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ROAD SAFETY AUDIT GUIDELINES FOR ROAD PROJECTS

A PIARC TECHNICAL REPORT

TECHNICAL COMMITTEE 3.1 *ROAD SAFETY*

PIARC

STATEMENTS

The World Road Association (PIARC) is a nonprofit organisation established in 1909 to improve international co-operation and to foster progress in the field of roads and road transport.

The study that is the subject of this report was defined in the PIARC Strategic Plan 2020–2023 and approved by the Council of the World Road Association, whose members are representatives of the member national governments. The members of the Technical Committee responsible for this report were nominated by the member national governments for their special competences.

Any opinions, findings, conclusions and recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of their parent organisations or agencies.

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AUTHORS/ ACKNOWLEDGEMENTS

This updated Road Safety Audit Guidelines for Road Projects is based on the documentation produced by World Road Association (PIARC) Techincal Committee C.2 Design and Operation of Safer Infrastructure (2016-2019 cycle) titled: *Review of Global Road Safety Audit Guidelines - With Specific Consideration for Low and Middle Income Countries (LMICs)* (2019R41EN). The RSA manuals selected for detailed review and consideration for the PIARC RSA Guide update were chosen as the best representation of different approaches that would be the most useful for LMICs to develop their own approach to RSAs. Further literature review of publications since 2019 was conducted for this report.

This document has been prepared by the working group three (WG 3) "*Update of Road Safety Audit (RSA) Guidelines*" of the Technical Committee 3.1 Road Safety during the 2020-2023 cycle of PIARC. Each of the key items documented by the above mentioned global review of RSA guides were addressed in this update by considering the best exemplar national guide identified. Additionally, findings from a TC 3.1 international survey of RSA training, implementation and sustaining programs and practices are integrated into the updated RSA guidelines. This report is the second edition of the orginial *Road Safety Audit Guidelines for Safety Checks on New Road Projects* (PIARC 2011).

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EXECUTIVE SUMMARY

2023R40EN

ROAD SAFETY AUDITS GUIDELINES FOR ROAD PROJECTS

A PIARC TECHNICAL REPORT

New road projects are constantly being planned and implemented that do not fully exploit the possibility to improve road safety by better design. This can be because there is either a lack of knowledge and understanding of the fundamental issues or as a result of having to balance the various, often competing, interests involved. Transport efficiencies and requirements and economics of the project are often given highest priority, followed by environmental considerations, with safety being considered as following standards and guidelines.

The traditional road engineering approach to safety has very often been to “wait and see”, that is, safety countermeasures are not considered until the crash situation becomes unacceptable. However, having knowledge about the circumstances which provoke crashes means it is possible to detect these faults early in the development of projects and certainly appropriate changes made well before the design faults are translated into reality.

The introduction of Road Infrastructure Safety Management (RISM) has resulted in a number of different road safety techniques being applied throughout the life cycle of a road. Road Safety Audit (RSA) is just one element of RISM. The others being Road Safety Impact Assessment, Road Safety Inspection and Network wide Road Safety Assessments (as defined in Directive (EU) 2008/96 and amendments in Directive (EU) 2019/1936). The correct use of these processes through the life of the road will ensure that road user safety is maximized, and death and serious injury are minimized.

For maximum effectiveness it is very important that RSA is carried out by a team of independent auditors from private firms, or road administration region/staff, not involved in the project design team. Auditors must be trained and fully qualified with appropriate experience of the safety issues associated with the types of project to be audited.

Although auditors must be independent of the design team, they cannot undertake the audit in isolation. Although the audit team carry out the audit, the responsibility for implementing- or rejecting the audit recommendations lies with the project client and design team who must be involved at key stages in the audit process.

Finally, resources are provided to assist the auditors and designers to identify potential deficiencies and develop suitable strategies to mitigate the consequences. Some examples from the 2009 PIARC Catalogue of Design Safety Problems and Potential Countermeasures report are presented.

The appendices provide auditors prompt lists for a RSA at various stages of project development and a RSA report format template for documentation.

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1. INTRODUCTION

With the United Nations General Assembly adopting the second Decade of Action for Road Safety 2021-2030 targeting the prevention of at least 50 percent of road trafffic deaths, the declaration continues to acknowledge that road safety is a global public health issue with the promulgation of the World Heath Organization Global Plan. Addressing the health and safety problem requires the holistic road Safe System approach to improve the design of roads and vehicles, enhance laws and law enforcemnt, and provide life saving emergency care for the injured. With the Global Plan continued focus on Low and Middle Income Countries, PIARC had proactively initiated this update to the Road Safety Audit Guidelines by preparing the *Review of Global Road Safety Audit Guidelines – With Specific Consideration for Low and Middle Income Countries (LMICs)* (2019R41EN). The guidelines review considered the core issues facing many LMICs. The RSA manuals selected for detailed review and consideration for the PIARC RSA Guide update were chosen as the best representation of different approaches that would be the most useful for LMICs to develop their own approach to RSAs. Each of the key items documented by the global review of RSA guides were addressed in this update by considering the best exemplar national guide identified. A companion to this RSA Guidelines is the PIARC 2023 report Specific Road Safety Issues for LMICs that identifies road safety managementdifficulties facing LMIC to institutionalize RSAs within the Safe Systems paradigm. The report includes case studies providing strategies to deploy and develop strong safety management and thus safety improvement outcomes. Related to RSAs are topics such as developing a road safety culture, road safety managemnt and leadership and building road safety expertice and science necessary to implement effective RSA programs.

In many countries, road safety requirements for planning, construction, and maintenance, as well as operation and equipment are contained in the applicable policies, rules, regulations, and technical standards and specifications. Yet, design possibilities for improved road safety afforded by the latest technological developments and the safe system approach are still not fully implemented. New scientific and technology findings take some time to find their way into the planning and engineering practices, because they need to be tested and accepted. Conflicting interests can also delay adoption of new transport policies, procedures and technologies.

The introduction of Road Infrastructure Safety Management (RISM) has resulted in a number of different road safety techniques and treatments being applied throughout the life cycle of a road. Road Safety Audit (RSA) is just one element of RISM. The correct use of these processes through the life of the road will ensure that road user safety is maximized, and death and serious injury are minimized. This RSA Guide provides information to form appropriate policies and procedures to institutionalise proactive safety considerations and effective enhancements thoughout the roadway project developent process.

1.1. USING THE RSA GUIDE

Formalized procedures for road safety audits (RSA) have been developed to avoid safety deficiencies during the planning and design phases of new road projects. In the case of reconstruction, road widening or substantial maintenance, an assessment of the existing road remains the normal procedure to detect safety deficiencies to correct them in the proposed design in the further project stages.

These PIARC Road Safety Audit Guidelines (RSAG) and the checklists for different types of roads and design phases are based on the evaluation of existing RSA guidelines around the world which have been carried out successfully.

RSAs required by road transportation agencies or by other legal entities are implemented to minimize crashes on newly built roads and to maximize the safety potential of existing road infrastructure and operation.. Formal RSA procedures ought to be included in national or regional roadway design manuals and in the roadway design process. Many transportation professionals and practitioners familiarize themselves with the entire RSAG, however, certain sections have more practical relevance depending on the varying interests and objectives of different users. For example, road agency management and policy makers, design teams, and road safety auditors use these guidelines differently and with varying detail.

These guidelines are intended to support and guide road transportation agencies (entities) at national and local levels for all road classifications.. The RSAG describes the principles of Road Safety Audits, defines projects that could benefit from an audit, specify steps and processes to be carried out, assign repsonsibilites as to the parties engaged in the audit. Detailed prompt lists and an illustrative example of a Road Safety Audit Report are also included.

These guidelines for RSAs are applicable for new roadway design and construction, roadway reconstruction or widening, other road improvements and major maintenance, in ruraland urban areas. These guidelines should be used with care and common sense as reliance on the prompt lists are no substitute for roadway safety experience.

Two purposes of the RSAG are as follows :

The Guidelines have the primary objective of promoting and enhancing RSA as a proactive process, within the road infrastructure safety management framework and implementing roadway Safe System principles.

The Guidelines identifies RSA principles recognized as best practices. These principles should be used to build effective national, regional and local RSA strategies, policies and procedures.

Reading and understanding these Guidelines does not qualify a practitioner as road safety auditor. Formal competency requirements exist, and these should be built into local policies and processes to qualify road safety auditors.

Throughout this document, the terminology refers to right side driving countries. Appropriate adjustments must be made for left side driving countries. For example, when crashes are said to occur when a vehicle leaves the road to the right, this means the nearside.

1.2. RSA Relationship to Road Infrastructure Safety Management

The benefits of integrating safety considerations within the general network development and operation have been widely recognized. As a result, formal Road Infrastructure Safety Management (RISM) systems and procedures which involve all levels of government have been established (See Chapter 3 of PIARC Road Safety Manual (RSM) for more information).

The key component of RISM systems is the adoption of proactive assessment and interventions of both new and existing roads. Road Safety Audit is one of four proactive approaches that can be used

to identify and address safety issues within a formal Safety Management System (See Chapters 9 and 10 of PIARC RSM for more detail).

Figure 1.1 shows how RSA fits within the RISM cycle and sets out nine types of safety analysis in relation to existing and new roads. (See Elvik (2010), for detail of each of the analyses methods)

Network Safety Ranking (NSR) and Road Safety Inspections (RSI) are aimed at the existing road network while Road Safety Impact Assessment (RSIA) and Road Safety Audit (RSA)are for proposed road projects. RSIAs demonstrate that RISM is not linear but is a circular process that continually feeds back to improve the quality and safety performance of road design. The assessment of high-risk sites improves knowledge of identified road deficiencies, as a result inform safety improvement recommendations for the other stages of road development.

Road Safety Evaluations Based on Human Factors Method (PIARC 2019) provides resources for the consideration of human factors throughout the RISM paradigm. Documented case studies from several different countries highlight the methods.

Figure 1.1 Road Infrastructure Safety Management Procedures at Each Stage of Road Development (adapted from Luca Persia, et.al 2016,)

<table>
<tr><td rowspan="10">Road Infrastructure Safety Management</td><td rowspan="2">Planning and Design</td><td>Road Safety Impact Assessment</td></tr>
<tr><td rowspan="2">Road Safety Audit</td></tr>
<tr><td>Construction and Pre-Opening</td></tr>
<tr><td rowspan="2">Normal Operation</td><td>Safety Performance Indicators

Network Safety Ranking</td></tr>
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<tr><td rowspan="3">Hazard identification and elimination</td><td>Road Assessment Programme</td></tr>
<tr><td>High Risk Sites</td></tr>
<tr><td>In-depth collision Investigation</td></tr>
<tr><td>Major upgrading and renewal</td><td>Road Safety Impact Assessment</td></tr>
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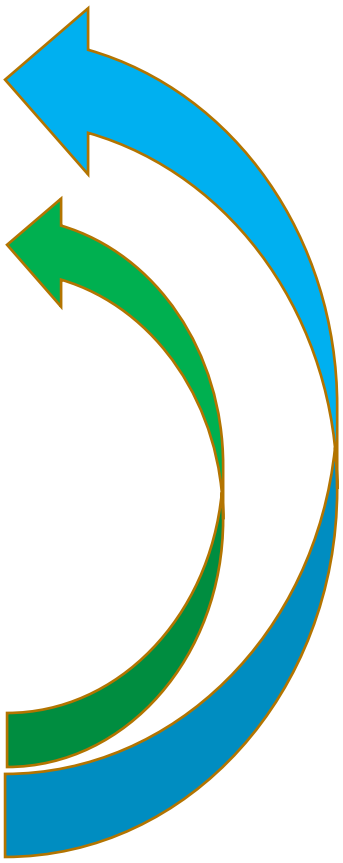


RSA is a proactive approach with the primary aim of identifying potential safety problems as early as possible in the design process so that decisions can be made about eliminating or minimising the problems, preferably before a project is implemented or crashes occur. Aligned with the Safe System approach, RSA focus on preventing fatal and serious injury crash types or reducing the severity of the outcome when they occur. However, RSAs do not preclude prevention considerations of other crash types and severity outcomes.

Since RSA is a proactive approach it should be distinguished from hazard identification and elimination which is a reactive approach. (see PIARC RSM Chapter 10.3 - Reactive Approaches).

Other proactive approaches that are included within a comprehensive Road Infrastructure Safety Management system are (See PIARC RSM Chapter 10.4 Proactive Identification):

- Road safety impact assessment
- Road safety inspection and
- Road assessment programmes

Australian Roads (Austroads[1]) RSA Guidelines also provides more detailed information on proactive RSA during project delivery stages.

In addition to this RSAG, PIARC has published the following to support RSIM:

- Road Accident Investigation Guidelines for road engineers (2013 – 2013R07EN)
- Road Safety Inspection Guidelines for safety checks of existing roads (2012 – 2012R27EN)
- Road Safety Evaluations Based on Human Factors Method (2019R27EN)

1.3. RSA Within the Safe System Approach

A Safe System approach (SSA) within the road transport system is built around the premise that death and injury are unacceptable and are preventable. This approach seeks to ensure that no road user is subject to kinetic energy exchange in a motor vehicle crash which will result in death or serious long-term disabling injury. OECD (2016) endorses the Safe System approach. International Transport Forum (ITF, 2016) suggest that the key Safe System principles are:

1. People make mistakes that can lead to road crashes

2. The human body has a limited physical ability to tolerate crash forces before harm occurs

3. A shared responsibility exists amongst those who design, build, manage and use roads and vehicles and those who provide post-crash care to prevent crashes resulting in serious injury or death

4. All parts of the system must be strengthened to multiply their effects; and if one part fails, road users are still protected.

The elements of the integrated, human-centric Safe System approach and their interactions are depicted in *Figure 1.2*. RSAs predate the emergence of the Safe System approach but continues to be a recognized as a proactive procedure with the understanding that designing and operating roads

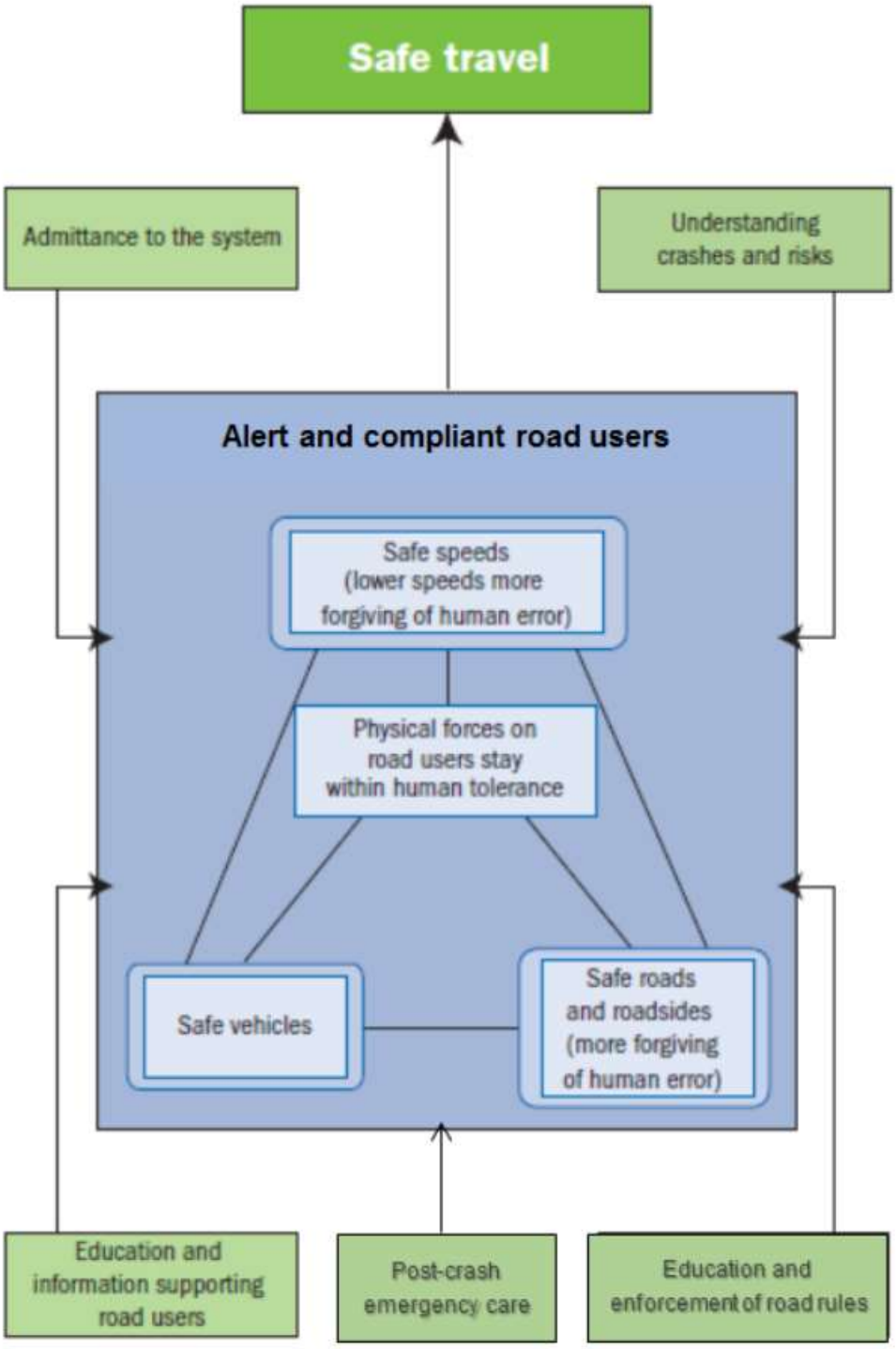
[1] Austroads is an organisation representing Australian States and Territories (8), Federal and Local Government (2) and New Zealand in it entirety (1).

using guidelines and standards alone does not result in a safe road system. Within the RISM proactive methods and RSA addresses the four main Safe System design elements:

- Safe roads and roadsides – that are predictable and forgiving of mistakes. They are self-explaining in that their design encourages safe travel speeds and help avoid errors.
- Safe speeds – travel speeds that suit the function and design of the road. People understand and comply with the speed limits and drive according to the conditions.
- Safe vehicles – that prevent crashes and protect all road users, including pedestrians and bicyclists and mico-mobility rollers.
- Safe road users – road users who are alert and unimpaired, and who comply with road rules improve safety, and expect safety improvements.

The Safe System challenges transportation officials, those responsible for designing and operating transportation systems, to shift their thinking away users' mistakes and to share the responsibility for the interaction and speed between roadway users, vehicles, design features, operations and policy makers.

Figure 1.2 Safe System Approach Elements – Source PIARC RSM



(See Chapter 4 of PIARC Road Safety Manual (RSM) for more information on safe system approaches).

Conducting RSA within the SSA requires understanding how kinetic energy generation relates to the outcomes of different crash types and to the involved users. RSA implementation has led to the identification of critical speed thresholds or target speeds for different crash types typically leading to deaths and serious injuries as follows:

- Head-on (crossing road centreline or median)

- Intersection/Driveway related (typically crossing or turning angle but also some high speed rear-end collisions)
- Run-off-road (vehicles leave travel lanes and overturns or hits a fixed object)
- Vulnerable road users (pedestrian, bicyclist, motorcyclists of varying abilities)

Key SSA questions for an audit to assess risk of the highway design include asking could there be:

- A head-on crash at speeds > 70km/h
- An intersection (angle or rear-end) crash at speeds > 50 km/h
- A run-off-road crash at speed > 40 km/h
- A vulnerable road user crash at speeds > 30 km/h

1.4. Defining Road SafetyAudits

RSA is a term used internationally to describe an independent review of a project to identify road or traffic safety concerns. The general definition used is: "A formal road safety examination of the road or traffic project, or any other type of project which affects road users, carried out by an independent, qualified team of auditors who report on the project crash potential and safety performance for all kinds of road users".

The essential elements of this definition are:

- a formal documented proactive process;
- an independent process during different stages of project development and design;
- carried out by someone with appropriate experience and training;
- restricted to road and users' safety issues.

Any project which will influence or affect road users' behavior should be audited. The systematic application of RSA results in the safety needs of all road users being fully considered. The road users include: motorists, horse riders and wagon/buggy operators, commercial and heavy vehicles, scooter and micro-mobility operators, motorcyclists, bicyclists, and pedestrians.

The outcome of a RSA is a Report, which identifies any road design safety deficiency and opportunities to reduce crash potential. If appropriate, the report also makes recommendations aimed at removing or reducing the deficiencies. These recommendations are developed into engineering solutions by the technical design team before final approval – or rejection-by the client (See following sections for more detail)

The time required to undertake a RSA is very short compared to the individual planning and design stages. Nonetheless, it should begin as early as possible in project development and repeated throughout the design process.

1.5. Objectives and Benefits of Road SafetyAudits

The purpose of a RSA is to proactively improve road safety by identifying and addressing risks associated with the design and operation of new roads or proposed road improvements and identifying improvements to reduce crash potential and severity. The objective is to:

> ***Identify potential road or traffic safety concerns for all road users and recommend design improvements and countermeasures to mitigate potential crashes and outcomes.***

Also, the safety audit aims to provide these benefits:

- minimize the risk and severity of road crashes for all users that may result from design deficiencies,
- minimize the need for remedial work,
- reduce the life cycle costs of the project by reducing crashes, disruption and trauma costs,
- improve the awareness of safe design practices of everyone (e.g., planners, roadway and traffic engineers) involved in the design and for local communities due to their involvement in the audit process, and
- An RSA at the preliminary design stage provides an opportunity to engage with local communities and thus and support and address local safety concerns.

RSA does not check if technical standards have been applied or if the project has been constructed according to the design/the plans, but to determine what could be improved pertaining to road safety from the perspective of all road users.

The earlier the project is audited within the design and development process the better. Early auditing can lead to the early elimination of problems and, consequently, minimize time and cost of redesign at later stages. Furthermore, the findings and lesson learned from RSA are important for persistent improvement of design standards, policies and guidelines. As such, mechanisms should be established for internal and wider feedback to the transportation industry and to community from RSA findings.

Although it is not always simple to quantify precisely the economic benefits of RSA, there is strong evidence that audits are highly cost-effective. A study by Austroads (Report Ap-R209-02) on the benefit of the RSA has demonstrated substantial benefit from the process. For the design stage audits, it was demonstrated that benefit cost ratio (BCR) of implementing all the recommendations from individual audits ranged from 3:1 to 242:1. Additionally, 75 percent of recommendations had a BCR greater than 10 and 90 percent of recommendations had a BCR greater than one(1). The World Bank estimated a $36 return for every $1 spent at the design stage (Deng, Jordan, Goodge 2012).

There are two expenses that can be attributed to an RSA. The cost of the RSA and the cost of implementing the recommendations contained within the audit report. Austroads (2022) estimates that the cost of RSA can be four (4) percent or lessof the total design cost. In many cases, these costs are not significantly high and items identified during the design stages may have no cost implications at all (although they may require some re-design time).

In terms of crash reduction benefit, the United Kingdom experience suggests that at least 33 percent of crashes can potentially be avoided or their severity reduced by conducting the RSA (Wells 1999).

2. DEVELOPING A SUSTAINABLE SAFETY AUDIT PROCESS

RSA has been an established procedure in many countries for over twenty years, and the practice is spreading. Nonetheless, the effectiveness of RSA depends on the formal recognition and incorporation into the design process by road authorities. Some countries require for all such design standards (or norms) to be approved by their national government to provide the legal basis for all changes and modifications to the road (highway) network.

National and local road authorities and/or road operators are responsible for managing the safe operation of their respective road networks and are liable for any safety deficiencies that cause harm to the users and public in general.

A PIARC survey of common initialization of RISM and Safety Audits revealed these common threads:

Universities have developed curriculum and case studies and offer courses to certify RSA trainers and/or auditors for road authorities and their contractors.

National road authorities internally develop training based on international practices or contract with experts (e.g, though PIARC, IRF, WB) to develop and conduct training.

National or state/provincial road authorities offer exams and certification based on the developed training (see Chapter 4 for more information on qualifications)

Continuing education guidance, recommendations or requirements are provided by the road authorities.

Without the adoption of formal policies and procedures, road authorities are left with relying on international standards to apply on roads project. They may tend to assume that policies include fully developed systems of RSAs. As a result, international experts are used who may not be familiar with local design practices and local road users' behavior. Difficulty, for Lower and Middle Income Countries (LMICs) in particular, in implementing RSA policies and to develop practices outside projects funded through the International Development Banks must be overcome by management priority for action.

The starting point for developing a sustainable RISM process is to include RSA in a formal national design policy and standards. An increasing number of countries worldwide have national RSA requirements that are embedded in the design standards and must be applied on the national road networks. For example, EU countries are obliged to conduct RSAs on infrastructure projects (Directive (EU) 2008/96 amended by Directive 2019/1936). Therefore, application of good practice cascades down to local road authorities and becomes recommended best practice for RISM administration. Over time it beomes inadmissible for local road authorities to continue to ignore such proactive safety practices when road users are exposed to the same types of, and in some cases, greater risk.

Once a formal RSA standards have been adopted, resources are then required for their implementation. These resources come from a pool of local technical expertise in roadway design, traffic operations and safety.

RSA undertaken by suitable qualified and experienced road safety professionals; it is not an isolated technical intervention. The most important attribute for those who undertake audits is to thoroughly understand the factors that cause death and injury on local road networks. They can acquire this expertise through training and involvement in collision investigation and road safety improvement projects within the country or locality.

Initially authorities implementing RSA processes will lack both the knowledge and experience to undertake audits themselves. They will need to rely on national or international support to get the systems underway. However, to maintain these processes local expertise needs to be developed. This can only be done by requiring local safety staff to be involved in the early application of RSAs. These teams can be engineers, planners, educators, police officers or even administrators who have a sound knowledge of the local road safety issues. With time they will gain experience by analysing crash, traffic and community information that exists and is observed plus noticing success of implemented remedial treatments. Ultimately, their experience to allow them to undertake audits as Team Members and ultimately as Audit Leaders.

While this knowledge and experience is being gained, calling on experienced auditors is recommended corroborate found issues and recommendations. The development of a wider auditor network, possibly as part of a professional association can provide a venue, where ideas and problems can be discussed in a positive way. At the same time, experienced auditors 'mentoring' and developing additional audit resources grows the local capabilities.

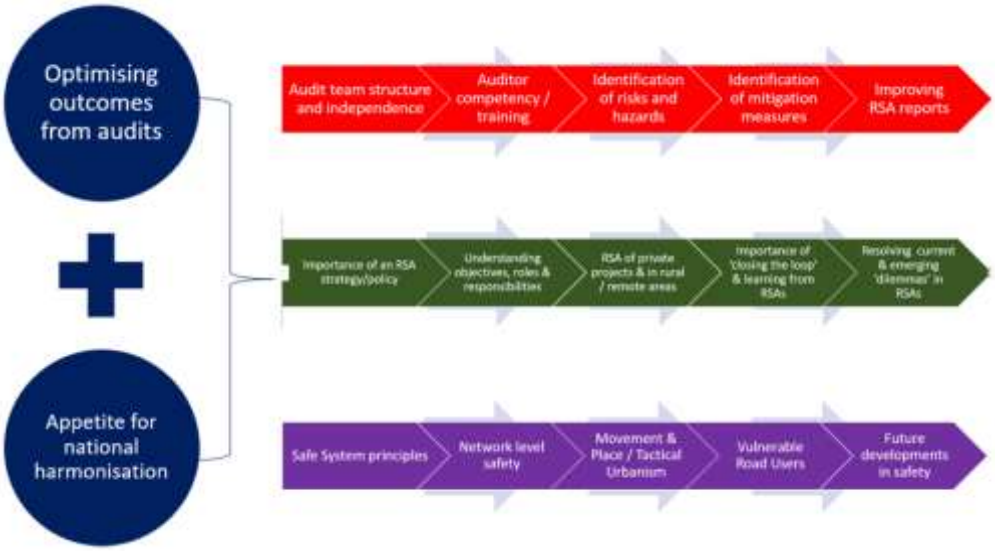
Agreeing to a standard curriculum of base knowledge and providing a local programme of continuing professional development ensures local audit findings addresses the true local safety issues.

National institutions already exist for both training and development of technical professionals. One way of standardizing qualifications and experience is to use curriculum based widely accepted training and experience criteria and and to incorporate a Road Safety Audit certification within these bodies. Necessarily, maintaining relationships with and links inks to international institutions in countries with more developed audit practices improve local standards, procedures and practices.

As mentioned above, successful RSA processes, output and and outcomes involves a wide array of stakeholders. Accordingly, the development of a local RSA strategy and associated policy is actively encouraged. Existing RSA strategies and policies should be regularly reviewed and updated to provide guidelines on the types of projects to be audited and whento perform audits during the project development cycle. The New Roads and Projects: RSA (Roads Safety Manuals for Africa) provides a valuable section on embedding RSA in the RISM process. Although containing some overlapping topics, the Austroads RSA Guide provides a visual listing of the themes and elements (pathway) needed to improve RSA practices and outcomes with the intended desire to bring regional or national RSA implementation consistency as shown in *Figure 2.1*.

Across the elements in *Figure 2.1* is the theme of improving the RSA process and reports and the Safe System practices of the client (Road Administration). Audits may recommend improvements that are not standard practices. As such, adopting and implementing a system for the Road Administration, region or country to collect unique and new recommendations and lessons learned from RSAs will optimize outcomes (education and acceptance from clients; critique or feedback on audit reporting) and bring, perhaps, immerging and untried designs and actions that have been effectives elsewhere. Learning from RSAs by routinely collating and disseminating experience and practices to clients, stakeholders and the road transport industry will bring improvements to policies, standards, guidelines, and the audit process to enhance the application of Safe Systems and severe crash reduction outcomes.

Figure 2.1 Illustration of Operating and Improving RSA Process and Outcomes (AustRoads RSA Guide, 2022)



3. WHAT SHOULD BE AUDITED

3.1. AREA OF APPLICATION

In most countries roads are categorised in accordance with standards for the functional classification of the road network according to:

- primary function,
- traffic mix (motor vehicles only or mixed with non-motorized or slow agricultural traffic),
- localisation (rural or urban - built-up development- areas).

Roads are planned, designed, built, maintained and operated in accordance with the corresponding technical standards and specifications. A RSA should be undertaken on any design for new roads and on any proposal for changes in existing roads or road environment which are likely to alter interactions between different road users, or between road users and their environment.

In low and middle income countries (LMICs), the functional classification of a road is often blurred by the lack of land-use development planning and right-of-way use policy with non-travel related activities encroaching into the roadway. As a result, the actual road function and use by local road users can be very different from the original design criteria specified in the design manuals. Cooperation between the road owner and the local authorities should be undertaken to enable creation of safer areas outside of the right-of-way for these activities. Then – but not before – enforcement can be implemented.

The intent of an RSA is to examine the crash potential, crash severity and expected safety performance of of a planned or ongoing road project that is a formal process using a structured procedure as opposed to design checks performed during the project stages. Importantly, someone who has appropriate experience and training, and who is independent from the designer and the decision maker should conduct the RSA.

An RSA is an integral part of the design process but independent from the actual design. The road designer remains responsible for the final design. The designer should make regular checks to make sure crash mitigation is included as the design progresses. RSA does not alter the need for the Safe System approach. The audit process provides, at regular intervals, an independent assessment. The client remains responsible for the ultimate design and should consider that assessment. In the Safe System approach, clients such as national and local road administrations, companies for public roads and in special cases, infrastructure funding agencies are the decision makers in the design process.

After roads have been constructed, the conditions might have significantly changed, for example design standards, function of the road, traffic volume and distribution, vehicle weights, land use, and accesses can all adjust. Therefore, it is importantto inspect the existing road network. This procedure is termed Road Safety Inspection (RSI) within PIARC guidelines. This task should be coordinated with investigation of Crash Black Spots (high crash locations from network screening) on existing roads.

3.2. TYPES OF PROJECTS

RSA can be conducted on projects as diverse as:

- major highways construction and maintenance projects,
- minor improvements,
- major traffic management projects,

- gravel surfaced access roads,
- land-use (re)development projects
- temporary traffic management
- isolated facility improvement or
- single signs.

The relevant road authority is responsible to mandate types of projects subject to audit based upon the level of anticipated risk and the available resources (both financial and human).

4. WHO SHOULD CARRY OUT A ROAD SAFETY AUDIT

4.1. ROLES AND RESPONSIBILITES

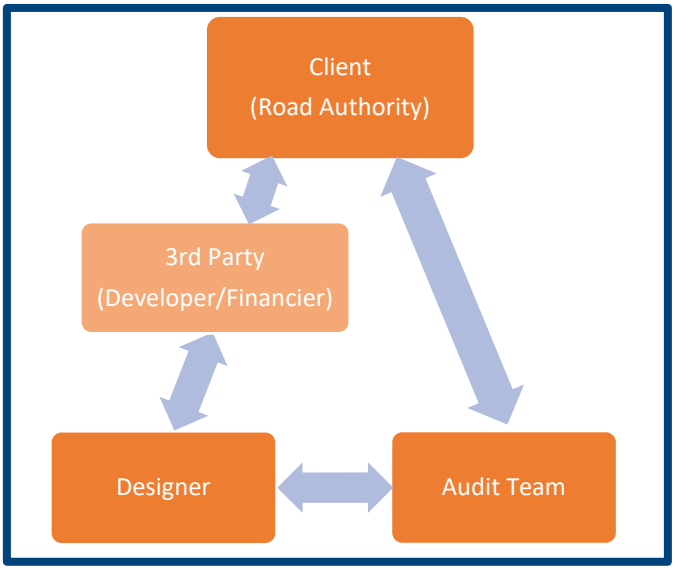
There are three main parties involved in RSA:

- The **client** (always the Road Authority or any other project owner and not necessarily the party contracting the audit),
- the **designer** and
- the **auditor(s)**

Their roles and responsibilities must be clearly defined and included in the adopted policies and general procedures to conducts RSAs.

Figure 4.1 presents the interrelation between the parties involved in the RSA and then each role is discussed in more detail

Figure 4.1 Partners of the Audit Process



The **client**, is the person or organisation responsible for the outcome and use of the RSA report. They will initiate the RSA, define the scope and commission the auditor(s). The auditors shall be an independent professional person, or team from the project design teams. They also review and approve qualifications and experience of the auditor(s.

The client will normally have the legal responsibility for the studied road networks' safety performance.

The client has the responsibility to ensure that audits are commissioned at the appropriate project stages and that the scope and responsibilities of the audit and auditors are clearly defined.

The road authorities that often commission audits. They are still the clients regardless which entities are funding the audits.

Instances may arise where private or third parties are funding or paying for the audits.

Developers, other mode or agencies, such as transit or parks, finance institution or land developer) who undertake construction or financing a road improvement that could adversely affect safety on the roadway or roadway network. In such cases, a Development Project RSA is required. These follow

the same RSA stages, however, they are the responsibility of the developer under direction from the relevant road authority. The road authority still makes the ultimate decision on scope and responsibilities of the audit team, selects the team members and receives the audit report for final determination

Importantly, the client and their representative managing the audit process fully understand the process and their key role in delivering quality outcomes. The design team advises on technical aspects of the project design and the client or the representative manage the process. Ultimately, the client assembles the settled process outcome and signs the final decisions document.

The **designer** is the manager, team or organisation responsible for the detailed technical design of projects. The designer acts under instruction from the client. The designer may be within the road authority (owner and client) or out-side consultant or contractor (in case of design build projects).

The designer will:

- Be the auditor(s) point of contact to provide project information.
- Provide technical support to auditor(s) and client
- Review the audit report and advise the client of consequences of recommendations and identify audit disagreements and audit recommendations.

While the designer may scope and define the terms of the RSA, the client makes the final decision on the acceptance or rejection of the audit recommendations. RSA commencement and closure meetings between the parties are efficient ways to clarify and discuss issues with the RSA findings and recommendations.

The **auditor(s)** is the person or team undertaking the RSA, who shall be independent of the designer. The auditor takes instruction from and reports to the client, who is advised by the designer.

A typical audit team would consist of:

- **team leader** has overall responsibility for carrying out the audit; this includes managing the process and the team and ensuring the report is delivered on time. The leader is responsible to complete the audit within the scope and terms of reference provided; some clients (road authorities) may require certification of the leader;
- **team member(s)** has responsibility for carrying out specific tasks and duties within the audit as delegated to them;
- **observer** is new to RSA and is developing knowledge and experience to become a formal member;
- **specialist advisers** have responsibility to provide specialist independent advice to the team as required. The specialist adviser need not be a full-time member of the team, being brought in when required. Non-engineering expertise (e.g., health, community, and modal agencies and advocates) can reveal unexpected aspects to the design process;
- a **local engineer and/or police and emergency response** representatives can alert the team to cultural sensitivities and concerns, as well as generating acceptance of the project in local communities.

Only the Audit Team has the formal responsibility of the audit report and findings. The team may take into account the comments and views of other stakeholders. within the team. Required audit team expertise will depend on the size and complexity of the project and the RSA stage under review.

All information and reports are distributed via the client. The auditors perform the RSA, the client takes decisions based on the audit recommendations, the designer modifies the project design, if required, and the client approves the results and, if needed, mediates between the auditor's recommendations and other private or public interests and plans. The designer can comment on the RSA recommendations by indicating their implication on cost, design impacts on right of way and environmental considerations. The designer's comments are useful as they help some clients understand potential implications of implementing the RSA recommendations. The responsibility of developing and adopting corrective solutions lies with the designer.

In many cases the audit team is appointed (or nominated) by the designer through the tendering process. However, to maintain audit team independence they must still report findings and take direction from the Client.

Different organisations manage road safety and design activities in different ways. Sometimes these activities are performed within the same organisation or department, at other times they may be in completely different authorities. Regardless of the case, responsibility for managing and deciding on audit outcomes remains with the client who oversees the project's successful operation and clearly defined lines of communication must be maintained throughout. Even when third party organisations are contracting the audit team, reports and decisions must be delivered through the client organisation.

4.2. AUDIT TEAM COMPETENCES

4.2.1. Independence of auditors

To be effective, a RSA shall be conducted by an audit team that is independent of the design team - even when the latter is the one contracted by the RSA the specific service. Auditors can be from private firms or road administrations, but they have to be independent of the project design team. However, they should not be isolated from the designers or client but should be part of the team.

The independence of the auditors is important for an impartial and unbiased judgement and evaluation. Independence in this context means that the audit is carried out by auditors who do not carry responsibility for the project and who are not involved in the project design to be audited. Auditors need to be objective in their assessments.

There are a number of possibilities for ensuring the independence of the safety auditor:

- safety audits can be performed by certified external consultants;
- safety audits can be performey the teams from other geographical districts/regions of a road authority audit;
- a national Research Institute for highways,
- a special department or organization of the ministry, such as a road safety agency, which is responsible for road transport or within the national or community road administration that organizes the audits and selects the audit team in respect of the skills and independency of the auditors.
- the safety auditor could be part of a road authority's staff, but with an explicitly stated function as safety controller.

4.2.2. Qualification of auditors

The success of a RSA depends to a very great extent on the skills, abilities and experience of the RSA Team and lead auditor. Selecting the right team for a particular project is essential. Competence in RSA comes through hands-on experience. Training is helpful at the start but is only a base upon which experience needs to be built.

Auditors carry significant responsibility. The quality of the auditor's recommendations to the client will have a great influence on the safe operation of the new or rehabilitated road and they will help to inform decisions about competing private and public interests. To fulfil this task, the auditor has to be trained and fully qualified.

RSA should be conducted by a team of auditors with adequate training and experience in road safety engineering principles and practices – including human factors considerations -, traffic engineering and traffic management, road design, crash investigation and prevention.

An auditor does not necessarily have to be a registered engineer, but they must have the necessary competencies: they can read technical information from a plan, they quite likely have a competency in roadway design and/or traffic engineering, and they have an appreciation of road safety risk from a variety of road user perspectives.

An auditor who has an understanding of road user behaviour and human perception and related factors is also important because the interactive nature of road user behaviour with the road environment. A basis of such understanding is provided in the **Human Factors Guidelines for a Safer Man-Road Interface** (PIARC 2016) ; NCHRP Report 600, Human Factors Guidelines for Road Systems 2nd Edition (NCHRP 2012) ; NCHRP Document 316, Human Factors Guidelines for Road Systems 2021 Update (NCHRP 2022). Further training in human factors fundamentals and application would benefit everyone involved with highway and traffic engineering and operations.

Different levels of training and experience are required for Audit Team leaders and Audit Team Members. The audit Team Leader should be the most experienced member of the team.

Having obtained an initial level of road safety knowledge through recognised RSA training (typically a 3, 5 or 10 day evaluated study programme), auditors need practical experience of collision investigation and taking part in audits. The easiest way to achieve this is to include trainees or local road safety staff in scheduled audits until they have completed sufficient audits to be included formally as an Audit Team Member. Once sufficient seniority haves been achieved, they can then progress to be an Audit Team Leader.

Auditors should have the ability to evaluate the traffic safety of a road for the different road user groups e.g. lorry and car drivers, pedestrians, cyclists, children, etc. In addition, auditors should be up to date on the latest safety information relating to the design and operation of roads. Keeping technical knowledge up to date and having experience of investigating collisions within the local environment is a vital part of auditor's knowledge and experience.

Furthermore, auditors are appointed on a project by projects basis from an assessment of their qualifications and experience related to that specific project type. Just because an auditor is accepted on one project does not mean they are automatically accepted for all rejects.

Different qualifications and experience are required for different stages of audit and type of project for example, an experienced road design engineer who is familiar with road design standards ~~is~~ may be required for the audit at the feasibility stage while someone with expertise in traffic signal control,

traffic signs, street lighting and crash barriers may be required for the audit at the detailed design stage. Similarly, an auditor who is only experienced in major urban highways is unlikely to have appropriate experience for a rural road rehabilitation project.

Different qualifications and experience may also be required in different regions of a country. For example, land use patterns and behaviour can differ depending on traditional practices. Local experience and understanding is an important consideration within the audit team.

4.2.3. Experience and training of auditors

Importantly, the safety audit team has substantial collective experience in road safety issues. The make up of the team will depend on the size and type of the projects being audited. Generally, as already stated, the team should comprise of a leader, team members, specialist advisers (where necessary) and observers (these will generally be junior staff gaining experience in RSA). The benefits of a team approach to an audit can be seen as more pairs of eyes, constructive debate, different skill sets, etc. The advantage of an audit team is to ensure all skill sets are adequately covered.

The AfDB – Road Safety Audits for Africa and Austroads RSA guides provide detailed RSA team and leader capacities and abilities for each of the RSA stages. They provide more details of skills, knowledge, abilities and attitudes needed from junior to senior auditors for continuance and improvement of RSA practices in a jurisdiction.

Building an auditor career pathway will institutionalize the RSA within the agency and instill the intended attitude towards Safe System approach to roadway design: passion for reducing trauma from crashes (more than another design check); audits are proven to provide safety benefits; audits provide chance to learn and improve design practices and processes.

The audit team leader should have completed relevant university education and have significant experience in road safety engineering and crash investigation. Four to five years conducting RSAs would be a minimum length of experience. Team members would normally be expected to have relevant education also plus about 2 years' experience.

Ideally, road authority or the national transportation agency should organize the training, certification and refresher courses for the authorized auditors.

When setting up the team, consideration should be given to any particular features of the project that will require specialist input. For instance, non-motorised and other vulnerable users often have specific needs, railway crossings or complex signal-controlled intersections.

Typical training and experience requirements, based on the above referenced Africa RSA guide, are shown below in *Table 4.1- 4.3*.

Table 4.1 - Road Safety Audit Team Leader Competencies

Team Leader	Required	Desirable
Qualification	University degree in road engineering, traffic or related road safety field OR Extensive (10 plus years') experience in a related road safety field including crash investigation	Higher degree in traffic or road engineering subject
Training	Formal course(s) crash investigation or road safety engineering training. Completion of a recognised RSA course.	
Experience	Robust (e.g., 5 years')experience in a relevant road safety, design, construction or traffic engineering field Relevant (e.g., 3 years') experience of crash investigation Experience working in the country/region	Extensive (e.g., 10 plus years') experience in a relevant road safety, design, construction or traffic engineering field Robust (5 years') experience of crash investigation
RSA Experience	Must have recently (e.g., within 2 years) undertaken at least 3 to 5 RSA of representative stages as a RSA Team Leader or Member For those with more than extensive (10 years') experience of crash investigation or RSA, must have undertaken: - 5 to 10 RSAs within the last 5 to10 years as a Team Leader or Member AND -1 RSA within the last year as a Team Leader or Member	Promotes or trains others in RSAs. Organization or senior auditor mentor assessments.
Continuing Professional Development	Demonstrate regular and periodic (e.g., 3-5 years) training course(s) in the field of RSA, crash investigation or road safety engineering as required by Road Administration.	Membership of a local or international RSA organisation.

Table 4.2 - Road Safety Audit Team Member Competencies

Team Member	Required	Desirable
Qualification	University degree OR Robust (5 years') experience in a related road safety field including crash investigation	Degree in road engineering, traffic or related road safety field
Training	Formal crash investigation or road safety engineering training. Completion of a recognised RSA course.	
Experience	Some (3 years') experience in a relevant road safety, design, construction or traffic engineering field Initial (1-2 years') experience of crash investigation Experience working in the country/region	Some more (3-5 years') experience in a relevant road safety, design, construction or traffic engineering field Some more (2-3 years') experience of crash investigation
RSA Experience	Must have undertaken at least 3 RSA of representative stages recently as a RSA Team Leader, Member or Observer For those with more than 5 years' experience of crash investigation or RSAs, must have undertaken: - 3 to 5 RSAs within the last 3 to 5 years as aTeam Leader or Member AND -1 RSA within the last year as a Team Leader, Member or observer	Organization or mentor assessments.
Continuing Professional Development	Demonstrate regular and periodic (e.g., 3-5 years) in the field of RSA, crash investigation or road safety engineering as required by Road Administration.	Membership of a local or international RSA organisation

Table 4.3 - Road Safety Audit Observer Competencies

Observer	Essential
Experience:	Initial (1-3 years') experience of crash investigation or road safety OR Completion of a recognised RSA course as required by Road Administration.

5. LEGAL ASPECTS

Experience in many countries indicates that claims related to the use of RSA have not been a problem. RSA provide a means to check that all reasonable safety initiatives have been taken in the planning, design, construction and operation of projects. The auditors are simply identifying safety issues or concerns that have the potential to reduce the safety level of a future road or existing road.

5.1. Liability for the Road Authority

The potential for liability can appear an important factor for road authorities in deciding whether or not to undertake RSA. However, the correct undertaking of RSA should not expose those authorities that adopt them to a greater liability. With regard to legal liability, these main principles can be expressed:

- if the road safety audit procedures are deemed to be an asset to the public, the fears of legal liability should not be used to prevent their use;
- documentation is very important, indeed essential. The client's response to an audit report must provide reasons for not accepting any auditor's recommendation. The response should be detailed and defendable;
- response reports must be placed in the project file. It could be used for any investigation reviewing the actions or inactions taken by the road authority and identifying what was said and done at the time of responding to the audit.

If no RSA has been undertaken and no documented reasoning exists, road authorities are more likely to be faced with a claim for damages in the case of injury on a new or rehabilitated road.

5.2. Liability of the Auditors

RSA practitioners often ask if road agencies (clients) will increase their liability by identifying risk, especially if they are not prioritized nor mitigated. Experience has shown that it is better to identify risks within the design process and rely on the agencies risk assessment and prioritisation protocols than to not adopt a process (RSA) and remain ignorant until crash(es) occurs. The responses to specific audit recommendations by the design team should be accompanied by a reasonable explanation or justification when faced with a number of complex or expensive mitigation measures based on the priorities and level of risk that can be quantified and the client is prepared to accept.

Many RSA practitioners will not be involved with legal proceedings. However, it is important for auditors to be aware of potential for personal professional liability without due concern of engaging in improving design plans. Basically, the auditor should not be held as a 'guarantor of safety' if recommendations are made diligently, within their competency and standard practices. Focus is given to unprofessional and incompetent recommendations that should have been foreseen. This serves as a reminder to clients that they should engage a qualified and experienced lead auditor who then assembles a suitable and credentialed team.

Ensuring recommendations do not specify design solutions but leave the technical design team the scope to develop appropriate engineering solutions also reduces the likelihood of personal liability for auditors.

Liability of the auditor team should not be considered independently of the liability of the designer. Claims about the consequence of following the auditor's recommendations if a crash happens should be balanced with the consideration of what would have happened without audit, and if the road was constructed based on the standards decision by the designer.

6. WHEN SHOULD AUDITS BE CONDUCTED?

The RSA process is divided into distinct stages, which are similar in most countries where it is undertaken. This allows the client to take corrective action in a timely manner and prevents the designer from abortive effort.

In most countries where RSA is practiced, it is undertaken at several, or all, of the following key stages during project design and commissioning:

- Feasibility- initial identification and assessment of route segment (project limits)
- Preliminary design- initial design proposals
- Draft design- preliminary design with layout details
- Detailed design- finalized proposals prior to issuing contract documents
- Work zone audit – for complex major projects it is often necessary to review the safety and operation of temporary road layouts during construction phases. These should be undertaken for each change in the temporary layout with sufficient lead time to review.
- Pre-opening- substantial completion of construction when all traffic control devices are in place
- Post-opening- (i.e., monitoring performance. This can be linked with data collection as part of a Road Safety Inspection regime for existing roads or networks).

It is not always necessary to undertake audits at every stage. But at least one audit should be undertaken during each of the planning, design and construction phases.

RSA should be a mandatory component of the design and construction process for all types of roads. These need to be formally included in any design manuals and processes and be a contractual requirement of road development.

Practical factors such as having sufficient numbers of experienced auditors and financial resources have to be taken into account before implementing the audit process. For this reason, it is important for a road agency to develop a road safety audit policy and to apply that policy consistently. The audit policy should contain a clear statement about what road projects are to be audited and at what stage in the process.

The RSA process starts when the initial decision is taken to change the layout or configuration of an existing road or build a new road. This can range from simple changes to road markings, provision of pedestrian or bicyclist facilities or major reconstruction. As soon as a design team or organization is appointed the audit process can start. In all cases, the results of any crash investigation and especially any previous Road Safety Inspection Reports must be considered in the preliminary design or feasibility study. The earlier in the project development process that RSA is undertaken, the easier it is to effect major safety changes. As the design process progresses, fundamental decisions have been taken that can make unforeseen safety impacts more difficult to change.

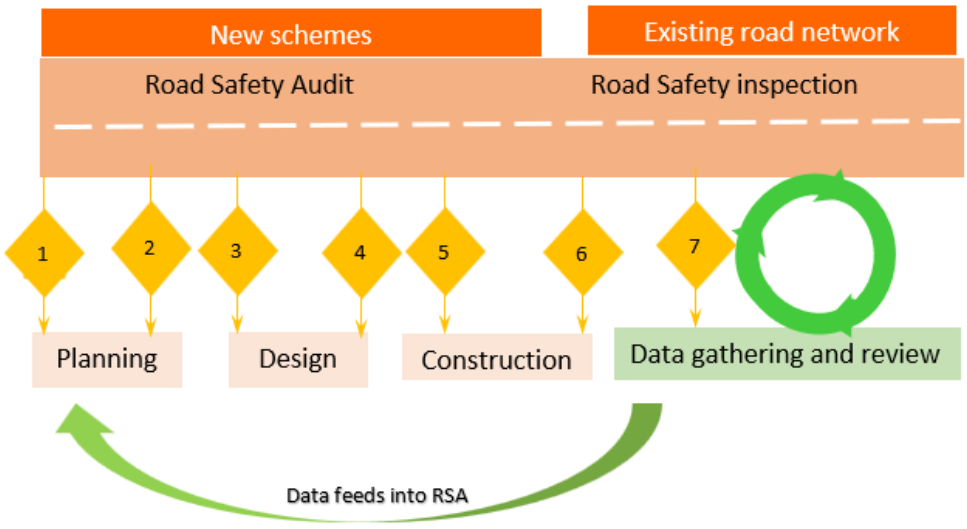
In the case of new roads the audit process can start at the feasibility study stage if the proposed alignment is detailed enough to make a reasonable audit. In this stage, the audit is to assist the client in deciding between the different alignments. The auditor will check this in Phase 1 of the audit. In some countries, however, RSA does not start until the submission of the preliminary design by the consultant to the client.

Before opening the considered road to traffic, a Pre-opening Audit should be made to check if the project has been constructed with respect to road safety fundamentals and whether any other items not previously discovered have come to light during construction.

The final stage of the RSA process is Monitoring or conducting RSIs. It is important that an evaluation of the actual safety situation is made after some years by the road administration especially when the decision for reconstruction was based on improving road safety or when new technology or designs have been implemented. Often crash studies are carried out 1 year and 3 years after opening to check assumptions made at the time of design so as to better inform future projects.

Figure 6.1 below shows the different RSA stages within the lifecycle of a new road project and also how Road Safety Audit and Road Safety Inspection sit together in a holistic safety management structure for both new projects and the existing road network.

Figure 6.1 RSA and RSI Stages in the RISM



7. THE AUDIT PROCESS

The general RSA procedure will include three main phases for the Client, the Design Team and the Audit Team:

- commissioning,
- undertaking,
- completion.

The different steps in the process are presented in the *Table 7.1* below. The steps can also be applied to audit of temporary traffic management required during the construction period. In that case, the proposed temporary traffic management measures and signing plans, for each different configuration of traffic lane should be evaluated before their implementation.

When temporary traffic arrangements are in place, an inspection is highly recommended in daylight and at night time prior to opening when representatives of the road and enforcement agencies should also be present.

7.1. COMMISSIONING A ROAD SAFETY AUDIT

7.1.1. Order the audit

The decision to audit should always be taken by the client (Road Administration or Road Authority), sometimes referred to as the RSA project sponsor, as they are the owners and/or design regulators with legal responsibility for the safe and efficient operation of public road network. But it may be regulated by Ministry decision or by law.

The complete RSA process shall be specified and detailed in procurement and contract documents. The client should plan for and order the management of RSA through the project development shown in *Figure 6.1* and presented in *Table 7.1*, including:

- Stages to undertake a RSA (depending on size and complexity of project)
- People and organisations to be involved, depending on RSA stage, collectively known as the project team.

The clients representative or design project manager, as well as the design teams are core members of the client team ordering the RSA, as shown in *Chapter 4.* Larger, complex design project commissioned by public sector or development banks can have an external project manager. However, the roadway owners are strongly recommended to have RSA representatives involved when the new infrastructure will become their responsible asset.

Table 7.1 - Road Safety Audit Process

Steps of the audit process		Responsible
Commissioning	▼	
	Ordering the audit	Client (road authority)
	▼	
	Selecting the team	Client (road authority- with designer)
	▼	
	Collection of background information and Audit Brief	Client (road authority with designer)
	▼	
	Commencement meeting	Client (road authority), designer and team auditors
Undertaking	▼	
	Analysis of background information	Team auditors
	▼	
	Site inspections	Team auditors
	▼	
	Audit finding	Team auditors
	▼	
	Written audit report	Team auditors
Completion	▼	
	Completion meeting	Team auditors and client (road authority); Designer is optional
	▼	
	Written response to the audit report (decision to make changes or not)	Client (road authority); Designer is optional
	▼	
	Follow up Implementation	Client (road authority) and Designer

7.1.2. Selecting the team

The client commissions the audit team. Ideally, it should be a team with different skills appropriate to the project. In extreme circumstances, or for very small projects, an RSA can be undertaken by an individual, but at least two auditors are preferred. One person in the team should be appointed as the team leader to manage the team and the process. A list of potential auditors compiled by the client can be helpful for the selection process.

Legislation may dictate that all services are procured via a competitive tendering process. It therefore may not be possible for a client to simply appoint a team of auditors from a panel – but they still need to approve the skills and qualifications of the nominated individuals as appropriate for the project.

Instead of commissioning the auditors directly, the client may require the design organisation or 3rd party to organize and nominate the audit team to perform (and pay for) the audit as part of the contracting process. They may also appoint an agent to carry out aspects of the commissioning process. Any such agent needs to be aware of the full requirements of the audit process to be able to commission an appropriate audit team for the project in question. In all these instances the client will still be responsible for agreeing the independence and quality of the audit, and approving the final audit report.

In the case of the audit team being contracted as part of the design organisation, the audit team must have no direct involvement with the design development. Any contact between the design team and audit team – other than through written instruction of the client or at formal meeting held in the presence of the client could compromise the audit independence and value.

The nature and makeup of the team is dependent upon the complexity of the audit task and the size and type of the project being audited. It can also vary for each audit stage. The principal benefit of having a team is the exchange of diverse experience, knowledge and approaches of different experts.

The composition of the team depends on the size and type of project, the stage of the audit and available resources. Audit at different stages may require different skills. Feasibility and preliminary design stages should be undertaken by very experienced auditors including road safety specialists, crash investigation specialists, human factors specialists, highway design and traffic engineers and individual(s) experienced in conducting RSA. More than one of these skills can often be found in a single person although it is recommended that the team comprises more than one experienced person Seconding a person(s) from the local municipality where the project is located can assist with capacity building and with securing local acceptance of the road project.

The feasibility stage requires both a visionary approach and traffic skills to be able to identify the wider network effects of a project and ensure that the proposed project is the appropriate solution. The impact of the project on existing and future development also needs to be considered at this early stage.

In cases of rehabilitation, widening or larger maintenance of an existing road the feasibility stage audit may be replaced by an RSI or wider Road Safety Assessment. A RSA is not appropriate until a Design Team has been appointed and able to review any subsequent recommendations. Undertaking an RSI or Assessment will result in design solutions being proposed rather than providing recommendations for the design team to consider from an audit .

As the detailed design progresses, the types of skill sets required varies. For example, team members with expertise in road design, traffic control and operations, lighting, pavement and drainage, non-motorised users and active travel may be needed. A person with knowledge of human factors in design and behavioural aspects of road safety is also a very useful asset. Behavioural aspects can vary from region to region within a country, for example, rural areas in an LMIC with mixed non-motorized travel. Local knowledge is essential!

At the pre-opening and post-opening stages, it is also important to consider including members with experience in traffic and safety for pedestrians and cyclists, plus others with experience regarding all aspects of facility maintenance including signage, lighting traffic controls, vegetation, snow removal, livestock control, local customs, and behaviour. Pre and post opening site inspections are similar to work carried out during an RSI but have a different outcome in the audit report recommendations.

It may be useful to include a Police officer who is experienced in road safety and crash investigation. A Road Safety officer or others with particular knowledge and experience of children's issues and/or other vulnerable users would also be beneficial. Inviting input from local transit providers, health and emergency medical services, school and community groups can provide context to the type and abilities of roadway users.

7.1.3. Collection of background information and Audit Brief

The Audit Brief is the instruction to the audit team describing the project to be undertaken and must contain sufficient background information to enable the audit to be satisfactorily carried out. All the necessary material (information and report) constituting the Brief and are gathered together by the design team, passed to road authority for their input and approval (irrespective of who is funding the audit), then distributed to the audit team.

Importantly, the audit team is given all required documents at the beginning. Incomplete documents lead to questions and additional demands, resulting in more time and work being required to collect complementary site specific information and data for the audit. Much of the information may be gathered in the procurement of the audit team (for request for proposals and contract scoping).

The Brief must include sufficient information to enable an efficient audit to be undertaken and should ideally contain the following, as a minimum:

- background to the project and its intended function (phases to be audited),
- timing of audits (design plans by phase, draft RSA Report submittals, follow-up meetings and complete)
- design standards and specifications used and plans/drawings by phase,
- details of any part of the project which are not in accordance with national or agency standards and policies,
- specific project details which may affect road safety,
- in cases of a rehabilitation, widening or larger maintenance of an existing road any crash data which are available. In the absence of crash data, local inputs can be useful,
- existing and future traffic flow and composition including different vehicle types and modes,
- any previous RSA or RSI reports,
- any local issues that need to be taken into account, which might affect road safety, for example:

- key existing travel generators and attractors and with planned development
- specific user groups such as children, elderly, disabled, transit, non-motorized, public health facilities,
- local Road Safety officer, if appropriate, Emergency Response, Public Health official and Police contact details.

The number of documents required increases as the design phases proceed. From the existing documents, the informationthat should be available to the auditor depending on the audit phase is listed in, but not limited to, *Table 7.2*. If background information deemed beneficial is not available, the RSA scope and contract should include resources for collection and compiling. If resources and information are not available, the audit team should report to the client early in the process and the audit report should clearly indicate what was needed but missing so those referring to the audit know what design related information was considered.

Table 7.2 - Background Information

Feasibility -Stage	Preliminary Design and Detailed design	Traffic Opening
Future road: • Explanatory report • Overview map • Overview site plans with type of intersection(s) • Construction sketches and layout options • Continuity with adjacent road networks and land uses • Environmental constraints • Existing network and future road traffic volumes forecasts and make up • Historical speed data on existing network roads and predicted opening speeds Reconstruction: • Any existing signing and marking plans • Traffic volumes and make up; speed data • Explanatory report • Overview map • Overview site plans with type of intersection • Construction sketches and layout options • Continuity with adjacent road networks and land uses	• Result of previous audit phase with client's decision • Explanatory report • Ooverview map • Traffic analysis including traffic volume time of day prognosis for all kinds of users • Seasonal traffic and speed variations data • Crash data (on existing roads) • Crash diagrams and maps with black spots and dangerous road sections • Cross sections • Safety devices • General vertical and horizontal alignment plans • Construction plans • Site plans of landscape measures • Signing and marking plans • Site plans with road equipment • Intersections with signs, markings and signal installation plans • Traffic engineering documents for signal planning • Weather data, including potential adverse conditions. • Known adjacent land uses and any future planned	• Result of previous audit phase with client's decisions. • Explanatory report • General vertical and horizontal alignment plans • Site plans of landscape detailed planning • Signing and marking plans • Site plans with road equipment • Signal installation plans • Traffic engineering documents for signal planning

7.1.4. Commencement Meeting

The objective of the commencement meeting is to ensure the design team understands the audit process and to provide the audit team with all the necessary information. All the parties involved in the audit process should be present at this first meeting. It is valuable for the audit team to meet with the design team at the beginning of the audit process to enable any queries relating to the Brief to be addressed.

This meeting provides the opportunity to explain to the audit team the projects' purpose, particular issues and any problems which have been encountered during the planning, design or construction stages. Opportunity should be taken for the audit team to become fully acquainted with the stated objectives of the project. The meeting is also a good time to explain the process and distinguish between the task and responsibilities of the audit team and those of the designer. The protocol for delivery of the audit reports should also be discussed at this meeting. For smaller projects the RSA may be commenced immediately after the meeting, sometimes the same day.

7.2. Undertaking the Road Safety Audit

7.2.1. Analysis of background information

For some projects even before the commencement meeting, the audit team are able to review in detail the plans and other information provided. If the information is not available until after the commencement meeting the audit team may need additional time to consider the potential impact on all different types of road users. All the information should be assessed with the aim to identify issues and items for:

- further clarification about the project; and
- further investigation during the site visit.

At this time, it is often possible to identify areas of the project which contain potential safety problems. Any missing information needs to be requested. Audit recommendations can only be based on the information provided -not on any assumption of what may be happening.

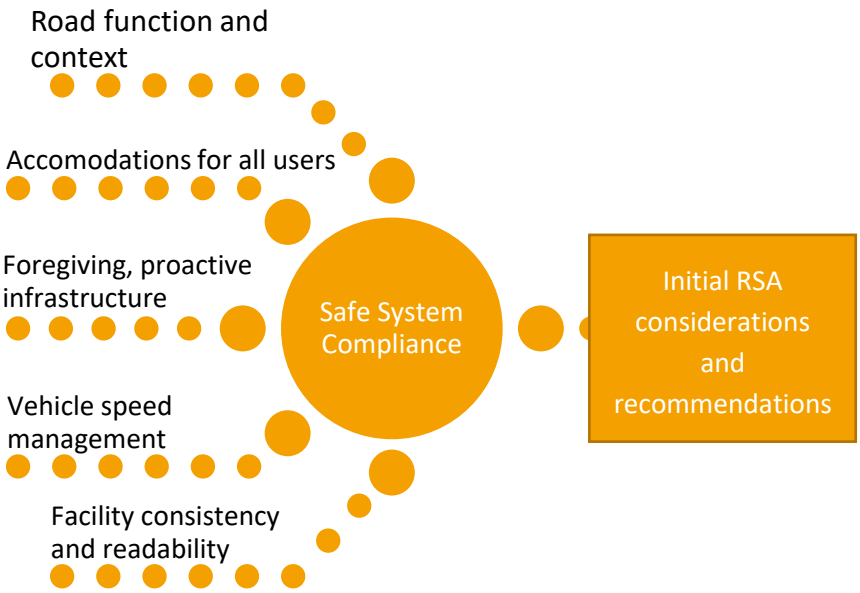
Where the audit team consider that they have not received all the relevant information they need to inform he client in writing and confirm its availability. If any relevant information is NOT available this needs to be clearly stated in the final audit report.

Summarizing the information addressing the Safe System approach elements in *Figure 7.1*, helps to formulate the detailed RSA considerations and initial recommendations. Auditors should be given sufficient time to compile the necessary information and conduct the RSA steps to ensure the findings and recommendations are thorough.

The Road Safety Evaluations Based on Human Factors Method (PIARC 2019) provides the key factors for consideration in the evaluation of the proposed design in relation to the existing roadway design elements and adjacent environment. Fundamentally, the three main considerations in the evaluation tool for scoring roadways are:

- the road should give the driver enough reaction time; and
- the road must offer a safe field of view; and
- the road must follow the driver's perception / expectation logic.

Figure 7.1 – Safe Systems Considerations



(Based on African RSA Guidance, 2014)

7.2.2. Site inspections

For a clear understanding of the project to be gained, it is important that the auditors carry out a site inspection. Field inspections allow the auditor to see how the proposal interacts with surrounding and nearby roads. They provide the audit team with a feel for existing conditions. Site investigations should be undertaken under the range of traffic and environmental conditions likely to be encountered. Extremely important to choose an appropriate day for the site investigation, where the audit team will witness the "real" conditions. Care should be taken to choose a day that represents typical conditions

Both nighttime and daytime investigations are essential to appreciate the situation for pre- and post-opening audits. It may also be necessary to view the location at other times of the day (e.g. after school finishes) or specific day of the week. Fridays, weekends and holidays should be avoided as they are likely to be atypical (understanding that in some areas, like parks and entertainment venues, weekends have typical traffic and vulnerable users to be considered). To evaluate the traffic facility from the viewpoint of all road users, the auditor should inspect the road from the perspective of drivers, cyclists, pedestrians, equestrians, and, if present, animal herders as appropriate. Again, local variations in behaviour need to be considered. The auditor can view the new road and the measure, and audit on site only in the audit stage prior to opening when all works are substantially complete. Prior to that any consideration of safety concerns has to be undertaken from the plans and information provided. Site inspections during early and detailed design are still important to set the plans in context and appreciate how different road users might be affected. They also provide a valuable opportunity to assess how the project road will tie into the existing road network (even before construction has started).

Recording video of the roadway(s) inspected is recommended, particularly for high volume and speed roadways, with audio captured to supplement field notes with the focus on locating and identifying safety risks to be mitigated. Photographs taken systematically (prescribed order) to focus on features and elements from different perspectives provide record of conditions and good RSA report

illustrations. Reference to verbal and pictorial comments on the design plans can be helpful for reporting. Remember safety of the auditors is essential. A risk assessment of the expected conditions should be prepared. Access to the roadways, means of travel and potential stopping places must be carefully considered.

The audit team carries out the site inspection on the basis of their personal experience and knowledge of road safety. To help with the consideration of safety aspects and ensure that none have not been overlooked during this experience-based procedure, RSA has moved from using detailed checklists to prompt lists (see 7.2.3 below) to assist auditors at all stages.

The use of lists and any photographic depictions as well as the quantitative analysis of the combination of horizontal and vertical alignment cannot replace the comprehensive examination of the design or the completed road made by an experienced auditor; simply working through the checklists, therefore, does not make for an authoritative safety audit. The above-mentioned Human Factors Evaluation Method includes further assessment processes and an evaluation tool to score the sub-items of the three fundamental considerations.

Experienced auditors should use the prompt list (see Section 7.2.3 and Appendix 1) as a reference during and at the end of inspections. At all times when inspecting, the auditors must have the following basic questions in mind:

- What will cause some to be hurt?
- What chain of events (maneuvers or actions) could be involved?
- What road users will be affected and in what way/severity?
- Is the risk temporal or spatial (e.g., time of day, direction of travel)?
- Is the solution effective for all relevant road users to use the traffic facility or is a combination recommended?
- Is the design that has been selected the best for traffic safety (what is the expected benefit or effectiveness), within the framework of the regulations?
- Do new findings concerning traffic safety and road design make a different design seem advisable?

7.2.3. Use of prompt lists

To ensure that safety aspects have not been overlooked during the procedure, prompt lists can be used to assist the auditors in considering the relevant issues. Different lists have been developed a varying degrees of details for different stages of a project's development. The list presents different questions regarding the safety of all users but they are not exhaustive. They identify issues and problems that can arise at the relevant stage of an audit, but should not be viewed to cover all potential issues and circumstances. The auditors should use their own judgment about the safety of any particular feature.

The prompt lists are set against the following background:

- full exploitation of any room for discretion in the technical standards and specifications in order to optimise road safety;
- findings from local crash investigations;
- results of new research work;
- experience gained from earlier audits;
- regularly occurring design errors.

Prompt lists can either be very detailed or can cover generic headings. The former can be very useful in organisations/countries where a long history of road safety engineering does not exist, but care should be taken to ensure they are not simply used as 'tick list' rather than as aids to using road safety engineering experience and judgment. The latter is useful in pointing designers and checkers towards more generic issues for consideration.

Appendix 1 provides a more detailed list of typical design aspects to be considered and possible safety aspects for those interested in considering more design aspects for different roadway types. Examples of higher level prompt lists have been developed, including the OECD Directive Appendix (2019), in the United States by FHWA in their RSA Guidelines, and in the Austroads RSA Guide (2022).

The lists are an aid for the application of the knowledge and experience and to make sure that all factors are considered. Their chief value lies in action as an "aide mémoire" for the audit team to ensure that no important aspects are overlooked.

They are there to assist the auditor in considering the relevant safety issues of a particular project. They do not form part of the audit report and whilst their use can be recommended in the brief, they should not be required to be submitted as proof that all matters have been considered.

7.3. AUDIT FINDINGS

Following the site inspection, the audit team reviews in detail the safety implications that have been identified for the project back in the office. It is important that all relevant aspects have been covered. Again, reference to prompt lists can be very beneficial.

The auditors indicate any road safety problems and include proposals for addressing these deficiencies

7.4. AUDIT REPORT

The audit results are described in a report, which is delivered to the client. The report should clearly and concisely describe the project, the audit stage, the audit team members and the audit process. But the main role of the audit report is to describe aspects of the project that involve road safety concerns and make recommendations about corrective actions for the design team and client to consider. Elements that are not considered as a road safety issue are not reported upon.

The written audit report lists the safety deficits that have been identified. The auditors suggest areas to be examined to eliminate or mitigate identified safety deficiencies in the design. It is not within the auditors remit to create a new design or state specific design solutions, but they may make recommendations for changes to avoid the safety deficits.

The auditor only considers safety aspects of road users whilst the client and design team have much wider aspects to consider such as cost and land requirements. Therefore, it is the designer's responsibility to determine the final technical solution and to document their reasoning. This response is then submitted to the client to accept or reject final solutions as appropriate.

A comprehensive audit report will contain the following material:

- a brief description of the proposed project,
- a clear statement regarding which stage of the audit process the report relates to and the audit standard being applied,
- details of the specific deficiencies identified, with reasons why these are regarded as deficiencies It is important to identify the types of users who could be injured and the types of collisions that could occur if the concern is left unresolved.
- recommendations for actions to remove or reduce the impact of these deficiencies,
- copies of any plans used in the audit together with a list of other documents and drawings used,
- concluding statement signed to confirm compliance with the specified audit standard.

In the report all problems need to be clearly identified and reported on separately. Combining problems or suggesting multiple recommendations (even those at the same location) can then make it difficult for the designer and client to make a clear and precise response. Identifying design elements or attributes (location, feature, size etc.) with risks must be communicated objectively and effectively without subjective judgement terms to assist in the mitigation. Terms such as, unsafe, sub-standard, unacceptable or deficient may be subjective and should be avoided.

In many cases, recommendations should not define a specific solution, merely indicate the sort of action that should be taken. During early stages there may be recommendations on an existing roadway element that may have short term improvements to consider immediately (e.g., low cost maintenance or traffic control device enhancements). As such, the time period (short, medium and long term) of the recommendations may be specified or categorized. The designer and client has the responsibility to define the solution not the auditor. However, at times the range or specific treatments are known and provided. *Table 7.3* provides an example of proper recommendations to make with the audit report.

Table 7.3: Examples of Good and Poor Audit Report Recommendations

Safety Concern Identified by the Audit Team	Example of a Recommendation with Too Much Emphasis on Redesign ✖	Example of a Recommendation Guiding the Designers √
There is a risk an errant vehicle could either strike the bridge parapet and/ or drop into the river below. Significant run-off-road crashes have or could happen.	Redesign the curve before the bridge; increase it from a 500 meter (m) to an 800 m radius curve. This will allow drivers.to have a clearer view of the bridge, and they then should not run off the road. Reduce the super elevation accordingly, and introduce curve widening between 4+680 and 4+920 in compliance with national directive 2016/09A.	As the bridge parapet and the large drop are hazards within the clear zone, use the roadside hazard management strategy to assist in appropriate treatments to delineate the road and protect bridge. Consider shielding the parapet and the drop with suitable safety barrier.
Pedestrians crossing to and/or from bus stops along the roadway will be at risk from the high-speed traffic, which will be travelling at almost 100 kilometres per hour. Serious pedestrian collisions could result.	Install five pedestrian crossings (one at each bus stop) at 5+220, 6+660, 10+100, 13+350 and 18+600. Install a pair of regulatory pedestrian crossing signs (R3-2B) at each crossing. Install rumble strips (minimum 10 strips, by 20 millimetres high, made from class 4 white thermoplastic), plus a “Pedestrian Crossing Ahead” warning sign (W16-2B) 100 m in advance of each crossing.	Do not install any formal devices such as pedestrian crossings (drivers do not comply with these), but rather guide pedestrians to selected signed and preferably signal crossing points within the median, that are kept clear of vegetation, with appropriate signs to warn drivers of pedestrians and bus stops.
The intersection will be controlled by signals. Speeds on the highway will be high; it is likely some drivers will not stop on the red signal. Right angle crashes could result.	Redesign the radius of each corner. The 15 m radius shown is not adequate for a highway with a side road intersection such as this. Trucks and buses will mount the curb when turning; this must not be allowed.	The installation of traffic signals may require electronic speed enforcement and assistance from the police and the ministry to control approach speeds. As this intersection appears to have reasonably balanced traffic flows, and roundabouts are known to be safer than traffic signals, especially in semirural areas, so a roundabout should be examined.

Including photographs in the audit report helps both designers and clients to understand the problem being described. The use of photographs to support RSA recommendations is shown in *Figure 7.2.*

Figure 7.2 Reconstruction Access Problem and Recommendation

Summary : Unpaved vehicular tracks intersecting with the current alignment of the new road are to be closed with potential 1 in 4 side slopes at the rear of the footway. These could be used as an informal vehicular access point
Location 
DESCRIPTION: This item was raised in the previous stage of audit and the Design Team has confirmed that all closed roads have indirect access to the new road. The Audit Team still has some concerns over this issue and therefore has been raised again. The site visit has shown that there are several current unpaved vehicular tracks that intersect with the current alignment of new road. These roads are to be closed with no direct formal access. There is concern that some drivers will still attempt to access the new road from these historic tracks by utilising the 1 in 4 slope and traversing the new footway. This increases the potential for conflict and injury between motor vehicles and pedestrians. Furthermore, where the footway forms part of culvert drain there is the potential for structural damage.
Recommendation : Provide vertical obstruction to the rear of the footway to physically restrict vehicular movements at these locations.

Typically, however, annotation of design plans is used to identify the design element of concern and the location. *Figure 7.3* provides an example of identifying signing and marking missing and *Figure 7.4* is an example of missing roadside barriers shown on plans and documented in the RSA report. Appendix 2 provides an example of an audit report layout and other example report outlines are provided in the Austroads RSA Guide (2022) and in the United Kingdom RSA Governance (2020).

Figure 7.3 New Construction Traffic Control Problem and Recommendation

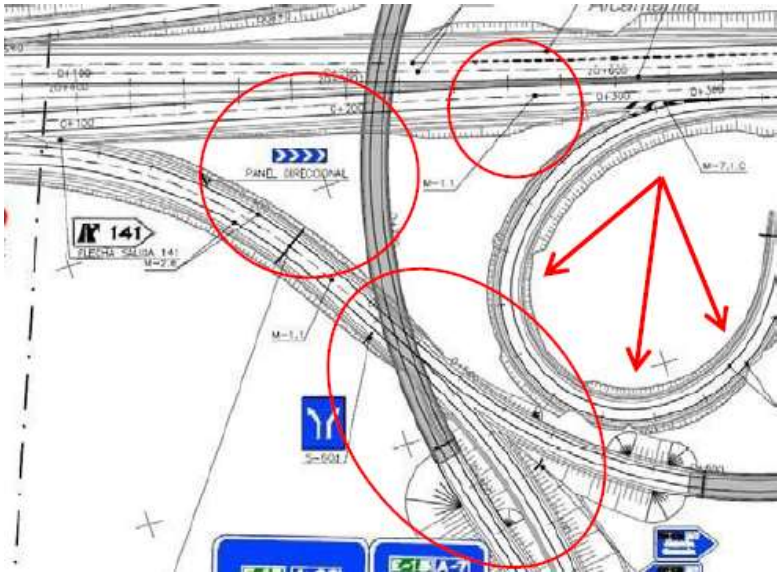
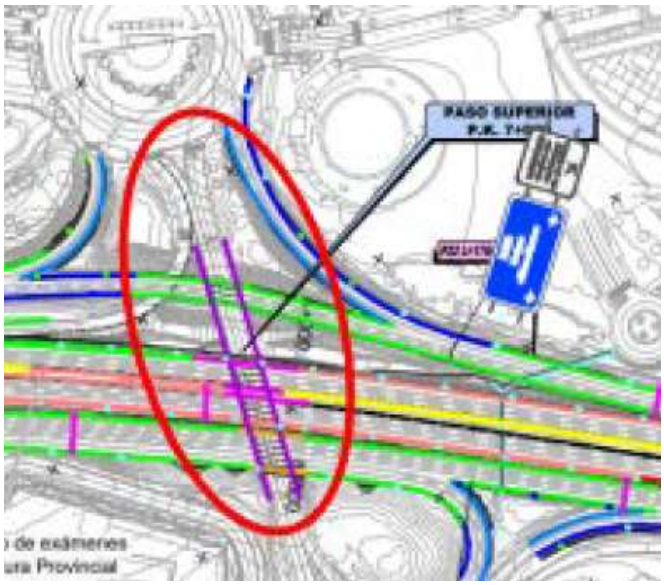
Summary : Lack of signing and marking of junctions and curves.
Location: 
Description: Expanding an existing cloverleaf interchange with additional direct ramps missed the opportunity to provide enhanced traffic control devices at junctions and on the loop ramp curve. There are no lane selection arrow markings, warning or yield signs at the junctions. Further, there is a lack of right turn and curve warning signs. The lack of signage and road markings at this complex interchange with high traffic volumes should provide improved guidance and warning for adequate time for manoeuvres and speed adjustment.
Recommendation : Provide adequate speed reduction, warning and yield signing. Add lane marking redundancy at ramp junctions.

Figure 7.4 Reconstruction Roadside Problem and Recommendation

Summary : Lack of roadside barriers.
Location: 
Description: Reconstruction an existing interchange overpass structure did not provide safety barriers connected to the parapets. With the elevated fill approaches to the overpass structure, additional roadside barriers are warranted on each side of the road approaching the structure.
Recommendation Provide safety barriers with an appropriate level of containment for the necessary length in advance to the overpass structure..

7.5. COMPLETION OF THE ROAD SAFETY AUDIT

Because the RSA team has a position of independence, a draft of the report may not necessarily be provided to the client or designer for comments prior to finalisation. However, auditors and clients/designers may be in favour of exchange based on the draft report so that there is mutual understanding. With RSA requirements, clients may be willing to accommodate draft recommendations that are not typical or a unique to standard practices. The intent is to continue to learn from documented effective safety practices even if they have not been tried by the client. This will improve acceptance of RSA iddentified risks and recommendations, the continued learning and implementation of safety improvments. See Chapter 2 for related client, regional, or countrywide enhancements of RSAs and Safe System approach practices.

The final report may simply be sent to the client.

Upon receipt of the report, the client must consider the indicated problems and proposals and make a decision as to how the project should proceed. The client refers the audit report to the designer. The steps are shown in Table 4.1

7.5.1. Completion meeting

A completion meeting between the client, the designer and the auditors is often needed to discuss the audit finding prior to formal submission. It is important that the audit team leader, design leader and client are present so that all parties can clearly understand the audit findings and recommendations made (proposed mitigation measures). The meeting should not be viewed as an opportunity to debate or question the findings or recommendations; however, unresolved misunderstandings can be addressed. The meeting may be useful opportunity for the client and designer to explore mitigation options through brainstorming.

7.5.2. Response to audit report

The client reviews the formal audit report and considers the indicated problems and proposals. The client can request the designer to comment and give response to the report's recommendations but the client decides finally whether recommendations are to be adopted or not. The client has to determine if, and to what extent, the remarks and proposals in the audit report will lead to design modifications.

All recommendations must be given due consideration. Those that are accepted should be implemented without delay. Those problems identified that are considered to be insignificant, outside the terms of reference or that solutions recommended are not considered suitable must be addressed by means of a formal written response. It is important that this formal response gives reasons why the recommendations are not accepted. This response acts as an evidence trail through the decision-making process.

The reports containing any remaining disagreements are presented to a senior person in the client's organisation for a final decision. In some countries, conflicts arise if the auditor's recommendation is to adopt a design not complying with the existing standards and norms. For example, new designs may be available from another country or state. Thus, adopting legal provisions easing use of exceptions to the standards when recommended by auditors may be formalized. Gathering information in such situations may speed up the adoption of improved standards, or at least quicken procedures to improve them, and/or to make standards an "indicative" norm (See Chapter 2).

Following the client's decision, the design team modifies the project in accordance with the accepted amendments and the work is implemented.

The written response to the audit report will become part of the project design documentation and remain with the design throughout its development and implementation. Providing a summary of the audit recommendation decisions in a tabular form enables easy tracking of the process, as shown in *Table 7.4*.

Table 7.4: Example of an Audit Response Log

(1) RSA Problem	(2) RSA recommendation	• Design Organisation Response	(3) Client Organisation Response	(4) Agreed RSA Action
Problem No: *1* ***Location:*** *Existing service access junction with A1167* ***Summary:*** *Presence of a redundant stone wall restricts visibility northwards for emerging traffic.*	***Recommendation:*** *This wall should be removed as far as possible to improve visibility for emerging vehicles.*	*Disagree* *The position of the wall is outside of the visibility splay for the access junction. Drawing number 0050984-0916-0-WP shows the position of the wall in relation to the visibility splay from the junction mouth.*	*<Insert the Overseeing Organisations response>*	*<Insert the Design Organisation and the Overseeing Organisations agreed action to the problem>*
Problem No: *2* ***Location:*** *new car park access onto service road* ***Summary:*** *Presence of a very small traffic island encouraging inappropriate crossing*	***Recommendation:*** *Alternative separation to a narrow physical island should be provided*	*Accepted – Alternative Solution* *This will be considered further at detailed design stage, with either a wider island or a continuous crossing point to be provided.*	*<Insert the Overseeing Organisations response>*	*<Insert the Design Organisation and the Overseeing Organisations agreed action to the problem>*
Problem No: *3* ***Location:*** *new car park access onto service road* ***Summary:*** *Presence of a narrowed and circuitous footway*	***Recommendation:*** *Remove the narrowed footway and direct pedestrians onto the protected walkway adjacent to the Disable Parking bays.*	*Accepted – Alternative Solution* *This will be considered further at detailed design stage, with either removal or widening of the narrowed footway to take place.*		
Problem No: *4* ***Location:*** *North side of existing service access* ***Summary:*** *Direct pedestrian link from footway into car park not included on proposals*	***Recommendation:*** *The existing footpath link is retained and tied into the amended footway maintain a direct desire line from A1167 to the retail car park.*	*Accepted* *At detailed design stage, the existing footpath link will be included in the proposals.*		
Problem No: *5* ***Location:*** *Proposed splitter island in junction* ***Summary:*** *Tactile paving is provided on either kerb crossing –*	***Recommendation:*** *Provide appropriate tactile paving to identify extent of safe refuge.*	*Accepted* *At detailed design stage, tactile paving will be provided on the refuge island.*		

which needs to be dropped to carriageway level, but no comparable warning is provided in the refuge island which could result in visually impaired pedestrian crossing in front of manoeuvring vehicles.				
Problem No: *6* ***Location:*** *southern approach to secondary access* ***Summary:*** *Existing signing only for restricted use causing confusion for all drivers.*	***Recommendation:*** *All unnecessary signing should be removed and replaced with clear unambiguous signs sited with adequate visibility to provide sufficient direction for all users.*	*Accepted* *At detailed design stage, all unnecessary signing will be removed and replaced with clear signage sited with adequate visibility.*		
Problem No: *7* ***Location:*** *southern approach to secondary access* ***Summary:*** *extended central hatching could obstruct vehicles turning into existing industrial estate to the north.*	***Recommendation:*** *The extent of hatching should be amended to ensure all turning traffic within its length is able to manoeuvre clear of main road traffic.*	*Accepted* *At detailed design stage, the extent of the hatching will be amended to ensure all turning traffic within its length is able to manoeuvre clear of the main road traffic.*		
Problem No: *8* ***Location:*** *proposed new access between service road and car park* ***Summary:*** *Provision of road marking around entrance may lead to drivers and pedestrian confusion.*	***Recommendation:*** *At detailed design stage rationalise necessary information and guidance in this area.*	*Accepted* *At detailed design stage, the road markings around the entrance will be rationalised to avoid driver/pedestrian confusion.*		

7.5.3. Follow up implementation

A key element in the entire process is the post-opening monitoring. Importantly, the safety performance of the project should be monitored at specific intervals. Usually, monitoring occurs one year and three years after opening. In this way, the validity of decisions taken can be checked and modified for future projects if necessary. The report of the auditor and decisions of the client are documents which will become a part of the design and construction documentation of the project.

8. TYPICAL SAFETY DEFICIENCIES

8.1. GENERAL

Much valuable information can be gained from studying the crash patterns on different types of road. This information can feed directly into better design of roads to improve safety. Furthermore, ongoing research can also be a source of information on potential safety deficiencies and improvements, even when this research has not yet been introduced into the relevant technical standards and specifications.

This chapter does not attempt to describe all the factors of crashes that are directly related to design issues but focuses on the primary characteristics of crashes that are particularly applicable to a specific road type. Important deficiencies that can have a critical effect on both number and severity of crashes are also included. This brief summary does not replace a comprehensive analysis of road safety within the framework of the safety audit, but it does provide some structure for using the prompt lists contained in the Appendix I and the more robust Catalogue of design safety problems and potential countermeasures (PIARC 2009). The catalogue presents the most common types of design deficiences in a grpahical and readily understood way, and also provides a range of potential solutions to these design issues.

8.2. MOTORWAYS/FREEWAYS (HIGH SPEED DUAL CARRIAGEWAYS)

The most significant types of crashes on these roads are the crashes in longitudinal traffic; in Europe, over 40 percent of crashes on motorways result from rear-end shunts and overtaking crashes (incl. crashes when changing lanes). Adequate forward sight visibility, good lane markings and a clear view of stationary traffic ahead are therefore very important.

Single vehicle crashes resulting from the loss of control, without involvement of another road user, account for over 30 percent of crash costs on European motorways. Balanced alignment, good drainage of surface water, adequate pavement friction, prompt clearance debris and road surroundings that keeps drivers alert are therefore important factors to be considered.

Crashes involving vehicles leaving the road account for about 40 percent of crash costs on motorways and, in particular, crashes which involve vehicles leaving the road to the right represent particular risks with almost 26 percent of the crash costs. Forgiving roadside areas, either totally clear zones or passively safe areas, are therefore important safety considerations.

Typical safety deficiencies affecting the design of motorways are:

- lack of climbing lanes;
- insufficient drainage, often caused by paving the median at bends in the road;
- insufficient drainage can also occur on flat gradients where there are changes in super-elevation;
- insufficient distance between interchanges or ramps as a result of additional access facilities;
- missing, insufficient or incorrect roadside safety installations;
- poor combinations of horizontal and vertical alignment, in particular hidden dips (see *Figure 8.1*);

- lack of either clear zones (a strip of land adjacent to the road containing no dangerous obstacles) or "forgiving roadsides" (those where the obstacles are passively safe e.g. breakaway sign pots, lighting columns etc.);
- lack of safety fences either in the median strip or at the sides of the road.
- control of livestock and pedestrian access

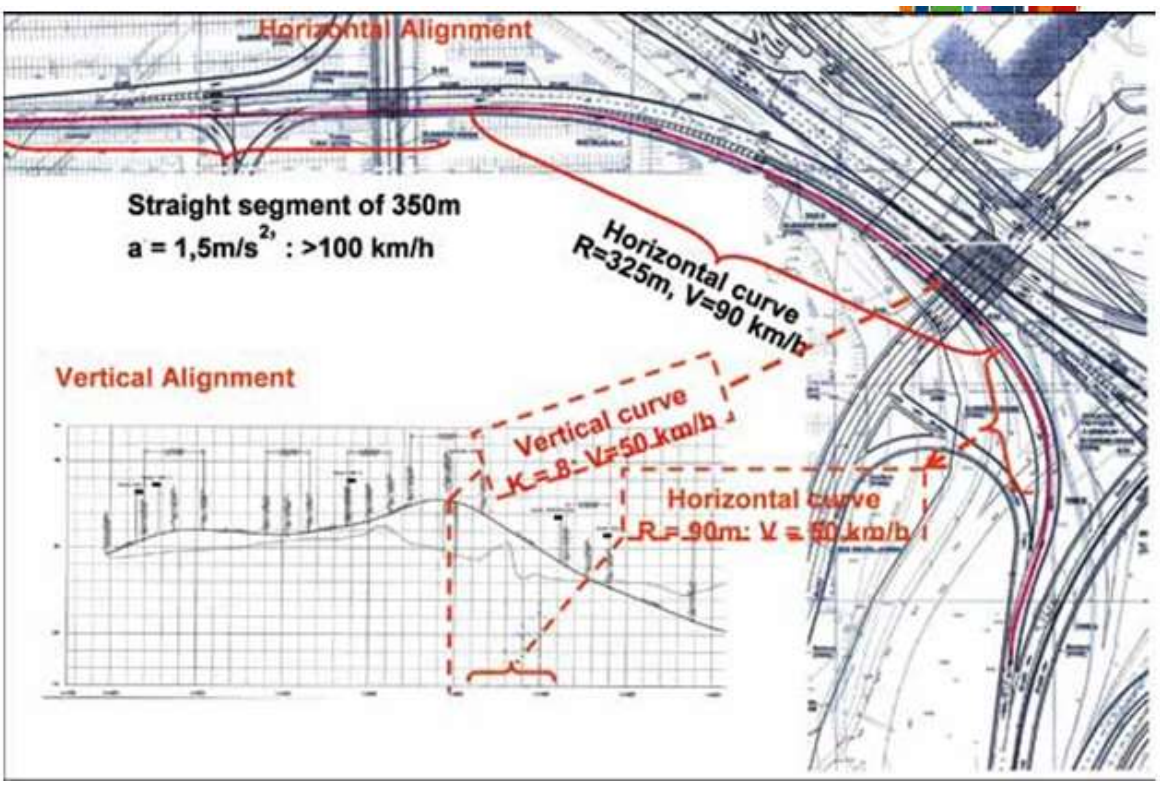


Figure 8.1: Inadequate combination of horizontal and vertical alignment

8.3. HIGH SPEED INTERURBAN ROADS

On European interurban roads, single vehicle crashes account for almost half of all crash costs and these crashes tend to be very severe. A balanced horizontal alignment (balanced with no long tangents and similar curve radii – no extreme curves) and a good combination of horizontal and vertical alignment, good drainage of the road surface and adequate pavement friction are therefore important safety features. The severity of single vehicle crashes is greatly exacerbated by the presence of deep open drainage ditches and insufficient passive safety features.

Rear-end shunts, crashes whilst overtaking and head-on crashes account for over 20 percent of all crashes on high speed European interurban roads. It is important, therefore, that these are carefully considered at the design stage.

Crashes involving vehicles leaving the road account for about 30 percent of crash trauma and associated costs on interurban roads and tend to be very severe, particularly where trees are involved. In Germany, for instance, collisions with trees result in almost 25 percent of the entire crash costs on interurban roads. A recoverable and, where possible, obstacle- free roadside design is therefore important. Where roadside obstacles cannot be avoided, passive safety installations or traffic management measures, in particular enforcement of the speed limit and, if necessary, a reduction of the speed limit is required. Reducing travel speeds is a key element in reducing the severity of crashes.

Pedestrian and cyclist crashes are particularly frequent on interurban roads in linear villages and generally have twice the level of severity of personal injury of vehicle to vehicle crashes. Careful consideration should be given to pedestrians, cyclists and other vulnerable road users including special routes for pedestrians and cyclists along the road and at intersections. Children, elderly people, and disabled people are particularly at risk. The risk posed by livestock needs to be assessed and appropriate measures considered. Poor spatial planning can also exacerbate these issues.

Typical safety deficiencies affecting the design of interurban roads are:

- cross sections with wide hard shoulders which are (wrongly) regularly used for overtaking;
- inconsistent radius sequence;
- “hidden-dips”;
- lack of correlation between alignment and intersection type;
- driveways (particularly more than 5/km)
- inadequate sight distances at intersections
- lack of protection for left-turning movements;
- missing/insufficiently separated pedestrian and cyclist facilities;
- insufficient superelevation on bends;
- insufficient drainage or deep open drainage ditches;
- lack of strong and stable verges;
- missing, insufficient or incorrect passive safety installations;
- errors in centre markings on crests and in curves with insufficient over- taking sight distances;
- lack of either clear zones (a strip of land adjacent to the road containing no dangerous obstacles) or “forgiving roadsides” (those where the obstacles are passively safe e.g. breakaway sign pots, lighting columns etc).
- failure to consider non-motorised transport and livestock.
- inadequate traffic calming at transition from rural to urban or peri-urban areas.

It is clear that, safety can also be positively influenced by the selection of a comparatively safe cross section together with comparatively safe intersection types.

8.4. Major Urban Roads and Residential Streets

Inside built-up European areas, crashes at intersections account for about half of all crash costs and crashes involving pedestrians and cyclists at intersections and along the road are frequent and often have severe consequences. The protection of vulnerable road users is particularly important inside built-up areas: in Germany for instance, almost 40 percent of crash costs on major urban roads involve pedestrians and cyclists; on residential roads, the percentage is even higher at almost 54 percent. Because of the extremely high severity of crashes at railway grade (level) crossings, very specific attention must be paid to safeguarding these crossings.

Collisions with trees on high-speed major urban roads are also significant (these crashes have twice the severity of all other crashes inside built-up areas).

Children, elderly, and disabled people are particularly vulnerable in built-up areas. Safe sidewalks and pedestrian crossings, including centre refuge islands, both along the road and at intersections

are very useful safety features. On high-speed roads in built up areas, separate paths for vulnerable users should be considered. In addition strong regulations against parking on sidewalks should be considered. All too often the needs of pedestrians and other vulnerable road users are ignored and they are forced to share the carriageway with fast moving traffic. Particular attention is required for urban roads around schools, libraries, hospitals, sports arenas, grocery store and other entertainment venues.

Typical safety deficiencies affecting the design of major urban roads are:

- lack of accommodation for pedestrians and cyclists along the road and at intersections (or uncontrolled crossings);
- signal controls that do not consider the needs of all road users, including lack of protection for left-turning movements or excessive delays for pedestrians and cyclists;
- lack of protection for crossing pedestrians and cyclists on open sections of road;
- inappropriate minimum width and cross sections;
- inappropriate parking and loading facilities;
- inappropriate medians on urban arterials;
- poorly placed lighting, signage and traffic signals;
- inadequate sight distances at intersections;
- inappropriate and inadequate provisions for public transport.

Typical safety deficits affecting the design of residential roads are:

- lack of accommodation for pedestrians and cyclists along the road and at intersections (or at uncontrolled crossings);
- lack of visual contact between motorists and pedestrians;
- wide travel lanes and ineffective traffic calming,
- inappropriate parking (e.g., near intersections) and loading facilities,
- inadequate sight distances at intersections

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10. APPENDIX 1: AUDIT PROMPTS

- Determine which list is needed, based on the stage of audit undertaken.
- Photocopy or create an electronic document (e.g., spreadsheet) of the list(s). Use the copy for the desktop audit and the site inspection.
- Remind team members that a successful audit is not achieved by just ticking each item on the prompt list. The topics in each list cover only the common elements of a road project; they are detailed but not exhaustive.
- Also remember some items may not be relevant to the project being audited. Auditors need to, therefore, exercise their own judgment about the safety of any feature in the design of the project. This is where experience and judgment are paramount.
- Audit team members are encouraged to think broadly about the safety of future road users of the road project and not to be restricted only to items on the lists.
- The prompt lists are carefully worded so a negative answer (No) to any question means there is a safety issue that may need to be included in the audit report.
- A positive answer (Yes) given to any question means that issue has been examined but is not considered likely to present a safety issue to future road users.

Note: The prompt lists are for the assistance of the audit team. It is not necessary to attach completed checklists to an audit report or to pass them to the client. The road safety audit report is the necessary deliverable from an audit. That is what is required by the project manager.

10.1. FEASIBILITY STUDIES

	Issue
1.1	**Project function and scope:** Is the project consistent with the development plans for the area? Is the project consistent with the planned road hierarchy for the area? Will the project adequately cater for the number and proportions of users: - cars?- motorcyclists?- pedal cyclists?- pedestrians?- heavy vehicles?- buses?- agricultural uses? Does the road need to accommodate animal drawn vehicles?
1.2	**Major generators of traffic** Does the project serve major generators of traffic safely? Are there any developments, planned or committed, that may affect the new road? Are vulnerable road user travel/trip patterns accounted ?
1.3	**Network effects:** Will the project alter the volume and speed of traffic on the surrounding road network? - If so, will these effects result in safety problems? Will the project alter surrounding land-use that will impact road safety? Will local vehicle and pedestrian movements be cut by the project? - if so, will this result in safety problems? Does the project relieve crash-prone routes or sites?
1.4	**General design issues:** Is the design appropriate for the road's function, category, traffic mix, design year traffic volume, and adjacent land-use and fit within the physical contraints of teh landscape ? Is the design speed appropriate? Does the horizontal and vertical alignment fit well together, particualrly for visiblity of curves? Has a clear zone been defined and, if so, is it adequate? Can any sudden change in the speed environment be safely accommodated? Are there likely to be safety problems where the new / improved road connects with the existing road network? Will the route permit the achievement of alignment standards (horizontal and vertical)? Does the route fit in with the physical constraints of the landscape? Will the road be affected by adverse weather (e.g. high winds, ice, dust, mist, etc.)?

	Does the road cross areas where wild animals are present (e.g. parks and game reserves)? Are standards (e.g., cross-sections) consistently applied?
1.5	**Junctions, public transit stops and access control:** Is the frequency of junctions and their type appropriate for the road function, design speed, traffic volumes and turning movements? Are the proposed junctions at locations where sight distances and other design requirements can be met? Are there any properties with direct access? If so, are they necessary, and in visible locations? Are there any bus stops, on-street parking and other facilities obstructing traffic ? If so, are they necessary, and in visible locations?
1.6	**Staging:** Will the project be carried out in stages? Will junctions be built in interim or final form? Have design compromises been made which might affect the safety of the interim stages?
1.7	**Evaluation of alternatives:** Is the road safety performance one of the evaluation criteria?

10.2. PRELIMINARY DESIGN

	Issue
2.1	**General topics:** Have the circumstances changed since the last audit (e.g. traffic volume, traffic mix, development plans, etc.)? Has the general form of the project design remained unchanged?
2.2	**General design issues:** Is the design appropriate for the road's function, category, traffic mix, design year traffic volume, etc? Is the design speed and speed limit for each section of the road appropriate to the function of the road, the traffic mix, and the road environment?
2.3	**Cross-sections** Are the widths of the lanes, shoulders, medians (if any) in accordance with standards and adequate for the function of the road and the expected mix of traffic ? Does the cross-section help to reinforce the speed limit? Are the needs and possible separation of pedestrians, bicyclists and motorcyclists adequately accommodated? Is there a need to separate through traffic from access traffic in towns? Are there narrow sections (e.g. at bridges, culverts)? Are these avoidable? If they are unavoidable, are they handled as safely as possible? Are overtaking / climbing lanes provided if needed? Are changes in cross-section (e.g. at terminal points) handled safely? Will the carriageway drain adequately?
2.4	**Shoulders and roadside areas** Are the shoulders of appropriate width and materials? Has a clear zone been defined and, if so, is it adequate? Check embankment offests, heights and steepness of foreslopes - if they are too high / steep, will they be protected by safety barrier? Has adequate provision been made for bus lay-bys (pull-outs), rest areas, etc.?
2.5	**Alignment** Does the horizontal and vertical alignment give sufficient forward visibility for the selected design speed? Are there any substandard (inconsistent) elements?

	Does the horizontal and vertical alignment fit well together, particualrly for visiblity of curves? Does the alignment provide regular, safe overtaking opportunities? Does the alignment avoid creating situations where the forward visibility is marginal for safe overtaking (dilemma zones)? Does the alignment help to reinforce the speed limit? Does the alignment considers the proportion of heavy vehicles ? Has adequate provision been made for climbing lanes, emergency escape ramps ?
2.6	**Junctions:** Can the number of junctions be reduced to improve safety? Are junctions so close together that there may be a "see-through" problem? Is the junction in a safe location (especially regarding visibility requirements)? Is the type of junction (priority, control, etc.) suitable for the function of the two roads, the traffic volume, the traffic movements (vehicular and pedestrian), the approach speeds and the site constraints? Is it the safest alternative – for all road users? Are the junctions all of the same type? If not, will this be confusing for drivers? Will the layout and function of the junction be understood by drivers as they approach? Does the layout conform to established Tanzanian practice? Is the route through the junction as simple, clear and logical as possible? Is there adequate provision for channelling (and protecting) where necessary the different streams of traffic? Is there proper "lane balance", and "through lane continuity"? Are there any "trap lanes" (i.e. a turning lane that is not clearly signed and so may be mistaken for a through lane)? Is the layout of the junction adequate for all permitted vehicular movements and for all types of vehicle? Does the layout encourage slow, controlled speeds at and on the approach to STOP and GIVE WAY signs / lines? Is there adequate provision for pedestrians and cyclists? Does the junction design permit adequate signing?
2.7	**Pedestrians and other special road users** Have pedestrian needs been satisfactorily considered (check whether there is evidence of a survey having been done)?

	Have the needs of cyclists and motorcyclists been considered, especially at junctions (check whether these vehicles were covered by the traffic surveys)? Have the needs of bus users been considered?
2.8	**Major traffic generators / access control** Does the route serve major generators of traffic safely? Are accesses to major traffic generators located near to hazards (e.g. junctions, sharp bends, sections with restricted visibility)? Risk of queues? Can accesses to existing properties be used safely? Are there any properties with direct access? Is there an alternative to direct access?
2.9	**Bridges** Is the outline design satisfactory from a safety viewpoint (continuation of full carriageway and shoulder width, provision for pedestrians, cyclists, etc)?
2.10	**Railway crossings** If the road crosses a railway, is an at-grade crossing acceptable given the road function, speed, traffic volume, etc? If an at-grade crossing is acceptable, is it located where visibility is adequate? Will there be adequate visibility to queue tails? Does the crossing need to be equipped with barriers and signals?
2.11	**Staged development** Will the project be carried out in stages? Will junctions be built in interim or final form? Have design compromises been made which might affect the safety of the interim stages?

10.3. DRAFT DESIGN

	Issue
3.1	**General topics:** Have the circumstances changed since the last audit (e.g. traffic volume, traffic mix, development plans, etc.)? Has the general form of the project design remained unchanged?
3.2	**General design issues:** Is the design appropriate for the road's function, category, traffic mix, design year traffic volume, etc? Is the design speed and speed limit for each section of the road appropriate to the function of the road, the traffic mix, and the road environment?
3.3	**Cross-sections** Are the widths of the lanes, shoulders, medians (if any) in accordance with standards and adequate for the function of the road and the mix of traffic likely to use it? Does the cross-section help to reinforce the speed limit? Are the needs and possible separation of pedestrians, bicyclists and motorcyclists adequately accommodated? Is there a need to separate through traffic from access traffic in towns? Are there narrow sections (e.g. at bridges, culverts)? Are these avoidable? If they are unavoidable, are they handled as safely as possible? Are overtaking / climbing lanes provided if needed? Are changes in cross-section (e.g. at terminal points) handled safely? Will the carriageway drain adequately?
3.4	**Shoulders and roadside areas** Are the shoulders of appropriate width and construction? Has a clear zone been defined and, if so, is it adequate? Check embankment heights and steepness of foreslopes - if they are too high / steep, will they be protected by safety barrier? Has adequate provision been made for bus lay-bys, rest areas, etc.?
3.5	**Alignment** Does the horizontal and vertical alignment give sufficient forward visibility for the selected design speed? Are there any substandard (inconsistent) elements?

	Does the horizontal and vertical alignment fit well together, particualrly for visiblity of curves? Does the alignment provide regular, safe overtaking opportunities? Does the alignment avoid creating situations where the forward visibility is marginal for safe overtaking (dilemma zones)? Does the alignment help to reinforce the speed limit? Does the alignment considers the proportion of heavy vehicles ? Has adequate provision been made for climbing lanes, emergency escape ramps ?
3.6	**Junctions:** Can the number of junctions be reduced to improve safety? Are junctions so close together that there may be a "see-through" problem? Is the junction in a safe location (especially regarding visibility requirements)? Is the type of junction (priority, control, etc.) suitable for the function of the two roads, the traffic volume, the traffic movements (vehicular and pedestrian), the approach speeds and the site constraints? Is it the safest alternative – for all road users? Are the junctions all of the same type? If not, will this be confusing for drivers? Will the layout and function of the junction be understood by drivers as they approach? Does the layout conform to established Tanzanian practice? Is the route through the junction as simple, clear and logical as possible? Is there adequate provision for channelling (and protecting) where necessary the different streams of traffic? Is there proper "lane balance", and "through lane continuity"? Are there any "trap lanes" (i.e. a turning lane that is not clearly signed and so may be mistaken for a through lane)? Is the layout of the junction adequate for all permitted vehicular movements and for all types of vehicle? Does the layout encourage slow, controlled speeds at and on the approach to STOP and GIVE WAY signs / lines? Is there adequate provision for pedestrians and cyclists? Does the junction design permit adequate signing?
3.7	**Pedestrians and other special road users** Have pedestrian needs been satisfactorily considered (check whether there is evidence of a survey having been done)?

	Have the needs of cyclists and motorcyclists been considered, especially at junctions (check whether these vehicles were covered by the traffic surveys)? Have the needs of bus users been considered?
3.8	**Major traffic generators / access control** Does the route serve major generators of traffic safely? Are accesses to major traffic generators located near to hazards (e.g. junctions, sharp bends, sections with restricted visibility)? Risk of queues? Can accesses to existing properties be used safely? Are there any properties with direct access? Is there an alternative to direct access?
3.9	**Bridges** Is the outline design satisfactory from a safety viewpoint (continuation of full carriageway and shoulder width, provision for pedestrians, cyclists, etc)?
3.10	**Railway crossings** If the road crosses a railway, is an at-grade crossing acceptable given the road function, speed, traffic volume, etc? If an at-grade crossing is acceptable, is it located where visibility is adequate? Will there be adequate visibility to queue tails? Does the crossing need to be equipped with barriers and signals?
3.11	**Staged development** Will the project be carried out in stages? Will junctions be built in interim or final form? Have design compromises been made which might affect the safety of the interim stages?

10.4. DETAILED DESIGN

	Issue
4.1	**General topics:** Check for major changes since the last audit. Are there any safety implications? Check that the circumstances for the proposals still apply. Have there been any significant changes to the network or area to be served? Is the proposed function of the road still as intended? Are future improvements planned that will affect the safe use of the road?
4.2	**Detail of geometric design:** Are the design details (e.g. lane and shoulder widths, crossfall, superelevation, footway design, etc.) consistent?
4.3	**Cross-sections** Have there been changes to the cross-sections that affect safety of users especially the vulnerable? Is the design free of undesirable changes in cross-section design? Are the clearances in accordance with standards? Have overtaking / climbing lanes been designed in a safe manner (particularly the lane add and lane drop)? If there are narrowings for speed management purposes, are they safe (check whether cyclists might get squeezed)?
4.4	**Drainage** Will the new road drain adequately (particularly at sag curves)? Are the road grades and crossfall adequate for satisfactory drainage? Are flat spots avoided (check at start/end of superelevation)? Are roadside drains of a safe design (can they be traversed safely by out-of-control vehicles; are they a hazard to pedestrians)? Will pedestrian areas, cycleways, lay-bys and other paved areas drain adequately?
4.5	**Shoulders, edge treatment and roadside areas** Are the shoulders of appropriate design (width, elevation and crossfall, materials, avoidance of edge drop off)? Have the clear zone standards been met? If not, can the hazards be removed of shielded?

	Are there any “open windows” through which out-of-control vehicles could traverse? If so, can they be closed, or shielded? Has the need for a median and its width been accomodated. If there is a median, is it free of hazardous objects? If not, can they be removed, or shielded? Has adequate provision been made for bus lay-bys (pull outs), rest areas, etc.? Are any lay-bys, rest areas, etc. located and designed for appropriate speeds and standards? Are culvert ends (headwalls) located outside the clear zone, or have they been designed not to be a hazard, or has adequate protection been provided? Is the design of kerbs appropriate for the speed of traffic and the road environment?
4.6	**Alignment** Does the horizontal and vertical alignment fit well together and give sufficient forward visibility for the selected design speed? Are there any substandard (inconsistent) sections? Are substandard sections adequately signed? Are changes in speed handled safely? Does the alignment provide regular, safe overtaking opportunities? Does the alignment avoid creating situations where the forward visibility is marginal for safe overtaking and junction visibility (dilemma zones)? Does the proposed treatment at curves make appropriate and safe provision for: transition curves, superelevation and carriageway widening? Does the alignment help to reinforce the speed limit? Is the design free of sight line obstructions (fences, street furniture, safety barrier, signs, landscaping, bridge abutments, parked vehicles) particulary to see curves and intersections? Is visibility adequate at any pedestrian crossings? Is crossing lighting warranted ? Check that drivers will be able to read the road ahead. Are there any awkward surprises or visual illusions that could confuse drivers? If so, can they be avoided? If not, are they handled safely? Does the vertical alignment put excessive demands on the power of heavy vehicles? Has it been designed so that maximum grades are interspersed with recovery grades?
4.7	**Junctions:** Will the layout and function of the junction be understood by drivers as they approach? Does the layout conform to established practice? Is there proper “lane balance”, and “through lane continuity”? Are there sufficient lanes for the volume of traffic? Is the route through the junction as simple, clear and logical as possible?

	Is there adequate provision for channelling (and protecting) where necessary the different movements of traffic? Is the layout of the junction adequate for all permitted vehicular movements and for all types of vehicle? Are the lane widths adequate (check need for widening on curves)? Are the traffic islands sufficiently large to avoid being a hazard (especially at night)? Does the shape provide small entry angles and guide vehicles into the correct travel path? Are there any "trap lanes"? Can they be avoided? If not, are they signed adequately? Does the layout encourage slow, controlled speeds at and on the approach to STOP and GIVE WAY signs / lines? Are the sight lines at and on the approach to STOP and GIVE WAY lines and other critical decision points adequate and unobstructed? Are there are awkward differences in level on the approach to and within the junction? If there is likely to be queuing, will approaching vehicles be able to see the queue tails in time to stop safely? Are there any 'local' features that may affect the safe use of the junction? Is there a need to provide for U-turns? If so, is the distance to adjacent junctions adequate and does the layout permit U-turns for all vehicle types? Is there adequate provision for pedestrians (clear, convenient crossing points, refuge islands, dropped kerbs, etc.)? Is there a need to use pedestrian barrier to channel pedestrians to safe crossing points? Is the junction accomodating cyclists? Are there acceleration and deceleration lanes? If so, are they long enough for traffic to merge or diverse at appropriate speeds? Is the junction adequately and correctly signed or signalised in accordance with the traffic control standards and manuals? Does the junction need lighting? If lighting is to be provided, are the lighting columns positioned to minimize collisions? **Additional lists where junctions include:** **Traffic Signals** Can the signals be clearly seen on the approach to the junction? Do measures need to be taken to reduce speeds on approach to the junction? Is there any confusion when groups of signals are placed close together (see-through effect)? Is there a need to fit signal hoods to prevent drivers seeing signals that do not apply to them?

	Will the signals be hidden in bright sunshine? Are the signal heads fitted with backing boards? Are the signal lamps the correct size? Are there at least two signal heads (primary and secondary) controlling each traffic movement? If there are two or more lanes on the approach, is there a need to provide a second primary signal - on a traffic island? Is there likely to be any confusion over which signal controls each movement? Is there sufficient lateral clearance between signal heads and the carriageway? Do the signal colours, arrangement, signal sequence, and signal timings conform to accepted practice? Are they in accordance with the Traffic Signs Regulations and the advice in the Traffic Signs Manual? Does the signal phasing prevent any unexpected conflict situations? Is it necessary to have protected right turns? Is the "intergreen time" between conflicting phases sufficient for safe operation? Can the junction be used safely if the signals are not working or are switched to flashing amber? Is there a phase to accommodate pedestrians? Are the settings and timings adequate for safe use? Can pedestrians get confused about which signal applies to them? Is the junction properly marked in accordance with the advice in the Traffic Signs Manual? Is the stop line perpendicular to the centre line? Is the control equipment located in a safe place where it will not interfere with visibility and is unlikely to be hit by errant vehicles? Is there safe parking for the maintenance vehicle? **Roundabouts** Is the geometry simple and easily understood by drivers on the approach to the roundabout? Is the size of the roundabout sufficient for the volume and mix of traffic and the number of entries? Is the central island sufficiently conspicuous? Are there too many entries for safe, efficient operation? Are the entries and exits spaced far enough apart? Does the design deflect entering traffic sufficiently to ensure that entry speeds are no greater than 50 km/h? Is the visibility for entering traffic and circulating traffic adequate?

	Has the centre island been designed to be forgiving to errant vehicles? Has adequate provision been made for pedestrians to cross the arms of the roundabout? Have the needs of cyclists been considered? Is the signing and marking in conformity with the guidance given in the Traffic Signs Manual? Are the markings adequate? Is there a need for dedicated lanes? **Grade separated** Is the vertical alignment adequate? Can the drivers see the junction? If there are merge situations, are they arranged so that the traffic joins the mainline from the nearside, i.e. from the left? Is the merge/diverge point clearly identifiable for drivers on the mainline? Are the acceleration lanes of adequate length and design? Are the deceleration tapers of adequate length and design? Is joining traffic inter-visible with the mainline? Is the design speed for the ramps adequate? Does the design of the ramp provide adequate forward visibility? Are there sharp bends on the ramps? (consider use of chevron signs and safety barrier) Are there any accesses on the ramps? Can they be relocated? Are the off-ramps long enough to accommodate peak traffic flows without queues extending back onto the mainline? Check whether safety barrier is needed on embanked ramps and other road sections.
4.8	**Traffic Signs:** Is the level of signing appropriate for the road? Is there an over-reliance on signs (instead of better geometric design)? Do the signs (incl. road markings) conform to the Traffic Signs Regulations and the advice given in the Traffic Signs Manual? Can the signs be seen and are they of sufficient size? Do the signs convey the correct message? Are signs located in appropriate and safe places? Do signs give adequate information to drivers? Do the signs need to be protected with safety barrier? Are gantry signs needed? If gantry signs are used can they be seen at night? Do they need to be externally illuminated?

	Does the project make provision for removing unnecessary, wrong or outworn signs? Are the road markings correct? Are the criteria for the use of no overtaking centre lines specified, and, if they are, are they correct for the traffic speed on each section? Will traffic island markings need to be reinforced by rumble strips or flexible traffic cylinders? Will reflective pavement markers (road studs) be needed? Should roadside marker posts (delineators) be provided in order to improve the "readability" of the road?
4.9	**Bridges** Is the design satisfactory from a safety viewpoint (continuation of full carriageway and shoulder width, provision for pedestrians, cyclists, etc.)? Will pedestrians have a clear and safe path onto and off the bridge? Does the parapet need to function as a safety barrier? If so, will it perform satisfactorily? Has the parapet been designed for safety (height, level of containment, limit on size of openings, etc.)? Are the parapet ends properly shielded?
4.10	**Safety barrier** Are safety barriers provided where necessary? Are they long enough to prevent an out-of-control vehicle from reaching the hazard? Are the terminal arrangements (upstream and downstream ends) safe? Do safety barriers restrict visibility? Do safety barriers block pedestrian desire lines? Has steel beam guardrail been designed correctly (check beam height, post spacing, lateral clearance, spacer blocks, nuts and bolts, reflectors, terminal pieces, and whether the beams are overlapped correctly)? Check that transitions between barrier types (e.g. steel beam guardrail to concrete bridge parapet) are safe. Are there any features that could create a safety problem?
4.11	**Provision for Pedestrians** Are pedestrian accomodations provided where needed? Is there an appropriate number of accessible and appropriately controlled crossing points serving the main pedestrian movements for the speed limit and number of lanes?

	Is there a need for special provision outside schools, hospitals, shopping and other major generators of pedestrian movement? Does the network enable pedestrians to avoid major conflicts with vehicular traffic? Is there good intervisibility between pedestrians and drivers? Do the main crossing points have features / facilities to help pedestrians (e.g. "dropped kerbs", refuges, "build-outs", zebra crossings, signal-controlled crossings, etc.) Is there likely to be any confusion about who has right of way at crossing facilities? Does the signing and marking conform to the traffic control manuals Are there any obstructions (signs, lighting columns, safety barrier, etc) in the facility? If so, can they be removed or moved? Is it necessary to channel pedestrians to safe crossing points using pedestrian barrier? If pedestrian barrier is used is it of a safe design (not dangerous when hit by vehicles)?
4.12	**Access to Properties:** Can accesses to existing properties be used safely? Are there any special measures that need to be incorporated into the design to ensure safety (i.e. near schools, public areas, or commercial centres)
4.13	**Utilities:** Is there adequate clearance for overhead utility lines? Can utility apparatus be accessed safely? Can maintenance vehicles be parked safely? Are fixed object apurtenances, such as power boxes and access chambers, located in a safe place (e.g. away from traffic lanes) or shielded
4.14	**Vegetation and landscaping:** Are there any trees/vegetation/landscaping located where they may interfere with visibility and affect the safety of road users?
4.15	**Lighting:** Is lighting required and, if so, has it been adequately provided? Does the lighting adequately illuminate critical points, such as pedestrian crossings, refuges, merge and diverge areas, STOP and GIVE WAY lines, etc.)? Will the lighting project mislead drivers in any way (e.g. regarding priorities at junctions, or alignment)? If there are sites with night-time accident problems, are these covered by the lighting project?

	Are the lighting columns located where they are less likely to be hit by out-of-control vehicles (as far as the need for even illumination allows)? Are the lighting columns of a design that makes them as little a hazard as possible? Is there adequate clearance between the lighting column and the edge of the carriageway? Do lighting columns on a median need to be protected by safety barrier?
4.16	**Railway crossings:** Is the crossing located where visibility is adequate? Will there be adequate visibility to queued traffic? Is there a need for speed management measures on the approaches to the crossing? Is there a need for barriers and signals? If so, have these been correctly designed? Has the railroad given its approval? Should the railway crossing signals be inter-connected with traffic signals ?
4.17	**Maintenance:** Can access to structures be carried out safely? Can maintenance vehicles stop in a safe place? Is ther appropriate access for mowing, culvert, signing and ancilllary structure maintenance ?
4.18	**Publicity and training:** If the project will bring big changes to the traffic environment (e.g. more traffic, faster traffic) is it necessary to undertake a road safety awareness campaign amongst roadside communities? Are new designs or more complex traffic movements incorporated that necessitates local educaitons, particularly for young and aging drivers.

10.5. CONSTRUCTION ROADWORKS

	Issue
5.1	**Providing safely for everyone:** Do the roadworks proposals cater safely for the passage of all types of traffic and road users? Check that pedestrians and cyclists will be safe when crossing the site? Can local people access their properties on foot and by vehicle?
5.2	**Signing** Does the signing provide sufficient advance warning of the roadworks? Is all the signing in accordance with the provisions of the Traffic Signs Manual?
5.3	**Safe traffic movement through the site:** Do the arrangements for the passage of traffic encourage smooth flow of traffic at safe speeds? Will speed humps, speed limit signs, or other speed control measures be required? Does the signing and channelisation provide clear guidance to drivers on which way they should go? Are traffic lanes of sufficient width, taking account of vehicle mix, likelihood of wide vehicles, etc.? Are the barricades, markers and other channelisation devices adequate (check size, robustness, colour, visibility, spacing, etc.)?
5.4	**Diversion roads** Are any diversion roads designed to safe standards (check width, alignment, drainage, edge markers, side slopes, junctions, signing, surfacing, etc.)? Will there be a need for speed humps, speed limit signs, no overtaking signs, or other speed control measures?
5.5	**Work areas** Are all work areas, excavations, stockpiles of materials, etc., adequately fenced off and protected from moving traffic? Has sufficient space been left for workers and plant to operate without coming into conflict with moving traffic?
5.6	**One-way working** Is one-way working acceptable, given the road's traffic function, traffic volume and speed? Is the advance signing adequate (check visibility to queue tails)? Will the traffic queues obstruct junctions and accesses, or cause other problems? How will traffic be controlled ? (traffic signals or STOP/GO boards are much safer than flagmen)

	If one-way working will operate at night, what will be the traffic control arrangements? - is there likely to be abuse by impatient drivers? Will the STOP/GO signs or traffic signals be clearly visible to approaching traffic? Is the shuttle lane excessively long? Will the traffic control lead to unacceptably long delays to traffic?
5.7	**Access for works traffic** Are the accesses for works vehicles safe (check location, signing, need for control, etc.)?
5.8	**Safety at night** Will the site operate safely at night? Will lighting be needed?

10.6. PRE-OPENING

	Issue
6.1	**General topics:** Have any changes been made during construction that may lead to safety problems? Has the design been correctly translated into physical form? Check that no roadside hazards have been installed or overlooked. Is safety adequate for: pedestrians of all ages, bicyclists, truck and bus movements, motorcycles, cars?
6.2	**Drainage:** Is the drainage of the road and its surroundings adequate? Will the discharge from the drains cause problems (e.g. washaways of rail track or roads)?
6.3	**Environmental:** Is planting located to avoid obstruction to visibility and sight lines? Will planting cause problems when mature (i.e. size of trunk or canopy spread)? Does planting obscure pedestrian movements near the edge of the road? Check that no natural feature creates a danger by its presence or loss of visibility.
6.4	**Roadside:** Are there any obstructions or other hazards remaining in the clear zone? Are there any “open windows” through which out-of-control vehicles could fall? Have the appropriate types of kerbs (if any) been used?
6.5	**Safety barriers:** Are safety barriers provided everywhere they are needed? Are they long enough to prevent an out-of-control vehicle from reaching the hazard? Are the terminal arrangements (upstream and downstream ends) safe? Do safety barriers restrict visibility? Do safety barriers block pedestrian desire lines? Has steel beam guardrail been designed and installed correctly (check beam height, post spacing, lateral clearance, spacer blocks, nuts and bolts, reflectors, terminal pieces, and whether the beams have been overlapped correctly)? Check that transitions between barrier types (e.g. steel beam guardrail to concrete bridge parapet) are safe. Are there any features that could create a safety problem?

6.6	**Access to property and developments:** Are all accesses safe for their intended use? Are all accesses adequate, in terms of design, location and visibility?
6.7	**Services:** Are access chambers, lines, boxes, lighting columns etc. located in a safe place? (i.e. clear of traffic lanes and behind any safety barrier). Is there a safe place for maintenance vehicles to stop?
6.8	**Alignment:** Check that the route has no safety problems in each direction. Are there any problems at night that are not apparent during the day? Is there adequate visibility/stopping sight distance? Check that the form of road and its traffic management are easily recognised under likely traffic conditions. Check the need for more signs and markings. Check that the edge delineation of the edge of the carriageway is clear. Are drivers misled by any visual illusion? Could the alignment of the old road mislead drivers? Is the transition from the old, unimproved road to the new road satisfactory (good delineation, no awkward manoeuvres)?
6.9	**Junctions:** Is the junction clearly visible to approaching drivers? Is the form and function of the junction clear to drivers on all approaches? Are the STOP and GIVE WAY lines visible at a safe stopping distance? Are there any problems at night that are not apparent during the day? **Additional items to consider for specific types of junction:** **Traffic signals:** Can the signals be seen clearly on all approaches? Is the alignment of the signal heads correct? Are the signal lamps bright enough? or too bright (glare)? Can the signals be seen by only those who need to see them? Is the sequence of operation correctly set? (include pedestrian phases if appropriate). Are lane markings for dedicated turns adequate?

	Are all pedestrian signals functioning correctly and safely? **Roundabouts:** Check that the roundabout is fully visible and recognisable from all approaches. Check that all signs and markings are correctly placed.
6.10	**Traffic signs:** Are the correct signs used and are they correctly placed? Check the visibility, legend and legibility in both daylight and in darkness. Are there spelling or design errors? Do they give the correct message to drivers? Are they readable? Are they located in a safe place? Are they interfering with visibility at junctions? Are clearance standards met? Do the signs obstruct footways? Are safety barriers needed to protect posts from vehicle impact? Are any more signs required? Are all the road markings placed correctly and fully visible? Are reflective pavement markers correct and visible? Check that all redundant signs (including markings) from the old alignment and temporary signs used during construction have been removed.
6.11	**Surface treatment** Does the surface appear to have adequate skid-resistance? Are there any areas where there is excessive bleeding of bitumen?
6.12	**Pedestrian/Non Motorised Users:** Is there an adequate network of footways and safe crossing points? Are there any obstructions that may affect safe passage of pedestrians? Are there “dropped kerbs” at crossing points? Are there any gaps in the network of footways? Is there sufficient pedestrian guardrailing? Has it been installed correctly? Does it obstruct visibility? Are there any places where cyclists may be particularly at risk?

10.7. POST-OPENING AND EXISTING ROADS (RSI)

	Issue
7.1	**General topics:** Review previous road safety audit (if carried out). Are there any issues still causing concern? Do the Police have any concerns over accidents that may have occurred since opening (is there a predominant accident type that could indicate a particular problem)? Is there any confusion between the road and the adjacent network? If a service road is present does the service road operate safely? Is there any problem with headlight glare? Has there been any change of use of existing developments on or near the road that has affected traffic safety? Is the surface of the road free from defects that may result in safety problems (i.e. loss of control or skidding)?
7.2	**Cross-section:** Are the lanes, shoulders, medians etc., of adequate width? Is there a pavement edge drop (i.e. shoulder is lower than carriageway)? Does the cross-section change with different speed limits?
7.3	**Drainage:** Is the drainage of the road and its surroundings adequate? Have the side drains been designed to a safe standard for vehicles and pedestrians? Are culverts and headwalls outside the clear zone, or are they protected by safety barriers?
7.4	**Roadside:** Are the shoulders of an appropriate design (width, profile, surfacing, etc)? Are there any obstructions or other hazards in the clear zone? - if so, can they be removed? - if they cannot be removed do they need to be protected by safety barrier? Are the kerbs (if any) of the appropriate type for the speed environment?
7.5	**Safety barriers:** Are safety barriers provided where necessary? Are they long enough to prevent an out-of-control vehicle from reaching the hazard? Are the terminal arrangements (upstream and downstream ends) safe?

	Do safety barriers restrict visibility? Do safety barriers block pedestrian desire lines? Has steel beam guardrail been designed and installed correctly (check beam height, post spacing, lateral clearance, spacer blocks, nuts and bolts, reflectors, terminal pieces, and whether the beams have been overlapped correctly)? Check that transitions between barrier types (e.g. steel beam guardrail to concrete bridge parapet) are safe. Are there any features that could create a safety problem?
7.6	**Alignment:** Is sight distance adequate for the speed of traffic using the route? Is the horizontal and vertical alignment suitable for the 85th percentile speed of traffic? If not:- • Are there sufficient warning signs? • Have speed limits been imposed? - are they correctly signed? • Are there any sections of road that may cause concerns? Consider: • Is the alignment clearly defined? • Have all old road markings been removed? Are there sufficient clear overtaking sections? Are there sections with marginal visibility for overtaking (dilemma zones)? Are there sections where the alignment is dangerous (e.g. sharp curves after long straight sections, sharp curves after crests, long downgrades)? Is the design of curves adequate (check superelevation, transitions, carriageway widening)? Are there long / steep hills where climbing lanes would help prevent unsafe overtaking?
7.7	**Speed management** Does the geometric design (cross-section, alignment, etc.) reinforce the speed limit? Is the traffic exceeding the speed limit? Is there a need for speed management measures? Are speed humps and other speed control devices of a safe design and are they adequately signed?
7.8	**Junctions:** Are junctions located in safe places? (Check in relation to horizontal and vertical alignments) Is the layout of junctions obvious on each approach? Does the layout accommodate all types of vehicles? Is the visibility from the side road adequate?

	Is the method of control appropriate? (Priority/signalled) Are dedicated turning lanes adequate (i.e. lengths and widths) to accommodate volume and mix of traffic? Is the signing on the approach to an junction adequate? Is the visibility of signing adequate ? Is there adequate provision for pedestrians and cyclists? If the junction is a roundabout is it designed to control speeds to 50km/h? **Where there are signals:** Do they operate correctly? Are they clearly visible from all approaches (in all conditions) ? Can signals only be seen by those who should see them? Are control cabinets located in a safe place?
7.9	**Pedestrian and cyclists** Are there adequate, safe facilities for pedestrian movement? Are pedestrian facilities used as intended? Are there any places where cyclists are particularly at risk?
7.10	**Bus and parking facilities** Are there sufficient roadside bus stop and parking facilities? Are stopping areas located and designed to safe standards? Are bus stops and parking facilities used in a safe manner?
7.11	**Access to properties** Is there any roadside activity that may cause road safety problems? Is the number of roadside accesses compatible with the function of the road and the volume and speed of traffic? Are all accesses adequate in terms of design, location and visibility?
7.12	**Bridges** Is the cross-section of the approach road maintained across the bridge? Are there many pedestrians and cyclists crossing the bridge? Can they cross safely? Is the bridge parapet safe (height, design, level of containment, limit on size of openings, etc.)? Are the ends of the bridge parapet adequately protected?
7.13	**Traffic signs**

	Are all the necessary signs in place? Are they readable? (consider in all conditions). Are they located in a safe place? Do they give the correct message? Is there any confusion in the message they give? Do posts need protection? Is edge delineation adequate? Are road markings correct and in good condition? Are reflective pavement markers (road studs) correct and in good condition?
7.14	**Environmental:** Does vegetation obstruct: • Traffic signs; • Visibility at junctions; • Stopping sight distances on the mainline; • Footways / crossing points?

11. APPENDIX 2: EXAMPLE AUDIT REPORT FORMAT

11.1. PROJECT DETAILS

Provide:

Report Title and date

Unique File ref and revision issue

Prepared by : name and title

On behalf of: name of road authority and 3rd party if applicable

11.2. INTRODUCTION

Provide:

1) a description of the proposed highway project including details of its location and its objectives. Make reference to any strategic decisions and confirm that any recommendations to make significant changes in relation to these elements are unlikely to be acceptable.

2) details of who supplied the RSA brief, who approved the RSA brief and who approved the RSA team.

3) identification of the RSA team membership as well as the names of other contributors such as the police, maintaining agent and specialist advisors.

4) details of who attended the site visit, the date, time periods when the audit was undertaken and the weather/traffic conditions on the day of the visit. Include the state of completion of the works at the pre-opening RSA.

5) the terms of reference of the RSA confirmation and that the RSA team has examined and reported only on the road safety implications of the project as presented and has not examined or verified the compliance of the designs to any other criteria.

11.3. ITEMS RAISED IN PREVIOUS RSAS

Report any of the RSA actions in the RSA decisions for the previous stage that have been agreed for action but not completed.

Where the RSA action is not completed, or an RSA response is not provided, outstanding problems and recommendations will be repeated here.

Where the circumstances have changed it may be necessary to revise the earlier problem and recommendation and this will be included only in section 4.

11.4. ITEMS RAISED IN THIS AUDIT

Complete the information below.

For each individual road safety issue identified from the supplied information and site visit Number each problem uniquely 1,2,3, etc or 1.1, 1.2 etc.

PROBLEM

Location: Insert the location of the problem and reference to a project drawing.

Summary: Provide a short summary of the problem. Describe the nature of the problem supported by background reasoning and include the type of collisions and/or road user injuries likely to occur.

Include a photograph of the location or an extract from the supplied drawings if possible to provide additional reference.

RECOMMENDATION Provide a proportionate and viable recommendation, based on the RSA stage, to eliminate or mitigate the identified RSA problem.

11.5. Audit Team Statement

Include the following statement to be signed by the RSA team leader and RSA team member(s):

We certify that this road safety audit has been carried out in accordance with *(name and issue of relevant audit standard used)*

ROAD SAFETY AUDIT TEAM LEADER

Name:

Signed:

Position:

Organisation:

Date:

ROAD SAFETY AUDIT TEAM MEMBER(S)

Name:

Signed:

Position:

Organisation:

Date:

List other names and details of other contributors such as the police, maintaining agent and specialist advisors

11.6. Details of Drawings and Documents Provided

Provide a list of all documents and drawings (with issue date and unique ref) used in the audit to determine whether road safety problems exist with the project.

11.7. Problem Location Plan

In additon to providing location information in Section 4 Item Raised, you have the option to insert as an appendix to the RSA report marked up plan sheets showing the locations of each problem as identified in Section 4.

World Road Association (PIARC)

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