all users?
• Mini Roundabouts	Are the approach speeds for each arm likely to be appropriate for a mini roundabout?
	Is the centre island visible from all approaches?
• Traffic Signals	Will speed discrimination equipment be required?
	Is the advance signing adequate?
	Are signals clearly visible in relation to the likely approach speeds?
	Is “see through” likely to be a problem?
	Would lantern filters assist?
	Is the visibility of signals likely to be affected by sunrise/sunset?
	Would high intensity signals and/or backing boards improve visibility?
	Would high-level signal units be of value?
	Are the markings for right turning vehicles adequate?
	Is there a need for box junction markings?
	Is the phasing appropriate?
	Will pedestrian/cyclist phases be needed?
	Does the number of exit lanes equal the number of approach lanes, if not is the taper length adequate?
	Is the required junction intervisibility provided?

List B4: Non Motorised User Provision

Item	Possible Issues
• Adjacent Land	Are accesses to and from adjacent land/properties safe to use? Has adjacent land been suitably fenced?
• Pedestrians	Are facilities required for NMUs at: a) junctions; b) pelican/zebra crossings; c) refuges; d) other locations? Are crossing facilities placed and designed to attract maximum use? Are guardrails/fencing present/required to deter pedestrians from crossing the road at unsafe locations? For each type of crossing (bridges, subways, at grade) have the following been fully considered? a) visibility both by and of pedestrians; b) use by mobility and visually impaired; c) use by elderly; d) use by children/schools; e) need for guardrails in verges/central reserve;

	f) signs; g) width and gradient; h) surfacing; i) provision of dropped kerbs; j) avoidance of channels and gullies; k) need for deterrent kerbing; i) need for lighting.
• Cyclists	Have the needs of cyclists been considered especially at junctions and roundabouts? Are cycle lanes or segregated cycle tracks required? Does the signing make clear the intended use of such facilities? Are cycle crossings adequately signed? Do guardrails need to be provided to make cyclists slow down or dismount at junctions/crossings? Has lighting been provided on cycle routes?
• Equestrians	Should bridleways or shared facilities be provided? Does the signing make clear the intended use of such paths and is sufficient local signing provided to attract users? Have suitable parapets/rails been provided where necessary?
• ADS and Local Traffic Signs	Do destinations shown accord with signing policy? Are signs easy to understand? Are the signs located behind safety fencing and out of the way of pedestrians and cyclists? Is there a need for overhead signs? Where overhead signs are necessary is there sufficient headroom to enable designated NMU usage? Do signs need reflectorisations where road is unlit and is facing material appropriate for location?
• Variable Message Signs	Are the legends relevant and easily understood? Are signs located behind safety fencing?
• Lighting	Has lighting been considered at new junctions and where adjoining existing roads? Is there a need for lighting, including lighting of signs and bollards? Are lighting columns located in the best positions e.g. behind safety fences and not obstructing NMU routes?
• Road Markings	Are road markings appropriate to location? a) Centre lines; b) Edge lines; c) Hatching; d) Studs; e) Text/Destinations; f) Approved and/or conform to the regulations.
• Poles and Columns	Are poles and columns protected by safety fencing where appropriate?

ANNEX C: STAGE 3 CHECKLISTS—COMPLETION OF CONSTRUCTION

The Audit Team should consider whether the design has been properly translated into the scheme as constructed and that no inherent road safety defect has been incorporated into the works.

Particular attention should be paid to design changes, which have occurred during construction.

List C1: General

Item	Possible Issues
• Departures from Standards	Are there any adverse road safety implications of any departures granted since Stage 2?
• Drainage	Does drainage of roads, cycle routes and footpaths appear adequate? Do drainage features such as gullies obstruct footpaths, cycle routes or equestrian routes?
• Climatic Conditions	Are any extraordinary measures required?
• Landscaping	Could planting obscure signs or sight lines (including during periods of windy weather)? Does mounding obscure signs or visibility?
• Public Utilities	Have boxes, pillars, posts and cabinets been located so that they don't obscure visibility?
• Access	Is the visibility to/from access adequate? Are the accesses of adequate length to ensure all vehicles clear the main carriageway?
• Skid Resistance	Do any joints in the surfacing appear to have excessive bleeding or low skid resistance? Do surface changes occur at locations where they could adversely affect motorcycle stability?
• Fences and Road Restraint Systems	Is the restraint system adequate? In the case of wooden post and rail boundary fences, are the rails placed on the non-traffic side of the posts?
• Adjacent Development	Have environmental barriers been provided and do they create a hazard?
• Bridge Parapets	Is the projection of any attachment excessive?
• Network management	Have appropriate signs and/or markings been installed in respect of Traffic Regulation Orders?

List C2: Local Alignment

Item	Possible Issues
• Visibility	Are the sight lines clear of obstruction?
• New/Existing Road Interface	Is there a need for additional signs and/or road markings?

List C3: Junctions

Item	Possible Issues
• Visibility	Are all visibility splays clear of obstructions?
• Road Markings	Do the carriageway markings clearly define routes and priorities? Have all superseded road markings and studs been removed adequately?

• Roundabouts	Can the junction be seen from appropriate distances and is the signing adequate?
• Traffic Signals	Can the signals be seen from appropriate distances? Can drivers see signals for opposing traffic? For the operation of signals: Do phases correspond to the design? Do pedestrian phases give adequate crossing time?
• T, X and Y junctions	Are priorities clearly defined? Is signing adequate?

List C4: Non Motorised User Provision

Item	Possible Issues
• Adjacent Land	Has suitable fencing been provided?
• Pedestrians	Are the following adequate for each type of crossing (bridges, subways, at grade)? a) visibility; b) signs; c) surfacing; d) other guardrails; e) drop kerbing or flush surfaces; f) tactile paving.
• Cyclists	Do the following provide sufficient levels of road safety for cyclists on, or crossing the road? a) visibility; b) signs; c) guardrails; d) drop kerbing or flush surfaces; e) surfacing; f) tactile paving.
• Equestrians	Do the following provide sufficient levels of road safety for equestrians? a) visibility; b) signs; c) guardrails.

List C5: Road Signs, Carriageway Markings And Lighting

Item	Possible Issues
• Signs	Are the visibility, locations and legibility of all signs (during daylight and darkness) adequate? Are signposts protected from vehicle impact? Will signposts impede the safe and convenient passage of pedestrians and cyclists? Have additional warning signs been provided where necessary?
• Variable Message Signs	Can VMS be read and easily understood at distances appropriate for vehicle speeds? Are they adequately protected from vehicle impact?
• Lighting	Does the street lighting provide adequate illumination of roadside features, road markings and non-vehicular users to drivers? Is the level of illumination adequate for the road safety of non-motor vehicle users?
• Carriageway Markings	Are all road markings/studs clear and appropriate for their location? Have all superseded road markings and studs been removed adequately?

Preliminary Design

General Topics

Item	Issues to be Considered	Check	Comments
1 Changes since Stage 1	Check for any major changes in principle since the Stage 1 Audit was carried out. Check that the conditions for which the project was originally designed still apply, i.e., there have not been significant changes to the surrounding network or area to be served, or traffic mix.		
2 Drainage	Will the new road drain adequately? Is there a possibility of surface flooding or overflowing from surrounding or intersected drains and water courses?		
3 Climatic conditions	Do weather records or local experience indicate a problem (e.g., snow, ice, wind, fog)?		
4 Landscaping	Is the landscaping design or planting likely to lead to a lowering of safety with mature or seasonal growth? (i.e.through loss of visibility, obscuring signs, shading or light effects, leaves, flowers, or seeds dropping on the highway) ? Is "frangible" vegetation appropriate? Consider pedestrian visibility in particular.		
5 Services	Does the design adequately deal with buried and overhead services? At this stage the location of fixed objects or furniture associated with services should be checked, including the position of poles.		
6 Access to property and developments	Can all accesses be used safely? Are there any downstream/upstream effects from development accesses, particularly near intersections? Check rest area accesses.		
7 Emergency vehicles and access	Has provision been made for safe access by emergency vehicles and vehicles? Check the design of medians and barriers, and the ability of emergency vehicles to stop without necessarily disrupting traffic.		
8 Future widening and/or realignments	If the project is only a stage towards a wider or divided roadway, is the signing and design adequate to impart this message to drivers? Is the transition from two way to divided roadway handled safely?		
9 Staging of the project	If the scheme is to be staged or constructed at different times, are the construction plans and program arranged to ensure maximum safety and do they include specific safety measures, signing, and adequate transitional geometry for any temporary arrangements?		
10 Staging of the works	If the construction of this project is to be staged or split into several contracts check that these are arranged for maximum safety.		
11 Significant adjacent developments	Check that the design handles accesses to major adjacent generators of traffic and parking and developments safely. Check that lighting or traffic signals on an adjacent road do not affect the drivers' perception of the road ahead.		
12 Stability of cut and fill	Check that the geological conditions in the country through which the road is to be constructed do not pose a significant threat to safety of vehicle occupants.		
13 Maintenance	Check if maintenance vehicles can be safely located.		

Design Issues

Item	Issues to be Considered	Check	Comments
1 Geometry of horizontal and vertical alignment	Do the horizontal and vertical design of the project fit together comfortably? Check the design for adequacy with regard to the function of the road. Check the possibility of drivers not being able to read the road characteristics due to visual illusions, subliminal delineation, etc., (e.g., line of trees, line of poles, etc).		

2 Typical crosssections	Are the lane widths, shoulders, medians and other cross section features in accordance with standard design or adequate for the function of the road?		
3 Effect of crosssectional variation	Check that there are no undesirable variations in cross section design. Check cross slopes which could affect safety, particularly where sections of existing highway have been utilised, or where there have been compromises to accommodate accesses, etc. Check where compromises have been made such as narrowing at bridge approaches or to avoid physical features.		
4 Roadway layout	Check that total traffic management features in addition to horizontal and vertical alignment and cross section) are not likely to create unsafe conditions. Check the layout of road markings and reflective media both on the road and on the surrounds to deal with changes in alignment, particularly where these are substandard.		
5 Design standards	Check the appropriateness of the design speed and speed limit. What design and check vehicles are used?		
6 Shoulders and edge treatment	Check the safety aspects of shoulder provision, including the provision of sealed shoulders, the width and treatment on embankments and cross slope of shoulders. Are the shoulders likely to be used by slow moving vehicles or cyclists? Check safety aspects of rest areas.		
7 The effect of departures from standards or guidelines	Are there any approved departures from standards or guidelines which affect safety? Are there any hitherto undetected departures from standards which should be brought to the attention of the designer?		

Alignment Details

Item	Issues to be Considered	Check	Comments
1 Visibility, sight distance	Are horizontal and vertical alignments consistent with the required visibility requirements? Check that sight lines are not obstructed by: (a) Fences and crash barriers (b) Boundary fences (c) Street furniture (d) Parking facilities (e) Signs (f) Landscaping (g) Bridge abutments. Inappropriate consideration of horizontal and vertical alignment (e.g. horizontal curve just over a crest vertical curve). Check that railway crossings, bridges and other hazards are conspicuous. Are there any other local features which affect visibility? Will sight lines be obstructed by temporary features such as parked vehicles in turn outs, or by parked or queued traffic generally?		
2 New/existing road interface	Have implications for safety at the interface been considered? Are there sudden changes in the speed profile or access or lateral acceleration characteristics? Does the interface occur near any hazard, i.e., at a crest or bend or where poor visibility or distractions occur? Check that the change is affected safely where roadway standards differ. Check transition is safe where road environment changes, for example, urban to rural, fast to slow, lit to unlit. Check the need for advance warning.		
3 Readability by drivers	Will the general layout, function and broad features be recognized by drivers in adequate time? Check the approach speed and general likely position of vehicles as they track through the project.		

Intersections

Item	Issues to be Considered	Check	Comments
1 Visibility to and visibility at intersection	Are horizontal and vertical alignments consistent with the required visibility requirements? Will drivers be aware of the presence of the intersection (especially if facing a Stop/Yield sign)? Check that sight lines are not obstructed by: (a) Fences and crash barriers (b) Boundary fences (c) Street furniture (d) Parking facilities (e) Signs (f) Landscaping (g) Bridge abutments. Check that railway crossings, bridges and other hazards are conspicuous. Are there any local features which require affect visibility? Will sight lines be obstructed by permanent or temporary features such as parked vehicles in turn outs, or by parked or queued traffic generally?		
2 Layout, including appropriateness	Is the type of intersection selected (crossroad, T, roundabout, signalized, etc.) appropriate for the function of the two roads? Are the proposed controls (Stop, Yield, signals, etc.) appropriate for the particular intersection being considered? Are junction sizes appropriate for all vehicle movements? Are there any unusual features which could affect road safety (e.g., cyclists, heavy truck movements, public transport operations, etc.)? Are the lane widths and swept paths adequate for all vehicles? Are there any upstream or downstream geometric features which could affect safety, e.g., merging of lanes?		
3 Readability by drivers	Will the general type, function, priority rules and broad features be recognized by drivers in adequate time. Check the approach speed and general likely position of vehicles as they track through the project.		

Special Road Users

Item	Issues to be Considered	Check	Comments
1 Adjacent land	Will adjacent activity and intensity of land use have an adverse safety effect on the project? Are special measures needed?		
2 Pedestrians	Have pedestrian needs been If footpaths are not specifically provided, is the road layout safe for use by pedestrians, particularly at blind corners or on bridges? Are pedestrian subways or footbridges sited to provide maximum use? Is the avoidance of footbridges or subways possible by crossing the road at grade? Has specific provision been made for pedestrian crossings, school crossings or pedestrian signals? Are these sited to provide maximum use? Are pedestrian refuges/curb extensions needed? Is specific provision required for special groups, e.g., the young, elderly, sick, disabled, deaf, or blind?		
3 Cyclists	Have the needs of cyclists been considered, especially at intersections? Is a bicycle lane needed? Are any bikeways separate from the main roadway, of standard or adequate design? Is there a need for shared pedestrian/cycle facilities? Where bikeways terminate at intersections or adjacent to the roadway, has the transition treatment been handled safely? Are there any needs for special bicycle facilities (e.g., bicycle signals) if not already provided?		

4 Equestrians and stock	Have the needs of equestrians been considered, including the use of verges or shoulders and rules regarding the use of the roadway? Can underpass facilities be used by equestrians/stock?		
5 Freight	Have the needs of truck drivers been considered, including turning radii and lane widths?		
6 Public Transport	Have the needs of public transport users been considered? Are bus stops positioned for safety?		
7 Road maintenance vehicles	Road maintenance vehicles Has provision been made for road maintenance vehicles to safely be used at this site?		

Signs and Lighting

Item	Issues to be Considered	Check	Comments
1 Lighting	Is this project to be lit? Are there difficulties of illuminating sections of the road caused by trees or overpasses, for example? Has the question of siting of lighting poles been considered as part of the general concept of the project? Are frangible or slip-base poles to be provided? Are any special needs created by ambient lighting? Are there any aspects of the provision of lighting poles which would require consideration from the safety point of view in their being struck by vehicles?		
2 Signs	Are sign structures needed? Are signs located at points to allow adequate readability? Are signs located to limit visibility from accesses and intersecting roads? Are signs appropriate to the drivers needs (i.e., destination signs, advisory speed signs, etc)? Have the safety aspects of signs been considered as part of the general concept? Are there any aspects of the provision of sign posts which would require consideration from the safety point of view in their being struck by vehicles?		
3 Marking and delineation	Check that the appropriate standard of delineation and marking has been adopted.		

Construction and Operation

Item	Issues to be Considered	Check	Comments
1 Buildability	Are there any features which could inhibit safe construction (e.g., through traffic, construction vehicles.)?		
2 Operation	Is adequate safe access to the works available?		
3 Traffic management	Are there any factors requiring specific road safety provision, including maintenance?		
4 Network management	Are there any traffic management features which management would require special attention during construction or during the transition from construction to full operation?		

Other Issues

Item	Issues to be Considered	Check	Comments
1 Safety aspects not already covered	This could include unusual events, special effects of land uses alongside, including stock being driven onto or along the road. The ability of the road to take overweight or over-dimension vehicles or other large vehicles - trucks - buses - emergency vehicles - utility/road maintenance vehicles.		

	The ability to close the road for special events in a safe manner. The special requirements of scenic or tourist routes. The provision of rest areas with safe access and egress. Safety auditors are to check for any issue or item not already covered.		

Detailed Design

General Topics

Item	Issues to be Considered	Check	Comments
1 Changes since Stage 2	Check for any major changes in principle since the Stage 2 Audit was carried out. Check that the conditions for which the project was originally designed still apply, i.e., there have not been significant changes to the surrounding network or area to be served, or traffic mix.		
2 Drainage	Will the new road drain adequately? Is there a possibility of surface flooding or overflowing from surrounding or intersected drains and water courses? Is pit spacing adequate to limit flooding?		
3 Climatic conditions	Do weather records or local experience indicate a problem (e.g., snow, ice, wind, fog)?		
4 Landscaping	Check the landscape design or planting species for a lowering of safety. Is it likely to lead to a lower safety with mature or seasonal growth (e.g. through loss of visibility, obscuring signs, shading or light effects, leaves, flowers or seeds dropping on to the highway)? Is frangible vegetation appropriate? Consider pedestrian visibility in particular.		
5 Services	Does the design adequately deal with buried and overhead services? Check the location of fixed objects or furniture associated with services, including for loss of visibility and check the position of lighting and other poles for accuracy. Check the clearance to overhead wires.		
6 Access to property and developments	Can all accesses be used safely? Are there any downstream or upstream effects from accesses, particularly near intersections?		
7 Emergency vehicles and access	Has provision been made for safe access by emergency vehicles? Check the design of medians and vehicle barriers, and the ability of emergency vehicles to stop without necessarily disrupting traffic.		
8 Future widening and/or realignments	If the project is only a stage towards a wider or divided roadway, is the signing and design adequate to impart this message to drivers? Is the transition from two way to divided roadway handled safely?		
9 Staging of the project	If the project is to be staged or constructed at different times, are the construction plans and program arranged to ensure maximum safety and do they include specific safety measures, signing, also adequate transitional geometry for any temporary arrangements?		
10 Staging of the works	If the construction of this project is to be staged or split into several contracts check that these are arranged for maximum safety.		
11 Significant adjacent developments	Check that the design handles accesses to major adjacent generators of traffic and developments safely. Check the need for screening against glare from lighting of adjacent developments. Check that lighting or traffic signals on an adjacent road do not affect the drivers' perception of the road ahead.		
12 Stability of cut and fill	Do the geological conditions in the country through which the road is to be built pose significant threats to the safety of vehicle occupants? Check batters for stability, potential for loose material.		

13 Skid resistance	Check the need for high level skid surface on grades or where braking or good road adhesion is essential.		
14 Maintenance	Check that maintenance vehicles can be safely located.		

Design Issues

Item	Issues to be Considered	Check	Comments
1 Geometry of horizontal and vertical alignment	Check that the horizontal and vertical design of the project fit together comfortably. Check the design for adequacy having regard to the function of the road. Check the possibility of drivers not being able to read the road characteristics, i.e., visual illusions, subliminal delineation, etc.		
2 Typical cross sections	Are the lane widths, shoulders, medians and other cross section features in accordance with standard design or adequate for the function of the road?		
3 Effect of cross-sectional variation	Check that there are no variations in cross section design which could affect safety, particularly where sections of existing highway have been utilized, or there have been compromises to accommodate accesses, etc. Check where compromises have been made, e.g., at bridges or to avoid physical features.		
4 Roadway layout	Check that total traffic management features (i.e., in addition to questions of horizontal and vertical alignment and cross section) are not likely to create unsafe conditions. This includes the installation of signs and markings both on the road and nearby to deal with changes in alignment, particularly where these are substandard.		
5 Shoulders and edge treatment	Check the safety aspects of shoulder provision, if any, including seal shoulders, the width and treatment on embankments and cross slopes of shoulders. Are the shoulders likely to be used by slow moving vehicles or cyclists?		
6 The effect of departures from standards or guidelines	Are there any approved departures from standards or guidelines which affect safety? Are there any hitherto undetected departures from standards which should be brought to the attention of the designer?		
7 Visibility, sight distance	Are horizontal and vertical alignments consistent with the required visibility requirements? Confirm that the standard adopted for provision of visibility in the design is appropriate for the ruling or 85th percentile speed and for any unusual traffic mix. Check that sight lines are not obstructed by: (a) Safety fences and barriers (b) Boundary fences (c) Street furniture (d) Parking facilities (e) Signs (f) Landscaping (g) Bridge abutments. Check that railway crossings, bridges and other hazards are conspicuous. Will sight lines be obstructed by temporary features such as parked vehicles in turn outs, or by parked or queued traffic generally?		
8 Signs and markings	Has the design approach taken into account the provision of signs and road markings? Are they adequately detailed so as to promote good traffic management and safety?		

Alignment Details

Item	Issues to be Considered	Check	Comments
1 Visibility, sight distance	Are horizontal and vertical alignments consistent with the required visibility requirements? Confirm that the standard adopted for provision of visibility in the design is appropriate for the ruling or 85th percentile speed and for any nusual traffic mix. Check sight lines are not obstructed by: (a) Safety fences and barriers (b) Boundary fences (c) Street furniture (d) Parking facilities (e) Signs (f) Landscaping (g) Bridge abutments. Check that railway crossings, bridges and other hazards are conspicuous. Will sight lines be obstructed by temporary features such as parked vehicles in turn outs, or by parked or queued traffic generally?		
2 New/existing road interface	Have implications for safety at the interface been considered? Include the accident rate and severity on the adjacent network, and the effect of sudden changes in the speed profile or access and side friction characteristics. Does the interface occur near any hazard, i.e., at a crest or bend or where poor visibility or distractions occur? Check that the change is affected safely where roadway standards differ. Check transition is safe where road environment changes, for example, urban to rural, fast to slow, lit to unlit. Check the need for advance warning.		
3 Readability by drivers	Will the general layout, function and broad features be recognized by drivers in adequate time for safety not to be impaired? If new work is of higher geometric standard —is there clear and unambiguous advance warning or reduction in standard? Is there need for a transition zone between higher standard of new road and lower standard of old road (especially perception of horizontal curvature, which is the primary determinant out of desired speed). Check the approach speed and general likely position of vehicles as they track through the project.		
4 Detail of geometric design	Check that the design standards are appropriate for all the new requirements of the proposed project. Check for consistency of general standards and guidelines such as lane widths and cross slopes.		
5 Treatment of bridges and culverts	Check that the geometric transition from the standard cross section to that on the bridge is handled so as to promote safety.		

Intersections

Item	Issues to be Considered	Check	Comments
1 Visibility to and visibility at intersection	Are horizontal and vertical alignments consistent with the required visibility requirements? Will drivers be aware of the presence of the intersection (especially if facing a Stop/Yield sign)? Confirm that the standard adopted for provision of visibility in the design is appropriate for the ruling or 85th percentile speed and for any unusual traffic mix. Check that sight lines are not obstructed by: (a) Safety fences and barriers (b) Boundary fences (c) Street furniture (d) Parking facilities (e) Signs (f) Landscaping (g) Bridge abutments. Check that railway crossings, bridges and other hazards are conspicuous. Will sight lines be obstructed by permanent or temporary features such as parked vehicles in turn outs, or by parked or queued traffic generally?		
2 Layout	Check junctions and accesses are adequate for all vehicle movements. Check turning paths to establish that the layout caters for the design vehicles and other road users. Checks safety of any unusual features. Check if heavy truck movements or curvature of the roadway may suggest that the opposing left turn lanes be offset to gain sight distance. Check need for crash attenuators or pedestrian fences. Check need for channelization islands and signs. Check features for visibility intrusion e.g., crash attenuators, pedestrian fences, signs, and traffic signals. Check safety where vehicles (including buses and taxis) may park or service premises within the intersection area.		
3 Readability by drivers	Will the general type, function, priority rules and broad features be recognized by drivers in adequate time. Check the approach speed and general likely position of vehicles as they track through the project. Is there anything misleading?		
4 Detail of geometric design	Check the layout adopted for traffic safety, compliance with standards or reason for variation, swept paths, ability to handle unusual traffic mixes or circumstances safely. Check that receiving lanes are 12 ft. (3.6m) wide with a 4 ft. (1.2m) outside shoulder, minimum. Check that roadways meet at angles of 90 degrees, and no less than 75 degrees. Check the correctness of the design approach speed and general likely position of vehicles.		
5 Traffic signals	Check visibility of signal head. Can drivers be confused by seeing other signal aspects within the intersection or elsewhere? Check need for high intensity signals, strobes, and/or backplates if likely to be affected by sunrise/sunset. Check if separate signal heads are used to control movements in each lane. Check to see that the protected left turn phase is leading, not trailing. Check markings for left and right turn vehicles. Determine if protected-only phases can be used without an unacceptable reduction in level of service. Check if right-turn-on-red has been prohibited at skewed intersections if angle is less than 75 degrees or greater than 105 degrees. Check if street name signs are included. Check if overhead lane control signs are appropriate. Check need for pedestrian phases and/or protected turning movements.		
6	Check that deflection angles of approach roads are adequate.		

Roundabouts and approach islands	Check need for splitter islands. Check that center island is prominent. Check need for hazard markers and markings and that they are correctly located. Check need for dedicated lanes. Check that speeds are not likely to be greater than 50 km/h (or lower in local street). Check that speeds are not likely to be greater than 50 km/h (or lower in local street). Check pole location on central island and nearby curbs.		
7 Other intersections	Check the need for curbed or painted islands and refuges. Check intersection has adequate storage space for turning movements. Check that staggered cross roads can accommodate all vehicle types and movements.		

Special Road Users

Item	Issues to be Considered	Check	Comments
1 Adjacent land	Check that access to and from adjacent land/properties is safe. Consider the special needs of agriculture, movements of stock.		
2 Pedestrians	Check that fencing is adequate on freeways. Check need to deter pedestrians from crossing road at unsafe locations. Check if raised channelization is used in low speed areas. Check provision for pedestrians to cross safely at: (a) Intersections (b) Signalized and pedestrian crossings (c) Refuges (d) Curb extensions (e) Other locations. Check the following for each crossing (bridges, subways, at grade) as necessary: (a) Visibility (b) Use by disabled (c) Use by elderly (d) Use by children/schools (e) Need for pedestrian fencing on reservations and medians (f) Signs (g) Width and gradient (h) Surfacing (j) Avoidance of channels and gullies (k) Need for deterrent curbing (I) Need for lighting (m) Sited to provide maximum use (n) Can their use be avoided by crossing at grade or elsewhere?		
3 Cyclists	Check needs of cyclists have been considered: (a) At intersections (particularly roundabouts) (b) On roads having speed in excess of 50 km/h (c) Bicycle routes and crossings. Check shared bikeway/footway facilities including subways and bridges are safe and adequately signed.		
4 Equestrians and stock	Check needs have been considered and adequately signed and catered for.		
5 Freight	Check needs have been considered and adequately signed and catered for.		
6 Public Transport	Check that needs have been considered and adequatelysigned and catered for.		
7 Road maintenance vehicles	Check that needs have been considered and adequatelysigned and catered for, i.e., crossovers, radii, sight distance concerns, etc.		

Signs and Lighting

Item	Issues to be Considered	Check	Comments
1 Lighting	Is this project to be lit? Are there difficulties of illuminating sections of the road caused by trees or over bridges, for example? Has the question of siting of lighting poles been considered as part of the general concept of the scheme? Are frangible or slip-base poles to be provided? Are any special needs created by ambient lighting? Are there any aspects of the provision of lighting poles which would require consideration from the safety point of view in their being struck by vehicles (e.g., traffic islands)?		
2 Signs	Are sign structures needed? Are signs located at points to allow adequate readability? Are signs located to limit visibility from accesses and intersecting roads? Are signs appropriate to the drivers needs, i.e., destination signs, advisory speed signs, etc.? Have the safety aspects of signs been considered as part of the general concept? Are there any aspects of the provision of sign posts which would require consideration from the safety point of view in their being struck by vehicles?		
3 Marking and delineation	Check that the appropriate standard of delineation and marking has been adopted.		

Physical Objects

Item	Issues to be Considered	Check	Comments
1 Median barriers	Are median barriers necessary and have they been properly detailed? Are there any design features such as end conditions which require special attention?		
2 Poles and other obstructions	Are there any poles located adjacent to moving traffic which could be sited elsewhere, (i.e., atthe property boundary)? Have frangible or breakaway poles been detailed? Is the unprotected median width adequate to accommodate lighting poles? Check the position of traffic signal controllers and other service apparatus. Are there any other obstructions which are likely to create a safety hazard and can they be mitigated or relocated?		
3 Crash attenuators and guide rail	Is a crash attenuator provided where necessary and is it properly detailed? Are there any features about the design or presence of the crash attenuator which could create danger to any road user, including pedestrians? Are the end conditions of the crash attenuator likely to create a safety problem? Do any guide rail installations restrict sight distance? Is the guide rail designed according to standards: - end treatments - NCHRP 350 requirements - driveway treatments - intersecting road treatments - anchorages - post spacings - block outs - post depths - rail overlaps - minimum unobstructive distances		
4 Bridges and culverts	Check bridge barrier and culvert end walls for: (a) Visibility (b) Ease of recognition (c) Proximity to moving traffic (d) Possibility of causing injury or damage (e) Collapsible or frangible ends		

	(f) The need to be able to see through bridge guard railing for safety purposes (g) Signs and markings (h) Connection of bridge railing to bridge posts (i) Connection of approach barriers to bridge (j) End post transition of stiffness between approach barrier and bridge end post.		

Construction and Operation

Item	Issues to be Considered	Check	Comments
1 Constructability	Check that traffic management provisions are adequate during construction period. Check that site access routes are safe. Check need for construction safety zones, including overhead work. Check need for restrictions on any road. Check that law enforcement and other emergency services have been consulted.		
2 Operation	Check access to structures and road furniture is safe. Check that the road or utilities in the road reserve can be maintained safely. Both road users and maintenance personnel should be considered.		
3 Traffic management	Check that the traffic management of the construction site has been adequately spelled out from the safety point of view, and that the transition from the existing arrangements to the construction site and from the construction site to the final layout can be effected safely, and has been adequately detailed.		
4 Network management	Check that all parking and clearway matters affecting road safety have been considered.		
5 Temporary traffic control and management	Check that the arrangements for temporary traffic control or management, including possible signals, temporary diversions including signing and lighting of the site have been adequately detailed from the safety point of view.		

Other Issues

Item	Issues to be Considered	Check	Comments
1 Safety aspects not already covered	Safety auditors are to check for any issue or item not already covered. This could include: (a) Unusual events (b) Special effects on land uses alongside (c) Stock being driven onto or along the road (d) The ability of the road to take overweight or over-dimension vehicles or other large vehicles - trucks - buses - emergency vehicles - utility/road maintenance vehicles. (e) The ability to close the road for special events in a safe manner. (f) The special requirements of scenic or tourist routes. (g) Signals not at intersections.		

	Yes	No	N/A	Comments
ROAD SAFETY AUDIT—GENERAL ISSUES (1 OF 2)				
INTERSECTIONS				
Are intersections free of sight restrictions that could result in safety problems?				
Are intersections free of abrupt changes in elevation or surface condition?				
Are advance warning signs installed when intersection traffic control cannot be seen a safe distance ahead of the intersection?				
SIGNING AND DELINEATION				
Signing				
Is the road free of locations where signing is needed to improve safety?				
Are the regulatory, warning, and directory signs in place conspicuous?				
Is the road free of unnecessary signing that may cause safety problems?				
Are signs effective for likely conditions?				
Can signs be read at a safe distance?				
Is the road free of signing that impairs safe sight distances?				
Delineation				
Is the road free of locations with improper or unsuitable delineation (post delineators, chevrons, object markers)?				

	Yes	No	N/A	Comments
ROAD SAFETY AUDIT—GENERAL ISSUES (2 OF 2)				
ROADSIDE FEATURES / PHYSICAL OBJECTS				
Are clear zones free of hazardous, non-traversable side slopes with no safety barriers?				
Are the clear zones free of nonconforming and/or dangerous obstruction that are not properly attenuated?				
SPECIAL ROAD USERS				
Are travel paths and crossing points for pedestrians and cyclists properly signed and/or marked?				
Are bus stops safely located with adequate clearance and visibility from the traffic lane?				
Is appropriate advance signing provided for bus stops and refuse areas?				
RAILROAD CROSSINGS				
Are railroad crossing (cross bucks) signs used on each approach at railroad crossings?				
Are railroad crossings free of vegetation and other obstructions that have the potential to restrict sight distance?				
Are roadway approach grades to railroad crossings flat enough to prevent vehicle snagging?				
CONSISTENCY				
Is the road section free of inconsistencies that could result in safety problems?				

	Yes	No	N/A	Comments
ROAD SAFETY AUDIT—PAVED ROAD ISSUES (1 OF 1)				
PAVEMENT MARKINGS				
Is the road free of locations with pavement marking safety deficiencies?				
Is the road free of pavement markings that are not effective for likely conditions?				
Is the road free of old pavement markings that affect the safety of the roadway?				
PAVEMENT CONDITION				
Is the pavement free of defects that could result in safety problems (e.g., loss of steering control)?				
Are changes in surface type (e.g., pavement ends) free of drop-offs/poor transitions?				
Is the pavement free of locations that appear to have inadequate skid resistance that could result in safety problems, particularly on curves, steep grades, and approaches to intersections?				
Is the pavement free of areas where ponding or sheet flow of water occurs resulting in safety problems?				
Is the pavement free of loose aggregate/gravel that may cause safety problems?				

	Yes	No	N/A	Comments
ROAD SAFETY AUDIT—UNPAVED ROAD ISSUES (1 OF 1) **<u>ROADWAY SURFACE</u>** Is the road surface free of defects that could result in safety problems (e.g., loss of steering control)? Is the road surface free of areas where ponding or sheet flow of water occurs resulting in safety problems? Is the road surface free of loose gravel/fines that may cause safety problems (control, visibility, etc.)? Are changes in surface type (e.g., pavement ends) free of drop-offs/poor transitions?				

Road Safety Audits and Road Safety Audit Reviews

Road safety audits (RSAs), adaptable to local needs and conditions, are a powerful tool for state and local agencies to enhance the state of safety practices in their jurisdictions. With fewer new projects being constructed, the focus of RSAs is shifting to use by local agencies on existing roadways. For an existing road, the RSA is called a road safety audit review (RSAR).

What is an RSA? Simply put, an RSA is an examination of a future or existing roadway in which an independent, qualified audit team reports on safety issues. The step-by-step procedure of an RSA can be performed during any or all stages of a project, including planning, preliminary design, detailed design, construction, pre-opening, and on existing roads.

RSAs are a proactive approach to improving transportation safety. Agencies in the United States are just beginning to focus on RSAs. Considering the unacceptable number of motor vehicle crashes that occur each year, the potential savings—in lives, serious injuries, and property damage—is incalculable.

Although concerns have been raised that the use of RSAs would increase an agency's liability, in fact, just the opposite should be true. Implementing a plan to reduce the crash potential and improve the safety performance of a roadway using a proactive approach to safety can be used in defense of tort liability. Identifying and documenting safety issues on an existing roadway is not an admission of guilt. Rather, it is the first step in a process designed to improve safety. Proper documentation, communication, and logical prioritization of an agency's plan to address safety issues would be difficult to fault.

An RSAR program need not be disruptive to an agency's ongoing operations; it can be implemented in small stages as time and resources allow. Classifying the roads in your jurisdiction and tailoring the RSAR to fit your needs is a practical approach to improving road safety that can be implemented in spite of limited resources and the ongoing need to focus on maintenance and operations. Consider using the expertise of personnel from neighboring counties to lend more eyes and fresh viewpoints in assessing the safety of your roadways. Seek additional and special funding from 402 safety funds using the results of the audit.

Determine the value of an RSAR by (1) having a roadway section audited using a team of three or four road supervisors and engineers from adjacent counties, and/or (2) auditing a major project being designed to improve one of your roads. The value of the RSA/RSAR process as an important component of any agency's safety strategy will become evident.

Planning for an RSAR Program

I. Classify your roadway system functionally.
   a. Identify several sections of roadways in each functional classification for an RSAR trial.

II. Begin a trial RSAR program.
   a. Solicit reviews from team of adjacent local county engineers and road supervisors (three or four).
   b. Provide the RSAR for one another's selected roadways. (Use the attached RSAR Tool Kit.)

III. Prepare a brief statement of your findings.
   a. Briefly summarize the safety issues.
   b. Prioritize the issues identified.
   c. Recommend actions to be taken.
   d. Provide an overall evaluation of the road section.
   e. Discuss the findings with each county.

IV. Seek special funding as needed.
   a. Consider applying for 402 safety funds.

V. Implement and evaluate the RSAR program.
   a. Implement improvements.
   b. Evaluate the RSAR concept.
   c. Evaluate the effectiveness of the improvements.

VI. Make the decision on beginning an RSAR trial program.
   a. Begin an RSAR program by developing a four- or five-year plan to look at all roadways.
   b. Consider auditing the design of a major project from a safety viewpoint for all road users.

VII. Promote the proactive RSA/RSAR program.

RSA TOOL KIT

Developed by Eugene M. Wilson, Ph.D., PE, PTOE

Safety Issues to LOOK FOR:

Roadside Features

1. Are clear zones free of hazards and non-traversable side slopes without safety barriers?
2. Are the clear zones free of nonconforming and/or dangerous obstructions that are not properly shielded?

Road Surface—Pavement Condition

3. Is the pavement free of defects that could result in safety problems (e.g., loss of steering control)?
4. Are changes in surface type (e.g., pavement ends or begins) free of poor transitions?
5. Is the pavement free of locations that appear to have inadequate skid resistance that could result in safety problems, particularly on curves, steep grades, and approaches to intersections?
6. Is the pavement free of areas where ponding or sheet flow of water may occur resulting in safety problems?
7. Is the pavement free of loose aggregate/gravel that may cause safety problems?

Road Surface—Pavement Markings

8. Is the road free of locations with pavement marking safety deficiencies?
9. Is the road free of pavement markings that are not effective for the conditions present?
10. Is the road free of old pavement markings that affect the safety of the roadway?

Road Surface—Unpaved Roads

11. Is the road surface free of defects that could result in safety problems (e.g., loss of steering control)?
12. Is the road surface free of areas where ponding or sheet flow of water may occur resulting in safety problems?
13. Is the road surface free of loose gravel or fines that may cause safety problems (control, visibility, etc.)?
14. Are changes in surface type (e.g., pavement ends or begins) free of drop-offs or poor transitions?

Signing and Delineation

15. Is the road free of locations where signing is needed to improve safety?
16. Are existing regulatory, warning, and directory signs conspicuous?
17. Is the road free of locations with improper signing that may cause safety problems?
18. Is the road free of unnecessary signing that may cause safety problems?
19. Are signs effective for existing conditions?
20. Can signs be read at a safe distance?
21. Is the road free of signing that impairs safe sight distances?
22. Is the road free of locations with improper or unsuitable delineation (post delineators, chevrons, and object markers)?

Intersections and Approaches

23. Are intersections free of sight restrictions that could result in safety problems?
24. Are intersections free of abrupt changes in elevation or surface condition?
25. Are advance warning signs installed when intersection traffic control cannot be seen a safe distance ahead of the intersection?

Special Road Users, Railroad Crossings, Consistency

26. Are travel paths and crossing points for pedestrians and cyclists properly signed and/or marked?
27. Are bus stops and mail boxes safely located with adequate clearance and visibility from the traffic lane?
28. Is appropriate advance signing provided for bus stops and refuge areas?
29. Are railroad crossing (cross bucks) signs used on each approach at railroad crossings?
30. Are railroad advance warning signs used at railroad crossing approaches?
31. Are railroad crossings free of vegetation and other obstructions that have the potential to restrict sight distance?
32. Are roadway approach grades to railroad crossings flat enough to prevent vehicle snagging?
33. Is the road section free of inconsistencies that could result in safety problems?

APPENDIX E

South Carolina DOT Road Safety Audit Program

SCDOT
SAFETY AUDIT

Administrative Procedures

August 2002

Road Safety Audit Roles/Responsibilities
Road Safety Audit Team Selection Process
Road Safety Audit Project Selection Process
Road Safety Audit Project Procedures
Road Safety Audit Reporting Procedures
Follow-up on Results of Audit

SCDOT ROAD SAFETY AUDIT PROGRAM

Administrative Procedures
August, 2002

ROAD SAFETY AUDIT (RSA) ROLES/RESPONSIBILITIES

Program Coordination

The SCDOT RSA Program will be coordinated by the SCDOT Safety Office. The Director of Safety is responsible for oversight and management of the program.

Road Safety Audit Program Advisory Committee

An RSA Program Advisory Committee has been established to provide guidance and advice in the implementation of the RSA Program. The RSA Program Advisory Committee's role in the program is as follows:

- Participate in quarterly or semi-annual (as appropriate) meetings.
- Review program procedures and make recommendations to enhance operations.
- Review and approve annual projects selected for audit.
- Review and approve an annual report to be submitted to Executive Management, detailing progress, cost, cost savings, and benefits realized by the program.

The RSA Program Advisory Committee is chaired by the Director of Safety. Committee members include:

- Deputy State Highway Engineer
- Director of Construction
- Director of Maintenance
- Director of Pre-Construction
- Director of Traffic Engineering
- Director of Planning
- District Engineering Administrators (2–3 selected annually).

RSA Program Coordinator

The Director of Safety will assign a staff member to serve as the RSA Program Coordinator (PC). The RSA PC is responsible for day-to-day operations and the full implementation of the program. Responsibilities include but are not limited to the following areas:

- Develops, monitors, and updates policies and procedures for the RSA Program.
- Solicits and assembles an annual list of proposed projects for consideration for audit.
- Assembles RSA personnel on a bi-annual basis.
- Develops and prepares a final annual list of projects selected for audit.
- Schedules and coordinates RSA Program Advisory Committee meetings.
- Coordinates bi-annual RSA personnel training through seminars/workshops.
- Obtains project information from Pre-Construction Program Manager (PM) and/or District Engineering Administrator (DEA).
- Makes RSA team assignments based on project specifics in coordination with Engineering Directors and DEAs.
- Coordinates team meetings for each stage of the project.
- Oversees and monitors the implementation of RSA stages for all audits conducted.
- Monitors communication between RSA teams and the PM and/or DEA.

- Serves as a mediator for conflict resolution.
- Provides the RSA team with the DEA's response to audit.
- Briefs the RSA Program Advisory Committee on the annual progress of audits.
- Maintains all original correspondence, audit reports, budget, and logistics associated with all audits.
- Monitors funding allocated to RSA projects.
- Develops RSA Program annual budget.
- Compiles evaluation data as appropriate for roads/projects for which audits were conducted.

RSA Team

An RSA Team will be established for each project selected for audit. A different team may be established for the various phases of the audit, depending upon the amount of time between phases and the availability of team members. The RSA PC will select team members based upon their expertise as related to the project selected for audit. The RSA PC will contact the appropriate Engineering Director/DEA to verify the availability of the selected individual for service on a team. Once the Engineering Director/DEA has given approval for the individual to serve on the team, the person selected will be notified accordingly.

RSA Team members will be nominated for service bi-annually by the Engineering Directors and DEAs. Team members will serve a two-year term and will receive training in the RSA concept and procedures prior to service. Each RSA Team is responsible for the following:

- Completing RSA training prior to participating in an audit.
- Electing a Team Leader at the beginning of each audit.
- Using their expertise to identify concerns relative to proposed project.
- Preparing audit reports for each audit stage completed.
- Providing documentation to the RSA PC regarding expenditures and time allocated to a specific audit.

District Engineering Administrator

The DEAs will serve as the central point of contact for projects selected for audit within their districts. The DEA's role in the RSA Program is as follows:

- Provide necessary information on the project as requested by the RSA PC.
- Present the project to the audit team.
- Be available for questions during an audit.
- Review RSA report recommendations.
- Determine action(s) to be taken.
- Investigate alternate solutions to address the identified concerns.
- Respond to concerns outlined in the RSA report.
- Respond to the RSA report and forward a written response to the RSA PC.
- Seek funding and implement solutions.

In fulfilling these responsibilities, the DEA may appoint/assign staff as appropriate to assemble the information needed.

Pre-Construction Program Manager

The PM's role in the RSA Program is as follows:

- Provide necessary information on projects as requested by the RSA PC.
- Present project (Stages 1 and 2) to audit team.
- Be available for questions during audit.

ROAD SAFETY AUDIT TEAM SELECTION PROCESS

- The RSA PC will assemble RSA teams based on assigned projects. Teams will include a minimum of four members and often additional members from the following areas:

  – Preconstruction
  – Construction (includes CRM representative)
  – Planning
  – Traffic engineering
  – Maintenance
  – District offices
  – Non-SCDOT personnel (police/fire/EMS/community organizations—pedestrian, bicyclist, transit, etc./local traffic engineers)
  – Safety
  – Risk management

- The RSA PC will submit a memorandum to the DEA or Engineering Director advising which project team members in their division are being requested to serve on a team. Once approval is granted, the RSA PC will contact the individual selected.

- The RSA PC will schedule a meeting with each team independently. At the meeting, the teams will select a Team Leader for each project.

- The RSA PC will open the meeting, introducing the team members and then the Pre-Construction PM and/or the DEA (or his assigned staff person) who will present the audit projects. Following the introductions and project presentation, the team will be required to accomplish the following:

  – Select a Team Leader.

  – Establish a Project Completion Schedule.

    > Schedule a meeting with project PM,
    > Conduct the audit and draft a report, and
    > Establish final submittal date of report.

  – Assign Project Responsibilities (if applicable).

- RSA Team members will serve a two-year term. Department Directors and DEAs will have the opportunity to assign individuals to assist in the RSA Program on a bi-annual cycle.

- RSA Training Workshops will be conducted every two years for new team members. The RSA PC will conduct the workshops.

ROAD SAFETY AUDIT PROJECT SELECTION PROCESS

- During the first week of May of each year, the RSA PC will request from various SCDOT Directors/DEAs/Deputy State Highway Engineer a list of five potential projects to be evaluated through the RSA program for the upcoming fiscal year (July 1–June 30). Proposed projects will be submitted to the RSA PC within two weeks of the request. The following individuals will be asked to submit potential projects:

  – Director of Preconstruction
  – Director of Construction
  – Director of Planning
  – Director of Traffic Engineering
  – Director of Maintenance

- District Engineering Administrators
- Director of Safety
- Deputy State Highway Engineer.

- The RSA PC will compile a summary of the potential projects by category: (1) new infrastructure projects, (2) projects under construction, and (3) existing infrastructure with high crash frequencies. The listing will denote if a road/project has been proposed by more than one office.

- The RSA PC will review the project summary and compile a proposed list of projects selected for audit for the upcoming fiscal year. The number of projects included for audit may vary annually and will be based on the availability of budget funds and the estimated amount of time needed to conduct audits on the projects selected.

- Upon completion of the "Proposed Projects Selected for Audit" list, the RSA PC will schedule a meeting of the RSA Program Advisory Committee for mid-June. The RSA PC will forward the "Proposed Projects Selected for Audit" list to members of the RSA Program Advisory Committee for their review in advance of the meeting.

- The RSA PC shall serve as staff/resource personnel for the Advisory Committee.

- The RSA PC will make all necessary arrangements for the annual RSA Advisory Committee meeting, as well as prepare all necessary materials.

- The RSA Advisory Committee will meet on the scheduled day to discuss and select the RSA projects for the upcoming fiscal year. Projects will be chosen as follows:

  - 2-New Infrastructure Projects
  - 5-Projects Under Construction
  - 3-Existing Infrastructure.

- The RSA Advisory Committee will review RSA operational procedures and discuss any recommended changes.

- The RSA PC will provide the Committee with an annual report summarizing the results of audits conducted during the previous fiscal year.

- The RSA PC will prepare meeting minutes from the annual meeting and distribute them to all Committee and RSA Team members.

ROAD SAFETY AUDIT PROJECT PROCEDURES

Projects will be evaluated using the established RSA stages.

Future Roads

- RSA Stage 1—Planning
  The RSA team will complete at a minimum the following:

  - Review basic project scope,
  - Review proposed layouts for alternative routes,
  - Evaluate intersection access and surrounding topography,
  - Examine project impact to surrounding roadway system, and
  - Evaluate type of access/access management.

- RSA Stage 2—Preliminary Design
  The RSA team will evaluate at a minimum the following categories:

- Alignment alternatives,
- Interchange type and layout,
- Intersection design,
- Sight distances,
- Lane and shoulder widths,
- Provisions for non-motorized vehicles, and
- Superelevation.

- Once a project is under construction, the Team will follow guidelines for RSA stages listed under "Roads Under Construction."

Roads Under Construction

- RSA Stage 3—Final Design
  The RSA team will evaluate at a minimum the following:

  - Final geometric design,
  - Signing and pavement marking plan,
  - Lighting,
  - Landscaping,
  - Provisions for special users, and
  - Drainage, guardrail, and other roadside obstacles.

- RSA Stage 4—Pre-Opening
  The RSA team will review the road after most construction is complete. The main focus is to find overlooked physical obstructions and weather-related concerns missed in prior audit stages.

- Once the project is complete, the Team will follow guidelines for the RSA stage listed under "Existing Roadways."

Existing Roadways

- RSA Stage 5—Operations Review
  This stage allows the audit team a final look at how well the road operates and to identify safety concerns while observing actual traffic and traveling the route.

ROAD SAFETY AUDIT REPORTING PROCEDURES

The following steps will be completed for each RSA stage:

- The RSA team meets with the Pre-Construction PM or DEA (or the staff person to whom he has assigned the project) to discuss the project and receive background materials.

- The RSA team conducts a RSA audit based on established RSA procedures.

- Upon completion of each RSA stage, the Team will discuss their observations, develop recommendations, prioritize recommendations, and establish a consensus on which concerns and recommendations should be included in the RSA report. The Team Leader will prepare a report outlining the stage's findings and recommendations. The report will be submitted to the DEA in charge of the project, RSA Team members, and the RSA (PC).

- The DEA has up to 45 days to reply to the RSA report. The RSA Team will determine the amount of time for reply, based on the complexity of the recommendations made. The time for response may vary from 15 to 45 days. Extensions may be requested as needed. The reply should address each of the issues listed. The DEA has the option of incorporating the recommendations; however, the recommendations are not mandatory. If the DEA does not use a recommendation, he must state a reason.

- In assembling information for response to the audit recommendations, the DEA (or the staff person assigned) should contact at a minimum the Pre-Construction Program Manager; Traffic Engineering; Environmental; Right-of-Way; and other units that may have pertinent information or be impacted by the recommendation. Information these groups provide will assist the DEA in making a determination as to whether the recommendation can be implemented.

- The DEA forwards his response to the RSA PC.

- The RSA PC will forward to the RSA Team the DEA’s response.

- The RSA PC is responsible for maintaining all original correspondence, reports, etc.

- Team members will provide copies of their time sheets and expense reports to the RSA PC to be used as documentation of total expenditures. This documentation will be filed by audit.

- The RSA PC will be required to review the expenditure/time documents and verify validity. If there are any discrepancies, the RSA PC will request an explanation (via email or written memorandum) from the team member.

Abbreviations used without definition in TRB Publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation